A History of the United States Atomic Energy Commission

Volume II
1947/1952

Atomic Shield

Richard G. Hewlett / Francis Duncan

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FOREWORD BY THE CHAIRMAN, HISTORICAL ADVISORY COMMITTEE

We, the members of the Historical Advisory Committee of the United States Atomic Energy Commission, have read this volume with pleasure and profit. We have not examined in detail the massive documentation on which the authors' narrative and judgments are based, and we do not as individuals or as a body attempt to add any authority to the ideas herein expressed. But we have followed the book in its making. Most of us met with the authors in six conferences during which we discussed at length the moot points concerning substantive information and interpretation. We are convinced that the authors have written as responsible and informed historians—that they have enjoyed access to virtually all of the pertinent materials and have said what they have wished to say without guidance or restraint from the Commission, save in matters which touched on national security. In a few instances beyond the jurisdiction of the Commission, the authors have not had access to all relevant materials. Where denial of access stems from considerations other than those of a present security danger we as historians regret the policy of withholding information, but we feel that the instances have not been numerous enough to affect severely an otherwise excellent study. Incomplete access to all of the relevant materials is one of the costs of writing history soon after the events, but there would be a much heavier cost in loss of information should the authors have left the task to a later generation. We heartily endorse their decision to go on with the job now and applaud the success with which they have followed that course.

George E. Mowry, Chairman

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PREFACE

Atomic Shield, the second volume in a historical series, begins in January, 1947, when the Commission assumed responsibility for the nation's atomic energy program; it ends with the detonation of the first thermonuclear device and the Presidential election in November, 1952. Thus it covers in a political sense most of the Truman Administration and in the international realm the chaotic years of the Marshall Plan, the Berlin blockade, and the Korean War.

In 1947 the nation's atomic energy establishment amounted to little more than the remnants of the military organization and facilities which had produced the world's first atomic weapons. By the end of 1952 the Commission's domain included an arsenal of nuclear weapons, a refurbished and greatly enlarged complex of research and production facilities, and a dozen experimental or research reactors. Even more significant, the Commission's activities were no longer completely isolated from the rest of American life, as had been the work of the Manhattan project during World War II. By 1952 hundreds of nuclear scientists were receiving financial support from the Commission for research in their own laboratories, and private industry was beginning to take an active part in developing nuclear power. The Commission itself was no longer unique among Government agencies in terms of its independence and special status; it was becoming an integral part of the Executive Branch.

Our task—to explain how this transformation occurred—proved more difficult than the one faced in Volume I. In place of a concentrated effort focused on a single goal, we were confronted by a variety of complex forces, by a rapidly expanding and evolving program which was documented by a mass of records several times that available for Volume I. Although we felt a temptation to adopt a topical and analytical approach, which several of our advisers urged upon us, we rejected this form of organization in favor of the narrative, chronological style of Volume I. A string of loosely joined essays would have been easier to write, but we thought it our duty as historians to attempt a more fundamental synthesis. We are content to stand on the position set forth in the Preface to Volume I: "Whatever the subject, whatever the essential significance of the event, whether and how we relate that event depends on its relevance to the central perspective. We think this criterion makes for good history. Indeed, the complex interrelationships of modern science, industry, and government make it impossible to take any other approach if history is to be kept within reasonable bounds."

The central perspective of Volume II was clearly to be that of the five Commissioners, but it was more difficult to define the unifying theme of a book encompassing a spectrum of subjects from radiation genetics to cost accounting and from community management to foreign policy. No one theme could bridge all these topics, but we soon detected in the documents a strong undercurrent of development around which most of our material could be organized. This central idea was the inexorable shift in the Commission's aims from the idealistic, hopeful anticipation of the peaceful atom to the grim realization that for reasons of national security atomic energy would have to continue to bear the image of war. Hence our title, *Atomic Shield,* a phrase used by scientists, military leaders, and the Commissioners themselves to justify, or perhaps to rationalize, the nation's expanding nuclear arsenal.

In selecting the title *Atomic Shield,* we do not mean to suggest a definitive interpretation of the post-World War II period of American history. Not enough time has passed for that. But we do believe our title reflects a common perspective shared by American leaders during those years and that it will help the reader to perceive the broad currents of historical change running through our narrative.

In organizing our chapters we tried to weave as many topics as possible into a single strand of narrative. The first three chapters are essentially one chronological account covering all aspects of the Commission's activities during the first half of 1947. Chapter 4 continues that thread through 1947 for all topics except weapon development and the production of fissionable materials, which are the theme of Chapters 5 and 6. The wide range of research and development supported by the Commission is similarly handled in chronological arrangement in Chapters 7 and 8. Chapters 9 and 10 stand by themselves as a history of international developments in atomic energy down to early 1950. Efforts at international control in the following three years were so unproductive that we chose to leave that subject for summary in a later volume. Chapter 11, describing the Commission's administrative activities down to the middle of 1949, completes our presentation of the Commission's first thirty months in power.

We early detected a clean break in most of the threads of historical development in the summer of 1949. The Hickenlooper hearings and the first Soviet nuclear detonation mark the beginning of the end of the Lilienthal era, during which military requirements progressively overshadowed the nation's initial hopes for the peaceful development of atomic energy. Chapters 12 and 13 cover the transition period from September, 1949, to June, 1950, beginning with the debate over development of a thermonuclear weapon, following events accompanying Lilienthal's resignation, and ending with the outbreak of the Korean War. Chapter 14 describes the new Commission under Gordon Dean's chairmanship and administrative developments in the later period, as did Chapter 11 for the earlier years. Chapter 15 likewise continues the story of research and development from the ends of Chapters 7 and 8. Reflecting the Commission's ever-increasing stress upon weapon development and the expansion of production facilities after 1950, Chapters 16 through 18 follow that theme in one chronological narrative to the end of 1952.

For our research we were granted complete access to all records in the files of the Commission and its contractors. Never was our access questioned, and in several instances the Commission's staff took the special action necessary to open for us records which had been sealed since the time of their creation. Most other Government organizations were equally cooperative. Neither at any time did the Commission require us to revise, delete, or change the interpretation of our manuscript, except for classified information which would adversely affect the national security.

This exception, however, is an important one and deserves special comment. The restrictions of classification have unavoidably blemished our work on some topics, mainly on those related to the production of fissionable materials and the design and production of nuclear weapons. Throughout the book our descriptions of the debates over weapon requirements lack the specific numbers needed for a full evaluation of these decisions. We ourselves have seen all the evidence and we have done our best to make our narrative as clear and accurate as possible within the limits of classification. We believe that even with these deletions our narrative accurately portrays the context of decisions; all the important factors in decisions have been explained or at least hinted at.

The most troubling deletions come in sections describing weapon development. Here again we think our narrative is not misleading, but the deletions and glossing over of details blunts the truth and fails to present the best case for the individuals involved. The best example of this problem is our description of the development of the thermonuclear weapon. Classification did not permit us to convey accurately the fundamental differences between the "Super" and the "New Super" (the latter a term we were obliged to coin to conceal the true name, which is still classified). Nor have we been able to tell all of the fascinating story of how new ideas evolved at Los Alamos in early 1951 to create the "New Super." We have studied at great length the contributions of Stanislaw Ulam and Edward Teller to this achievement, but we know that the unclassified version in Chapter 16 does not contain the evidence to support our conclusions. In this respect we have not given proper credit to either man. This is the price the historian of recent events must pay, but we believe that our own truncated version is better than nothing at all. It may still be decades before all the important facts become public knowledge; in the meantime the American people are entitled to all the information that can be released on these vital decisions.

After six years of research and writing it is almost impossible for us to acknowledge the assistance and encouragement of all those who have eased our task, but we wish to thank individually those whose efforts clearly have gone beyond their official or professional duties. First we express our gratitude to the members of the historical advisory committee, whose names appear in the foreword. Serving without compensation, they have patiently endured arduous trips, long meetings, and many hours of reading and criticizing the manuscript. For any remaining errors we alone are responsible, but for some of the better qualities of the book they deserve credit. We wish especially to express our appreciation to James P. Baxter, 3rd, president emeritus of Williams College and for a decade chairman of the advisory committee. As much as any other man, he was the first sponsor of this historical series. George E. Mowry, our present chairman, has admirably carried on the task of explaining the needs and purposes of the historian to Government officials.

During these six years the members of the Atomic Energy Commission not only took an interest in our work but also stood firm on the principle that the historian should have complete freedom to draw his own conclusions. We are grateful to Mary I. Bunting, Leland J. Haworth, Wilfrid E. Johnson, John G. Palfrey, James T. Ramey, and Gerald F. Tape, who as Commissioners during these years gave us the support we needed. We are especially indebted to Glenn T. Seaborg, who served as chairman of the Commission during the entire period of preparation of this book. His sense of history and his commitment to the value of historical research provided the kind of stimulus that few Government historians have experienced. We must also acknowledge our continuing debt to Woodford B. McCool, Secretary to the Commission, who established this project within his staff in 1957. Under his wing we have been able to do our work with exceptional freedom, not only from administrative restraints but also from pressing current assignments which he might have asked us to undertake.

We express our personal thanks to the members of our own staff who performed many of the tedious but important tasks of historical research. Among our research assistants, Ellen A. Thro, Millicent H. Brandenburg, and Joanna S. Zangrando assisted us on the early chapters. Alice L. Buck and John V. Flynn bore the brunt of our demands for the second half of the volume. Betty J. Wise typed the entire manuscript in more than a few drafts and checked editorial style and references. Without the skill, loyalty, and teamwork of these people our task would have been overwhelming.

Surely no historians have received greater cooperation from their associates than have we from the Commission's headquarters staff. From Robert E. Hollingsworth, the general manager, to messengers in the mail room, literally scores of Commission employees have followed with interest the progress of our work and, to meet our special needs, have done more than we could expect. At the risk of offending those we cannot mention, we express our thanks to those who took many hours from their other work to hunt for documents and references in the Commission's files: Carol Alexander, Velma E. Early, Opal L. Kirschman, Lester C. Koogle, Jr., Ulysses Marshall, James D. Nuse, Andrew J. O'Neill, Mary G. Thomas, Lillie B. Turner, Severina M. Tuttle, and Margaret N. Young. Charles F. Knesel, Robert L. Morgan, and Murray L. Nash helped us with classification problems. Helen Anderson prepared some of the line drawings. Morris Coles and Joseph G. Gratton handled publication arrangements. Elton P. Lord and James E. Westcott assisted with photographs.

In writing the history of an agency as decentralized as the Atomic Energy Commission, we found research in the field essential. There we could rely on the expert knowledge and cooperation of both Commission and contractor personnel: at Albuquerque Operations and the Los Alamos Office, Marjorie Allen, Richard G. Elliott, Lillie J. McConnell, and Lola W. Sissel; at Argonne National Laboratory, John H. Martens and E. Newman Pettitt; at Brookhaven National Laboratory, Marriette K. Kuper; at Idaho Operations, Mack C. Corbett and William L. Ginkel; at the Lawrence Radiation Laboratory, Eleanor Davisson, Harold A. Fidler, and Daniel M. Wilkes; at Los Alamos Scientific Laboratory, David A. Heimbach, Robert D. Krohn, Pat M. McAndrew, Gilbert R. Ortiz, and William H. Regan; at Oak Ridge Operations, Floyd F. Beets, Jr., James R. Langley, and Herman M. Roth; at Oak Ridge National Laboratory, Nathaniel T. Bray and Florence H. Evans; at Richland Operations, Ralph V. Button and Milton R. Cydell; and at Savannah River Operations, George O. Robinson, Jr.

Employees of other Government agencies were indispensable in finding records for us. We are especially grateful to Thomas E. Hohmann and Wilbur J. Nigh of the National Archives, William M. Franklin and Arthur G. Kogan of the Department of State, Rudolph A. Winnacker of the Department of Defense, Philip C. Brooks of the Harry S. Truman Library, and Ward A. Minge of the Air Force Special Weapons Center.

Hundreds of individuals offered us their personal recollections or private papers. For the use of private papers we wish to thank David E. Lilienthal, John H. Manley, Michael V. Forrestal, and Lewis L. Strauss. The many people who subjected themselves to our questions in interviews are listed in the note on the Sources.

The writing of contemporary history, especially of a large institution such as the Commission, presents unusual difficulties for the historian, but it also offers priceless advantages. The opportunities to talk with people who participated in historical events, to consult files documenting events to a degree beyond the imagination of previous generations of historians, and to visit the scenes of great accomplishments in the history of science and technology are rewards few historians have enjoyed. Forging the Atomic Shield was a great adventure. We hope our recording of it has captured some of that quality.

Richard G. Hewlett

Francis Duncan

Germantown, Maryland
May, 1969

THE TERRIBLE RESPONSIBILITY

CHAPTER 1

On the last Monday in January, 1947, a noisy crowd of reporters and spectators jammed Hearing Room 312 in the Senate Office Building in Washington. A dozen senators and representatives gathered on the horseshoe-shaped dais at one end of the room. Within the horseshoe stood a tall, balding man in his late forties. He chatted with six or eight of his associates, most of whom looked much younger than he. Exchanging a few pleasantries with the reporters, he tried to ignore the popping flashbulbs which seemed to be concentrated on him and on an elderly senator sitting quietly at the long desk on the left side of the dais.[1]

The chairman, standing under the large gilt mirror behind the center of the desk, banged his gavel for order. As quiet fell, Senator Bourke B. Hickenlooper of Iowa announced that the Senate section of the newly formed Joint Committee on Atomic Energy was meeting to consider President Truman's nominations to the Atomic Energy Commission.[2] The senator sensed something special about the occasion. He spoke of "a pioneering field," of "a new venture." He said the hearings would go on for several days.

The elderly senator to his right roused himself and asked about the schedule for the hearings. Kenneth D. McKellar of Tennessee, a senator since 1917 and until recently president *pro tempore*, glowered across the desk. He hoped, he said, it would be possible for him to attend both these hearings and those being held before the Senate Public Works Committee on the nomination of Gordon R. Clapp to be chairman of the Tennessee Valley Authority. Everyone in the room probably knew why. His interest here was David E. Lilienthal, who had resigned as chairman of TVA to accept a similar position with the new Atomic Energy Commission. A decade earlier Lilienthal had checked McKellar's attempt to exercise his patronage powers within TVA. With a mind warped by age and a smoldering hatred, McKellar was determined to prove a charge which the Dies committee had rejected a decade earlier: that Lilienthal and Clapp were the nucleus of a large Communist cell in TVA.[3]

Hickenlooper showed proper deference toward his senior colleague. He recognized the senator's right to question the nominee even though the senator was not a member of the committee. He would do his best to accommodate the senator, but he made no promises. For Hickenlooper, this was a moment of personal triumph. Elected to the Senate in 1944, he had won himself a seat on the Special Committee on Atomic Energy in 1945 and had had a prominent role in drafting the Atomic Energy Act of 1946.[4] Now, with Republicans in control of Congress for the first time since 1933, Hickenlooper found himself chairman of one of the most important committees of Congress. He could not afford to bow too deeply to the wishes of the aging Democrat from Tennessee.

Lilienthal leaned forward to catch Hickenlooper's questions. There
2 were the usual biographical data: born in Illinois, educated in Indiana public schools and DePauw University, graduated from Harvard Law School in 1923, practiced law with Donald R. Richberg in Chicago, served as a member of the Public Service Commission of Wisconsin, and appointed to TVA in 1933. His study of the international control of atomic energy in early 1946 had won acclaim as the Acheson-Lilienthal report and had paved the way for his nomination to the Commission.[5] He said he had no scientific or technical background worth mentioning, but he had learned something about technical enterprise at TVA.

Following Hickenlooper's easy pace, Lilienthal helped to move the dialogue into a philosophic vein. He said he believed the Commission's primary responsibility at the moment was to make atomic energy a weapon of war, but the most important fact in his mind was that it could be used either for peaceful purposes or for destruction. The new commission would have in its control a new source of energy with a potential unparalleled in human history. At the risk of sounding a little stuffy, Lilienthal called his "really a terrible responsibility; not only because of the great scope of powers vested, but because errors of judgment, serious errors of judgment, can mean missed opportunity for the people of this country—and even worse." [6]

These dramatic statements led Lilienthal to his main point. Neither the Commission nor the Congress could risk treating atomic energy as just another routine matter. The Commission was bringing to bear on the subject the best minds it could find to serve on both its staff and the several advisory committees it was organizing. Lilienthal did not hesitate to suggest that the Joint Committee take its responsibilities just as seriously.

Lilienthal's technique was obvious but he was using it well. He was flattering the senators and at the same time carefully holding the initiative, a tactic he had found effective in his long experience with Congressional committees. Even when McKellar interrupted with a few questions which attempted to disparage his knowledge of atomic energy, Lilienthal fended them off like a veteran. Only when Arthur H. Vandenberg joined the discussion did Lilienthal straighten again in his chair. Vandenberg, the new president *pro tempore* and chairman of the Foreign Relations Committee, was not to be dealt with lightly. Just a year earlier, he and Eugene D. Millikin had stepped into the sagging Senate hearings on atomic energy legislation, recast major sections of the bill to their own satisfactions, and then carried the bill through the Senate-House conference.

Now Vandenberg and Millikin seized on the pivot of the legislative debate: the role of the military in the Commission's affairs. Vandenberg asked how often the Commission had consulted with General Leslie R. Groves, who had directed the Army's Manhattan Engineer District until the Commission had taken over on January 1, 1947. Lilienthal admitted that he had not met with Groves since the day of the transfer; but he mentioned frequent discussions with the Military Liaison Committee, which Vandenberg had created by his famous amendment to the atomic energy bill. Millikin probed further. Were members of the committee attending all Commission meetings? Lilienthal was astounded. The idea had never occurred to him and he did not think it practical. The senators disagreed and Vandenberg made the point: ". . . in my opinion it will not be satisfactory if there is anywhere a single closed door to the military liaison or congressional committee. The responsibility is too great."[7]

Vandenberg's declaration punctured Lilienthal's optimism. When the day's session ended, he wondered whether the nominees might be forced eventually to withdraw their names.[8] But, as usual, reflection softened Vandenberg's position. Returning to the subject the next day, he explained that he did not really expect the military group and the Joint Committee to be in "constant attendance," but he believed they should be represented when they thought it necessary. Lilienthal for his part reiterated his conviction that both committees should have all the information they thought necessary. He had been concerned only about the administrative difficulties of meeting the senator's demand of the previous day.

Lilienthal's adroit explanation reassured Vandenberg, who confessed that he had oversimplified the issue. He even went so far as to express the hope that members of the Joint Committee "would never know any of the atomic secrets."[9] Brien McMahon, the enterprising young Democrat who had made his reputation in the Senate as the sponsor of the Atomic Energy Act of 1946, accepted Lilienthal's position, but he was not ready to forego his right to any information he thought he needed as a member of the committee. The discussion drifted off to other topics, but Lilienthal brought it back sharply to the question of security. He stressed the importance of security, and the difficulty of maintaining it in the relaxing atmosphere of peacetime. The Commission's task had been complicated, he said, "by some serious authorized breaches of security."

McMahon did not miss the allusion. Was not Lilienthal referring to the Smyth report, which the Army had released in 1945 shortly after the attack on Hiroshima? Lilienthal admitted the fact. Who authorized release of the Smyth report? Lilienthal suggested General Groves and "the President, I have no doubt." The barb was directed straight at Groves and the military. Lilienthal was tired of the committee's insinuations that the "secrets of the bomb" were safer with the Army than with a civilian commission. Perhaps in his annoyance he overlooked the fact that the report had been carefully written to release only that information which could not reasonably be held from the public.[10]

The front-page stories the following morning elated Lilienthal. The Commission was beginning to build its public image, something it needed in the national political arena. Unless the public understood the Commission's position and its aims, its accomplishments would be judged against public statements by others, perhaps even by Senator McKellar. Lilienthal regretted that in his testimony he had stepped on some toes. Groves, President James B. Conant of Harvard, under whose direction Smyth had written the report, and many of the scientists were unhappy with Lilienthal's statement. This he had anticipated, but the severity of Conant's displeasure surprised him. A few days later Conant explained his feelings. He told Lilienthal he thought McMahon's question had been a trap laid by such dissenting scientists as Leo Szilard to discredit the wartime leadership of the atomic energy project. Lilienthal was amazed to discover such a deep-seated feud at this level in the organization.[11]

For a few days the spotlight turned away from Lilienthal as the Joint Committee questioned the other nominees. The first was Robert F. Bacher, a 41-year-old nuclear physicist from Cornell University. After performing some early experiments on neutron reactions in 1941, Bacher had joined the radar project at the Massachusetts Institute of Technology. When Robert Oppenheimer established the new weapon laboratory in 1943, Bacher went to Los Alamos as a division director. After the war he had served as a technical adviser to Bernard M. Baruch at the United Nations Atomic Energy Commission and as chairman of the planning committee for the new Brookhaven National Laboratory, which the Commission would build at Upton, Long Island. In the midst of organizing a nuclear physics laboratory at Cornell, Bacher was not eager to accept appointment to the new commission. He did so only out of the conviction that if he did not, there would be no scientist appointed. He reassured the Joint Committee that he appreciated the need for close liaison with the military services and that he was not among the scientists who had protested the adoption of the Vandenberg amendment in 1946.

Lewis L. Strauss, ten years older than Bacher, was experienced in Congressional hearings. Starting his career in his father's shoe business in Virginia, he had had great aspirations. During World War I he offered his services to Herbert C. Hoover in the food relief program, became Hoover's private secretary, and attended the European peace conferences. Joining the investment firm of Kuhn Loeb in 1919, young Strauss quickly found success on Wall Street. In the late thirties he developed a philanthropic interest in scientific research, particularly in nuclear physics which he hoped would provide a cure for cancer, the disease that had afflicted both his parents. A member of the Naval Reserve since 1925, Strauss began active duty in 1941 in the inspection service. Concentrating on procurement, he became special assistant to Secretary of the Navy James V. Forrestal and left active duty in 1946 as a rear admiral. His nomination to the Commission brought him back to Washington just as he was resuming his financial career. As a Republican, a financier, and an admiral, Strauss had no trouble convincing the Joint Committee of the soundness of his views on the military significance of atomic energy and the importance of cooperation between the civilian and military authorities.[12]

In some ways Sumner T. Pike's background was similar to Strauss's.
He too had been a small-town boy who had found success in New York. Although Pike had had the advantages of a college education at Bowdoin, he had largely on his own resources made his way from a small fishing village on the Maine coast to a Wall Street investment firm in 1928. Retiring with a comfortable fortune in 1939, he had come to Washington as a business adviser to the Secretary of Commerce and had served as a member of the Securities and Exchange Commission and the Office of Price Administration during the war. In 1946 he had once again retired briefly to Lubec, Maine, where he lived in a large white frame house filled with shelves of well-read books on a variety of subjects. Pike's business career had given him some practical knowledge of mining and the petroleum industry and some understanding of geology; but he confessed to the Joint Committee that he had no technical or scientific training that would be of much help in the work of the Commission. After three months on the job, Pike said he had less confidence in his understanding of the Commission's function than he had had when he accepted the appointment.

William W. Waymack at fifty-eight was the oldest member of the Commission. Like Pike, he was a son of rural, Republican America. Born and educated in Iowa, he had been editor-in-chief of the Des Moines *Register* and *Tribune* and deputy chairman of the board of the Federal Reserve Bank of Chicago at the time of his appointment to the Commission. His interests in international relations and in agriculture involved him in the activities of many organizations, including the Carnegie Endowment for International Peace. Waymack's membership on that organization's atomic energy committee in 1946 provided Senator John W. Bricker with an opportunity to explore the Government's policy on international control. Waymack patiently explained to the Joint Committee that he supported Baruch's proposals before the United Nations even though they did not agree with the recommendations of the Carnegie report. There were moments when Lilienthal thought Waymack was taking unnecessary risks as he discussed controversial policy issues with the senators in his usual open and unassuming way, but he finally concluded his long testimony unscathed.

Carroll L. Wilson was the last nominee to be heard. A graduate of MIT in 1932, he had served as assistant to President Karl T. Compton in administering the institute and in Compton's work as chairman of the Government's Science Advisory Board in the early thirties. Wilson's experience as Compton's assistant on the National Research Council's patent-policy committee had led to his appointment in 1936 as special adviser to Vannevar Bush, who was then vice-president and dean of engineering at MIT. In 1940 Wilson had followed Bush to Washington and had helped him organize the National Defense Research Committee and its successor agency, the Office of Scientific Research and Development. Wilson's activities during World War II had given him little direct contact with atomic energy, but early in 1946 he had served as secretary to the State Department's board of consultants, which prepared the Acheson-Lilienthal report. Later in the year Lilienthal had asked Wilson to help organize the new Atomic Energy Commission, and Wilson had been nominated as general manager on December 30, 1946.

Wilson, who was only thirty-six and looked even younger, could expect the Joint Committee to ask some pointed questions about his experience and qualifications. Hickenlooper established that Wilson considered himself the chief executive officer of the Commission. Wilson said he met regularly with the Commissioners and prepared the agendas for their meetings. He recruited most of the senior staff, although he admitted that the principal appointments were subject to the Commissioners' approval. Wilson was in fact the chief administrator for a large enterprise involving a dozen installations and thousands of employees. Senator Edwin C. Johnson of Colorado asked Wilson if he had ever met a payroll. Wilson said his only experience in private industry had been the eight months he had spent in 1946 as vice-president and financial director of a research corporation with 150 employees.

Public interest in the hearings increased again on Monday, February 3, when both McKellar and Baruch were present. Baruch's testimony was especially important to Lilienthal. Not only did the elder statesman have enormous influence with Congress, but it was common knowledge that Baruch and Lilienthal had clashed in 1946 when Baruch became the United States representative on the United Nations Atomic Energy Commission. Now, however, Lilienthal was on good terms with Baruch. In a long telephone conversation on January 10, Baruch had told Lilienthal of his conversations with senators who intended to vote against Lilienthal's nomination and who seemed to be impressed by Baruch's reassurances.

Baruch's testimony on Monday, February 3, was about what Lilienthal expected. On the positive side, Baruch steadfastly supported Lilienthal as well qualified to be chairman, and adroitly parried the venomous implications of McKellar's questions. But it distressed Lilienthal to hear Baruch's reservations on complete civilian control of atomic energy, his praise of General Groves, and what Lilienthal considered a staged endorsement of General Thomas F. Farrell for the position of general manager. The final blow to Lilienthal was the committee's decision to remain after the public hearing late in the morning to hear Baruch in executive session. Lilienthal and his fellow Commissioners were pointedly excluded.[13]

Later Lilienthal admitted to his journal that Baruch had been "really helpful," and it was hard to see anything exceptionable in Baruch's remarks about the proper role of the military services in the development of atomic energy. Perhaps Lilienthal's sensitivity on this point had been heightened by discussions with Secretary of War Robert P. Patterson and General Lewis H. Brereton, chairman of the Military Liaison Committee. The Secretary had called Lilienthal late on Friday afternoon to sound out the Commission's reaction to the idea of appointing Groves to the Military Liaison Committee. Lilienthal, after making clear that the appointment was Patterson's responsibility, observed that appointment of a man who had formerly been in complete charge of the project to a quasi-supervisory or advisory position would probably create problems and might reopen old controversies. On the morning after the Baruch hearing, Brereton told Lilienthal that he had first learned of Groves's appointment to the committee on Thursday. Lilienthal doubted that Patterson himself had known this when he had called Lilienthal on Friday, but the affair did not inspire confidence.[14]

Lilienthal went home tired and discouraged on Monday night. He saw little hope of a favorable outcome in the face of the continuous pressure from those favoring military control, the committee's criticism of Wilson and the staff, the threat of communist espionage, and security leaks. These visions of despair, mingled with a diabolical specter of McKellar, defeated his desperate efforts to sleep. On Tuesday morning he was exhausted and near panic. Struggling through a long morning in his office, he lay down at intervals to recover his strength. At lunch in the cavernous cafeteria in the basement of the Interior Building, he stood holding his tray for ten minutes waiting for a table among scores of Government employees.[15]

When Lilienthal entered the hearing room, President Conant of Harvard was about to testify. At Baruch's suggestion in the executive session on Friday, Hickenlooper had called Conant to speak on behalf of Wilson. Conant described his almost-daily contacts with Wilson during the war and stressed the importance of Wilson's experience in serving as Bush's assistant. McKellar, foreshadowing what was to come, persisted in a long rhetorical discussion full of implications that Lilienthal had communist sympathies.

The spectators stirred in their seats as Hickenlooper called Lilienthal to the witness chair. He squirmed between the crowded tables of reporters, replaced the swivel chair with a straight-back model, nodded to the chairman, and turned to face McKellar, scowling over the long desk on his left. McKellar quickly turned to a question he had raised the previous week, the birthplace of Lilienthal's parents. Lilienthal knew it had been in Austria-Hungary but he did not recall the precise location. Having looked it up over the weekend, he could now say that it was in the vicinity of Pressburg, in what was now Czechoslovakia. "And under the domination of Russia, is it not?" The distasteful implications of that question made Lilienthal strain for self-control, but McKellar soon began rehashing the stale arguments about TVA administration. His intent was to demonstrate that Lilienthal had encouraged TVA to enter a variety of enterprises which would bring the Government into competition with private business. At last McKellar came to the point: "Your sympathies are very leftist, are they not?"

It was a moment of truth and Lilienthal seized upon it. Before his hearers knew what was happening, he was well launched on a broad definition of democracy. Democracy was an affirmative doctrine, not a negative one. The fundamental principle of democracy and of government under the Constitution was the integrity of the individual. One of the tenets of democracy was a deep belief in civil liberties and their protection "and a repugnance to anyone who would steal from a human being that which is most precious to him, his good name, by imputing things to him, by innuendo, or by insinuation." This kind of attack could tear the country apart and destroy it. "I deeply believe," he said, "in the capacity of democracy to surmount any trials that may lie ahead provided only we practice it in our daily lives."[16]

For once Lilienthal had let a surge of emotion rather than calculated reason rule his speech. As he concluded he realized that he had no clear sense of his exact phrases and sentences, but he saw signs of his effectiveness. The dramatic moment of silence in the hearing room at the end of his remarks, the solemn approbation from Senator McMahon, and the warm congratulations from the other senators, including Bricker and William F. Knowland after the session, all suggested a decisive victory. The front-page stories the following morning in the Washington *Post* and the New York *Times*, the extensive coverage by radio commentators, and then the flood of letters from the public helped to turn a moment of despair into a triumph. And, as Lilienthal wrote in his journal the following weekend, his statement "came at the right time—when hysteria was on its way to a frenetic pitch, and in a setting made to order—the voice of sanity and the appeal to reason from the pit of the inquisition."[17]

Hardly so dramatic, but far more dangerous to Lilienthal's cause than McKellar's attack, were new developments on the political scene. There had for weeks been rumors of a Republican attempt to reject the nominations, but the political guns had been notably silent during the first two weeks of the hearings. Except for daily accounts in the Washington *Times-Herald,* the McCormick and Hearst papers scarcely mentioned McKellar's charges. But on February 8, Lilienthal learned the truce was about to end. The opening salvo came from Senator H. Styles Bridges in a prepared statement released on Sunday afternoon for publication in Monday morning's papers. Stressing political issues, Bridges argued that the American people in the recent Congressional elections had rejected the brand of "extreme New Dealism" which Lilienthal espoused. "As with all left-wingers, it is indicated Lilienthal is sympathetic toward Russia, which is Communist-controlled." Bridges was careful to disassociate himself from McKellar's unsubstantiated charges that Lilienthal himself had associated with Communists, but he and some conservative newspapers made effective use of McKellar's campaign by tying New Deal philosophy to communism.[18]

An attack on the New Deal by a Republican Congress after fourteen frustrating years as the minority party was understandable, but Lilienthal was more sensitive to another argument in Bridges' statement. Lilienthal had, Bridges said, "directed the TVA, a social experiment, which is a wide departure from the American system of private ownership of property." For Lilienthal, these words had a familiar ring: he considered Bridges "an old enemy of TVA and . . . spokesman for the lowest of the private utility crowd." Not waiting for further attacks, Lilienthal took countermeasures on Monday, February 10. An article in the Washington *Post* announced that the Commission was approaching leading utility companies about participating in the early phases of studies for eventual development of power from atomic energy. At the hearings that afternoon Lilienthal had arranged for Walker L. Cisler to vouch for the loyalty of Herbert S. Marks, a former TVA attorney who was now the Commission's general counsel. The fact that Cisler was chief engineer of the Detroit Edison Company suggested that not all private power officials looked upon Lilienthal and his TVA associates as dangerous socialists.[19]

As the hearings ended on Monday afternoon, February 10, Martin Agronsky, the radio news reporter, rushed up to Lilienthal and McMahon with a report that Senator Robert A. Taft would oppose Lilienthal's confirmation. As chairman of the Republican policy committee and a leading contender for the Presidential nomination in 1948, Taft could swing the party against Lilienthal. Back in his office, Lilienthal found unmistakable signs of such a trend. The afternoon edition of the Washington *Times-Herald* carried the banner headline: "Lilienthal Branded Appeaser of Russia." Senator Kenneth S. Wherry, the Republican whip, echoed Bridges' charges. Lilienthal's colleague, Lewis Strauss, was disturbed by the rumor of a Taft statement and went to see his old friend. Strauss returned with nothing reassuring. There was to be no Taft statement immediately, but Taft apparently told reporters off the record that he agreed with Bridges and did not think Lilienthal should be confirmed.

Before leaving his office, Lilienthal called Presidential aide Clark M. Clifford at the White House. Clifford had discussed the day's events with President Truman, whose only concern was that Lilienthal might be thinking of giving up the fight. Lilienthal said he would gladly withdraw whenever the President wished, but he had no intention of doing so otherwise. He wanted the President to know that none of McKellar's charges had been supported by evidence and that the press, except for the Patterson-McCormick papers, had been supporting him.

Lilienthal lost no time in organizing his forces. On Wednesday, February 12, he discussed strategy with Clifford at the White House. On Thursday the President at his regular press conference told reporters that he considered Lilienthal fully and unusually qualified as chairman and that he thought McKellar's charges "absolutely unfounded." Meanwhile, there emerged other forces reminiscent of the battle of the previous year over the atomic energy bill. Harold C. Urey, the outspoken champion of the scientists, pleaded for Lilienthal's confirmation in a statement issued at the University of Chicago. Messages of support arrived from farm organizations and labor unions. Alfred Friendly kept up his daily barrage of feature stories on the front page of the Washington *Post* just as he had done a year earlier in supporting the McMahon bill. The Federation of American Scientists, which had rallied support for the McMahon bill, urged confirmation of Lilienthal in a letter from Robert R. Wilson. Likewise, the Reverend A. Powell Davies of All Souls Unitarian Church in Washington again took up the battle in gathering support for Lilienthal among a score of religious, educational, labor, women's, and veterans' groups.[20]

Other forces were operating behind the scenes. Dean G. Acheson, Under Secretary of State and a close friend of Lilienthal's, suggested to Secretary George C. Marshall that he warn Vandenberg that "further delay in the confirmation of the Atomic Energy Commission may damage our national security." Important policy questions related to international control of atomic energy were hanging fire until the Commission could get down to business. On Friday, February 14, Marshall discussed the appointments with the President at a Cabinet meeting and later met with Vandenberg and Senator Tom Connally, ranking Democrat on the Foreign Relations Committee. That same afternoon Vannevar Bush met in secret session with the Joint Committee to make a similar plea for quick action.[21]

Much of the outcome rested on the decisions of Vandenberg and Taft. Neither had yet declared himself publicly, but both had given some indications of their feelings. Vandenberg had not been able to conceal his contempt for McKellar's performance and he had stood firmly behind the Acheson-Lilienthal report when it had been attacked by Senator Johnson of Colorado, who was a Democratic member of the Joint Committee. He had been impressed too by the appeals of Marshall and Bush. The following week he wrote to an old friend in Michigan that he considered McKellar's charges against Lilienthal "a fantastic fabrication highly remindful of the 'lynch law.' " This left for criticism only Lilienthal's New Deal philosophy and his interest in public ownership, and Vandenberg found these poor reasons for opposing confirmation. Until there was some international agreement for control of atomic energy, the nation had no choice but to place its development and use in public hands. In this light Vandenberg found Lilienthal's liability a temporary asset. Furthermore, Vandenberg feared that rejection of Lilienthal would probably result "in the wholesale retirement of our scientists from our atomic organization" and the loss of another precious year in developing atomic power. Vandenberg conveyed these same fears to the Joint Committee in a public session on February 21, when he read a forceful letter from President Compton of MIT. Compton thought Lilienthal the best man for the job and predicted that failure to confirm him would be "a very serious blow to our future progress in the atomic energy field." [22]

It was probably not a coincidence that Taft made his position clear later the same day. In a blunt statement which rated banner headlines in conservative newspapers, Taft said that he found Lilienthal "temperamentally unfitted to head any important executive agency in a democratic government, and too 'soft' on issues connected with communism and Soviet Russia." He repudiated Vandenberg's argument, which he thought implied "the ridiculous proposition that Lilienthal is the indispensable man." Lilienthal was "a typical power-hungry bureaucrat," one of those who had dominated the Government and defied the wishes of Congress for years. He thought Lilienthal had managed TVA in an arbitrary and secretive manner, that he had unfairly driven Arthur E. Morgan from the TVA board and had covered up his action by repeatedly changing TVA minutes. There was no doubt in Taft's mind that Lilienthal had tolerated Communists in TVA and that the Acheson-Lilienthal plan would have given the Russians the atomic bomb.[23]

Taft, in other words, had embraced the arguments of McKellar, Bridges, Wherry, and the conservative press. Strauss was angry; he had been convinced that his friend would never make his opposition to Lilienthal explicit. He agreed with Lilienthal that Taft's sweeping attack made confirmation virtually impossible. A fight might split the Republican party, but Strauss was in a fighting mood. If they lost, they could always go into business together. Despite their different political backgrounds, Lilienthal and Strauss had become close associates during their first three months on the Commission, especially after McKellar's questions about Lilienthal's parents and other incidents which indicated the force of anti-Semitism in the opposition to Lilienthal.[24]

One consolation for Lilienthal was the fact that the hearings were nearing an end. Hour after hour, day after day, week after week McKellar had fumbled his way through the voluminous and inconclusive testimony presented to the House Committee on Un-American Activities in 1940. Former investigators for the Dies committee, Lilienthal's former assistants at TVA, local law enforcement officers from Tennessee, Knoxville businessmen and attorneys, dismissed TVA employees, former members of the Communist party in Knoxville, local busybodies, and cranks joined the parade of witnesses. So pointless and repetitious was the testimony, so "outrageous" was McKellar's conduct that Vandenberg chose to stay away. At one point Senator

McMahon exploded in a heated denunciation of the "lot of rag, tag, and bobtail that the Senator from Tennessee has produced." At last, on February 26, five weeks after the public hearings began, Senator McKellar announced that he had no more questions. Senator Hickenlooper, who had maintained a strict attitude of impartiality during the ordeal, hastily adjourned with the hope that this session would end the public hearings.[25]

McKellar, however, had not quite run out of ammunition. On February 28, he scored a victory when the Senate Public Works Committee rejected Clapp's nomination as TVA chairman by a vote of 7–5. He had also sent every member of the Senate a letter charging Lilienthal with misconduct in accepting payments from a commercial venture in Chicago at the time he was serving on the Wisconsin Public Utilities Commission. Hickenlooper had no choice but to reopen the hearings on March 3. Categorically disproving McKellar's charges on every point, Lilienthal dominated the two days of hearings and emerged with renewed confidence in his chances for a favorable vote in the committee.[26]

Lilienthal's last hurdle was two closed sessions before the Senate section of the Joint Committee early in March. Here, at least, the discussion could proceed without McKellar's maddening intrusions. Although the conversations were informal and sometimes candid, they revealed disagreements, mainly between Lilienthal and Hickenlooper. First, Hickenlooper was concerned that the Commission had used its statutory exemption from Civil Service regulations to grant what he considered unusually high salaries to the principal staff. For example, Marks as general counsel was receiving $14,000 per year, or $4,000 more than the assistant attorney general. Carroll Wilson observed that Marks's job was comparable to those of the statutory division directors, whose salaries the Congress had established at $14,000. Taking a broader view, Lilienthal argued that the novelty and importance of atomic energy demanded the very best talent available, regardless of cost. Strauss and McMahon supported Lilienthal, but Hickenlooper and Millikin could not accept the fact that the Commission, by their interpretation, had used authority granted for exceptional cases to establish a separate personnel system that would undermine the Civil Service program.

Hickenlooper's second concern was security. McKellar, in the course of his campaign against Lilienthal, had cast suspicions on a number of former TVA employees who now held key positions on the Commission's staff. Unwilling to take chances, he asked Lilienthal to send the committee FBI reports on the Commission's principal appointees. Hickenlooper was first annoyed that the Commission sent reports on only a few of its staff; later he was troubled by the information he found in some of the reports. Charges of "associations" with "communists," of "communist tendencies" were disturbing even if unsubstantiated or vague. Could not the Commission find some people who were "above suspicion?"[27]

Despite his own reservations and the growing uncertainty within the committee, Hickenlooper hoped to get a vote on the confirmations by Friday, March 7. The press had guessed Hickenlooper's intentions, and the Commissioners were impatiently awaiting the verdict. But the closed session on Friday morning dragged on inconclusively, as the senators attempted to evaluate the derogatory information in the FBI reports. Bricker especially was agitated about charges against Marks and other former TVA employees. Even some vigorous reassurances from Bush failed to calm fears. Bricker contained himself until Bush left, but no longer. He had not let McKellar's charges about communism in TVA color his judgment of Lilienthal; he did not see how Bridges's charges of New Dealism disqualified Lilienthal. But the FBI reports raised new doubts; Bricker would have to give further thought to his vote.[28]

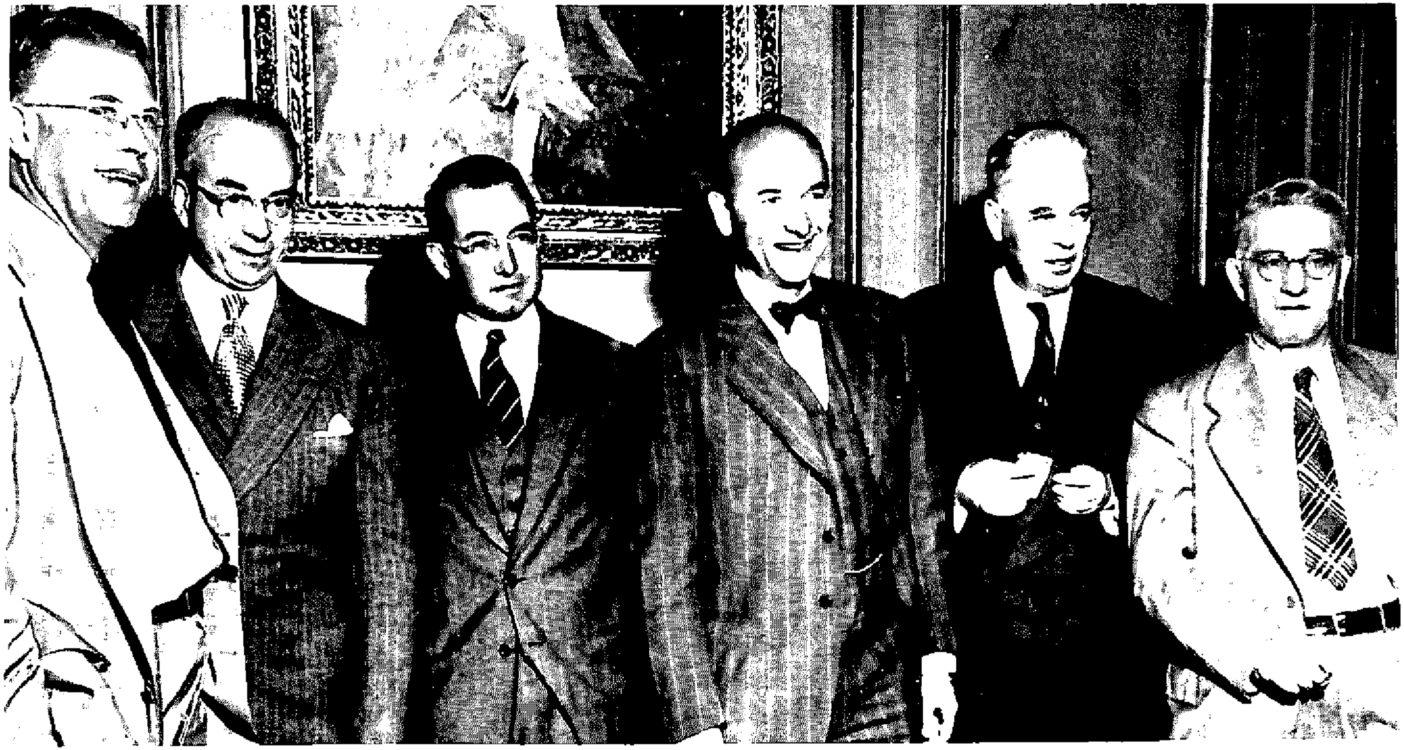
Hickenlooper, too, was upset. He went to Forrestal's home and told the Secretary of the Navy that he was disturbed by Lilienthal's "intransigence and inflexibility" on the matter of staff salaries. This had made Hickenlooper's task especially difficult at a crucial moment in his fight for confirmation. He was also distressed that Lilienthal had made important appointments without consulting the FBI files. At Hickenlooper's suggestion, Forrestal discussed these concerns with the President and with Strauss.[29]

Lilienthal appeared to hold the edge on Monday, March 10, as the Senate members of the Joint Committee assembled to vote, but the revelations of the previous week cast some uncertainty on the outcome. No one was in a mood for further discussion, and Hickenlooper quickly put the question to a vote. For Lilienthal, the vote was 8–1, only Bricker voting against. Senator Connally said he would vote only on the Lilienthal nomination because he did not know the other nominees. Thus for Bacher and Waymack the vote was 8–0; for Pike and Wilson, it was 6–2, with Bricker and Johnson voting in the negative.[30]

The vote was a triumph for Lilienthal and the Commission and perhaps, as the liberal press claimed, for democracy and the civilian control of atomic energy. But the margin of victory was really no more than a whisper. Over the weekend Lilienthal received from the FBI a shocking report which at first glance seemed to throw a heavy shadow of suspicion over Robert Oppenheimer, the wartime director of the Los Alamos weapon laboratory and a member of the board of consultants which had prepared the Acheson-Lilienthal report; he had recently been appointed on the Commission's recommendation to be chairman of its General Advisory Committee.[31] The file revealed that Oppenheimer's brother had been a Communist and that Oppenheimer's wife had a radical background. Even as the committee was meeting on Monday morning to cast its vote, the Commissioners were closeted in secret session trying to evaluate the dismaying information in the FBI file. Conant and Bush assured Lilienthal that General Groves had known these facts when he had selected Oppenheimer to head the weapon project in 1942, but Lilienthal probably thought that one word to the committee about the

Oppenheimer file would plunge the confirmation issue back into the sea of hysteria from which it was at last emerging.

Even if the Commission could exonerate Oppenheimer and keep the contents of the file from becoming public knowledge, the chances for confirmation were not clear. Bricker and Taft promised a long, hard fight in the Senate.[32] And even if they emerged victorious, the Commissioners would still face what Lilienthal, with some accuracy as well as exaggeration, had called the terrible responsibility.



OAKLAND TRIBUNE

THE COMMISSIONERS AT BERKELEY, AUGUST 1947 / After visiting the Bohemian Grove the Commissioners met with Ernest O. Lawrence in the regents' room in the administration building at the University of California on August 20, 1947. Left to right: Lawrence, Lewis L. Strauss, Robert F. Bacher, David E. Lilienthal, Sumner T. Pike, and William W. Waymack.

WIDE WORLD

CONFIRMATION HEARINGS BEGIN / David E. Lilienthal appearing before the Senate section of the Joint Committee on Atomic Energy on January 27, 1947, to answer questions on his qualifications as chairman. Seated around the dais from left to right are Representative Melvin Price and Senators Kenneth D. McKellar, Edwin C. Johnson, Brien McMahon, and Bourke B. Hickenlooper.

UNCERTAIN MANDATE

CHAPTER 2

During the first three months of 1947 the Commissioners had no choice but to focus their attention on the confirmation hearings. Until the Joint Committee and the Senate settled the question of confirmation, Lilienthal and his associates had at best an uncertain mandate for leadership. By law and Executive Order, however, they were already fully responsible for the nation's atomic energy program. Occasionally the Commissioners could find time for agency matters; but until the Senate acted, the Commissioners would have to rely on the veterans of the wartime project and the fledgling headquarters staff to keep the administrative machinery going.

THE VETERANS

On Friday morning, January 3, 1947, President James B. Conant of Harvard University hurried to the New War Department Building on Twenty-First Street in Washington for the first meeting of the Commission's General Advisory Committee. Waiting to greet him were Lilienthal and Carroll L. Wilson. Robert F. Bacher, the only Commissioner whom Conant knew well, had been delayed by a snowstorm in his flight east from Los Alamos, where he had been inspecting the nation's stockpile of atomic weapons. Also stranded on the way east were two members of the committee: Lee A. DuBridge, the new president of the California Institute of Technology, and Robert Oppenheimer, who was resuming his academic career at the same institution.[1]

Among the committee members present Conant found many friends: Enrico Fermi, the renowned nuclear physicist at the University of Chicago; Hood Worthington of the du Pont Company, who had helped to build the production plants at Hanford, Washington; Isidor I. Rabi, the Nobel laureate in physics and wartime leader at the MIT Radiation Laboratory; Hartley Rowe, one of Conant's division directors at NDRC and valuable consultant at Los Alamos; Cyril S. Smith, the British-born metallurgist who had a key role in weapon fabrication at Los Alamos; and Glenn T. Seaborg, the enterprising young chemist whose wartime research team had discovered plutonium and devised the chemical process used for its recovery for the Alamogordo test and the Nagasaki weapon.

Lilienthal began by distributing the Presidential commissions "with all the privileges and headaches appurtenant thereto." [2] Conant nominated Oppenheimer as chairman of the committee during 1947 and Rowe to serve as temporary chairman until Oppenheimer arrived. Not knowing where to begin, Rowe suggested that Lilienthal explain the role of the committee and its relationship to the Commission. Lilienthal's easy conversational manner stimulated discussion, and the committee members were soon adding their own thoughts on the subject. They agreed the committee could not be close enough to day-to-day operations to act as a technical consulting group to the Commission but that it might properly offer advice on major policy matters. To do this, the committee would need reports on the status of research and development, materials, and production. Wilson said he expected soon to assemble the leaders of the research laboratories to plan the status report on research and development. It would be easier to get information on materials and production.

The committee moved into a general discussion of the problems facing the Commission, not only with an air of congeniality among the group but also with special understanding of the existing program and the people who manned it. Every member of the committee, unlike most of the Commissioners and staff, had had a part in the wartime program. It would not have been hard for Conant to imagine as he sat there that he was reliving one of the many conferences he had attended during the war project. In addition to experience, the committee also commanded some of the best scientific and technical talent available in the nation. Certainly the Commission would rely heavily on the committee, at least until the Commissioners learned their jobs and Wilson had assembled and trained his staff.

After lunch the committee turned to substantive matters. Wilson was seeking a director of research, and the committee had a number of names to suggest. Then Wilson explained two legacies from General Groves: the new atomic energy laboratory which the General Electric Company had been promised when it had agreed to take over operation of the Hanford plant, and the new Brookhaven National Laboratory to be established as a regional research center for universities in the Northeast. In the closing weeks of 1946, the Commission had had little success in formulating policy for these new laboratories; now it could call upon the expert knowledge of the committee.[3]

Beyond merely giving advice, the committee demonstrated a willingness to take the initiative. During the afternoon Seaborg discussed some practical difficulties he had encountered in laboratory administration and proposed some actions the Commission could take to remove them. Seaborg was mostly concerned with the prompt declassification of technical data and the exemption of some laboratory employees from security clearances.

Before Oppenheimer arrived for the Saturday morning meeting on January 4, Conant proposed that the new chairman establish three subcommittees to study the information to be furnished by the Commission in the areas of research and development, materials, and production. Oppenheimer, when he finally arrived, had time to do little more than find out what had happened and establish the date of the next meeting, to be held on February 2.

Conant and Oppenheimer had much to discuss during the lunch hour. At two they would go to the Pentagon for the first meeting of the Atomic Energy Committee of the Joint Research and Development Board. The complicated title accurately reflected the complex organization which had evolved from Vannevar Bush's efforts to coordinate postwar research in the military services. As early as the summer of 1944, Bush had been concerned that, with the disbanding of the Office of Scientific Research and Development at the end of the war, the research and development activities vital to a modern defense establishment would soon disappear. Proposing a grand plan for Government-supported research which he announced in his report, *Science, The Endless Frontier,* Bush set about the task, even before the war was over, of establishing a National Research Foundation. He envisioned the new agency as having responsibilities for basic research in the physical and biological sciences as well as in applied research for the military services. In fact, Bush intended its authority to extend over all research and development activities supported by the Government, with the exception of applied research in atomic energy, which, largely for reasons of security, would be assigned to the new Commission.[4]

Although the bill for the National Science Foundation, as it came to be called, had bogged down during 1946 in endless political debate from which atomic energy legislation had barely escaped, Bush had hopes that the new Congress would soon create a science foundation. In the meantime, he was attempting to coordinate the research and development activities of the military services through a temporary instrument called the Joint Research and Development Board. As he explained to the Secretaries of War and the Navy in May, 1946, the new organization would have no authority over the internal affairs of either department but would assist in "the allocation of responsibility on matters of joint interest." Thus the joint board would help the services to decide which would develop a particular weapon. The board would not establish priorities, justify projects, or terminate them; it would, however, help to reduce duplication of effort and perhaps prove a step toward service unification.[5]

If, as Bush explained, the joint board was to function "as a court of arbitration," it would have to represent the interested parties equally. The charter called for a civilian chairman (Bush), designated by the two service secretaries, and two representatives for each military department. Day-to-day administration was the responsibility of the executive secretary, Lloyd V. Berkner, a physicist and radar specialist who had worked for Bush at the Carnegie Institution in Washington. Under Berkner's direction, the joint board in 1946 had organized six committees, each a miniature of the parent group and each responsible for one technical area of interest to the armed forces. The charter of the atomic energy committee, only recently established, bore the familiar requirement for equal representation. The three civilian members were Conant (chairman), Oppenheimer, and Crawford H. Greenewalt, a vice-president of the du Pont Company, who had sparked the company's efforts in building the plutonium production plant at Hanford. The six representatives of the Army and Navy were all members of the Military Liaison Committee.

Thus, Conant again found himself among friends as he introduced Bush to speak to the members of the new atomic energy committee. Bush explained the committee's charter and functions, and the group decided that it would use the Military Liaison Committee as its channel of communication with the Commission. Its immediate job was self-education, since most of the military members had no background in atomic energy. Conant asked Oppenheimer to make some recommendations for educating the committee.[6]

Conant must have felt a certain satisfaction on Saturday afternoon when the committee adjourned its first meeting. The task of rebuilding the nation's atomic energy program would be a big one, but at last there was a base for operation. While the new Commission was organizing itself, the General Advisory Committee could begin to define the policy questions, if not the solutions, and the atomic energy committee in the Pentagon could begin to acquaint the nation's military leaders with the facts of atomic energy. In the meantime, Bush and Conant were still on the scene, their authority somewhat concealed from public view but with the same firm hands in control of the project they had guided since the black days of Pearl Harbor in 1941.

THE HUMAN EQUATION

The presence of Bush and Conant must have been reassuring to Carroll Wilson, their young protégé who had just assumed the awesome duties of the Commission's first general manager. The new job gave him control of the Army's nation-wide complex of production plants, laboratories, and administrative offices in thirteen states from New York to California and from Washington to Tennessee. Manning these facilities at the time of the transfer were more than 2,000 military personnel, 4,000 civilian Government employees, and 38,000 contractor employees. By far the largest concentration was at

Oak Ridge, Tennessee, the headquarters for the Manhattan Engineer District and the location of two major production plants and a large research laboratory. Oak Ridge, including a Government-owned town of 40,000 people, alone absorbed half the Commission's civilian and contractor employees. The laboratory at Los Alamos, New Mexico, ran a poor second in size to Oak Ridge. Still operated for the Commission by the Manhattan District, most of its 2,000 Government employees were military personnel; most of the 6,000 contractor personnel were scientists and technicians in the weapon laboratory. The Hanford production plant and community at Richland, Washington, could claim almost 600 Commission employees, of whom about half were military. The 5,000 contractor employees all worked for the General Electric Company, which operated the plants and the community. The Commission's New York and Chicago offices, which administered research and procurement contracts, accounted for most of the remainder.

One striking feature about these statistics was the scattered nature of the Commission's operations. Another was the relatively small number of Government employees in contrast with contractor employment. Both these facts were the result of wartime policy decisions. To avoid the perils of possible enemy attack, sabotage, espionage, or operating accident, diversification and isolation were cardinal factors in selecting plant sites. General Groves's extraordinary pressure for progress in plant construction and operation required that private contractors rather than Government employees do most of the work. The small groups of military officers and civilian employees at each site were only large enough to administer the contract, maintain security, and oversee the work for Groves. Under the Atomic Energy Act the Commission could have reversed both trends, for it was empowered to operate all its facilities with direct Government employees. In fact the Commission would soon consider the advantages of centralizing its research laboratories; but even before the Commissioners assumed responsibility on January 1, they had decided to retain both principles. For one thing, they had enough problems without trying to modify the fundamental structure of the enterprise. Secondly, and more important, Lilienthal and his colleagues accepted decentralization and contractor operation as good practices in public administration.

For Lilienthal, decentralization was more than a management technique; it was essential to the operation of democracy in a modern society. During a decade in the Tennessee Valley he had seen firsthand how decentralization had revitalized not only the physical resources and economic institutions of the region, but also local governments and individual citizenship. Just as TVA had brought Tennessee farmers into consultations with its engineers, so had the federal agency, in cooperation with state and local governments, helped to rebuild democracy "at the grass roots." Summing up his argument in 1944, Lilienthal had said: "The task of harmonizing and from time to time adjusting the intricate, detailed maze of pieces that make up the unified development of resources in a world of technology is something that simply cannot be done effectively from some remote government or business headquarters."[7] This conviction underlay his long fight against Secretary Harold L. Ickes's efforts in the thirties to centralize all the power programs of the Federal Government in the Department of the Interior. He did not intend to surrender the principle in establishing the Atomic Energy Commission.

Groves himself had followed a similar course in the Manhattan project by placing the headquarters at Oak Ridge. His own office in Washington had always been small, never containing much more than thirty people during the war. There had been some growth in 1946 to perform functions not required in a secret wartime organization; but at the time of transfer there were scarcely more than a hundred employees in the Manhattan District's offices in the New War Department Building. By that time Wilson had acquired no more than a dozen employees in the temporary Commission offices in the same building. The two groups combined would be well within the limits which Lilienthal and Wilson envisaged for the Washington headquarters.

However, decentralization, as Lilienthal had often said in his speeches on the subject at TVA, meant much more than keeping the Washington headquarters staff small. Unless the agency's field offices had authority to make important decisions and had the talent necessary for these responsibilities, decentralization was nothing but a sham. In this respect, the Manhattan inheritance was not very helpful. Although there was a limited dispersion of authority common to Corps of Engineer projects, there was no real decentralization by Lilienthal's standards. The area engineers at New York, Chicago, and Hanford had very limited authority. General Kenneth D. Nichols's headquarters at Oak Ridge made all important administrative decisions, and Groves initiated all policy in Washington. To have expected any less authoritarian system of a military organization in wartime would have been unreasonable, but the same system obviously could not serve as the administrative framework for a peacetime enterprise emphasizing civilian control and "grass roots" democracy.

For Lilienthal's purposes, the main deficiency in the wartime organization was the concentration of authority at Oak Ridge. Military organization defined the relationships between Oak Ridge and the other installations. Military officers, most of them contemplating new assignments in late 1946, were directing the work of the area offices. In January, 1947, the atomic energy program would have collapsed without them. For the moment there could be no thought of anything but continuing operations under the military organization. From the Commission's point of view this was not an ideal arrangement, but circumstances would permit no other.

The Manhattan District organization had one further disadvantage for Wilson. His small Washington staff in January, 1947, consisted mostly of administrative personnel who could not be expected to assist him in operating decisions. Until he could assemble his own personal staff of men who had a working knowledge of nuclear science and technology, he would have to rely on the existing organization. And that group, by the very fact that it had been created for a specific wartime purpose, would be unable to begin the difficult process of adapting the enterprise to the more diffuse and complex demands of a peacetime, civilian environment.

Recruiting a complete staff for a Government agency was never easy, and putting decentralization into practice would complicate the task. Wilson needed not only capable people for top positions in Washington, but also unusually competent managers for the field offices. In his limited experience Wilson had never had the occasion, as did Lilienthal, to develop a full-blown philosophy of decentralization; but from the first he sensed the practical point that really strong field managers would insist on reporting directly to him. This meant that the Washington division directors could not be in the line of command between him and the field but would have to operate rather as members of his staff. Wilson first made this point in defining what he considered to be the qualifications of the director of military application. He thought the job required much more than competence in weapon technology. The director would not simply control the Commission's weapon activities; as a member of the general manager's staff his job would be to see that military requirements were considered in all aspects of the Commission's activities.[8]

With no direct experience in managing a large enterprise, Wilson had to rely upon intuition, common sense, and good advice in organizing the Commission staff. Fortunately he was well provided for in the last respect. On general approach he could count on the help of Bush, Conant, Lilienthal, and the other Commissioners. On the details he came to rely on one of his assistants, Richard O. Niehoff, a former TVA official and wartime director of administrative relations at the National Housing Agency. About to transfer to the State Department in October, 1946, Niehoff became interested in the Commission after reading about Lilienthal's appointment. Within a few days after reporting to State, he found himself on loan to the Commission and deeply involved in the hectic activities leading to the January transfer.

Without title, Niehoff was in effect the Commission's director of organization and personnel in the closing weeks of 1946. He organized the panel of consultants who selected Wilson as the first general manager and became his special assistant on organization and personnel recruitment.[9] Although Wilson never deferred to his assistant on matters of substance, Niehoff influenced the patterns of development by reinforcing his superior's intuitive convictions with an operating rationale learned in Lilienthal's TVA system. This rationale involved reliance on individual talent, initiative, and responsibility rather than the cramped regulations of the Civil Service Commission as the answer to effective administration in modern government. In practical terms it meant decentralization and an independent personnel system.

One of the intriguing possibilities Niehoff saw in the Atomic Energy Act was Section 12a(4), which authorized the Commission "to the extent the Commission deems necessary" to employ personnel and fix compensation without regard to Civil Service laws. Taking a cue from the act itself, which fixed Wilson's salary at $15,000 and that of the division directors at $14,000, Niehoff suggested that the salaries of division directors could range from $10,000 to $14,000, which would be far above the rates for comparable positions under Civil Service.[10] From this point it was only a short step to the question of whether the provision in Section 12 would justify exceptions for all positions in the Commission, or in effect an independent personnel system. This question had been high on the Commission's agenda in November, 1946, when Niehoff had requested Wallace S. Sayre, a professor of public administration at Cornell University, to study it.

Sayre was an admirable choice for the assignment. In addition to his academic experience, he had a working knowledge of government personnel systems, first at the municipal level for Mayor Fiorello H. LaGuardia of New York and later at the federal level during World War II as director of personnel for the Office of Price Administration. Like many of his colleagues, Sayre had seen the independent personnel system of Lilienthal's TVA as a beachhead in the long struggle to modernize the federal civil service. Having made the most of the relaxation of Civil Service regulations during the war, Sayre looked upon the Veteran's Preference Act of 1944 as an effort by conservative forces in the Congress, the permanent staff of the Civil Service Commission, and veterans' organizations not just to reimpose prewar restrictions but also to wipe out the modest gains of the Roosevelt Administration. A typical although probably exaggerated reaction to that possibility appeared in an article in *Harper's* magazine, which argued that the spoils system was preferable to the inflexibilities of Civil Service.[11]

With this background, Sayre did not need much explanation of his assignment, and within a few weeks he had his recommendations in draft form. Sayre contended that the Atomic Energy Act was "an unprecedented charter both in program and administration." [12] Because the Commission was charged with developing "pioneer ideas," with difficult types of experimentation, and the exercise of delicately balanced and responsible judgments, the success of the Commission was "uniquely dependent upon the quality of its staff." The Commission would have to recruit and retain "a creative staff of the highest intellectual quality, imbued with the scientific and the cooperative spirit—imaginative, flexible in thought and action, highly motivated yet capable of self restraint, and possessed of a genuine sense of dedication to the Commission's programs." An ordinary personnel program using routine techniques could not find such people. Furthermore, Sayre thought the Civil Service system would be too inflexible and too insensitive to the special qualities the Commission was seeking for it to be practical for recruiting. He cited the language of Section 12, which suggested that exemption from Civil Service regulations was to be the exception rather than the rule. But after discussing the legislative history of the section with the Commission's lawyers, he concluded there was statutory authority for a personnel system completely independent from Civil Service. He recommended an independent system which would meet the Commission's special needs but which would conform to Civil Service standards and procedures at all other points.

When Sayre discussed his study with the Commissioners early in January, 1947, he found he had little trouble convincing them of the advantages of an independent personnel system. Lilienthal's reaction was predictable from his TVA experience; Pike was aware of the advantages OPA had enjoyed during its temporary exemptions from Civil Service regulations during the war; and Bacher expressed the opinion of many scientists that Civil Service inspired industrious mediocrity. Strauss and Waymack had no strong feelings on the subject, and Wilson's opinion was close to Bacher's. For the moment, however, there was no thought of formal action. The traditional opposition to independent merit systems in Congressional committees and in the Civil Service Commission staff suggested proceeding cautiously. Certainly Wilson contemplated no action until the confirmation hearings were completed.

In the meantime Niehoff pushed ahead with plans for recruiting key personnel under the exception provided in Section 12. During Christmas week, 1946, he organized a panel to select a director of organization and personnel. Within a few weeks the panel had worked its way through a long list of candidates, and before the end of January, the Commission announced the appointment of G. Lyle Belsley, an assistant administrator at the National Housing Agency. No panel was necessary to recruit the initial cadre of the legal staff. Herbert S. Marks, who had worked with Wilson on the Lilienthal board of consultants, had been managing the Commission's legal affairs since November and was appointed general counsel on January 23. His deputies were Edwin E. Huddleson, Jr., also formerly with the State Department, and Joseph A. Volpe, Jr., formerly a special assistant to General Groves. Paul W. Ager, whom Lilienthal had brought from TVA to handle the financial aspects of the transfer, was appointed the Commission's budget officer. Other key administrative posts, in security and intelligence, public information, auditing, accounting, and administrative services, were still to be filled; but for the moment Wilson could begin to organize his headquarters staff around a strong nucleus.[13]

PERSONNEL SECURITY

To a large extent, the success of Wilson's efforts in recruiting personnel and organizing his staff would depend upon his ability to establish quickly an effective system for processing security clearances. As in other areas, the Commission's inheritance from the Army in the security field involved some liabilities as well as assets. In November, 1946, General Groves told Lilienthal that the pressures of war had forced him to hire some people of questionable backgrounds and associations. The Atomic Energy Act required complete security investigations by the FBI not only for new employees but also for all those inherited from the Army. From Groves's point of view, the new requirements of the Act provided a good justification for terminating the questionable employees.[14] The suggestion put the Commission in a difficult position. There would surely be political repercussions if the Commission in peacetime set about terminating employees who had devoted themselves to the project during the war. Even more to the point, some of these cases had not been settled precisely because they were difficult to judge, and the Commission as yet had no criteria for evaluating these or any others.

There had been little time to investigate, let alone provide for this situation in the closing days of 1946. The best Colonel Charles H. Banks, one of Groves's intelligence officers, could do was to draft a brief directive prescribing a skeleton plan making effective the new provisions of the Act. For the moment the plan, which was to take effect on January 13, 1947, would apply only to new Commission and contractor employees. Reinvestigations of Manhattan District personnel would have to come later. Since the FBI by law had to perform the investigations, Banks saw the need to send all clearance forms to Washington and therefore to replace the Army's local security files with a central control system. He also proposed a new Personnel Security Questionnaire, known henceforth in the trade as the "PSQ."[15]

Even before Banks's directive could go into effect, however, it was clear that the administrative machinery could not be set up in time. In an all-day meeting in Washington on January 7, security officers from the field agreed that they would have to use the Army procedures until the Commission could set up its own. After the meeting Volpe, with the help of some of the security officers, drafted a memorandum setting forth a tentative security procedure for review by the field offices. This review would take time. Meanwhile the Commission would be reluctant to hire anyone who had not been cleared in the Manhattan project. Volpe as a stand-in had every motive for finding a director of security as quickly as possible. On January 21, Wilson presented to the Commission a slate of names and won permission to approach the person at the top of the list. The Commission also authorized Wilson to hire Thomas O. Jones as a special assistant on security. Jones had been Groves's security officer at Los Alamos during the war and also at the Bikini weapon test in the summer of 1946.[16]

Jones, a quiet unobtrusive young man with little experience in high-level administration, quickly found himself in a beehive of activity. The first task was to draft some interim clearance procedures for the Washington headquarters until the formal agency regulation could be adopted. Belsley's appointment as director of organization and personnel provided a central point of control over recruitment at headquarters. Wilson directed him to hire no one without a full investigation by the FBI. If this proved impractical, he could hire former Manhattan District employees without FBI investigation; only with Wilson's written consent and a full written justification could he make emergency appointments with only a preliminary FBI file check.

During the following two weeks Jones spent much of his time working out the final version of the first formal security regulation, which Wilson approved on February 14. Closely resembling the earlier drafts, the new regulation established three types of clearances based on the degree of the individual's exposure to Restricted Data, as defined in the Atomic Energy Act. Certain contractor employees having no access to Restricted Data or to exclusion areas where such information was used were granted "P" clearances immediately and were subsequently subject to an FBI file check. The "S" clearance was reserved for frequent business visitors to Commission installations who would not have access to Restricted Data. All Commission employees, regardless of access, and all contractor employees with access to Restricted Data or exclusion areas would need the "Q" clearance, which required in advance of employment a full FBI security investigation. All Personnel Security Questionnaires were to be forwarded to the FBI through the Commission's central personnel clearance office in Washington.[17]

The February 14 directive made possible some orderly procedures, but it far from provided an efficient security system. Jones first estimated that the FBI investigations would take four weeks, but the Commission's requirements soon outran the resources. Investigation time soon dragged out to six weeks or more as thousands of PSQ's poured in from the field offices. Once the FBI had completed its investigations, the Commission had to evaluate the findings and grant the clearances. In the overwhelming majority of cases, there was no disturbing information, and clearances were quickly granted. But when some possibly derogatory information turned up, careful study was necessary. The mere presence of such information in the FBI file was not sufficient grounds for denying a clearance. Jones thought the tedious job of evaluation might require a full-time panel of reviewers. The need for a panel might prove even more pressing when the security division could get around to reinvestigations of former Manhattan District personnel.[18]

For a few weeks Jones went about his work with the expectation that the Commission would soon select a director of security to take over most of his responsibilities, but as February faded into March that hope disappeared too. In the meantime Jones worked out procedures for reporting security violations to the FBI and organized a panel of former Manhattan District security officers to draft a security manual for the Commission. There was also the task of developing security measures for the new headquarters building and compiling a list of former Army employees whose files contained questionable information and who thus would be given priority in reinvestigations. Late in March the Commission's leading candidate for the post of director of security declined to accept, and the Commission asked Jones to take over as acting director. It was not an enviable assignment, what with the growing lag in FBI investigations and the lack of a board to evaluate the findings. Jones sensed that the worst was yet to come, but he knuckled down to doing his job one day at a time.

LABOR CRISIS

There was much to be said for caution in the first weeks of 1947, but at times there was a need for action. None was more compelling than that for a decision on labor policy at the major production sites. During the war General Groves had persuaded the national labor unions not to attempt to organize the Manhattan District facilities, on the understanding that after the war the Army would permit collective bargaining elections in the plants under the provisions of the National Labor Relations Act. Keeping its word, the Army authorized elections at Oak Ridge in the summer of 1946—with unpromising results. In a struggle for power, the Congress of Industrial Organizations succeeded in winning the election in the K-25 gaseous-diffusion plant, operated by the Carbide and Carbon Chemicals Corporation, by only 25 votes in almost 4,000. The American Federation of Labor won decisively at the Clinton Laboratories, operated by the Monsanto Chemical Company, and carried the biggest union vote in the Tennessee Eastman Corporation's Y-12 plant, which elected not to organize. Not only were there hard feelings between the unions after the elections, but also the contracts negotiated by the companies with the two unions were different in important respects. Although the War Department thought the contracts were acceptable, the Army decided to leave formal approval to the Commission.[19]

Lilienthal had anticipated the need for quick action. Weeks earlier he had set about appointing a panel of industrial relations consultants. On January 3, the Commission announced the appointment of George H. Taylor, professor of industrial relations at the University of Pennsylvania; Lloyd K. Garrison, a New York lawyer and former general counsel of the War Labor Board; and David A. Morse, Assistant Secretary of Labor. Lilienthal saw the panel in his office the same day and within a week had a report on the situation at Oak Ridge.[20]

The panel recognized that differences in the contracts might open the way for renewed conflict between the unions, but both sides had negotiated in good faith and the wage rates in the contracts seemed acceptable. On balance, the panel thought the Commission should accept the contracts in part, with riders providing for revisions of certain sections, particularly those concerning work stoppages, security procedures, and the arbitration of grievances. The three consultants urged the Commission to discuss their problems with William Green and Philip Murray, the national presidents of the two unions, issue a general policy statement on accepting the contracts, and appoint a full-time labor relations expert to the staff.

The following week the Commission acted. On January 13 Wilson persuaded Clark Kerr of the University of California to work out a general policy statement for revising the Oak Ridge contracts. In the meantime, Wilson sent Ralph Seward, a labor negotiator in Philadelphia, to Oak Ridge to present the idea to the unions. On January 17 Seward got the necessary signatures on both contracts, a move which promised to allay the worst fears of the panel members. Kerr, with the help of John J. Flaherty, a Commission employee at Oak Ridge, completed a study which recommended Commission action on five articles in the Carbide contract and four in the Monsanto agreement.[21]

The panel accepted Kerr's recommendations early in February, and Belsley urged immediate discussion with the top leadership of the two unions. Although sympathetic to the idea, Wilson decided to postpone the meeting with Green and Murray until the Commissioners had been confirmed. Continuing unrest at Oak Ridge made that decision a calculated risk, but quick action in summoning experts had at least averted the immediate threat to the production of fissionable materials.

WHITHER RESEARCH?

As general manager, Wilson not only had to be ready to act quickly but also had to anticipate demands. Even before the General Advisory Committee met on January 3, he had set the formulation of a research and development program as a high priority. This was not a job for the research division in Oak Ridge, which was mostly responsible for administering Manhattan District contracts, or for the handful of temporary staff in his Washington office. First, he needed a director of research, a man of stature as a scientist and experience with research policy. The General Advisory Committee had set the tone in the list of distinguished scientists it had suggested for the job. Despite the impressive roster, Wilson had little trouble picking James B. Fisk. The same age, they had been roommates at MIT during the early thirties. While Wilson was serving as assistant to Compton and Bush, Fisk had studied at Cambridge and Harvard, taught physics at MIT, and become assistant director of physical research at the Bell Telephone Laboratories at the age of twenty-nine. Although he had devoted most of his energies during World War II to electronics and radar, he had learned enough about nuclear physics before the war to outline a proposal which alerted the British to the plutonium route to the weapon. An outstanding physicist well known to members of the General Advisory Committee, Fisk in directing industrial research at the

Bell Laboratories had gained experience which would be valuable to Wilson and the Commission. Fisk accepted the appointment on January 15.[22]

This was fast action on Wilson's part, but not fast enough to help him meet the deadline for the report to the advisory committee. The directors of the atomic energy laboratories were scheduled to meet at the University of California in Berkeley late in January. Wilson asked them to reschedule their meeting in Washington on January 16 in order to draft the report on research and development.

The group which assembled in Washington included some of the brightest stars in the galaxy of scientists who had participated in the wartime program. From the Argonne National Laboratory in Chicago came Walter H. Zinn, a student of Fermi's, who had directed construction of three experimental reactors, and Norman Hilberry, wartime assistant to Arthur H. Compton at the Metallurgical Laboratory; from the Radiation Laboratory at the University of California, Berkeley, Ernest O. Lawrence, the laboratory's dynamic founder and inventor of the cyclotron, and Edwin M. McMillan, the youthful codiscoverer of neptunium and inventor of the synchrotron principle; from the Clinton Laboratories at Oak Ridge, Tennessee, Eugene P. Wigner, the theoretical physicist who had conceived many of the early design principles for reactors, and Charles A. Thomas, an industrial chemist who had coordinated development of the plutonium weapon; from Los Alamos, Norris E. Bradbury, who had directed assembly of the Alamogordo device; from the new Brookhaven National Laboratory, Norman F. Ramsey, who had helped assemble the first atomic weapon on Tinian; and from the Ames Laboratory at Iowa State College, Frank H. Spedding, who had broken the bottleneck on uranium metal production for the world's first reactor.[23]

By prewar standards, the research activities described by the laboratory directors were impressive. Totaling thirteen contracts, the entire program would cost about $60 million in fiscal year 1947. Almost half this amount would go to the Clinton Laboratories at Oak Ridge. The Argonne National Laboratory, specializing in reactor development, would require more than $11 million. The Radiation Laboratory at Berkeley and the new Brookhaven Laboratory on Long Island would need about $6 million each and the new General Electric laboratory at Schenectady almost as much.

Just as impressive, however, was the task facing the Commission. The Army had supported the laboratories to meet the exigencies of war. Once the war was over, General Groves and his assistant, General Nichols, had kept the laboratories alive by authorizing modest short-range projects which would begin the transition from strictly military work to more general research. But the War Department was understandably reluctant on the strength of its wartime authority to do much more than hold the line. In the eighteen months since Hiroshima uncertainty and lack of purpose had sapped morale, and many of the scientists had returned to academic posts. True enough, Nichols had taken some steps to turn the larger wartime projects into national laboratories which would serve as regional research centers, but so far the changes were more in name than in fact.[24] The Commission had not inherited a research program but a collection of laboratories, all uncertain of the future and each pursuing an independent course.

If not an ideal forum for drafting a comprehensive research program, the meeting of laboratory directors at least enabled Wilson and his staff to explore the scope and diversity of laboratory activities. It was also an advantage to have the discussion led by such impressive authorities as Zinn on reactors, Wendell M. Latimer on chemistry, Wigner on physics, Lawrence on accelerators, and Spedding on metallurgy and ceramics. At the end of the meeting, Wilson asked each of them to prepare a portion of the report to the General Advisory Committee.

The biggest assignment fell to Zinn; for, as he told his staff at Argonne the following week, the Commission's research program seemed primarily a matter of reactor development. Weapon research would be important too, but the Commission intended to segregate that work in a special compartment. The Commission would need reactors not only to produce plutonium for weapons but also as a radiation source for the production of radioisotopes and for general research. There was also widespread public interest in using reactors to generate electric power.[25]

In drafting his section of the General Advisory Committee report, Zinn stressed power reactors. Here a fact of supreme importance was the shortage of fissionable material. Existing stocks of uranium ore seemed scarcely large enough to sustain production of a modest number of weapons, to say nothing of providing fuel for power plants. Zinn believed that the only hope for power reactors lay in those which would breed more fissionable material than they consumed. Such a reactor would operate on the principle that theoretically each fissioning nucleus of uranium or plutonium released on the average slightly more than two neutrons. If one neutron sustained the chain reaction, the second and the occasional third neutron might be captured by nuclei of fertile material to create two atoms of fissionable material where one had existed before. Thus a breeder reactor might produce power and at the same time augment the nation's small stocks of fissionable material.

Translating the breeder principle into practical hardware would be extremely difficult. Because the chances for breeding seemed marginal at best, neutron production and economy would be controlling factors in breeder designs. A complication was the fact that, while breeding seemed to improve with an increase in the energy of the neutrons used in the reactor, power-generating capabilities declined. Zinn described two approaches to this difficulty. At Argonne he was designing a small reactor which would use high-energy or "fast" neutrons. The new General Electric laboratory at Schenectady would try to compromise on power production and breeding by searching for an optimum intermediate-neutron energy. The low-energy or "thermal" reactor which Farrington Daniels and his associates were designing at the Clinton

Laboratories would concentrate on power production with no consideration of breeding.

Zinn's report noted that the Commission already had several reactors operating for research purposes: the rebuilt Fermi pile and a small heavy-water-moderated reactor at Argonne; two small reactors at Los Alamos; one test reactor at Hanford; and the X-10 graphite reactor at Clinton, which produced both large quantities of radioisotopes and radiation for research. None of these units, however, met the greatest need of the scientists, a reactor with a very large flux of neutrons and a number of large access ports for irradiating a variety of materials, including reactor components. The Clinton Laboratories had started designing a high-flux reactor, but Zinn predicted it could not be completed quickly. He estimated that six reactors then being developed would cost $30 million and would require an inventory of 280 kilograms of uranium 235. He guessed that the reactors would consume about 34 kilograms per year and might generate as much as 14 kilograms of new fissionable material.

Zinn was not entirely sure what the report should contain, and he had little time to write it. Only by working into the weekend in a Washington hotel room was he able to complete it for the meeting of the General Advisory Committee on Sunday morning, February 2.

Oppenheimer called the meeting to order shortly before ten in a huge, three-story-high conference room in the New War Department Building. In addition to all the members of the committee, three Commissioners and several members of the Military Liaison Committee were present. Oppenheimer explained why the military officers had been invited. A few days before he had asked Lilienthal to supply the committee with information on the weapon stockpile and production rates. The information was so sensitive that Lilienthal was willing to provide it only orally with military representatives present, and only with a general accuracy "within a plus or minus 20 percent." After the staff had left the room, Bacher, who had just returned from Los Alamos, related the information which a few weeks earlier had been known only to General Groves and a very few of his Manhattan District personnel. It was a dramatic moment as those present closed their notebooks and Bacher recited the magic numbers.[26]

Because the research and development report was less sensitive, the committee could consider it in written form. Oppenheimer began by describing the report prepared by the Scientific Panel to the Interim Committee in September, 1945.[27] That report had cited the greatest opportunities for progress in developing weapons, reactors, and radioisotopes for research. From the oral and written reports now before the General Advisory Committee, Oppenheimer understood that there had been "no real exploration of new weapons," either of the fissionable or thermonuclear type; no new reactor had been built and no reactor development program had been organized in the intervening seventeen months. Only in the production of isotopes in the Clinton reactor had the expectations of the Scientific Panel been realized.

As the discussion proceeded, Oppenheimer saw the dilemma facing the committee. If the program had been weak in only one area, the committee might easily have recommended greater effort there. But a general deficiency called for either a large increase in support for all activities or a more careful allocation of available resources. After lunch, Oppenheimer began to think out loud on the subject. As well as he understood the value of weapons, he could not give reactors a second priority. Remembering the spirited discussions of the Lilienthal board of consultants just a year earlier, he dwelt on the extraordinary opportunity to transform public understanding of atomic energy from a specter of war into a promise for peace by developing reactors for the production of power. Perhaps with a top priority it might be possible to obtain some power from a reactor in a year or two.

Fermi acknowledged similar hopes for the peaceful atom, but the dangerous international situation pushed him inexorably to the conclusion that weapons commanded the first priority. He urged an increase in plutonium production, a test of existing weapons, and development of a thermonuclear weapon. The achievement of nuclear power would have good psychological effects, but it would not mean much if the Commission did not greatly increase the supply of fissionable materials. Most of the other members agreed. The discussion of the relative importance of weapons and reactors soon gave way to an exploration of the weaknesses of the weapon laboratory at Los Alamos.

Perched on a remote mesa near Santa Fe, New Mexico, the laboratory at Los Alamos was but a shell of the wartime organization which had developed the first atomic bomb. Most of the well-known scientists had left in 1945, and the dilapidated temporary buildings stood as sorry monuments to better days. Housing and community facilities, substandard even during the war, were now intolerable. Some members of the committee believed that the leadership at Los Alamos was at best inexperienced and uninspired; most of the remaining scientists, though perhaps of average ability, seemed to lack the spark of genius which had been considered a necessary ingredient for success during the war. Would it be possible to develop new weapons under such conditions? Would it be better to move the laboratory to another location? Could outstanding scientists be induced to join the laboratory staff?

Although Oppenheimer marveled at the ability of his colleagues to find the heart of the issue, he was still reluctant to accept the conclusion that the production of weapons and the development of improved models would be necessary in the postwar world. Accepting that conclusion, however disheartening, Oppenheimer argued for a strong laboratory at Los Alamos. It would do no good to move the laboratory without recruiting better leadership and staff. Perhaps, he suggested, a strong reactor program would have greater appeal to the exceptional scientist than the development of thermonuclear weapons. Rabi feared that a reactor program at Los Alamos would spread the Commission's effort too thin. He felt there was already too much competition between laboratories.

In the end, agreement within the committee was almost unanimous. The first aim should be to revitalize Los Alamos and accelerate weapon research, especially on thermonuclear models. In reactor development both Fermi and Oppenheimer now gave highest priority to improvement of the plutonium production units at Hanford. They listed next the development of a power-breeder reactor and a high-flux test reactor, although they differed on the order of priority. For most of the members, the choice of the weapon alternative stemmed from a sense of duty, not enthusiasm. The hard realities of 1947 were fast replacing the heady idealism of 1945.

WEAPONS

The high priority assigned by the General Advisory Committee to weapon development and production would have pleased Norris E. Bradbury had he witnessed the discussion on February 2, 1947. A National Research Council fellow in physics, he had taught at MIT and Stanford before joining the Navy in 1941. As a naval officer he had had a key assignment at Los Alamos during the war and had succeeded Oppenheimer as director of the laboratory in 1945. Being Oppenheimer's successor was difficult enough, but Bradbury's position was otherwise precarious. In its discussions the committee seemed to assume that Bradbury's assignment was temporary. Either the laboratory would be disbanded or he would be replaced by a scientist of greater reputation. Some members of the committee believed that, whatever Bradbury's competence as a scientist, he lacked the stature to be director of the nation's atomic weapon laboratory.

If Bradbury sensed the uncertainty of his position, his actions did not suggest it. His determination to rebuild Los Alamos and strengthen research on weapons helped him to overcome the frustrations of poor facilities, demoralized staff, and, worst of all, indecision. Soon after the Commission was established in November, 1946, he submitted a comprehensive plan for research at Los Alamos, but there was in fact no one to receive it. The Army passed the report along its chain of command in the Manhattan District to Lilienthal, but the Commission's infant headquarters organization contained no one except Bacher with a knowledge of weapons.[28]

Essential to policy guidance on weapons was selecting an Army or Navy officer to serve as director of military application. In December, 1946, when the Commission had asked the service secretaries for recommendations, the only officer proposed was General Nichols, who had been General Groves's deputy in the Manhattan project. The Commissioners admired Nichols's ability but wanted to assure a clean break from the wartime administration. The Commission responded by asking the service secretaries for additional names, a request which Secretary of War Robert P. Patterson referred to Lauris Norstad, an able young Army Air Force general who was chief of the plans and operations division of the General Staff.[29]

Norstad surmised that the Navy would nominate prestigious admirals like William P. Blandy, who had directed the nuclear weapon test at Bikini in 1946. He observed that both Lilienthal and Wilson were young men. Would it not be wise to propose a number of officers spanning a range of years? Thus he suggested officers ranging from Lieutenant General Wilhelm D. Styer, age 53, to Lieutenant Colonel Andrew J. Goodpaster, age 32. As Norstad expected, the Commission found the new Army list promising, but he did not anticipate the immediate result. Wilson's telephone calls to Bush during the first week of January revealed Norstad as the author of the Army list. Informal discussions with Norstad convinced Lilienthal, Pike, and Wilson that the general himself should be considered for the position.

When neither Patterson nor General Dwight D. Eisenhower would consider releasing Norstad, the Commission selected from the middle of the Army's list a young officer from Norstad's own staff, Colonel James McCormack.[30] A Rhodes scholar following his graduation from West Point in 1932, McCormack had studied engineering at MIT. He had met Wilson during the war, when he had served as secretary to the Joint Committee on New Weapons, of which Bush was chairman. An intelligent young man with broad interests, McCormack had a flexibility that would make him a good staff officer. He had been uncertain about his future in the Army and accepted his new assignment as a rare opportunity for a productive military career. On its part the Commission considered McCormack worth the two months of negotiation with the Army which his selection required. As soon as the Commission could effect McCormack's transfer to his new job as a brigadier general, he could begin to help the Commission remove the uncertainties that were crippling Bradbury's efforts at Los Alamos.

RESEARCH AND DEVELOPMENT

James Fisk, the new director of research, was on the job before McCormack had been selected. He had the advantage of attending the General Advisory Committee meeting in early February and hearing the discussions of the relative importance of weapons and reactors. But the difficulties of Fisk's assignment counterbalanced any head start he might have enjoyed. In contrast to McCormack, whose responsibility largely involved one mission at one site, Fisk had to direct a broad range of vaguely defined activities in a dozen laboratories. To make matters worse, working conditions in many of the laboratories were chaotic and morale was low as a result of the delays in organizing postwar programs. John H. Manley, a veteran physicist in the atomic energy project and seasoned observer of laboratory operations, drew a disheartening picture of conditions at the Clinton Laboratories at Oak Ridge in February, 1947. Recently appointed the executive secretary of the General Advisory Committee, Manley described his visit to Oak Ridge in a frank report to his old friend and new boss, Oppenheimer.[31]

Manley found the disagreeable living and working conditions in the temporary buildings at Oak Ridge complicated by poor organization. At least three groups participated in policy decisions in the laboratory, and all were to some extent working at cross purposes. The scientists under Wigner's leadership were the remnants of the original team which conceived the design for the Oak Ridge and Hanford reactors during World War II. Impatient to resume fundamental research in nuclear physics interrupted by the war, the scientists concentrated their attention on the high-flux reactor and tended to regard short cuts to a power reactor as stunts. They also maintained the academic tradition of regarding Government regulations as senseless interference with their work.

The second group consisted of a few scientists and a larger number of engineers brought to Oak Ridge by the Monsanto Chemical Company, which had assumed the operating contract for Clinton from the University of Chicago in the summer of 1946. The original group resented the efforts of the Monsanto leadership to consolidate activities and to regularize procedures in the laboratory as an attempt to transform them into company men. As a result, the Monsanto project to develop the gas-cooled power reactor suggested in early 1946 by Farrington Daniels was isolated from other work in the laboratory.

The third group included the Army officers and civilian employees who had administered the contract during the war for the Army and who now were employees of the Commission. With little policy guidance from Washington, they had no choice but to use the regulations established during the war or, when this proved impossible, to guess in which direction the Commission would wish to move. During the war both the mission and lines of authority were clear. As these dissolved in 1946 and early 1947, misunderstanding and frustration crippled the laboratory.

Manley believed the unfavorable atmosphere in the laboratory damaged the quality of research. As a physicist he could appreciate the efforts of Wigner, Alvin M. Weinberg, and others who were designing the high-flux reactor, but he found the prospects for the reactor difficult to judge in the absence of a clear purpose. Certainly the reactor would be an important research tool, but he heard talk of building a high-temperature region into the reactor as a power experiment. Such a facility might obviate the need for experimental power reactors such as the Daniels reactor, but would it not reduce the reactor's value for research? In the Monsanto project, Manley had little confidence. Originally intended as a quick demonstration of the peaceful potential of atomic energy, the Daniels reactor was losing its identity as a power producer. Development studies had revealed technical obstacles which either reduced the possibility of building a practical power reactor or threatened to delay completion long enough to eliminate the advantages of early construction.

Manley found many scientists at Oak Ridge so discouraged that there was again talk of merging Clinton with the new Brookhaven Laboratory, either on the proposed Long Island site or at another location. A merger would make better use of the still-short supply of nuclear scientists and presumably would result in a laboratory better situated for contacts with leading universities and access to the skilled labor market. Some feared that the proposed merger would lead to domination by certain strong leaders in the Brookhaven organization like Rabi, a member of the General Advisory Committee. For everyone at the Clinton Laboratories the future was uncertain and for many it seemed hopeless.

FIELD OPERATIONS

Whether the General Advisory Committee gave first priority to weapons or reactors, success would depend on an adequate supply of fissionable materials. This responsibility the Commission assigned early in January, 1947, to Walter J. Williams, an engineer with fourteen years of construction experience in the Army. After supervising the building of several ordnance plants for the Army in the early years of the war, Williams had gone to Oak Ridge to direct construction of the electromagnetic separation plant for producing uranium 235. In 1945 he became Groves's production chief at the Oak Ridge gaseous-diffusion plant and later director of all production operations for the Manhattan District. With more interest in engineering than in the Army, Williams was pleased to retire as a colonel in 1946 and take a civilian job under Groves as director of field operations. He first met Wilson in November, 1946, and soon thereafter Wilson asked him to continue in the same job, at least until the general manager could organize his headquarters staff. The Commission appointed Williams director of production, but he continued to spend most of his time in the field assignment during the winter and spring of 1947.

The variety and number of problems confronting Williams would have dismayed a lesser man. During the last three days of February he fixed policy for the disposal of surplus equipment, selected consultants to study the gaseous-diffusion plant, determined prices to be charged for radioisotopes, revised the schedule for constructing the new weapon component plant near

Dayton, Ohio, negotiated a security supplement to a major construction contract, ordered the disposal of a surplus production plant, negotiated a contract for operation of the Y-12 electromagnetic plant at Oak Ridge, approved a proposal for architect-engineering at the new Argonne National Laboratory near Chicago, ordered an inspection of the new General Electric laboratory near Schenectady, advised headquarters on personnel ceilings, established the Commission position in a labor dispute at Oak Ridge, and approved hiring forty security guards for production plants at Hanford.[32]

To all these matters Williams brought a practical realism which helped him to go about an impossibly big job with poise and determination. He understood his assignment—to maintain the steady flow of materials from uranium mine to weapon plant—and he had little time or interest for tasks not related to that goal. At times he was impatient with the organizational jockeying and groping for policy in Washington. He grumbled about the interruptions by smart young gadflies on the Washington staff, but he had a natural loyalty and simple integrity which made it possible for him to work hard and without reservation for a younger and less experienced superior. Williams sometimes thought Wilson's approach idealistic and off the point, but he appreciated his superior's willingness to listen and act on the basis of facts. Although he understood every nuance of the Army system in the Manhattan District organization, Williams did not let the system dominate him. Nor was he cowed by Nichols or Groves, with whom he could disagree openly.

Certainly the difficulties facing the huge Tennessee installation deserved more attention than Williams could give them. The Commission's quick action in taking a position on the union contracts at Oak Ridge had removed the immediate crisis, but Williams found the issue far from settled. Complaints from the CIO leaders about Carbide labor practices kept him in constant touch with Colonel Curtis A. Nelson and the industrial relations staff. The dispute seemed mostly to involve administrative details, but Williams never lost sight of the fact that a labor walkout even for a few hours in the gaseous-diffusion plant might do irreparable damage to facilities for producing uranium 235.[33]

Nor was Williams able to avoid the entanglements of community problems. The three "atomic cities" at Oak Ridge, Hanford, and Los Alamos placed upon the Commission unprecedented peacetime responsibilities for community management. The three communities were much more than company towns in the usual sense. Not only did the Government own all the land and the buildings, but the Commission had also assumed from the Army the operation of all municipal facilities, schools, commercial establishments, local transportation, and government. No one could even visit Oak Ridge or Los Alamos without a Commission pass, much less live there without permission. Beyond the short-term administrative techniques of community management lay the task, happily unfamiliar to most Americans, of replacing a structure of total Government control with the institutions of democratic society.

In the winter of 1947 Williams's responsibilities extended to all three towns, but he concentrated his efforts at Oak Ridge. It was the largest community and had more than its share of difficulties. The Army had been able to do little to transform the hastily built temporary wooden structures on the scarred mud hillsides into a permanent town. As Colonel Paul F. Kromer reported in January, construction standards at Oak Ridge during the war had been at the barest minimum. After the war instructions were to plan ahead for only ninety to one hundred days. As a result schools were first improperly located and then overloaded, commercial facilities were inadequate, and office space, shops, service, and recreational units were substandard or too expensive for long-term operation. Since the Army had not planned the town as a permanent community, the Commission would have to begin with detailed surveys of existing facilities and a master plan for construction. Somehow Kromer had to develop plans for community improvements to be incorporated in the Commission's 1948 budget, then in preparation.[34]

BALANCING PRODUCTION AND RESEARCH

Williams's broad responsibilities as director of field operations involved him in every phase of the Commission's activities during the winter of 1947. Until Wilson could organize his headquarters staff and appoint deputy general managers to take over the field offices, Williams found himself in the curious position of making decisions which under normal circumstances would have fallen to other division directors or the general manager. As director of production Williams could be expected to take a firm hand in matters concerning the major production sites, but his responsibilities in the research area and even in some aspects of weapon production sometimes surpassed those of Fisk and McCormack. This was particularly true in administration of the laboratories. Fisk, as a personal friend and confidante of Wilson's, concentrated on policy issues and preferred for the time being to leave administration to Williams and his staff of Army officers at the various field installations. This division of responsibility had the advantage of keeping contract administration in the hands of Williams's experts. There was the added benefit that Williams, with direct control over both production and research activities, was in an excellent position to explore the fundamental question of finding a proper balance between these two cardinal endeavors.

One thing that drew Williams into research activities was the impatience of the laboratories to begin new construction after the long moratorium imposed by the Army. Because Wilson had not yet been able to organize the division of engineering in Washington, Williams had to assume responsibility for major construction projects. This in turn involved him in contract negotiation, contractor selection, site acquisition, and procurement. At the University of California in Berkeley, Lawrence and his staff wanted new buildings and equipment for research in high-energy physics. Spedding needed a permanent building for metallurgical research at Iowa State College in Ames. The letter contract with Associated Universities, Incorporated, in January, 1947, brought new pressures on Williams to speed plans and contractual arrangements for the new Brookhaven National Laboratory. Even more pressing were the demands coming from Zinn and the University of Chicago to begin construction of new facilities for the Argonne National Laboratory, still housed in a dozen university buildings on campus. Not until January, 1947, did the Commission give up on acquiring land in the Argonne Forest Preserve south of Chicago and agree on a site southwest of the city in Du Page County. Williams's staff at Chicago needed more than a month to make plans for acquiring the 3,500 acres in the site. On March 11, Williams himself went to Chicago for construction contract negotiations with William B. Harrell, the university's business manager.[35]

As in community matters, Williams found his greatest troubles with the laboratories right at home in Oak Ridge. The sagging morale and pessimism which Manley had noted at the Clinton Laboratories in February were, if anything, worse in March. There was no reason to believe that the laboratory would even continue to exist. While waiting in vain for some sign of encouragement or decision from Fisk, Wilson, or the Commissioners in Washington, Wigner and James H. Lum, the laboratory's codirectors, endured as best they could what they saw as indifference or harassment from the military officers on Williams's Oak Ridge staff. These differences came to a head on March 12, when Williams returned from his trip to Chicago. He learned that the scientists were conducting experiments with a critical mass of uranium 235. Colonel Walter P. Leber, Williams's representative at the laboratory, had warned Wigner that the experiment violated an order issued by General Groves in August, 1946, requiring the laboratories to submit to his office for prior approval written descriptions of all critical experiments. Wigner thought that Groves's order had been superseded by the laboratory directors at their meeting in Washington in February, 1947.[36]

The report alarmed Williams. Groves's order of the previous summer was designed to prevent the recurrence of an accident during a critical experiment at Los Alamos, which had taken the life of one scientist and injured several others.[37] Late in the afternoon Williams called Wilson in Washington to report that he intended to stop the experiments until Wigner complied with the regulation. With Wilson's support, Williams the following morning called Lum to insist the experiments be halted. A few minutes later Wigner called back. Unable to conceal his anger, Wigner admitted that the laboratory had been late in forwarding a written plan for the experiment, but he insisted the order from Groves was no longer in effect. Stopping the experiment now would cause great damage. Williams suggested that continuing the experiment might have the same result. He was disturbed that Wigner had ignored the warning from Colonel Leber. Wigner retorted that he took his orders from Charles A. Thomas and the Monsanto organization in St. Louis, not from Leber.[38]

Ultimately Wigner had no choice but to comply with the order, but his slender frame seethed with indignation. Pouring his frustrations by telephone into Thomas's sympathetic ear, Wigner decried what he saw as heavy-handed interference with scientific research. The experiment was nothing like the one which caused the accident at Los Alamos. It involved neutron measurements in a lattice arrangement of uranium 235 suspended in water. If such an elementary experiment in studies for the high-flux reactor could not be undertaken without administrative interference and delay, what hopes were there for any real development of power reactors?

In two weeks Wigner obtained the necessary administrative approval for the experiment, but the incident left its scars. It impressed Williams with the urgency of replacing held-over Army regulations and administrative practices with new, up-to-date procedures. For Wigner and the Monsanto organization, the incident shook their confidence in the future of the Clinton Laboratories. All could hope the dispute was but an isolated incident provoked by the transfer from Army to Commission control, but it could also be a forecast of more trouble ahead.

The following week brought Williams closer to the activities of other installations. On Monday morning, March 17, he was up before dawn and bounced over back-country Tennessee roads to the Knoxville airport where he boarded the converted B-25 bomber which the Commission had inherited from General Nichols. Before noon he was in Schenectady, where he inspected two buildings which General Electric was remodeling for its atomic power laboratory. Reviewing plans for the laboratory, he was surprised to learn that the ultimate cost was expected to be more than $40 million, far more than figures quoted earlier. He suggested that the company assemble its plans and ask Wilson for an appointment to discuss them with the Commission.

Williams was even more concerned about General Electric's plans for the plutonium production plants at Hanford. Harry A. Winne, a vice-president who had served on the Lilienthal board of consultants in 1946, told Williams that the company planned first to build new housing to replace some of the temporary wartime structures and to add storage tanks for the highly radioactive waste materials coming from the huge chemical plants which separated plutonium from the irradiated slugs of uranium.

Williams thought Winne's plans were inadequate. They would scarcely permit Hanford to maintain its present rate of production, which Williams viewed with growing concern. Plutonium production was a fraction of its wartime rate. Sustained operation of the three production reactors in 1945 had caused expansion of the large graphite block within the reactor shield. This expansion had distorted the aluminum tubes which contained the uranium slugs and through which the cooling water flowed. Unless some way could be found to stop this expansion, all three reactors might become inoperable within a few years. As a form of insurance, the Army had ordered the oldest reactor (B) shut down and placed on stand-by early in 1946. The two remaining reactors (D and F) were operating at reduced power to conserve their lives.[39]

Equally ominous were the prospects for separating plutonium from the slugs discharged from the reactors. The chemical separation plants built at Hanford during the war were still operating, but the process recovered only the plutonium, the great quantities of uranium in the slugs going into underground tanks with the highly radioactive fission products and wastes. There was something ironic and even alarming in the fact that the Commission, facing extreme shortages of uranium ore, was using a process which rendered most of its uranium useless. Seaborg and other chemists at the Chicago Metallurgical Laboratory had advocated developing a better process, but the Army was reluctant to authorize research which was clearly for postwar application. The Clinton, Argonne, and Hanford laboratories were all studying alternative processes on a small scale, but much greater effort would be required to stop the wasteful diversion of the Commission's dwindling ore supplies.

All this meant to Williams that General Electric should give top priority to the new chemical separation process called "Redox" and to plans for a new production reactor. He also wanted the company to study the possible hazards which might result from radioactive gases released from the chemical separation plants and to make plans for performing at Hanford the final steps in plutonium metal purification, still accomplished in inadequate temporary facilities at Los Alamos. Williams suggested that General Electric concentrate on Redox while he would find other contractors to help on the stack gas problem and the plutonium metal plant.

Early the next morning Williams flew to New York for meetings with Wilbur E. Kelley, a young engineer whom he had met at the Y-12 production plant in Oak Ridge during the war. Recently Williams had sent Kelley to New York to take over what the Army had called the Madison Square Area, which directed the raw materials program and handled other procurement activities in the Northeast. Information which Kelley was collecting for a written report to Wilson must have increased Williams's concern about the Redox process. Kelley estimated that to keep all operating plants going the Commission would have to provide large stocks of uranium ore to the St. Louis refinery. For the year ending April 1, 1948, the Commission could anticipate receiving 3,125 tons of uranium oxide (U_3O_8), most of which would come from the Shinkolobwe mine in the Belgian Congo. Virtually all of this concentrate would go into production channels on delivery. Since some of the material would be used to build up stockpiles, requirements for the following year would be somewhat smaller. Williams realized, however, that a substantial increase in ore procurement was necessary.[40]

Then Williams and Kelley met with Philip M. Morse, director of the Brookhaven National Laboratory, and Eldon C. Shoup, executive vice-president of Associated Universities, a corporation of nine universities in the Northeast, which would operate the laboratory. Preliminary plans called for a research reactor similar to the X-10 unit at Oak Ridge, a "hot" laboratory for processing irradiated materials from the reactor, and several accelerators in addition to general research facilities. But so far little had been done to transform the former Army camp into a laboratory. Most of the discussion centered on plans for the accelerators and housing for the scientists. Williams, perhaps thinking of headaches in the Oak Ridge community, opposed the suggestion that the Commission build any of the housing. He also told Kelley to negotiate a definitive contract to replace the letter agreement which the Commission had approved in January, 1947.[41]

Later on the afternoon of March 18 Williams again boarded his plane for a flight to Washington to pick up Wilson before making the longer trip over the mountains to Knoxville. This was Wilson's first visit to Oak Ridge as general manager, and Williams had arranged two full days of meetings and inspections. The staff meetings on March 19 and 20 gave Wilson a good feel for the caliber and morale of Oak Ridge personnel, and visits to K-25, Y-12, and X-10 gave him an opportunity to verify reports of the superb operation of the gaseous-diffusion plants and the administrative difficulties plaguing the Clinton Laboratories. On the latter subject he found particularly helpful the discussions at dinner on March 19 with Charles Thomas and Carroll A. Hochwalt, Monsanto vice-presidents who had general responsibility for the company's operations in the Oak Ridge laboratory and in weapon component facilities at Dayton, Ohio. Wilson had gone to Oak Ridge a year earlier with Thomas as a member of the Lilienthal board of consultants and had known Hochwalt as a scientist with the National Defense Research Committee during the war.[42]

The discussion aptly illustrated the fundamental question of balancing production and research activities. Like General Electric, Monsanto was deeply committed in both efforts. Wilson, to be sure, was concerned about Monsanto's troubles in the Clinton Laboratories, but these were overshadowed by his growing anxiety over construction progress on the new weapon component plant near Dayton. The neutron initiator which Monsanto had produced for the Army during the war was a critical part of the atomic weapon. The temporary wartime facilities had been adequate for producing on a laboratory scale the few units needed to win the war, but not for normal operations on a production scale. Williams had given construction of the new plant at Miamisburg, Ohio, the highest priority, and Wilson was anxious to extend the Monsanto contract, which would expire in June, 1947. After talking with Thomas and Hochwalt he was ready to recommend a four-year extension and amendments which would provide the company with a fee rather than payments for overhead. For strategic reasons Wilson also wanted a second production plant for the same component at another site, but to maintain secrecy he wanted Monsanto to operate it.[43]

FIRST SUMMATION

The trip to Oak Ridge had been a good change of pace for Wilson and helped him to see for himself some of the questions which were rapidly approaching decision. He was pleased that he had been able to reach an understanding on the Monsanto contract and found further encouragement on Friday morning, March 21, 1947, when Winne called to say that General Electric was acting on Williams's suggestion and wanted to discuss their hopes for the Schenectady laboratory and the Hanford plant. Wilson put the meeting on his calendar for Wednesday morning, April 2. That would be just a few days after the next meeting of the General Advisory Committee, scheduled for the weekend of March 28.[44]

The intervening week proved to be hectic. It started on Saturday morning when Wilson moved into his new office in the Commission's permanent headquarters building. Just a few blocks east of the temporary offices, the building at Nineteenth and Constitution Avenue, N.W., had been built in the middle thirties for the Public Health Service and had been the wartime headquarters of the Joint Chiefs of Staff. Only recently returned to the Surgeon General, it was virtually vacant. The building had the advantage of being near the White House and the major Executive departments, but Wilson thought its best feature was its small size, which would accommodate no more than 350 people comfortably and had little room for expansion. This fact would give him a good argument against appeals for increases in the headquarters staff.[45]

Monday brought the weekly staff meeting, discussions of security matters with Jones, a short Commission meeting, and a half hour with McCormack, who brought in a vigorous objection from the Military Liaison Committee about the small amount of space available in the new headquarters building. Not until dinner with Fisk was Wilson able to consider the policy papers which the staff was preparing for the meeting with the General Advisory Committee on Friday. Tuesday was even worse, with a dozen conferences on organization and personnel matters, a Commission meeting, business over lunch with Fisk, a meeting with University of Chicago officials about the Argonne construction project, a trip to FBI headquarters to discuss security arrangements with J. Edgar Hoover, and a late afternoon session to make plans for forthcoming discussions with the British. Wednesday and Thursday were equally crowded. At dinner on Wednesday Strauss told him of renewed complaints from the Navy about the military space assignment; on Thursday evening Wilson worked with Fisk on last-minute preparations for the advisory committee meeting.[46]

At the opening session on Friday, March 28, Wilson reported the steps he had taken to strengthen weapon production.[47] The Commission on Wednesday had approved double shifts for construction of the Miamisburg plant, and he had offered Monsanto a four-year extension of the contract which would expire in June. He had accepted McCormack's recommendation to keep the weapon laboratory at Los Alamos. He intended to strengthen the laboratory and to create normal living conditions at that remote location. He had extended the operating contract with the University of California to July, 1948. He had also discussed with the Military Liaison Committee the need for testing atomic weapons and proposed to prepare a policy paper on testing. On research activities Wilson said he had authorized Zinn to find a site at Argonne for the fast-breeder reactor, and he had told the University of Chicago that he would extend the contract for operating the laboratory for four years.

Wilson was now ready to discuss the policy papers which he hoped would lead to a solution to the Commission's most pressing operational problems. He began by describing the difficulties he had faced in taking over the project from the Army. It was one thing to understand the widespread activities the Commission had inherited; it was something else to act quickly enough. There was a real emergency in weapon production. The precarious condition of the Hanford reactors, the lack of critical weapon parts, the dreadfully inefficient plutonium separation process, the impending expiration of many operating contracts, the deplorable state of preparations for the 1948 budget, all were matters weighing on Wilson's mind. The need for quick decisions was apparent.

Wilson's policy papers reflected the sense of urgency which crept into his opening remarks. Though phrased in the tentative language of preliminary proposals, they implied some far-reaching decisions. To assure speedy action Wilson hoped the General Advisory Committee would consider his policy papers that weekend.[48]

After Wilson departed, the group heard three reports from its own subcommittees. Cyril Smith's paper suggested that the Commission concentrate on the fast-breeder and high-flux reactors and give only limited study to the General Electric and Daniels units. In reporting on weapons, Conant cited the need for tests and Fermi urged realistic theoretical studies of thermonuclear designs. Seaborg's report argued that a substantial increase in plutonium production would depend more on additional reactors at Hanford than on breeders. It was inconceivable that the Commission could continue to dump the large quantities of irradiated uranium into the waste tanks at Hanford. He explained research completed on the Redox process, which would use solvent extraction techniques to recover both uranium and plutonium. As a matter of fact, Seaborg pointed out, the successful development of breeding might well depend upon a process such as Redox to separate the plutonium bred in a reactor from uranium 238.[49]

On Saturday morning, March 29, 1947, Oppenheimer began the discussion of Wilson's policy papers. The first paper proposed "that for effective concentration on urgent problems and for security," the Commission's primary activities "be conducted as completely as possible with Atomic Energy Commission facilities, essentially disentangled from nonprogrammatic, fundamental research." This idea intrigued the committee; for it seemed to be suggesting a centralized Commission laboratory. The committee retraced the arguments at the February meeting: the disadvantages of geographical separation of scientists in the existing laboratories, the difficulties of finding leadership and scientific talent for several laboratories, and the danger of harming morale by attempting to move existing groups to a central location. Fermi in particular was concerned about the last point. He did not see how the group working on the high-flux reactor at Oak Ridge could be summarily directed to transfer to Argonne. He agreed that centralization was necessary, but did that require geographical consolidation? Would it not be better first to establish direction in Washington? Fermi was willing to approve Wilson's proposal in the general terms in which it was presented, but he was reluctant to add the more specific suggestion that the Commission consider establishing a central laboratory. Tentatively the committee decided both to approve the proposal and to add the suggestion.

One reason for a tentative decision was its relationship to the other policy papers Wilson had submitted. For example, in the second paper Wilson proposed a hard line with General Electric on its responsibilities at Hanford, in contrast with its interest in the new nuclear research laboratory at Schenectady. Wilson wanted much more effort than the company proposed on Redox, uranium waste recovery, production reactor replacement, and extension of existing reactor life and much less work on power reactors. The committee recommended a softer approach. The Commission should establish definite priorities for the work at Hanford and then explain to the company the full scope of its plans for renovating and enlarging production facilities at Hanford. If the General Electric officials understood, as the committee did, the Commission's tentative plan to replace the three existing reactors and the associated chemical separation facilities, the company would better appreciate the need to concentrate on production activities. At the same time, the committee was not so ready as Wilson was to order a reduction of effort on power reactors at Schenectady. The committee realized that the Schenectady laboratory would be a glaring exception to any plan to create a central laboratory, but the committee saw centralization realistically as a long-range goal rather than something to be accomplished in the short term.

Wilson's third paper was even more closely related to the proposal for a central laboratory. In it, the general manager suggested that the Clinton

Laboratories concentrate on the production and distribution of radioisotopes under the Monsanto contract. The new Oak Ridge Institute of Nuclear Studies would use the research facilities of the X-10 reactor as a part of a regional research center for universities in the Southeast. Weinberg's group on the high-flux reactor would stay at Oak Ridge until a new location, presumably the central laboratory, could be established. The committee agreed that the high-flux reactor was the backbone of a long-range reactor program and that Weinberg's team was a key group. But Clinton's problems would not be solved in the Oak Ridge context alone; the solution involved the decision on the central laboratory and even on the plans for studying the Redox process. The committee, for example, suggested that Monsanto might use some facilities at Clinton to develop a process for recovering the uranium in the waste tanks at Hanford while General Electric explored Redox with the chemical group at Argonne.

The conversation drifted back to the central laboratory proposal, and particularly to the question of location. There were many suggestions, but the most attractive was to use the new site for Argonne in Du Page County, Illinois, while the existing Argonne facilities would serve as a regional research center for universities in the Midwest. The new Argonne site had the advantage of being near a large metropolitan area and at the same time seemed to be big enough to accommodate both the fast-breeder and the high-flux reactors. As Oppenheimer later explained to the Commissioners, the committee hoped to make the best possible use of limited scientific manpower, and it wanted a well-directed, well-understood development program. This goal seemed impossible while the work was scattered in a number of isolated laboratories, particularly when the exchange of information between them was hampered by security regulations. If the Commission had been starting out fresh without any laboratories or security restrictions, the committee would certainly have recommended one laboratory for all research, including that on weapons. Under existing circumstances, such a plan was out of the question. The committee was not prepared to urge even a partial centralization if there were strong opposition to it among the scientists. But the committee hoped the Commission would explore the idea and try to find a workable arrangement.

Wilson's paper on weapons required little discussion, for it coincided in every important respect with the committee's own conclusions. Los Alamos would have the highest priority for weapon development and testing. The committee agreed that ordnance and production activities should be transferred to Sandia Base near Albuquerque, but Oppenheimer suggested that the weapons subcommittee he had just appointed discuss details of the transfer during its forthcoming visit to Los Alamos. These matters were of interest to the armed forces and the Joint Research and Development Board. It was important that the operations at Sandia be acceptable both to the Commission and the military.

On the more technical aspects of weapon development the committee preferred to withhold judgments until its subcommittee had visited Los Alamos. There was a general concern, however, about the fact that the only weapon use for uranium 235 during the war had been in the extremely inefficient gun-type model dropped on Hiroshima. The splendid operation of the gaseous-diffusion plants at Oak Ridge and the troubles encountered with the Hanford reactors suggested the urgency of finding some use for uranium 235 in an implosion weapon as well as enlarging plutonium production facilities.

Summing up three days of discussion, Oppenheimer observed that the committee had in effect proposed a series of priorities. First above all was the need to revitalize weapon activities at Los Alamos. Second only to weapons was the need for Redox. Only a little less important than Redox was the construction of new reactors at Hanford. Then followed, with much lower priorities, the efforts to extend the operating life of the existing reactors and to recover the uranium from the waste tanks at Hanford. In reactor development, the committee gave the highest priority to the fast-breeder and high-flux reactors. General Electric's research on the intermediate-power-breeder reactor would be less important than the company's efforts on Redox and the Hanford expansion. Work on the Daniels gas-cooled power reactor at Oak Ridge would be suspended until much more fundamental studies in reactor technology could be completed.

It had been a long session. When the committee finally adjourned late on Sunday afternoon, March 30, it had discussed in one way or another every aspect of the Commission's activities. The committee's suggestions were not always clear nor were its recommendations always consistent, but it spoke with the voice of authority. Its distinguished membership would have assured effectiveness in almost any situation; in the absence of strong Commission leadership in March, 1947, the committee's opinions were almost overriding.

REPORT TO THE PRESIDENT

If the General Advisory Committee for the moment was setting the course of the Commission's technical program, ultimate authority for the production of fissionable materials and weapons remained with the President. Congress had established this fact in the Atomic Energy Act, which provided that at least once each year the President should determine how much of these materials and how many weapons and weapon components should be manufactured. One of the Commission's first actions in January, 1947, was to request its staff to prepare a joint recommendation for the calendar year 1947 by the Commission and the Secretaries of War and Navy.[50]

During the hectic weeks of the confirmation hearings and the transi-

LOS ALAMOS SCIENTIFIC LABORATORY

MEMBERS OF THE GENERAL ADVISORY COMMITTEE VISIT LOS ALAMOS / Shortly after landing at the Santa Fe Airport, April 3, 1947. Left to right: James B. Conant, Robert Oppenheimer, General James McCormack, Hartley Rowe, John H. Manley, Isidore I. Rabi, and Roger S. Warner. Manley was the committee's executive secretary. McCormack and Warner were members of the Commission's staff.

LOS ALAMOS SCIENTIFIC LABORATORY

SCIENTISTS AT LOS ALAMOS / Many of the nation's leading scientists attended the nuclear physics conference at Los Alamos in August, 1946. Left to right, first row: Norris E. Bradbury, John H. Manley, Enrico Fermi, J. M. B. Kellogg; second row: Robert Oppenheimer, Richard P. Feynman, Phil B. Porter; third row: Gregory Breit (partly hidden), Arthur Hemmendinger, Arthur D. Schelberg.

tion from Army control, there was little time for such formalities as the Presidential directive. Not until early in March did Lilienthal find time even to write to Lieutenant General Lewis H. Brereton, chairman of the Military Liaison Committee, to apologize for the delay in calling the Commission's first meeting with the committee.[51] Not until a month later had Williams and McCormack assembled the information necessary to discuss the directive with Brereton.

The cryptic language of the draft directive approved by the Commission on March 27 suggested that its purpose was to record a decision rather than convey information.[52] It began by declaring that the service secretaries and the Joint Chiefs of Staff found "the present supply of atomic weapons . . . not adequate to meet the security requirements of the United States," but it gave no indication of the size of the stockpile. After urging that the use of fissionable materials for nonweapon purposes be limited to essential research which might lead to improvements in the production of materials and weapons, the authors recommended the maximum number of kilograms of fissionable material that should be diverted from weapons; but the written document contained only blank spaces where the numbers should appear. The statement concluded with the recommendation that the President "approve continuation of the current production program," but it did not tell the President what that program was. Obviously the Commission considered the report so sensitive that it would give the details to the President only in oral form.

The General Advisory Committee held its three-day meeting over the weekend. By Wednesday, April 2, 1947, Secretaries Patterson and Forrestal had joined Fleet Admiral William D. Leahy and Lilienthal in signing the document. At five o'clock on Thursday afternoon Lilienthal took the Commissioners to the White House for a briefing with President Truman. The subject for discussion was not the April 2 report, which the President had not yet seen, but a more general summary of the existing situation, dated April 3, 1947.[53] At Lilienthal's suggestion, Truman started to read the brief report: "After three months of authority over the American Atomic Energy enterprises, with access to sources of information and opportunity gradually to fit facts together, the Atomic Energy Commission must report to the President certain serious weaknesses in the situation from the standpoint of the national defense and security: 1. The present supply of atomic bombs is very small. The actual number for which all necessary parts are available is———."

As the President came to the blank, Lilienthal supplied the number. The shock was apparent on Truman's face. He went on reading: "None of these bombs is assembled. The highly technical operation of assembly hitherto has been effected by civilian teams no longer organized as such. Training of military personnel to effect assembly is not yet complete."

A solemn silence pervaded the office as the President continued to read. As he turned the pages, the Commissioners followed him on their copies. There was an explanation of the need for weapon tests, the need for a weapon making better use of uranium 235, the dangerously small inventory of certain critical bomb parts, the precarious state of the Hanford reactors, the wasteful plutonium separation process, and the shortage of raw materials.

Lilienthal wondered how the President would take the news that the nation had no nuclear weapons immediately ready for use. When Truman looked up at the end of the document, Lilienthal thought he looked grim and gray, the lines of his face visibly deepened. What did the Commission propose to do? He realized the difficulties the Commission faced, especially as the prolonged Senate debate on confirmation deprived it of a firm mandate for decision.

Just as Lilienthal began to explain some of the proposals in the April 2 report, White House Secretary Charles G. Ross interrupted to say that the Senate had just voted down a motion by Senator Bricker to recommit the nominations to the Joint Committee. The news broke the spell. Lilienthal's thoughts careened to the bitter fight that had been going on in the Senate for almost a month. He found himself without words; the policy decisions would have to wait for another day. Perhaps if the long agony of confirmation were soon to end, the Commission could get on with its business.

CONFIRMATION

The vote on the Bricker motion on April 3 marked a climax of an ugly debate on the nominations in the Senate. Early in March, following the favorable action by the Senate members of the Joint Committee on Atomic Energy, Lilienthal had hopes of an early if lively debate, but the Senate was preoccupied for weeks with legislation sponsored by Senator Taft to curb what the Republicans saw as the excessive power of organized labor. There was also a high priority on President Truman's proposals for aid to Greece and Turkey as a response to increasing Soviet pressure in the Middle East.

As a result, Senator Hickenlooper had no opportunity to start debate on the nominations until March 24. He began with a long historical discourse stressing the crippling effect of the delay, first in adopting atomic energy legislation and then in acting on the President's nominations.[54] Without mentioning Senator McKellar by name, Hickenlooper complained about the "burdensome rehash" of the earlier Dies committee testimony to which he and his colleagues had been subjected. The delay had paralyzed the Commission; the national security required timely if deliberate action in the Senate.

Hickenlooper followed this plea with a courageous and honest defense of the Lilienthal nomination. He not only dismissed the charges of communism against Lilienthal but also declared him to be fundamentally committed to Americanism, a man of high intelligence and administrative ability, with a deep devotion to human rights and the atomic energy enterprise. Hickenlooper seemed fully convinced of Lilienthal's qualifications, but he was also aware that he was vulnerable to attacks from his own party for coming to the defense of a Truman nominee. This attack came quickly as continual interruptions by Wherry and Bridges dragged the debate into a tangle of petty jibes by the time the Senate adjourned for the day.

If the harassing tactics of Bridges, Wherry, and McKellar on Monday and Tuesday, March 24 and 25, could be called a probing attack with light weapons, the speeches by Homer Ferguson of Michigan and Bricker of Ohio later that week were the heavy guns of the assault. Disdaining the sensational allegations against Lilienthal in the conservative press, Ferguson chose a loftier perspective.[55] He saw atomic energy as critical in the titanic struggle between two ways of life, democracy and communism. Lilienthal was not a Communist, but Ferguson quoted Lilienthal's books to demonstrate that he believed government domination of society was necessary and inevitable. Lilienthal saw the management expert as indispensable in modern society. To Ferguson's way of thinking, this belief made Lilienthal a "social aristocrat," a man who believed that experts must make the important decisions in government, which ordinary people could not make for themselves. These decisions, Ferguson argued, Lilienthal would make for the people's welfare, but such an approach led first to benevolent despotism and then to tyranny. Ferguson's argument was temperate and closely reasoned. Lilienthal was probably a loyal American in his own way, but it seemed outrageous that a man of his convictions could assume control of the nation's strongest defense against tyranny after the Republican victory at the polls in 1946.

Try as he would, Ferguson was not able to maintain to the end of his speech the contention that his disapproval of Lilienthal was based entirely on honest differences in their interpretation of the proper role of government. In the end he could not quite believe that the advocates of big government could be entirely honest. They could not resist the temptation to interpret the law to their own advantage, however laudable their intentions. Ferguson cited as an example of Lilienthal's lack of moral scruple the establishment of the Tennessee Valley Associated Cooperatives, Incorporated. Senator Knowland pointed out that the cooperative had been created in 1935, when Arthur E. Morgan was the TVA chairman; but the example was frequently cited by other Republicans to show that Lilienthal, as McKellar never tired of quoting from a Lilienthal speech, believed that "every government . . . is and must be a government of men and not of laws."

Senator Bricker was more ambivalent than Ferguson on the moral question.[56] He did not believe Lilienthal was a Communist, but he charged that Lilienthal had been insensitive to the dangers of Communists in TVA. As he continued, Bricker repeated most of McKellar's charges without explicitly accepting McKellar's conclusions. He was particularly concerned that the Commission had hired several men whose FBI files contained alleged information which Bricker considered disturbing. Although Bricker considered this "proof positive" that Lilienthal "tends toward the left, wants around him employees who are radically inclined," McMahon, Knowland, Alben W. Barkley, and other Senators denied that the files supported such an allegation about the employees.

Bricker rambled on, but he seemed to have a purpose in mind. Having "proved" Lilienthal's tendencies to the left, he asked Hickenlooper whether the FBI had investigated Lilienthal and the other nominees. Hickenlooper assured Bricker there had been no investigations, but he pointed to the President's statement that the records of the investigating agencies of the Executive Branch contained no derogatory information on the appointees. This was not good enough for Bricker. He urged the Senate not to miss this last chance to "clean up" the Commission, to sweep from its ranks the left-wingers of questionable character whom Lilienthal had gathered there. He concluded with a motion that the nominations be recommitted to the Senate members of the Joint Committee and that the FBI be requested to investigate all officers and employees, including the Commissioners and the general manager.

The Bricker motion was the signal for a full-scale attack by the anti-Lilienthal forces. Although McKellar and a few others repeated the old charges of communist tendencies, the Republican leadership concentrated on Lilienthal's philosophy of government and his alleged lack of moral scruple. John J. Williams of Delaware took up Ferguson's refrain of "a government of men, not of laws." Harry P. Cain of Washington saw Lilienthal as neither a Communist, a great administrator, nor an expert on atomic energy. He asked why the Senate "had to accept a controversial, contradictory, cloudy figure." Bridges and Wherry returned to the fray with the charge that Lilienthal had not consulted General Groves and was attempting to exclude the military from any voice in atomic energy affairs.

The summation of the Republican argument came in a long speech by Senator Taft of Ohio.[57] He repeated the main points in his statement to the press on February 21, but on the Senate floor he could elaborate them in a way that left no doubt of his deep conviction about Lilienthal's unfitness. Lilienthal was a radical seeking office at the very time the electorate had repudiated radicalism at the polls. He was not a Communist but he did not regard communism as a threat to American security. Taft's elaboration of this latter charge illustrated more clearly than ever before that his objections to Lilienthal stemmed from differences in fundamental approach to modern government. That Lilienthal in the 1930's could have tolerated in TVA an avowed former Communist was enough to disqualify him from appointment to an agency into which the infiltration of one communist agent might spell national disaster. Taft also argued that Lilienthal's attitude toward communism had not changed over the years. Had he not written the Acheson-Lilienthal report, which proposed to turn over all American atomic energy plants to an international agency controlled by Communists?

Both McMahon and Knowland rose to answer Taft's charges, or at least to put his conclusions about the Acheson-Lilienthal report in proper context. But Taft, having made up his mind about Lilienthal, would drive home his opposition with every argument at hand. He was even in a mood to accept the suggestion of Homer E. Capehart that, in view of recent signs of communist aggression in Turkey and Greece, the atomic energy enterprise be returned to Army control. After all, Taft observed, civilians had tried to build the Panama Canal, but the Army had had to come in to finish the job.

Remarks such as these led McMahon to the conclusion that the debate was moving from a discussion of Lilienthal's qualifications to a reexamination of the thorny issues of international and domestic control which had consumed weeks of legislative debate the previous year during passage of the Atomic Energy Act. Except for the continuing attack on Lilienthal's personal integrity, the debate seemed to be moving rapidly beyond Lilienthal to a review of the atomic energy legislation of the previous Congress. To McMahon, who had struggled against great odds for more than a year to establish the Commission, this trend was appalling. There was some consolation in the firm bipartisan support of all the Joint Committee members except Bricker, but as the debates continued hour after hour, day after day, the prospects of a favorable outcome dimmed. At last, on Wednesday afternoon, April 2, Hickenlooper succeeded in negotiating with the Senate leadership a unanimous consent resolution which would bring the Bricker motion to a vote at 5:00 P.M. on Thursday. The debate on Thursday would be divided equally between Wherry and Hickenlooper, who would allot time to those speaking for and against the motion.[58]

The Senate adopted the resolution, but tension in the chamber mounted under the pressure of the clock. Millard E. Tydings of Maryland talked through the dinner hour on Wednesday in support of the nominees and the Acheson-Lilienthal report. Finally gaining the floor in his own right after days of frustration, McMahon launched upon a systematic refutation of the charges against the nominees, the Atomic Energy Act, and the report. Skillful questioning by McKellar and the Republican opposition, however, soon mired McMahon in a controversy over Lilienthal's ethics in serving on the Wisconsin Public Utilities Commission in 1931 while he was still receiving compensation from the utilities newsletter which he had published in Chicago. Wherry induced Hickenlooper to read to the Senate eight telegrams he had received from power companies in Wisconsin in response to a request for information concerning the use of Lilienthal's name to obtain subscriptions. The debate boiled higher as senators on both sides tried to draw conclusions from the telegrams. Wayne L. Morse, the Oregon Republican, was incensed by Wherry's attack. When Wherry let the Senate adjourn just before midnight without giving him a chance to speak, Morse stormed off the floor, and the morning papers reported a scuffle in the cloakroom.[59]

At noon on Thursday, April 3, the Senate began debating under the limitations imposed by Hickenlooper's resolution. Wherry and Hickenlooper set the pace as they cautiously granted time to those wishing to speak. Wherry's forces concentrated on Lilienthal. Hickenlooper, McMahon, Knowland, and Morse answered the charges of the preceding days and drew on testimony from the hearings to support the nominees. The speeches, first from one side and then from the other, contained nothing new or dramatic, but there was a note of excitement in the air. The previous week the Washington *Post* had tallied 49 votes for Lilienthal and 27 against. But the Bricker motion and the hot debate of the previous evening had confused the issue. Several Republican senators who had previously announced their support for Lilienthal had changed their minds. The Federation of American Scientists, in a last-ditch effort to muster support, launched another barrage of mail and telegrams on the Senate. Vandenberg had been besieged for days to speak out in support of Lilienthal.

On Wednesday Thorfin R. Hogness, the Chicago chemist who a year earlier had devised with Vandenberg the compromise which saved the atomic energy bill, hurried to Washington with hopes of repeating his earlier success. Dashing from the train to Vandenberg's office in the Capitol, Hogness learned that Vandenberg had just stepped down from the rostrum as president *pro tempore* and was addressing the Senate. Scott W. Lucas of Illinois told Hogness the outcome was in doubt. In a straw vote in the cloakrooms on Wednesday night, the Bricker motion had a slight majority. The last few hours of the debate would determine the Commission's fate.[60]

As Vandenberg rose to speak, the spectators in the visitors' and press galleries stirred in their seats. For the moment the fact that Vandenberg and Taft, two leading contenders for the Republican Presidential nomination in 1948, were facing each other on a fundamental policy issue seemed to overshadow the question of the nominations.[61]

In his customary way, Vandenberg began with a few disarming remarks. He did not have any illusions that any senators were open to persuasion after weeks and months of bitter controversy, but he wished to use this forum to answer the thousands of letters from constituents on both sides of the question. He reminded the Senate that eight out of nine of its members on the committee had voted for confirmation after hearing weeks of testimony. Reading the names of the senators on the committee, he said he thought it "highly improbable that such a jury would almost unanimously go wrong." Then Vandenberg moved to the heart of his speech. In direct and forceful language he refuted the three principal charges against Lilienthal. He found Lilienthal "no part of a Communist by any stretch of the imagination." He did not see how Lilienthal's leadership of the Commission could endanger free enterprise since the Senate had already voted unanimously to make atomic energy a government monopoly. Nor could he accept the claim that the nominee's connection with the Acheson-Lilienthal report disclosed "a flaw in his reliability as a guardian of our atomic secrets." Dismissing the attacks on Lilienthal's moral character, Vandenberg moved to his conclusion. "In the interests of national welfare and for the sake of a square deal, Mr. Lilienthal ought to be confirmed." The galleries broke into prolonged applause.

Perhaps the tide was turning. Taft tried to introduce new evidence on the Wisconsin public utilities matter, but Vandenberg had broken the spell. Tedious moral appraisals of actions more than two decades old had lost the significance they seemed to have had on Wednesday evening. Hickenlooper confidently surrendered the remainder of his time to Senator Barkley, who added the great weight of his influence to Lilienthal's side of the scale. As the hour approached five, Bricker drew his last appeals to a close. Ninety senators answered the quorum call. The final vote was 52–38, a decisive victory for Lilienthal and the Commission. There remained only the formal vote on the nominations themselves on April 9.[62]

FIRST DECISIONS

Now that he had won the battle for confirmation, Lilienthal hoped he could soon conclude his unfinished business with the President. On April 3, 1947, the news of the defeat of the Bricker motion had interrupted his presentation of the Commission's immediate plans for producing materials and weapons. There had been no time to show the President the April 2 memorandum from the Commission and the service secretaries recommending the production and allocation of fissionable materials for calendar year 1947.

Lilienthal did not have long to wait. The week following the Senate action, Admiral Leahy called a meeting at the White House. On Wednesday morning, April 16, Lilienthal met with the service secretaries and Leahy in the President's office. Truman quickly read over the April 2 memorandum while Lilienthal supplied orally the numbers which fit in the blanks. Endorsing the document along the left-hand margin, the President asked Lilienthal to keep it in his files with the numbers added in ink. The memorandum was far too sensitive even for the White House files.[63]

The President had not forgotten the shocking news about the weapon stockpile he had received in the April 2 memorandum. He had locked it in his personal safe for future reference. The President's remarks gave Lilienthal a chance to bring up the alarming state of the production-weapon complex. Both Leahy and Forrestal were concerned about the shortage of certain critical weapon components; Lilienthal explained that the Commission had authorized an additional work shift in Monsanto's plant at Dayton, Ohio, and that additional facilities were under construction.

The conversation turned inevitably to raw materials. The long-range outlook over the next several years was difficult to determine. The principal source of ore was still the Shinkolobwe mine in the Belgian Congo, but most of the ore down to the 150-meter level would be exhausted in 1947. Then it might be necessary to shut down the mine for a year while a new shaft was sunk. Because a quasi-governmental corporation owned the mine, it would be difficult to accelerate operations at the site. Political changes in Belgium also complicated the situation. The Communists had refused to participate in the new government formed in late March and were therefore free to attack the government's policy of selling uranium to the Combined Development Trust for allocation to the United States, the United Kingdom, and Canada. The State Department also found ominous the report that the Belgians might nationalize their uranium deposits. Elsewhere the Commission would have to rely on low-grade ores, few of which could be recovered by existing processing techniques.[64]

Lilienthal's reference to the Combined Development Trust caused Secretary Patterson to ask about the allocation of Congo ores. He was aware that in July, 1946, the British after considerable pressure had forced Groves, Bush, and Acheson to accept a 50–50 allocation of all ore received between April 1 and December 31, 1946. Groves, arguing for allocation on the basis of need, had pointed out that the British had no immediate use for the ore while the Americans might have to shut down plants under the reduced allocation. The British had contended with equal logic that, since they had paid for half the ore, they should receive their share.[65] The July 31 agreement had never been popular on the American side, but in the chaos of early 1947, there was no thought of reopening negotiations. Lilienthal suggested that a better solution to the uranium shortage was the Redox process, and the Commission was going to concentrate on that.

Patterson was not to be diverted from the subject of international cooperation. He remarked that the British were becoming increasingly unhappy with what they considered an American failure to honor commitments. Leahy retorted that he did not understand the British attitude; there were no existing agreements on interchange. Patterson, no doubt remembering the hours he had spent negotiating the Truman-Attlee-King agreement of November 16, 1945, explained that most of the provisions of the wartime Quebec Agreement were still in effect, but the British had been told that the new Atomic Energy Act prevented exchange of technical information.[66] A further complication was the fact that the Senate Foreign Relations Committee had never been informed of the existence of the interchange agreement. Lilienthal said the Commissioners had worried about the failure to report the agreement since they had first learned of its existence. The longer the delay, the more difficult would be the disclosure; Lilienthal hoped that at the very least the information could come from the State Department rather than from the Commission.

The President had no doubts about the status of interchange. He said he remembered distinctly Churchill's saying that the Quebec Agreement did not extend beyond the war, and he was certain that he had made no agreement extending interchange. Leahy supported the President. Trying to be tactful, Lilienthal started to describe the comprehensive nature of the Quebec Agreement, but no one seemed to be interested. As a last resort, he suggested that relations with the British were particularly important, at least until negotiations were completed with the Union of South Africa to obtain uranium from gold mining operations. Forrestal was quick to reply that he considered any obligation to the British wiped out by the billions of dollars loaned by the United States.

The lack of understanding of the British position disturbed Lilienthal; it promised trouble for the future. But he found encouragement in the President's willingness to consider a weapon test and to support the Commission's plea to the House Appropriations Committee for additional funds. Perhaps at last the Commission could begin to act in its own right.

MISSION TO EDUCATE

Confirmation gave the Commissioners not only a legal mandate for action but also a license for leadership. During the weeks of uncertainty they had been reluctant to speak out on policy issues, and there was an understanding among them that they would avoid public speaking engagements. This restraint troubled Lilienthal, who saw in the confirmation hearings and in the public response to them an incredible lack of comprehension of the meaning and implications of atomic energy. His concern stemmed no doubt from his own ignorance of the subject in late 1945 and the revelation Oppenheimer accomplished in his lectures on atomic energy to the Lilienthal board of consultants in 1946. The Acheson-Lilienthal report was in large part the result of a vigorous exercise in self-education.

As the Senate debates neared an end in the last days of March, 1947, Lilienthal began to think about how he would take his message to the people. The opportunity came in an invitation from the American Society of Newspaper Editors to speak at their annual banquet in Washington on April 19. He had been hoping to get away on a short vacation after the final vote on confirmation, but the invitation was too tempting. As his friend Palmer Hoyt, editor of the Denver *Post,* told him, this was an extraordinary opportunity. All the influential newspaper editors in America would be there as well as many leaders of the Administration.[67]

For Lilienthal the speech took on the importance of an inaugural address. It had to be dramatic, provocative, and even a little bold in suggesting new ideas. The device for creating drama came to him quickly, but the substance of the speech emerged only after hours of thought and several discussions with Mrs. Lilienthal. As he had often done before, he finally dashed off a rough draft in shorthand and then began the tedious job of rewriting. By the time he entered the ballroom at the Statler Hotel on Saturday evening, the speech was part of him. His step was buoyant, his self-confidence supreme. He had not misjudged the opportunity; it seemed that everyone notable in journalism and politics was in the audience.

He started with his dramatic device. Holding high a cylinder of uranium metal for his audience to see, he explained that this inanimate substance was "the central object in the councils of the world." Fission of all the uranium atoms in the cylinder would release energy equivalent to 2,500 tons of coal. Now Lilienthal had caught every eye in his audience. It was a thrill to see all those intent, upturned faces.

Incredible as these facts seemed, he said, men were only beginning to understand the potential of atomic energy either for beneficial uses or for destruction. Would the United States maintain its lead or fall behind in the development of atomic energy? The answer would depend upon whether the American press could educate the people so that they would be able to understand the issues of atomic energy. What the people needed was not technical knowledge but a comprehension of the fundamental facts of existence in the atomic age. Did they know, for example, that the American atomic energy program had lost momentum since 1945? Were they acquainted with the contents of the Baruch plan for the international control of atomic energy? Did creative people in science and industry think atomic energy was important enough to command their talents and energy? Did the average citizen understand that the "secret" of atomic energy was not a simple formula which could be written on a sheet of paper and locked in a safe?

"Probably among the most important decisions in our history as a nation will be those made concerning the course and direction of atomic energy development, and the uses to which this new force is put." These decisions should not be made in secret. They should be made by a well-informed public, because they were human, not technical issues. "What I am proposing, therefore, is nothing less than a broad and sustained program of education at the grass roots of every community in the land." This was the function of the people's institutions of education and communication; it was a special responsibility of a free press.

The applause was enthusiastic, the comments warm and flattering. Supreme Court justices, senators, celebrated authors, and veteran editors came forward to congratulate him. General Eisenhower, the Army Chief of Staff, pushed through the crowd to say: "I am on your team." The speech was more than a pleasant conclusion to weeks of trial and anxiety. It announced that the Commission had at last received its mandate and intended to exercise it in the interests of the nation and mankind.

FIRST VENTURE

CHAPTER 3

Senate confirmation had at last given the Commissioners and the general manager a clear mandate for action. Freed from the uncertainties and distractions of the previous five months, Lilienthal and his associates could now hope to concentrate on their responsibilities under the Atomic Energy Act. First and foremost was the production of fissionable materials and weapons for the national defense. Almost as vital was the prompt exploitation of the nuclear sciences for human welfare. To some extent the production and development aspects were complementary; but in a finite world with limited budgets and resources, there would always be a need to balance one requirement against the other. This kind of evaluation would depend on a sound knowledge of a new and intricate technology, something which none of the Commissioners except Robert F. Bacher could yet claim.

While the Commissioners gained a better understanding of the atomic world, they could rely on the impressive experience and abilities of the General Advisory Committee for policy decisions, on Walter J. Williams for operational matters, and on Carroll L. Wilson, James B. Fisk, and James McCormack for the imagination and ideas needed to create an effective organization and program. With this kind of support, the Commissioners could embark on their first venture with some hope for success.

The spring of 1947, however, would bring difficulties and frustrations. The months of uncertainty had built up a backlog of questions relating to every phase of the atomic energy project, and many of these matters demanded immediate attention. A new directive for Los Alamos, the refurbishing of production plants for fissionable materials and weapon components, a policy for laboratory operation, a plan for developing new types of reactors, proposals for stimulating research in the nuclear sciences, and completion of the staff organization were all overdue. Even under the best of circumstances, it would have been difficult to meet these needs within a matter of months.

With the handicaps of renewed public controversy and political attack, the first venture was doomed to an inauspicious start.

ATOMIC ARSENAL

A new course for weapon production and development was for the moment the concern of Robert Oppenheimer and the General Advisory Committee. Rather than attempting to reach a decision at the committee's meeting late in March, 1947, Oppenheimer planned to return to California by way of Los Alamos with the weapon subcommittee for a first-hand view of the situation. Enrico Fermi was not able to go, but James B. Conant, Hartley Rowe, Isidor I. Rabi, John H. Manley, and McCormack accompanied him on the trip west. Although this return to "The Hill," as Los Alamos was called, must have been something of a homecoming for Oppenheimer, the agenda suggested little time for socializing. The questions at issue seemed difficult to define, hopelessly interrelated, and even more difficult to answer. Before deciding to develop a new weapon design, Norris E. Bradbury asked: "What rules should be set up for the relation between the *efficient* use of active material, the *amount* of active material, the *size* of the bang, and the *availability* of active material?" What should be the upper limit on unassembled critical mass in any weapon design? Was there a need for weapons larger than the wartime models regardless of the amount of fissionable material required? To these and other general questions Bradbury added a dozen inquiries about specific weapon designs.[1]

Obviously there was no need to explain the issues to the subcommittee. In addition to Oppenheimer's intimate knowledge of the weapon art, the members had the advantage of access to a comprehensive study which Bradbury had completed in January.[2] The report, manifesting Bradbury's direct and candid approach, avoided the cryptic phrases and vague generalizations which for security reasons often muddied descriptions of weapon activities. The report began with a technical description of the wartime implosion and gun-type weapons. Then Bradbury summarized the advantages to be expected in nine new schemes which might either improve the efficiency of implosion systems or make possible more economical use of uranium 235. He also reported recent successful efforts to improve the performance of detonators, high-explosive charges, and neutron initiators in nuclear weapons, and to refine the techniques used in studying implosion systems.

Perhaps less exotic than theoretical and experimental research but equally difficult were ordnance studies performed by the laboratory's Z division at Sandia Base near Kirtland Field on the eastern outskirts of Albuquerque. Originally established at Rowe's suggestion to relieve Los Alamos of certain engineering and production responsibilities, Sandia had borne the major burden of the Bikini weapon tests in 1946 and did not really get down to its intended task before the Commission took control in January. This included reliability tests of existing weapon components, improvements in fusing and firing units, development of ordnance aspects of new weapon models, and procurement of mechanical parts to be used in stockpiling the standard weapons. In the absence of a formal charter and seasoned leadership, however, the Sandia staff tended to operate as much on its own initiative as from coordinated directives from "The Hill."

Other engineering and production functions that might conceivably have been assigned to Sandia were scattered over a number of other sites. The final purification of uranium and plutonium metal was still the job of Los Alamos despite the long-standing intention to transfer these operations to permanent production facilities at Oak Ridge and Hanford. Likewise, certain steps in producing neutron initiators were still performed at Los Alamos. The delicate and exacting task of fabricating shaped charges of high explosive had been transferred to the Naval Ordnance Test Station at Inyokern, California, but the production of detonators was still the responsibility of Los Alamos. Certain other mechanical and electrical components were being produced by commercial manufacturers.

For the long term, Bradbury's report contained some interesting information about theoretical studies of thermonuclear reactions and plans for testing new weapon ideas. Ever since Oppenheimer's group had discovered in the summer of 1942 the theoretical possibility of a weapon based on the fusion of very light elements, there had been some interest in analyzing on paper the relative advantages of fusing various combinations of the hydrogen isotopes, deuterium and tritium. Because the extraordinary temperatures and pressures required to initiate the reaction suggested the need of a fission bomb, the idea had a low priority during the war. But Edward Teller and others at Los Alamos were still intrigued by the idea and found time to study it during the doldrums of 1946. Early in 1947 Bradbury could report that studies of thermonuclear reactions were now focused on two conceptions: an elaborate thermonuclear device called "Super" and a simpler device called "Alarm Clock," recently suggested by Teller.

Thermonuclear weapons might be important some day, but Bradbury was more concerned about testing the reliability of weapon models going into stockpile. He noted that the gun-type weapon had never been tested and had been detonated only at Hiroshima. The implosion weapon had been tested at Alamogordo, but the subsequent detonations at Nagasaki and Bikini lacked the instrumentation necessary to obtain reliable scientific data. Reestablishing production of the standard models had inevitably introduced minor changes which cumulatively might impair reliability. Bradbury thought it imperative to test stockpile models as well as potentially more efficient devices under development. Since preparations for a test would take nine months to a year, Bradbury hoped for a decision soon.

Although the subject matter of the Los Alamos conference was as sensitive as any that could have been discussed in the United States in the spring of 1947, Bradbury brought a large number of his staff with him. This was no time to apply the security restrictions and compartmentalization which an extraordinary emphasis on secrecy imposed on many discussions of Commission business. The discussion was full, frank, and highly technical. Oppenheimer and his colleagues, men of great understanding and experience, could give Bradbury and his staff sensible answers to the many questions which had been crippling the strategy of weapon development at Los Alamos for more than a year. And the same discussions helped the subcommittee members to formulate in their own thinking a feasible plan for the future.

Most of the technical details were of interest only to those at the meeting, but they added up to some general conclusions of great import for the Commission and the military services. The subcommittee was convinced of the need for a scientific test in the spring of 1948 of new weapon models which would make better use of the implosion system and which would permit more efficient use of uranium 235. They were prepared to recommend the kinds of devices to be tested. They urged delay in further development of several new types of weapons suggested by the military services pending receipt of formal requirements. They also confirmed the proposal made at the March meeting of the full committee, that Los Alamos devote more effort to the study of thermonuclear reactions, with the understanding that the many practical difficulties involved made early success unlikely. As for more immediate matters, the subcommittee recommended strengthening the Los Alamos staff on the theoretical side, increasing initiator production at Los Alamos until the Monsanto Chemical Company could complete new facilities at Miamisburg, Ohio, improving the shaky capability at Inyokern for producing high-explosive components, and helping Bradbury find an associate director for activities at Sandia.[3]

After the meeting on Thursday, April 3, Oppenheimer and Manley finished their paperwork. The minutes of the meeting and a report for Conant's signature as subcommittee chairman had to be drafted. Oppenheimer also found time to finish his formal letter to Lilienthal, reporting on the meeting of the full committee the previous weekend. On Friday morning the group returned to Albuquerque for a visit to Sandia before starting home.

The Sandia installation was hardly impressive to the eye. Built on the site of the original Albuquerque airport, it consisted of a dozen ramshackle wooden buildings constructed early in World War II for an air depot training station. Since the war the Army had constructed four new buildings to accommodate activities transferred from Los Alamos, but three of these were wooden frame buildings and the fourth was a Quonset hut. There the subcommittee could see where Sandia technicians had sorted out as best they could the weapon components left over from the wartime project. Now new components were arriving for assembly and testing prior to transfer to the ordnance section at Kirtland Field, where the high-explosive charges produced at Inyokern would be added. Finally, the completed weapons would be stored in igloos located in a large arroyo south of the runways.[4]

Oppenheimer's group probably viewed the situation at Sandia with mixed feelings. The physical facilities were obviously, almost ludicrously, inadequate. To realize that the nation's vaunted power to wage nuclear war rested on this slender reed must have been a sobering experience. At the same time, there were clear signs of initiative, enterprise, and even enthusiasm at Sandia. The technical group was making the best of a bad situation with encouraging results. The Air Force had not yet been able to establish a satisfactory working relationship with Sandia. The day before Oppenheimer arrived, Colonel John G. Armstrong at Kirtland wrote his headquarters that the future was still uncertain. Groves and General Lewis H. Brereton had not yet been able to take any action on Armstrong's proposal to establish an Air Force tactical and technical liaison committee at Kirtland to work with Sandia, a decision they could not make until the Armed Forces Special Weapons Project had its charter.[5]

Before leaving Sandia Oppenheimer called Bacher in Washington to report his impressions. In intentionally cryptic language he told Bacher he was pleased with the outcome of the Los Alamos meeting. For one thing, Bradbury had been cordial to Conant, who had earlier made some uncomplimentary remarks about Los Alamos. General McCormack was flying back to Washington that night with copies of Oppenheimer's report. He assured Bacher that every recommendation in the report deserved "hearty concurrence." At last some members of the committee were able to "see the bottom of the barrel," Oppenheimer remarked. "They realize what there is and what there is not." That realization may not have been comforting, but it was a necessary first step.[6]

On the homeward flight from Albuquerque McCormack carried with him not only Oppenheimer's report but also a legitimate concern about the status of weapon production. After further verifying the information he had picked up at Los Alamos, he summarized the situation for Wilson on Saturday, April 12. Continued production seemed tenuous on many counts, but McCormack thought the most critical items were the high-explosive castings and initiators. For the short run, emergency production operations at Los Alamos were probably the answer, even if they did delay research activities. But the ultimate solution seemed to lie in new plants. McCormack questioned the need for the elaborate design which was causing procurement delays for the new Miamisburg plant, but there seemed now to be no alternative but to continue with the present design which would place the facility entirely underground. He was investigating the possibility of some simplifications and was asking Williams to do what he could to expedite construction. In the meantime, technicians at Los Alamos and the temporary facilities at Dayton would try to meet production requirements.[7]

Conditions at Inyokern were equally bad. The existing Navy facilities had not been designed for production operations, and acceptable castings of high explosive had come only after months of failure. General Groves had approved construction of additional facilities at Inyokern in October, 1946, but construction had not yet started. McCormack was trying through Admiral William S. Parsons to get Navy action, but even if this were successful, additional production could not be expected before April, 1948. For a new plant McCormack had asked his staff to investigate several World War II ordnance installations, including the one at Burlington, Iowa.

ADJUSTING PRIORITIES

McCormack's trip to Los Alamos had helped to fill in details about the Los Alamos situation, but Wilson had not waited for his return to take action. The meetings of the General Advisory Committee the previous week had already confirmed Wilson's and Williams's conclusions that quick decisions were required. Wilson, Williams, and the Commissioners had spent most of Tuesday, April 1, with Charles A. Thomas and Carroll A. Hochwalt to discuss the Monsanto contract. The purpose was to keep a full head of steam behind initiator production at Dayton and at the same time to suggest to Monsanto the possibility of retrenchment at the Clinton Laboratories, should the recommendations of the General Advisory Committee be adopted.

On Wednesday there was a similar all-day session with officials from General Electric, including Harry A. Winne, Kenneth H. Kingdon, C. Guy Suits, and Harvey Brooks. Backed by the opinion of the General Advisory Committee, Wilson was firm on the question of priorities. If the Commission were going to take full advantage of using plutonium in building a weapon stockpile, it had to give highest priority to constructing two new reactors at Hanford and developing Redox. Since construction of the reactors would take at least two years and the existing units might not last even that long, the new reactors might not result in an increase in production. Everything, however, depended on Redox; for without the new process which would recover uranium as well as plutonium from the irradiated slugs, there seemed little hope of providing enough uranium feed for all the reactors. If Redox were developed in time, enriched material from the gaseous-diffusion plants could be used to compensate for the slight depreciation of the 235 isotope in the uranium which had already gone through the reactors.[8]

The implications were clear enough. General Electric would have to put its major effort into the new reactors and Redox, both at Hanford and the Schenectady laboratory. The Commission was willing to make the task as simple as possible. The new reactors and their associated facilities could resemble the existing units in all respects, except for those features which had proven unnecessary. The company could count on help from the Commission's laboratories on Redox, and the Commission would find other contractors to work on a process to recover the uranium already in waste storage tanks at Hanford and to control the release of radioactivity in stack gas. Williams agreed to ask Carbide to take over planning of the new uranium-235 and plutonium metal refining plants to replace the temporary facilities at Los Alamos. But even to complete its scaled-down assignments, General Electric would have to alter its plans drastically. Schenectady would have to put much more of its effort on Hanford reactor design at the expense of the intermediate-power-breeder reactor. Plans for the new Knolls Atomic Power Laboratory along the Mohawk River east of the city would have to be scaled down from the company's proposal of $36 million to the original $20 million. Wilson also asked the company not to build the Van de Graaff accelerator already approved, on the grounds that General Electric should concentrate on applied research for Hanford and leave fundamental, unclassified research to the universities.

The decision was a blow to the company's hopes for an aggressive effort to develop nuclear power and the breeder reactor, but Wilson saw no alternative. The national security seemed to depend directly on the new facilities at Hanford. Furthermore, he thought a slower pace on power reactors than the company proposed would be prudent in light of sobering estimates of chances for early success coming to him informally from individual members of the General Advisory Committee.

For Wilson's three division directors the rest of April sped by in a blur of meetings, telephone calls, and train trips. Williams kept on hounding suppliers for steel for the new Monsanto initiator plant and explored with Fisk and Hood Worthington of du Pont the best ways to reenrich the depleted uranium to be recovered in the Redox process. After some discussion Williams also persuaded Clark E. Center of Carbide to take responsibility for designing the new uranium-235 and plutonium metal plants. Fisk was heavily engaged in laboratory affairs, but he had to find time to follow up on the meeting with the General Electric group. It was his task to draft the letter which finally went to the company on May 6 as the Commission's formal position regarding the shift in emphasis from Schenectady to Hanford.[9]

TOWARD A WEAPON STOCKPILE

McCormack had his hands full in April with troubles at Inyokern, Sandia, and Los Alamos. He hoped to better the April, 1948, target date for the new production facilities at Inyokern by obtaining an additional $684,000 for the project. Work at Sandia was still far from a production-line basis, but there was some satisfaction in learning that the first new high-explosive shapes from Inyokern had been successfully assembled on April 25. That news meant that the nation would soon have ready weapons in stockpile. Prospects were also brighter for the beleaguered families of scientists still enduring life in temporary wartime facilities at Los Alamos. Before the end of April, invitations were out for bids to pave the roads in the community, and a contract had been awarded to build a commercial center with bank, drug store, theater, barber shop, and other basic services. Roger S. Warner, Jr., an engineer who had directed the work of Z division at Los Alamos and Sandia, still handled most of these contract activities in Washington with the part-time help of two Army officers, but McCormack now had enough staff in his new division to begin thinking about taking over. He had also proposed the appointment of Carroll L. Tyler, a retired Navy captain, as manager of the new Santa Fe office, which would coordinate the Commission's weapon activities in the field.[10]

Of greatest immediate concern to McCormack were plans for the first full-dress meeting with the Military Liaison Committee on April 30. Recent correspondence with the committee indicated its growing impatience to acquire an intimate knowledge of the activities and plans of his division, but the Commission took the position that all phases of its work related in some way to military applications. Thus McCormack provided the committee not just with a proposal for a series of weapon tests in 1948 but also with a long-range agenda covering the Commission's plans in production, reactor development, radiological warfare, nuclear propulsion, physical and biomedical research, and intelligence.[11]

The agenda suggested that the Commission was more than willing to meet the committee's request for information. But the Commission did not look forward to the meeting as a pleasant occasion. Ever since the War Department in January, 1947, announced Groves's appointment to the committee, Lilienthal had anticipated trouble. He took some comfort in a report which McCormack brought back when he briefed the Joint Chiefs of Staff on the weapon test plans on April 27. In Groves's presence General Eisenhower reportedly had made some kind remarks about Lilienthal's speech before the American Society of Newspaper Editors. Perhaps the Commission could count on Eisenhower's support if it encountered trouble in installing its own organization at Los Alamos and Sandia. Bradbury had reported that Groves was insisting weapons be assembled only at Sandia, a request which Bradbury thought had "political fragrance." [12]

Some of these matters cropped up in the meeting on April 30. When McCormack suggested a survey of the status of non-nuclear bomb components at Los Alamos and Sandia, Groves expressed a lack of confidence in Los Alamos and declared that the battalion at Sandia had been ready to assemble high-explosive charges since December 15, 1946. On other matters Groves questioned the practicality of the Commission's proposals, but the other members of the liaison committee considered them reasonable. Admiral

Parsons supported the Commission's plan for comprehensive testing of selected weapon components, and the committee accepted McCormack's proposal of a weapon production figure for Los Alamos. Everyone but Groves agreed on the urgent need for new production reactors at Hanford. He favored limiting work to engineering studies until an adequate supply of raw materials was assured.

As the discussion moved on to plans for weapon tests and the other items on the agenda, the new Commission and its staff must have made a favorable impression on the high-ranking members of the committee. The careful work of Oppenheimer and the General Advisory Committee, of McCormack and Bradbury, of Wilson, Fisk, and Williams, permitted the Commission to present positive ideas and support them with confidence. The Commission would press forward with its plans to increase the production of weapon components and plutonium. There would be more research on Redox and waste uranium recovery processes, and the Commission's expenditures for uranium ore exploration would increase tenfold in the coming year. Even on matters of great military import the Commissioners could now speak with some authority. Lilienthal explained plans for the weapon test series in 1948, and Strauss urged more effort on the part of the military in establishing a system for detecting nuclear tests in other countries.[13]

By the end of April, 1947, McCormack had reason to believe that he had taken the first important steps toward creating an arsenal of atomic weapons. If the plans born in that hectic month reached fulfillment, the United States would soon have at its disposal the unprecedented military power which all the world assumed lay behind President Truman's stiffening foreign policy in the face of communist aggression. There was of course no real assurance that the new reactors at Hanford, the Redox process, the Monsanto plant, or the Sandia facilities could be completed in time. And even if they could, McCormack felt a growing anxiety about the nation's ability to use its new power wisely. He agreed with Brereton's concern that strategic planners did not yet have enough background to make sound recommendations to the Joint Chiefs of Staff on military weapons. General Eisenhower had shown interest in setting up an advanced planning group in the War Department, but as yet not much progress had been made. McCormack was distressed by the hubbub that arose over publication of a War Department study which attempted to analyze the effects of the atomic bomb on national security. If there could be no public discussion of such questions, what hope was there for intelligent answers? Somehow someone would have to start some long-range planning, and McCormack hoped it could be on an interservice basis as a first step toward unification of the armed forces.[14]

Building a stockpile of atomic weapons also raised difficult questions about responsibility for the custody and maintenance of weapons. During the closing weeks of 1946, the Commission had succeeded in acquiring custody of the existing stockpile of weapon parts, with the understanding that the question would later be considered on its merits. Not much interested in the theoretical arguments, McCormack looked upon custody and maintenance as a practical matter of having reliable weapons when and where they were needed. But he knew that Lilienthal and others saw the issue as but one aspect of the larger debate over civilian versus military control. Perhaps by keeping the discussion on practical matters McCormack could lead the Commissioners away from the old animosities which the debate on the atomic energy bill had engendered a year earlier.[15]

REORIENTING THE LABORATORIES

At its March meeting the General Advisory Committee had recognized the supreme importance of bolstering the production of fissionable materials and weapons. At the same time the committee had given almost equal stress to the need to reorganize and revitalize the Commission's research activities. Wilson and Fisk were no less aware of this need, if only because of the pressure for decision coming from the laboratories. Before Oppenheimer could complete his written report to the Commission during his visit to Los Alamos in the first week of April, Wilson and Fisk were already making decisions which would determine the course of the Commission's research effort.

The size and function of the new General Electric laboratory at Schenectady was a central part of the Commission's discussions with Winne and his staff on April 2. Indeed, the Schenectady dilemma was a good example of the larger question facing the Commission: how to give first priority to weapons and production and still strike a proper balance in research and development. Although the Commission was willing to authorize scarcely more than half the funds General Electric requested, \$20 million for the new Knolls Atomic Power Laboratory represented a substantial commitment. Later the same week the Commission was equally receptive to a request from Iowa State for a new laboratory to replace wartime facilities and to a recommendation from the Manhattan District's research staff for construction of the new Brookhaven National Laboratory. The Commission's only reservation was its desire to examine the plans for the Brookhaven research reactor before construction of that facility was started. At the same meeting the Commission decided not to put a dollar ceiling on construction of the new Argonne laboratory until there was some assurance that the existing plans were adequate.[16]

The future of the Clinton Laboratories at Oak Ridge was much less clear. The General Advisory Committee had concluded the laboratory was not worth saving. As Oppenheimer had told the Commissioners on March 30, "Most of us think that the evidence is in that Clinton will not live even if it is built up." [17] His suggestion was that Clinton should be limited to research and the production of radioisotopes with the existing reactor and that reactor development be transferred to a new central laboratory, probably at Argonne.

In discussing the committee's proposal with Fisk, Wilson admitted that in the long run a central laboratory at some site other than Oak Ridge might be the best solution, but there was no time to study such a far-reaching proposal. The Monsanto contract at Clinton was due to expire in June, and the company's decision to renew the contract would depend upon the Commission's plans for the laboratory. Besides, Wilson reasoned, the main trouble at Clinton was not the geographical location of the laboratory, as some members of the General Advisory Committee seemed to think, but rather the lack of good management. Wilson also surmised that Monsanto was not very interested in some of the projects at Clinton.[18]

Fisk and Wilson concluded that the Commission should consolidate and refocus Monsanto's responsibilities on essential projects which would stimulate the interest of the laboratory staff. This approach would mean construction of the high-flux reactor at Clinton, high-priority work on chemical engineering problems in reactor operations, heavy emphasis on processes for recovering uranium from Hanford reactor wastes, and continued full-scale production of radioisotopes. In place of designing and building the Daniels unit, the laboratory would devote some effort to studying components for power reactors. Except for construction of the high-flux reactor at Clinton, the plan followed the recommendations of the General Advisory Committee.

When Fisk presented the proposal to the Commission on April 8, he explained that he and Wilson were a long way from a decision on the central laboratory. The high-flux reactor was an important first step in any reactor development program. Would it not make sense to keep the high-flux at Clinton, where it could be built without committing the Commission on the central laboratory? Such a decision would also scotch Thomas's proposal that Monsanto build the high-flux near the company's laboratories in Dayton or St. Louis if it were not to be built at Clinton. The Commission's difficulties in fulfilling the Army's commitment to build a laboratory for General Electric at Schenectady scarcely recommended the idea of a second laboratory of that type. Furthermore, Wilson had good reason to believe that few of the scientists working on the high-flux reactor at Clinton would be willing to follow the project to a Monsanto laboratory.[19]

No one was very happy with Fisk's proposal, but for the moment it seemed the best solution. By the next morning the Commissioners had Oppenheimer's written report from Los Alamos with its strong recommendation for putting the high-flux reactor in a new central laboratory. A long discussion of Oppenheimer's report seemed to neutralize Wilson's and Fisk's arguments of the previous day. By Thursday afternoon, April 10, Fisk and McCormack could report that they had talked with Conant, who strongly opposed their idea. Conant doubted that Monsanto had sufficient interest in the project or could attract to Oak Ridge the caliber of scientists needed for the job. Furthermore, Conant argued, building the high-flux at Clinton would commit the Commission to supporting the laboratory for an indefinite period. Oppenheimer had also told Wilson by telephone that he agreed with Conant. The weight of opinion from Conant and Oppenheimer decided the issue: the high-flux would not be built at Clinton. But neither would there be a central laboratory in the immediate future. The Commission authorized Wilson to negotiate a three-year extension of the contract with Monsanto, with no commitment on the high-flux.[20]

Fisk could only speculate what would have happened had his proposal been adopted, but he could see that the Commission's decision on April 10 would not help to lift the pall of discouragement and aimlessness which had settled over the Clinton scientists. In view of the low morale in the laboratory, Fisk could hardly expect a three-year extension of the existing contract to be greeted with enthusiasm; certainly it would not compensate for loss of the high-flux reactor. Even worse, perhaps, was the lack of decision on the future of the Daniels reactor and other central activities of the laboratory. No one wished to question the intentions or wisdom of the General Advisory Committee; but was it necessarily good that an advisory group, by the sheer weight of its prestige, could reverse the decisions of those directly responsible for operations?

REACTORS AT CLINTON

Fully to appreciate the problems of Clinton, the General Advisory Committee would have had to look at them through the eyes of Eugene P. Wigner, who had lived with them for almost a year. Clinton was every bit the strange melange of activity which Manley had described in his February, 1947, report. And yet there was beneath the surface confusion a sense of purpose and a dedication to scientific research which, Wigner thought, needed only to be channeled in the right direction. Wigner was as ready as anyone to criticize the laboratory, including his own leadership, but he believed in Clinton's potential.[21]

The center of Wigner's interest in April, 1947, was the high-flux reactor, not just because it promised to be a valuable facility for testing the components of new reactors, but because it had exciting possibilities in its own right. Far from the blueprint stage, the high-flux was still an idea for the most part, an idea that haunted the minds of the Clinton scientists in different forms at different times. Recently, however, Wigner had seen evidence that these diverse ideas were converging in one conception—that of a reactor consisting of plates of uranium enriched in the 235 isotope, around which ordinary water would be circulated as both a coolant and a neutron moderator.

What excited the scientists was the idea that one might propose to build a reactor using ordinary water as a moderator. The younger men who had heard Fermi and others lecture on the fundamentals of reactor physics during World War II knew only too well the prime requisites of a moderator: a low atomic weight, which would permit elastic collisions with neutrons and thus slow them down quickly; and a low affinity for neutrons, so that the number of neutrons available would not be reduced by absorption in the moderator. Carbon had been found good in the first respect and acceptable in the second. Heavy water (containing the hydrogen-2 isotope) was excellent in both respects. Ordinary water was excellent in the first respect but had a relatively large appetite for neutrons. At a time when it was not certain that any system would sustain a chain reaction, only the optimum designs using graphite or heavy water were considered. But in 1944, after the scientists at the Metallurgical Laboratory had passed the heaviest load of their wartime responsibilities to the engineers at Hanford, there was time to think about more daring designs. At a conference in Chicago on May 24, 1944, Fermi had suggested the possibility of dissolving a uranium salt in water, which would serve as a moderator. Wigner was impressed by some of Philip Morrison's experiments, which indicated the chances of a chain reaction in ordinary water were much better than Wigner had expected. He suggested the idea of fabricating the uranium in aluminum-coated plates which could be suspended in water.[22]

These imaginative ideas were but two of many proposed, and like many others they had receded into the background by the time the scientists at Clinton got down to the realities of reactor design in 1946. The first full-scale description of the high-flux reactor committed to paper proposed aluminum-clad, plate-type elements cooled internally by ordinary water but suspended in a lattice arrangement in a tank of heavy water as moderator. The reactor would have a power rating of 30 megawatts and would produce a neutron flux many times that of any existing facility. Apparently no longer a dream of the theoretical physicists, the high-flux was now the responsibility of the technical division under Miles C. Leverett, who predicted with some confidence in the spring of 1946 that construction could be started by July 1, and the reactor completed in about a year.[23]

Events proved, however, that others were not so settled on the design as Leverett seemed to be. The consideration of other possibilities tended to dilute interest in the established design, and July 1 passed without any decision to begin construction. One of the distracting possibilities was a suggestion from Alvin M. Weinberg, who had worked closely with Wigner in reactor design. In April, 1946, Weinberg ventured the thought that scientists had overlooked the advantages of water reactors. The relatively poor qualities of ordinary water as a moderator and its inefficiency as a heat-transfer medium at ordinary pressures had caused scientists to discount its use in power reactors. This tendency in part explained the recent emphasis on gas cooling, which had been proposed for the Daniels reactor, and liquid-metal coolants, which were under study for the fast-breeder at Argonne and the intermediate-power-breeder at Schenectady. But what, Weinberg asked, would happen if water were used at high pressures? Tests had shown that water would perform satisfactorily at temperatures up to 374 degrees centigrade and at pressures up to 215 atmospheres. Corrosion was not severe in stainless steel and might be acceptable in aluminum. He concluded: "These facts suggest that a high pressure water power plant may be built with less development work than either the gas or liquid metal plants, and that such a plant might be very reliable." Weinberg admitted that water might not be the best heat transfer medium, but he thought hot water would probably have to be used in breeder reactors. He went even further. He thought a chain reaction might be possible in unenriched uranium with ordinary water as a moderator if the temperature of the water were high enough.[24]

Other scientists at Clinton and elsewhere had thought of the same possibility, but Weinberg was in an excellent position to bring it to bear on the high-flux design. At Clinton second only to Wigner in stature as a reactor physicist, Weinberg had his superior's confidence and support. Working closely with Leverett, Gale Young, Lothar W. Nordheim, and others in the laboratory, Wigner and Weinberg carefully weighed the advantages of the water reactor against those of the original high-flux design. Finally, on August 23, 1946, they decided to make the change. It would certainly set back the schedule for the high-flux, but the advantages were substantial. Not only did the new design eliminate the need for heavy water, still a scarce and expensive material, but it also made possible a much simpler and more compact design. Instead of placing the fuel element assemblies in a lattice, they could be stacked closely together, an arrangement which promised to increase the power density and thus the flux of fast neutrons by ten times over that possible in the heavy-water approach.[25]

Theoretical and engineering studies in the remaining months of 1946 increased the laboratory's enthusiasm for the new design. The frustrations of early 1947 and the drop in morale set back work on the high-flux as it did all other projects in the laboratory, but by the end of March Wigner was convinced that Weinberg was on the right track. A general report on the high-flux design gave impressive evidence of the accomplishments of the past year. For Wigner and Weinberg the high-flux was unquestionably the most valuable reactor the Commission could build in 1947. All the work at Clinton pointed to success. Then came the Commission's ambivalent decision of April 10, 1947, which in one breath expressed confidence in the high-flux and in the next stated the intention to build the reactor at another site, not yet determined.

If the news from Washington disappointed Wigner, Weinberg, and the former Metallurgical Laboratory scientists at Clinton, its impact must have been equally severe on Farrington Daniels, C. Rogers McCullough, and the Monsanto team which had dedicated its efforts to the gas-cooled power reactor called the "Daniels Pile." In 1946 the project had enjoyed top priority in the Manhattan District's reactor plans. Never claiming that the reactor in a technical sense would be a practical producer of power, Daniels saw it as the answer to a critical need to demonstrate to American industry and to the world the feasibility of using nuclear energy for power generation. Starting with the technology at hand, such as the air-cooled X-10 research reactor at Clinton, Daniels thought he could attain his relatively modest goal without involving the project in time-consuming fundamental studies.[26]

By the autumn of 1946, however, almost everyone at Clinton realized the power project was in trouble. Wigner, as codirector of the laboratory, was not willing to take responsibility for the project unless some of the design features were subjected to detailed study and tests. Daniels, now only a part-time consultant at Clinton, argued that the physicists were hamstringing the project with needless detail. Even when he had to admit the need for more data, Daniels was confident enough in his own judgment to suggest proceeding with the original design pending the outcome of further study. Convincing evidence of error led often only to the substitution of a new scheme as questionable as the original.[27]

For Daniels power demonstration was the overriding consideration. He confided to McCullough in January, 1947, that he would rather have a second-class reactor in one year than a first-class one in two years. Thomas, whose experience on the Lilienthal board of consultants led him to accept Daniels's scale of values, kept Monsanto support behind the project; but he confessed to Wigner in February, 1947, that the goal of the project was becoming confused. That, he thought, might explain the difficulty in fixing on a final design. Wigner replied that he could not submit the design to routine engineering until the physicists had checked out such things as the critical size of the reactor, its response to increases in temperature, and the rate of diffusion of rare gases through the beryllium-oxide moderator.[28]

Wigner's lack of enthusiasm and the shaky foundations on which the design seemed to rest were adequate justification for the unfavorable reaction of the General Advisory Committee, Wilson, and Fisk.[29] A prompt decision to terminate the project in April, 1947, as Wilson and Fisk had advocated, might have caused an outcry from Daniels and Monsanto. But when the Commission lost track of the decision in its discussion of the central laboratory and the future of Clinton on April 10, it condemned Wigner and the laboratory to more months of indecision and permitted Daniels to keep up his fight on the strength of hopes he would never realize.

REACTORS FOR THE MILITARY

Unfortunately, the future of the high-flux and the Daniels reactors was not the only source of anxiety at Oak Ridge. Two other projects competing for the limited resources available were not under Commission jurisdiction but were creatures of the military services. At the April 10 meeting the two efforts did not even enter the Commission's discussion of reactor activities at Oak Ridge, but both seemed to have the potential for far-reaching impact on Oak Ridge and, if successful, on the future of nuclear power.

The first of these projects bore the title of "NEPA," an acronym from Nuclear Energy for the Propulsion of Aircraft. NEPA stemmed directly from Army Air Force efforts during World War II to develop jet engines for aircraft. Jet power had immediate application in interceptor aircraft, where high fuel consumption and therefore short range did not cancel out the advantages of high speed. This development threatened to give defensive aircraft a distinct advantage over long-range bombers, a threat which became the concern of General Curtis E. LeMay's research and development staff.

In 1944 Colonel Donald J. Keirn, a jet-engine expert at Wright Field,

Ohio, learned that the Manhattan project was concerned with atomic energy. An inquiry to Vannevar Bush brought the abrupt reply that the Army was developing atomic energy for bombs, not for aircraft propulsion. Not until the mission of the Manhattan project became common knowledge at the end of the war was Keirn able to reopen the question. Then four aircraft manufacturers proposed to investigate the possibilities of aircraft nuclear propulsion. It would not have been easy for the Air Force or the manufacturers to break through the secrecy barriers around the Manhattan project; but with help from Air Force General Roscoe C. Wilson, Keirn succeeded in April, 1946, in winning Groves's acceptance of an agreement that the Air Force would negotiate contracts with interested companies to conduct research in existing facilities at Oak Ridge and in cooperation with Monsanto research on power reactors. As a member of Groves's staff Keirn would maintain control through review of the contracts, security arrangements, and research proposals. The Army would furnish housing and laboratory facilities at Oak Ridge; the Air Force would pay most of the costs.[30]

In an effort to satisfy Groves's continuing concern about administrative and security controls, the Air Force on May 23, 1946, granted a prime contract to the Fairchild Engine and Airplane Corporation, whose president, J. Carlton Ward, was spearheading the aircraft industry's interest in the project. Nine other participating companies, the Navy's Bureau of Aeronautics, and the National Advisory Committee for Aeronautics were to be represented on a board of consultants and would receive technical information through channels strictly controlled by the Manhattan District. The nine associated companies could also participate as Fairchild subcontractors.[31]

On paper NEPA was to be an impressive enterprise, consisting of extensive Fairchild operations at Oak Ridge supported by a variety of research activities performed elsewhere by subcontractors. Actually, the first Air Force and Fairchild personnel did not arrive in Oak Ridge until September, 1946, and not more than thirty were assigned by late November. Part of the trouble was the lack of adequate housing and office space. For a time the NEPA technical staff hoped to move into the Clinton Laboratories near the Monsanto group working on the Daniels reactor, but eventually they had to accept much less desirable space in the abandoned thermal diffusion separation plant isolated in the K-25 production area, a dozen miles from the Monsanto group. There the NEPA group, under the direction of Gordon Simmons, Jr., undertook paper studies and calculations of various systems for transferring heat from a reactor source to conventional propeller jets, turbojets, and ramjets.[32]

From the beginning it was clear that NEPA was to be the domain of engineers, not nuclear physicists, and that the chief concern was aircraft engines and equipment, not nuclear reactors. The great variety of subjects under investigation and the leisurely pace of research at Oak Ridge did not suggest an attitude of urgency. On the other hand, so few people in the project knew anything about atomic energy that it was difficult to know where to begin. The NEPA staff seemed much more concerned about administrative procedures, tables of organization, recruiting, and public relations than about the fundamental question of whether existing reactor technology offered any feasible way of using nuclear energy in an aircraft. The implicit assumption was that in the total effort reactor design was but one of many problems, one which safely could be left for the Monsanto group to resolve. This would have been a risky assumption even if Monsanto had been devoting all of its attention to the aircraft reactor. The difficulties Daniels and the Monsanto group were facing in 1947 made such an assumption nothing but a daydream.

Conant recognized some of these weaknesses when Ward and Simmons briefed the atomic energy committee of the Joint Research and Development Board on March 10, 1947. After the NEPA group left, Conant asked Crawford H. Greenewalt to investigate NEPA in the course of his survey of reactor development projects, and Oppenheimer suggested that any information acquired be given to the reactor subcommittee of the General Advisory Committee. Beyond the question of technical feasibility, Conant raised the issue of military requirements. Development of an aircraft reactor was clearly to be a most difficult and therefore expensive enterprise. Was there in fact a sound military justification for embarking on such an ambitious effort?

This was the subject of the committee's meeting on March 31.[33] The discussion centered on written reports which Greenewalt had requested from the military officers acquainted with NEPA. Air Force General Alden S. Crawford presented a convincing analysis supporting the need for nuclear power in long-range bombers. On the assumption that an effective delivery system for atomic weapons would require a bomber with a range of 12,000 miles at speeds exceeding 450 miles per hour, Crawford concluded that only nuclear-powered aircraft would be able to carry sufficient fuel. To conserve the nation's small supply of fissionable material, he suggested that initially efforts be concentrated on applying nuclear energy in turbojet systems even though the Air Force might later want applications to ramjets and rockets for guided missiles then under study in Project RAND. Admiral Leslie C. Stevens of the Navy's Bureau of Aeronautics in his own paper confirmed Crawford's conclusions about the unique advantages of nuclear power in long-range bombers, and supported NEPA's contention that such an airplane was at least theoretically possible.

Conant, however, remained unconvinced and Oppenheimer suggested additional study of such questions as the amount of time, fissionable material, and scientific effort that might be required. Privately both men had grave doubts about the chances for success within reasonable time and cost, but it would take more than opinion to stop NEPA and the Air Force's bid for a place in atomic energy development.

Like the Air Force, the Navy also had developed an interest in the possibilities of nuclear propulsion before the end of World War II. The fact

that Navy interest went back to 1939, before the Army or Groves knew anything about atomic energy, was a point Navy officers often recalled. Ross Gunn and Philip H. Abelson at the Naval Research Laboratory had never forgotten the abrupt termination of their contacts with the Manhattan project in the summer of 1943 after they had offered the Army results of Navy research which contributed to the production of uranium 235 for the Hiroshima weapon. Nor did Gunn abandon his determination to establish a completely independent Navy project to study nuclear propulsion for naval vessels, particularly submarines.[34]

Early in 1946, this determination took the form of a demand for copies of all Manhattan District technical reports and for wholesale clearances of Navy personnel for access to atomic energy information. Unfortunately for Gunn and his associates, they were not able to obtain full Navy support for their position. The blanket requests for clearances from Admiral Harold G. Bowen, chief of the Navy's new Office of Research and Inventions, were so far from the spirit of the tight security restrictions surrounding the Manhattan project that Groves hardly had to take them seriously. Furthermore, Groves had demonstrated his good faith toward the Navy in the summer of 1944 by clearing two high-ranking officers in the Bureau of Ships, Admiral Earle W. Mills and Captain Thorvald A. Solberg, for access to nonweapon research information in connection with their service on the Tolman committee on postwar policy. Maintaining that he was always prepared to grant clearances to individual Navy personnel who could be assigned full-time to the Manhattan project for specific purposes, Groves had permitted Abelson to spend several months at the Clinton Laboratories in the spring of 1946. There Abelson had gained a full understanding of the status of reactor development, including Weinberg's latest thinking on water reactors.[35]

Two other developments in the early postwar period helped to doom Gunn's hopes for an independent Navy project. First, by pleading Gunn's case too strongly, Admiral Bowen aroused fears in the Bureau of Ships that his new office and the Naval Research Laboratory were trying to take over all Navy activities in atomic energy. Secondly, a preliminary proposal by Abelson and his associates in March, 1946, to build a nuclear submarine in two years by using an existing hull design and conventional turbines coupled to a reactor, convinced Mills and his associates that the Naval Research Laboratory was underestimating the time and effort required to develop nuclear propulsion for ships. Admiral Chester W. Nimitz, Chief of Naval Operations, resolved the issue early in May, 1946, by adopting the approach advocated by the Bureau of Ships. Mills, Solberg, and Parsons, who directed ordnance development of the wartime weapons at Los Alamos, had long agreed that the Navy should abandon any idea of an independent project for the present and instead should assign several well-qualified officers and civilians to the Manhattan project. Their purpose would be not to design a naval propulsion reactor but to learn the fundamentals of nuclear technology. Initially they would be assigned to Clinton.[36]

Mills saw the importance of the Clinton assignments. The job required intelligent men, well grounded in engineering, and with enough initiative and drive to maintain a Navy perspective during any extended assignment in an Army laboratory. As senior officer in the group Mills selected Captain Hyman G. Rickover, whose excellent work on shipboard electric problems had first brought him to Mills's attention during World War II. Mills had no question about Rickover's intelligence, industry, or tenacity; for these qualities he was well known. Equally well established was his reputation as an ambitious, outspoken officer who often criticized traditional Navy methods of operation. Rickover had been in Washington in April, 1946, looking for a new assignment. He had heard about the Navy's interest in nuclear propulsion and inquired about the possibility of his assignment to the project. Once Mills had explained that the future of the project was anything but certain, Rickover began to have second thoughts about it; but Mills had made up his mind. He arranged with General Kenneth D. Nichols to have Rickover assigned as Williams's assistant in Oak Ridge. On June 14, Rickover went to Oak Ridge with Nichols aboard the General's plane. Within a few days the other members of the group arrived. They included Lieutenant Commanders Louis H. Roddis, Jr., James M. Dunford, and Miles A. Libbey, Lieutenant Raymond H. Dick, and three civilians.

Theoretically the members of the Navy group were assigned to Oak Ridge as individuals, but Rickover as senior officer quickly took command and established within the group a sense of discipline and esprit de corps which became legendary at Oak Ridge. In contrast to the banker's hours and time-serving attitude of many at Oak Ridge, the Navy group had a mission and little time for anything else. They read everything they could find, attended every technical meeting and seminar offered, listened to any engineer who would talk, and wrote dozens of concise, detailed reports which soon accumulated in Navy files as one of the best summaries of nuclear technology in existence. The reports were to the point and factual; there was no special pleading or wishful thinking. Every project, every idea was evaluated for its use in naval propulsion systems. Within six months Rickover's group had a better understanding of the technical status of many projects than did those directly participating in them.[37]

Study and report writing, however, did not constitute all the Navy effort on nuclear propulsion in 1946. Before the end of June, the Bureau of Ships had approved two research contracts with private companies to study the use of sodium-potassium alloy in heat transfer systems and had received from the General Electric Company a proposal to develop a nuclear power plant for a destroyer. Soon after the Atomic Energy Act became law on August 1, an event which numbered the days of the Manhattan project, Groves approved a request from Mills for Army support of a paper study of the destroyer plant at General Electric. In November, 1946, the Massachusetts Institute of Technology submitted to the Navy an ambitious proposal for study and development of a nuclear propulsion system. In December Rickover and his assistants visited both the General Electric and MIT laboratories to discuss the work in progress and to explore the possibilities of combining the two efforts into one project at Schenectady. Agreement on a combined project proved impossible, but MIT was willing to accept research contracts on specific problems such as shielding design. At Rickover's suggestion, General Electric scaled down its effort to a power plant for a destroyer escort, in the interests of saving fissionable material. Further conferences with the General Electric staff convinced Rickover that the company was on the right track. He assured Mills that the General Electric proposal was the best hope the Navy had for a nuclear submarine within four years. The company proposed to have a sodium-cooled plant installed in a destroyer escort by September, 1948, and in a submarine by July, 1950.[38]

By the spring of 1947 Rickover and his group had learned all they needed to know at Oak Ridge and were preparing for a seven-week tour of Commission laboratories and major installations. The General Electric project looked like a promising start, but Mills warned Rickover that the new Atomic Energy Commission was not yet well enough organized to make a prompt decision on the Navy effort. In May, 1947, the Commission had more pressing issues to decide; the Navy would have to wait for its day in court.

EXIT MONSANTO

When Conant and Oppenheimer reversed the Commission's decision to build the high-flux reactor at Clinton, they imposed additional complications on Wilson and Fisk. For one thing, the shift kept alive the possibility of a central laboratory, a proposal which both men looked upon with skepticism. For another, it would make negotiations with Monsanto much more difficult.

Wilson made clear the reasons for his concern in a wide-ranging discussion with Thomas and other Monsanto officials in St. Louis on May 2, 1947. He stressed the important contributions which the company could make in producing initiators at Dayton and radioisotopes in the X-10 reactor at Clinton. He was counting on Monsanto's help in developing a process to recover uranium from the waste tanks at Hanford and Clinton and in operating Clinton as a regional research center for universities in the Southeast. But he wanted the Monsanto leadership to know that the Commmission was considering a sharp curtailment of reactor development work at Clinton. The General Advisory Committee believed that plans to construct the Daniels reactor were premature, and that construction of a power unit might be four or five years away. The Commission intended to put more effort into the high-flux, but there was a good chance that the reactor itself would not be built at Clinton. Wilson also let it be known that he was not satisfied with Monsanto management at Clinton and that he expected the company to assign one of its top officers, perhaps Hochwalt, to direct Monsanto operations at the laboratory.[39]

Thomas replied by pointing out the company's many accomplishments during the previous two difficult years. The high-flux reactor had been completely redesigned. The power group had learned much about design requirements for the Daniels unit, and the laboratory had made great strides in establishing an outstanding program in radiation biology under the direction of Alexander Hollaender. Thomas was more concerned about plans for the high-flux. He thought the laboratory needed an important assignment in physics as well as chemistry. Wilson had argued that it did not seem appropriate to permit a private company to build and control a reactor which would be a fundamental research tool for other Commission projects. Thomas had only to note that the Commission was permitting General Electric to build the intermediate-power-breeder at Schenectady.

Wilson was uneasy as he started back to Washington with Fisk on Friday afternoon. Thomas was not enthusiastic about the new arrangement, and Wilson knew the company had never been completely happy at Clinton. His premonitions proved correct. On Tuesday morning, May 6, he received a telegram from Thomas stating that the company would not be interested in the Clinton contract if it did not include the high-flux. Now the issue seemed clear-cut: the Commission had to decide whether to keep Clinton as a major laboratory or establish a central laboratory elsewhere.

Wilson presented the issue in those terms to the Commissioners later that morning. He held that the Commission was in no position to organize a central laboratory with its own employees. Both Bacher and Fisk thought most of the scientists would remain at Clinton if the company installed better management. The price would be to change course again and build the high-flux at Clinton. Wilson left the meeting to call Conant in Cambridge. Conant needed no time to consider the question. Monsanto had to be retained at Clinton, even at the price named. Conant's word was enough for the

Commissioners. After the meeting Wilson sent Thomas a telegram accepting Monsanto's condition and asking him to come to Washington for further discussions.[40]

Wilson was confident when Thomas and his associates arrived for their meeting with the Commissioners on Thursday afternoon, May 8. That morning Williams had called from Oak Ridge with assurances that Monsanto was more willing to accept a new contract than the telegram on Tuesday had suggested. Wilson put his position on paper: if Monsanto would replace the dual leadership at Clinton with a single director who was a good administrator and had the full support of the St. Louis organization, the Commission would make every effort to improve conditions at Oak Ridge and give the high-flux a top priority. The company could continue component development for the Daniels project, maintain radioisotope production, and operate the X-10 reactor as a regional research facility. The rest of the program could be trimmed to a modest scale.[41]

Thomas found Wilson's proposal encouraging, but Monsanto's position had now stiffened. Not only did the company want the high-flux, but it would have to be built either at Dayton or St. Louis. Fisk thought Thomas was simply trying to escape the Clinton contract. Wilson and the Commissioners tended to agree, but they asked Wilson to keep negotiating. Although Thomas for a time relented on his latest demand, he found other objections to the contract. At last on May 22 he wrote Wilson that Monsanto would have to withdraw. The company was willing to operate the Dayton plant under a separate contract and would still agree to build the high-flux at a company site.

The letter was sad news for the Commissioners. Lilienthal hated to see Monsanto go. He thought General Electric's success in winning the promise of the Schenectady laboratory from General Groves had led Thomas to believe the Commission would give in on the high-flux location, but Lilienthal wanted to avoid such a bargain. Still, the prospect of finding a new contractor to take over Clinton was not very good. In a moment of desperation someone suggested trying to bring du Pont back to Clinton. Lilienthal thought that would mean that the Commission would become part of du Pont rather than the other way around. Du Pont could hardly be expected to conform its management policies to a contract the Commission would have to beg the company to accept. Perhaps, Strauss suggested, the scientists at Clinton could themselves form a corporation to serve as the contractor. Other companies were already expressing an interest. Lilienthal thought something would turn up; but until a new contractor could be found for Clinton, the future of the laboratory and the high-flux would be uncertain.[42]

Coming just a few days before the fourth meeting of the General Advisory Committee on May 30, 1947, the Monsanto decision was certain to reopen the question of the central laboratory and the future of Clinton. Wilson attempted to forestall the discussion by stating to the committee the

Commission's determination not to establish a central laboratory, but the committee had no intention of dropping the subject. Wilson's arguments convinced no one that building the high-flux reactor at Clinton was a good idea. Rabi urged that MIT be asked to construct and operate the reactor at Brookhaven. Although Conant favored the Argonne site, he agreed with Rabi that Clinton would never be a strong laboratory. Nor was there any inclination to take seriously the Commission's contention that a central laboratory would conflict with Lilienthal's doctrine of decentralization. That was simply a play on words. The committee hoped the Commission would give further thought to the central laboratory and would consider building the high-flux at a site other than Clinton, if not abandoning the laboratory altogether.[43]

OPENING DOORS FOR RESEARCH

Oppenheimer's committee considered a broad range of topics over the Memorial Day weekend, but much of the discussion centered around the need to broaden both Commission support of basic research in the United States and participation in nuclear research by independent scientists. These interests stemmed directly from the new appreciation of the importance of science in the postwar world. Radar, the proximity fuse, and the atomic bomb were seen as the products of a vigorous and well-supported research effort during the war; many Americans considered broad Federal support of scientific research and development essential to the national welfare in peacetime as well. The question for debate was not really *whether* but *how*—how, for example, could the Federal Government support university research without restricting traditional academic freedoms? Or how could the Government exercise appropriate administrative controls in the public interest if the scientists were really free? More dramatic and emotional issues concealed these fundamental questions in the prolonged debates on atomic energy legislation and the National Science Foundation in 1946. Even in early 1947 most people found few answers to these questions in the new Atomic Energy Act, and the outcome of the National Science Foundation debate, aborted in 1946, had not yet begun to appear.[44]

As often happened when events outran policy, those officials in the best position to act were reluctant to do so. Perhaps few persons in the Government in early 1947 had had better exposure to the requirements for, and the capabilities of, modern large-scale research programs than did Wilson and Fisk. Yet, during the winter of 1947, they held doggedly to the line that scientific talent and resources had to be conserved for immediately essential activities, such as weapon design and testing, improvements in production reactors, and development of the Redox process.

While the Commission was preoccupied with these and other matters, research proposals began coming in from universities, Government agencies, private companies, and the Commission's national laboratories. Fisk reported to the General Advisory Committee at its May meeting that these proposals, if accepted, would total more than $19 million in capital costs and more than $4 million in annual operating expenditures for the Commission. What action, Fisk wanted to know, should the Commission take? What proportion (if any) of the Commission's budget should support basic research not directly related to the Commission's program? And how would the Commission justify such support in view of the legislative history of the Atomic Energy Act, which showed that Congress had stricken from the McMahon bill the authority to award grants-in-aid? [45]

What brought these questions to a head was a proposal from the Office of Naval Research requesting the Commission to contribute $4.1 million to support high-energy physics. While scientists both inside and outside the Government had been struggling with the policy issues in the debate about the National Science Foundation, the Navy had quietly undertaken to finance construction of high-energy accelerators on university campuses. Before World War II a few enterprising physicists like Ernest O. Lawrence at the University of California had been able to find support for such efforts in private foundations, but in the postwar world possession of an accelerator was no longer optional in a good physics laboratory. In response to requests the Navy had awarded twelve contracts for the construction of accelerators, most of them cyclotrons ranging in size up to that of the 184-inch machine in Lawrence's laboratory at Berkeley. Now, in the spring of 1947, the Navy was running into budget restrictions which threatened completion of the accelerators already started.[46]

The Navy request posed some tough questions for Fisk. On the one hand, it seemed ridiculous that the Navy, rather than the Commission, should be supporting research on the atomic nucleus. On the other hand, Fisk quite reasonably asked how deeper probes into the nucleus with protons from more powerful accelerators would contribute to the design of better weapons and reactors. If they would not, Fisk doubted that Commission support was justified, no matter how much such projects might contribute to man's understanding of nature.

Another research policy issue in the spring of 1947 concerned the foreign distribution of radioisotopes. Before World War II there had been extensive research using radioactive materials, and it had become customary for university laboratories in the United States to give European scientists samples of radioisotopes produced in cyclotrons. After the war the demand for accelerators was too great to permit their use for isotope production, and the Manhattan District had been able to meet all domestic needs solely by operation of the X-10 research reactor at Clinton. Scientists abroad, deprived of their prewar sources and having few of their own, began pressing for even modest samples from the materials copiously generated in the Clinton reactor.

After the Commission was appointed, scientists at Brookhaven and eastern universities began appealing to Bacher on behalf of their European colleagues. Bacher passed the appeals to Wilson, whose immediate reaction was that nothing in the Atomic Energy Act prohibited foreign distribution of isotopes and that it would be in the national interest to comply with the requests. General Nichols pointed out that the Manhattan District had carefully avoided committing the Commission on the subject. Setting aside the legal question, he saw no practical difficulty in extending distribution abroad and suggested using domestic procedures, with added provisions disclaiming Commission responsibility for the use of the isotopes and requiring foreign applicants to describe the proposed use and to report their results in scientific journals. The study of legal questions took several months, but the lawyers concluded there were no insuperable obstacles. Radioisotopes seemed to fall under the Act's definition of "byproduct material," and the Act posed no geographic limitations on the distribution of such materials. There was some uncertainty whether isotopes would come under the provisions of Section 10(a), which prohibited the "exchange of information with other nations with respect to the use of atomic energy for industrial purposes," but the lawyers thought this was a matter of judgment which the Commission should carefully document in the record.[47]

By the time these issues had been resolved in late March, the scientists were becoming restive, and renewed appeals were arriving in Bacher's office. A number of distinguished American scientists, all members of an international society called the Isotope Research Group, urged Commission action. As an illustration, they cited the denial of a Canadian request for a small sample of carbon 14, worth five cents, for radiographic tests of biologic material.[48]

Apparently the only reason for further delay was the continuing reservation expressed by Commissioner Strauss, who feared the radioactive samples might fall into the wrong hands and "provide the means to conduct research on the use of radiological poisons in warfare." If the Commission could not control the eventual disposition of the isotopes, Strauss thought "it would be best not to export them at all." Rather than risk a formal confrontation with Strauss, Lilienthal and Wilson decided to submit the proposed foreign distribution plan to the General Advisory Committee at the May meeting. The plan followed closely the administrative procedures suggested by Nichols. In order to avoid the distribution of isotopes which would further the development of atomic energy for military or industrial purposes, the list would not include any natural radioisotope above atomic number 83 (bismuth) or any artificially produced isotope above 92 (uranium), and use would be restricted to medical research and therapy.[49]

The General Advisory Committee took a strong stand on both the foreign distribution of isotopes and the accelerator proposal. The subcommittee on research under DuBridge's leadership thought the Office of Naval

Research had performed a valuable service in financing accelerator construction at a time when no other Government agency was in a position to help. The Navy had exercised discretion in awarding the contracts and had succeeded in encouraging just the sort of research that was needed. The committee argued that the completely unclassified nature of the accelerator projects suggested that a civilian agency like the Commission, rather than the Navy, should support them.[50]

On the foreign distribution of isotopes the committee "heartily concurred." It would have the effect abroad of restoring confidence in American scientists. Rather than question the proposal, the committee suggested a much more liberal policy. It questioned the restriction to medical therapy and research and urged broadening the authorization at least to include the biological sciences, if not all basic research. The committee, at Fermi's suggestion, also favored including hydrogen 3 (tritium) in the distribution list, on the security grounds that its omission would suggest that the material had special classified uses.

Oppenheimer got to the fundamental issue on May 31 in a long discussion with the Commission which Lilienthal termed "as brilliant, lively, and accurate a statement as I believe I have ever heard." Oppenheimer stated directly that the Commission would have to support fundamental research in the nuclear sciences. And by that he meant nuclear physics and chemistry and not just the compilation of data and the development of processes related to Commission activities. Furthermore, the support would have to go to scientists working in university and private laboratories.

In a diplomatic way Oppenheimer suggested that Wilson and Fisk were asking the wrong question. The issue was not what proportion of the Commission's budget should go for basic research or how many accelerators the Commission could appropriately support, but how many accelerators would meet the needs of well-qualified research teams already in existence. The competence of the research group and not the substance of its proposal should be the criterion for selection. The Office of Naval Research had proceeded in just this way and had granted liberal contracts which the scientists were happy to accept. Oppenheimer hoped the Commission would take over the Navy contracts, but only on the condition that it did so with the same criteria and as little red tape as the Navy found necessary.[51]

Bacher agreed with Oppenheimer in principle, but he thought that in a practical sense there had to be some consideration of the magnitude of support for basic research. DuBridge argued that this would be true if the Commission were thinking of building ten Berkeley laboratories, but the Navy program, which seemed fully adequate, involved a negligible proportion of the Commission's budget. Fisk said he could agree with Oppenheimer in the long term, but he was still concerned about finding enough scientists for essential work during the next several years.

As Oppenheimer continued, he revealed the committee's interest in other positive measures to increase participation in nuclear research. He hoped the Commission would declassify broad topics in the nuclear sciences and segregate research on them from classified activities. This action would end the intolerable situation, of which Fermi complained, that required scientists to write down their ideas in the fundamental sciences and have them declassified before they could discuss them with their colleagues. Oppenheimer urged the Commission to broaden the distribution of radioisotopes to scientists abroad for uses beyond therapeutic and medical research, to take a positive stand on releasing to the public information on recent discoveries in the fundamental sciences.

Saving the committee's greatest concern until last, he stressed the need for a realistic and authoritative statement on the prospects for nuclear power. Convinced that industrial use of atomic energy was at least a decade away, the committee was disturbed by the "rather bad discrepancy between expectation and probable reality." He thought it was "very terrifying to have news releases about how there is going to be atomic power in Britain in two years." The committee believed the Commission could issue a statement on this subject without compromising classified information. In these and other ways Oppenheimer thought the Commission could take the lead in opening the doors to fundamental research in the nuclear sciences.

The committee's comments and suggestions had been helpful in a general way, but Fisk had reservations about their practicality. It was one thing to theorize about the Commission's program and its goals and something else to apply policies in day-to-day operations. The force of the committee's arguments and the prestige behind them were too great for a direct confrontation, but Fisk could bide his time. In a burst of enthusiasm on June 5, the Commission had agreed to support the Navy accelerator program temporarily until it could assume direct responsibility for the contracts, but Fisk saw no need for an immediate response to the Navy. Further discussions revealed that the Navy could finance the projects for another year. On July 17 he sent to the Commission a draft letter commending the Navy for supporting the twelve projects but declaring the Commission's inability to assume the burden. Applied research and development had to come first, and it was not yet "clear how the task of providing public funds to support such a program should be apportioned." [52]

The other proposals of the General Advisory Committee fared no better in the late spring of 1947. Fisk was reluctant to commit himself on the private research proposals and had little time to consider the broad outlines of a basic research program. Even in applied areas such as reactor development he took no immediate steps to formulate a policy which would guide the national laboratories. In May, with Lilienthal's encouragement, he appointed a research council consisting of the directors of the principal laboratories, but the group had no plans to meet until midsummer. Nor did Fisk hasten to appoint the committee recommended by Oppenheimer's group to study the hazards of building reactors near centers of population. Finding a replacement for Monsanto and mounting the research effort on Redox were more pressing concerns of the moment; the important but less immediate goals of the General Advisory Committee would have to wait.[53]

A SOBERING DECISION

If Fisk had difficulty interpreting the General Advisory Committee's recommendations on research and development, McCormack and Williams had no trouble understanding its thoughts on weapons and production. Without prompt action on these matters, there would be little hope of building an effective arsenal of atomic weapons before the end of the decade.

On the weapon test, the weapon subcommittee had settled most of the technical issues at the April meeting in Los Alamos. There was general agreement on the numbers of shots and on the design of the devices to be tested. Now it was up to Lilienthal and the Commission to work out the policy issues at the Pentagon and the White House. Although the need for the test series was obvious, Lilienthal and others found the decision difficult to swallow. It was in a way an admission that the fervent hopes and plans for international control of atomic energy had all but vanished. Nor did the Bikini tests of the previous year make the decision any easier. The lack of scientific instrumentation and the presence of large numbers of observers at Operation *Crossroads*, although consistent with the purposes of the armed forces, made it difficult to convince scientists that the 1948 tests were really designed to produce significant data.

Since a decision on the weapon test rested ultimately with President Truman, Lilienthal faced the unfamiliar task of transforming a Commission decision into a significant Administration policy. He began on April 25, 1947, with a letter to the Military Liaison Committee explaining the need for the test and outlining the Commission's plans. A month later General Brereton could report only that he had sent a written proposal to General Eisenhower and the Joint Chiefs of Staff; there was still no formal concurrence from the military services. Progress was just as slow in the Department of State. Lilienthal raised the question in a long discussion with Secretary George C. Marshall on June 11. He explained that the proposed test would have international repercussions, especially since it would be necessary to conduct the operation outside the United States. Marshall acknowledged this difficulty, but he was even more concerned about timing. It would be most unfortunate if the test occurred at any time close to the foreign ministers' conference scheduled for London in November. Marshall seemed to accept the need for the test, but he wanted to reserve judgment until he had discussed it in the department.[54]

Meanwhile, Lilienthal, still nervous about the decision, had been sounding out the President through Admiral William D. Leahy. On June 14, he called Lilienthal to report that the President was all for the idea but wanted to discuss it with the service secretaries. The final decision came in a White House meeting on June 27. Lilienthal presented the case to the President, the service secretaries, the members of the Joint Chiefs of Staff, and Secretary Marshall. The discussion centered around the time and place for the tests. Eisenhower suggested April, 1948, which was acceptable to Lilienthal although he hoped to be ready by February. Patterson joined Marshall in expressing a preference for holding the test in the continental United States, but Eisenhower supported Lilienthal's contention that a more remote location, somewhere in the Pacific, was preferable. All agreed that the test should be conducted with no fanfare and with no foreign observers. Under Secretary of State Dean G. Acheson reinforced this opinion the following day in a discussion with Lilienthal. It was especially important to keep plans for the test a closely held secret. The public's only preparation for the event was a short sentence tucked in the Commission's semiannual report to the Congress: "The Atomic Energy Commission is establishing proving grounds in the Pacific for routine experiments and tests of atomic weapons." [55]

CONSTRUCTION AT HANFORD

Fortunately Williams did not have to await a Presidential decision to start the campaign for new production facilities at Hanford. He was already concerned about General Electric's failure to come to grips with the project and the absence of a permanent field manager at the site. A trip to Schenectady on May 16 did not alleviate his fears on either point. Although Winne, the company's vice-president, promised full cooperation, Williams found it necessary to remind the General Electric officials that they were working under a cost contract with Government funds and would have to accept firm Commission direction and control. He thought that the holdover Army officer in charge at Hanford had been too lax with the company and should be replaced by a permanent manager as soon as possible.[56]

Despite his best efforts, Williams found he could do little to improve the Hanford situation in June. The company seemed to busy itself more with words than actions, and the lack of firm Commission control at the site made it difficult for Williams to exert his authority across the continent. Finally he decided to take matters into his own hands. Over the holiday weekend in July he flew west with Fred C. Schlemmer, a Commission consultant who had been one of Lilienthal's construction engineers at TVA. Conditions at Hanford were even worse than they expected. Williams found "an air of complacency about the whole place." Schlemmer thought the company was engulfed by procrastination, a state of mind encouraged by the local Commission staff, which seemed to be impressed by the fact that General Electric had not been enthusiastic about the contract in the first place.[57]

The greatest weakness was in design and construction of new facilities. With no experience in such a large construction enterprise, General Electric had hardly begun to make the necessary plans, much less start the actual work. The Army colonel in charge reported that not more than thirty of the estimated eight hundred technical and advisory personnel needed were on the job. Not more than 1 per cent of the purchase orders required for the $100 million project had been placed. The organization chart was a cluster of empty squares. Existing housing would accommodate only 5,000 of the estimated 23,000 construction workers needed. Schools and other community facilities were completely inadequate for a permanent town. There was no doubt in Williams's or Schlemmer's minds that the combined responsibility for construction and operation far exceeded General Electric's capabilities. The most pressing need was for a strong resident Commission manager. Scarcely less urgent was the appointment of experienced architect-engineer and construction contractors. Williams thought work on town facilities should begin at once so that they could be completed before plant construction reached its peak. He also favored building the new production reactors as replacement facilities near existing units, where they could use the same cooling-water facilities. The Commission seemed to accept Williams's recommendations in a general discussion with the Military Liaison Committee on July 18, but it was still Williams's job to carry them out. On his success would depend the future of Hanford.[58]

TALENT SEARCH

With good reason the Commission concentrated during the spring of 1947 on plans for rebuilding and expanding the structure of both its production and research activities. As the General Advisory Committee recognized at its March and May meetings, immediate decisions were necessary to assure the production of fissionable materials and weapons and to revitalize research and development activities. Equally important for Wilson, and perhaps of even more immediate consequence, was the need to organize and appoint his principal staff.

Unfortunately the high priority given to recruitment in February had not produced results. Of the five key positions in the field, those of managers at Oak Ridge, Los Alamos, Hanford, Chicago, and New York, Wilson had succeeded in filling only the New York post with the appointment of Wilbur E. Kelley. Despite the many hours which Wilson, Williams, and Richard O.

Niehoff devoted to inquiries and interviews, a succession of promising candidates turned down the job at Oak Ridge. The variety and magnitude of the responsibilities and the isolation of the site hardly made the position attractive at the salary the Commission was offering. Wilson and McCormack had been successful in recruiting retired Navy Captain Carroll L. Tyler as manager of the new Santa Fe office, but complications in personnel regulations would make it impossible for Tyler to begin work before July. Wilson had been able to do even less on the Hanford and Chicago positions, for which no promising candidates were in sight.[59]

Wilson fully understood the growing danger of the situation. In April he had asked his friend William Webster, a distinguished engineer and New England utilities executive, to visit the field sites. On May 15, Webster reported that Los Alamos was still a mess. Organization at Hanford and Chicago, still under makeshift direction by temporary military officers, was very weak. Oak Ridge had some good people but many more problems than the other sites. Kelley, the only manager on the job, was having trouble operating without a written delegation of authority. Williams agreed with Webster's conclusions: there was little hope of implementing production and research plans until the field offices were staffed and organized.[60]

One reason for the delay in completing the New York directive was the difficulty of defining the broad powers of the manager in a decentralized organization. As finally issued on June 9, the directive assigned Kelley full responsibility for procuring source materials, processing feed materials such as uranium for the production plants, supervising all construction and research contracts assigned to the office, issuing licenses to holders of source materials, and administering the Commission's health physics and industrial hygiene program. He was authorized, without consulting the general manager, to negotiate contracts involving less than $1 million and to appoint his own staff. Hopefully the New York directive would serve as a guide for those at the other sites.

Wilson's recruiting efforts had been no more successful at headquarters than in the field. He had not even been able to define the functions of the statutory division of engineering, much less recruit its director. Despite Waymack's efforts, Wilson still had no good prospects for director of public information. Although Edward R. Trapnell was doing a good job of handling day-to-day press relations, the Commission wanted someone with exceptional talent and experience to direct its efforts to explain atomic energy to the American people. A similar consideration had made it impossible to find a director of security. No ordinary "gumshoe" would be able to weigh the subtle factors involved in devising a security system which would protect individual rights as well as atomic secrets. None of those the Commission thought qualified had yet been willing to accept. Even in the headquarters personnel office there had been uncertainty and confusion. The need to establish an executive secretariat to manage the Commission's business led to

G. Lyle Belsley's appointment first as secretary and then as assistant general manager with responsibility for congressional relations and internal management reports as well. This action left Niehoff in charge of personnel for several weeks until Wilson appointed Fletcher C. Waller, wartime director of civilian personnel and training in the War Department. In the meantime there had been little progress in developing with the Civil Service Commission an independent merit system for Commission employees.[61]

SHADOW OF SECURITY

The snags in personnel operations were disheartening, but of deeper concern to the Commission were the extraordinary requirements for security and the dangers they implied. Compliance with the Atomic Energy Act called for a system of personnel security investigations unprecedented in American Government. During World War II there had been no uniform requirements for security investigations, certainly not by the FBI. Amid the personal sacrifices of war there was little room for concern about infringing upon individual rights, and criteria for security clearances were left to the individual judgment of military commanders like Groves and the directors of other especially sensitive agencies. In peacetime Lilienthal and his associates were determined not to jeopardize individual rights in the interests of secrecy. The statutory provision for FBI clearance of Commission personnel made necessary centralized control of security investigations and hence uniform criteria and procedures. It did not mean, as the Commission had trouble convincing J. Edgar Hoover, that it would turn over its security operations to the FBI. The FBI could conduct the investigations, but the Commission would devise its own methods of evaluating FBI reports. The Commission would not even go so far as to grant FBI agents free access to its installations and files.[62]

Everything hung upon the evaluation. The Commission had to take every precaution to keep out all but the loyal and trustworthy. Too zealous a pursuit of security, however, could do irreparable harm to innocent individuals. Lilienthal thought that refusal of a clearance to a physicist was tantamount to saddling him with a police record, something which, according to the Constitution, could be done only in an open court of law. He came to dread those days when the Commission was called upon "to play God and decide on *ex parte* evidence of FBI detectives whether Mr. A.'s or Mrs. B.'s loyalty, character, or associations are such as to justify permitting them access to Commission work and facilities." Special security boards of Commission officials could handle most of the cases, but the really tough ones, especially the reinvestigations of employees inherited from the Manhattan District, inevitably found their way to the Commissioners.[63]

The security task would have been difficult enough in a placid era; in the turmoil of 1947, it was impossible. The Soviet Union's rejection of the Baruch plan for international control of atomic energy, the aggressive thrust of Communist power in Eastern Europe and the Middle East, the President's offer of assistance to Greece and Turkey, Secretary of State Marshall's speech at Harvard University in June, all served to dramatize the widening gulf between East and West. One reaction to this unhappy development was the obsessive search for the seeds of communism in every liberal movement, what Lilienthal had called "hysteria" during the confirmation fight. A second reaction, that of many of the atomic scientists, was to try harder than ever to keep open the few remaining channels of communications between scientists in the West, if not between those of East and West. As the full dimensions of the "Iron Curtain" appeared, the first group demanded a rooting out of "communist" influences and a tightening of security controls around the "secret of the bomb." The second group, concerned about the vitality of science in the West, argued that fundamentally there was no secret, that science would survive only if the traditional ways of free investigation and communication were restored. Between these two schools of thought was the fledgling Commission, its dilemma illustrated, in Lilienthal's words, by the demand that it guard closely a secret that did not exist.[64]

The ferocity of the attack on Lilienthal during the confirmation hearings and debate and the passion aroused by the communist issue should have put the Commission on guard against outside attempts to ferret out disloyal employees and lax security; but the extraordinary pressures for decision and the lack of staff had forced the Commission to rely on Army procedures and personnel. The first signs of trouble appeared late in May, when Congressman J. Parnell Thomas published an article in *American* magazine charging that most of the atomic energy patents which the Army had withheld from publication during the war were now available to the Russians and anyone else through the Patent Office. The next blow came on Thursday, June 5, when Senator Hickenlooper learned that *Liberty* magazine was about to publish another Thomas article attacking the Commission's security system at Oak Ridge. To make matters worse, Thomas claimed that his article was based on information obtained during a visit to Oak Ridge in February, 1947, with Robert E. Stripling, an investigator for the House Un-American Activities Committee.[65]

Hickenlooper alerted Strauss to the impending crisis and the two of them discussed the situation with Lilienthal on Thursday noon. Hickenlooper intended immediately to send two of his own investigators, David S. Teeple and William Sheehy, to Oak Ridge to check Thomas's story. Lilienthal called in Joseph A. Volpe and Thomas O. Jones and asked them to find out how Thomas had gained access to Oak Ridge and especially to the files of certain employees whom the Commission was finding it difficult to clear after reinvestigation.[66]

It must have seemed ironic to Lilienthal that the Thomas incident had broken on that particular day. Earlier on Thursday morning he had been pondering the whole question of protecting civil liberties in the course of security investigations. At the moment the Commission was considering a difficult case at Brookhaven involving a four-month suspension from employment pending a decision on clearance. The Commission had also to pass on a request from Patterson that it approve legislation authorizing the service secretaries and the Commission to dismiss employees summarily in the interests of national security. In this request the Commission had reluctantly agreed to concur, but only after reasserting its right to provide for administrative review of any decision to dismiss an employee. Both the Brookhaven case and the Patterson letter pointed to the urgency of establishing review procedures which would protect the rights of individual employees in security cases.[67]

The day did not end without one more security crisis. At six-fifteen Lilienthal learned that the security division had received from the FBI some highly classified weapon information which two Army sergeants had taken from Los Alamos in March, 1946, as souvenirs. The air of mystery surrounding the security breach itself aroused suspicion. Jones could only report that on April 30, 1947, the FBI had told him it had received a "tip" that documents were missing at Los Alamos. A check of the files revealed the loss and led to the identification of the two former Army sergeants as Alexander Von der Luft and Ernest D. Wallis. The FBI had recovered the documents with the help of Von der Luft, who by this time was a student at Princeton University. Since espionage did not seem to be involved, the security implications were not alarming; but, like the Thomas article, the Von der Luft-Wallis case could be a source of embarrassment to the Commission. The question was whether the Thomas article and the Von der Luft-Wallis case were merely coincidental or part of a planned attack on the Commission.[68]

Williams, who was still in charge of Oak Ridge operations pending selection of a local manager, found it hard to accept the possibility of coincidence. He never had time to run down all the details on how Thomas had obtained information from the Oak Ridge files, but he thought the time had come for the Commission to place key functions in the field offices in the hands of its own employees. He warned Wilson that unless the Commission cleaned house the combined forces of military and Congressional opponents might bring the civilian Commission to an untimely end.[69]

If the Oak Ridge incident had heightened Commission suspicions of the Army, Thomas did not help to reduce them. He admitted openly that his purpose was to turn the atomic energy program back to the Army. In his article in *Liberty* Thomas had charged that all the production plants and especially the Clinton Laboratories were "heavily infested" with "Communist suspects." He concluded "that in the present chaotic world situation our only solution is to repeal the act and return Manhattan District to the army, which can best administer security." There were, in fact, then pending in Congress six bills for that purpose.[70]

Lilienthal's one consolation was that, despite the furor which the Von der Luft-Wallis case and the Thomas article would certainly create, the Commission and its own staff had not been guilty of any gross breaches of security. In reporting the Von der Luft-Wallis case to the Joint Committee on June 17, Lilienthal could stress the point that the incident had occurred in a military installation under Army control, long before the Commission had been created. Without going into details, he could assure the committee that he had taken steps to prevent a recurrence of the Thomas incident. Henceforth members of Congress would be permitted to visit the Commission's installations only after clearance with Washington. Furthermore, the Commission would admit only the congressman and not others in his party.[71]

Teeple's report to the Joint Committee on his recent visit to Oak Ridge tended to absolve the Commission of gross malfeasance, if not of less than concerted attention to security matters. Although Teeple and Sheehy had failed to detect the glaring laxities which the Thomas article suggested, they did find a need for more guards and better security facilities to replace the dilapidated wartime fences and control posts. They were especially critical of the Clinton Laboratories, where they considered the shabby buildings a fire hazard, security facilities inadequate, and employee morale low. They also concluded that about fifteen employees in the laboratories should be terminated for security reasons. While admitting the need for improvements, Lilienthal could again suggest that all these deficiencies had been inherited from General Groves.

It was fortunate also that the security crises of early June had had most of their impact within Government circles rather than in the public press. The Thomas article, although it contained some dramatic charges, appeared sufficiently biased and vague to cause readers to question its accuracy. Even the Hearst and Patterson papers, which usually featured security stories, gave little attention to the Thomas article. The Von der Luft-Wallis case was not yet public knowledge, a fact which gave the Commission time to put its best foot forward. Yet both incidents served adequate warning upon the Commission that it could not place too much emphasis on security. The warning was not lost. Wilson expedited the appointment of Bernard W. Menke, a former Manhattan District security officer, as security director at Oak Ridge with instructions to tighten up security operations. The Von der Luft-Wallis case involved General Counsel Herbert S. Marks in extensive discussions with the Department of Justice, since the prospective defendants could not be prosecuted under the Atomic Energy Act but only under more general statutes covering the removal of Government records and property. It was also important to make sure that the case could be tried without revealing classified weapon information.[72]

On what Lilienthal considered the more positive side, the Commission also made some headway in June on the perplexing question of establishing adequate administrative procedures to protect individuals in security cases. He liked the General Advisory Committee's idea of appointing a personnel security review board consisting of distinguished jurists to review the more difficult cases in a judicial manner. Before taking any definite action he asked two outstanding lawyers, Archibald S. Alexander and Robert L. Finley, to examine the Commission's security operations and make recommendations. After close inspection of the procedures the Commission had used in evaluating sixty-seven security cases involving derogatory information, Alexander and Finley concluded that "substantial justice" had been done. They believed that the staff's performance manifested concern about protecting the national security and assuring that "no individual should be denied employment on vague hearsay evidence or gossip, but only for facts, reasonably well documented and indicating a security risk." By way of improvement, they suggested the need for precise, written security standards, some tightening of administrative procedures, and the need for appellate review of cases in which derogatory information seemed sufficient to justify denying or revoking a clearance. The Commission could perform this appellate function itself or establish a review board, as Lilienthal suggested. In either case the workload promised to be heavy. Estimating that the Commission would have to process 74,000 clearances in 1947, Alexander and Finley predicted 250 cases involving derogatory information. They urged in the interests of justice that some method be established to give applicants an opportunity to explain or contradict derogatory information reported by the FBI, either in written statements or in a formal hearing before the appeal board. At the same time, the consultants warned that granting such rights, especially the right to a hearing, might go far beyond existing practice in the Government and always involved the danger of compromising the FBI's sources of information.[73]

Before the Commission could act on these recommendations, a new crisis burst upon the scene. On Wednesday, July 9, 1947, the New York *Sun* proclaimed in banner headlines the theft "of highly secret data on the atomic bomb" from Oak Ridge. The article by *Sun* reporter Robert Nellor predicted the incident would rival the Canadian spy case of 1946 and would lead to a "total reorganization" of the nation's atomic energy program. The alarming revelations were likely to lead the casual reader to the same conclusion; but anyone privy to the details of the June crisis and its repercussions was likely to see suspicious similarities. It did not take much imagination to suggest that Nellor had started with the Thomas article (poor security at Oak Ridge), added to it scraps of information about the Von der Luft-Wallis case (stolen documents), and embellished it with gossip about Joint Committee concern (inspired by the Teeple-Sheehy report).

Unfortunately for the Commission, the *Sun* story, unlike the Thomas article, received major attention in the press. The Hearst and Patterson papers leaped at the opportunity to discredit the Commission, and even the sympathetic *PM* and the Washington *Post* gave it prominent space. So interwoven were fact and fiction that Hickenlooper had no choice but to set the record straight in the course of denying the central allegation. In supporting Lilienthal's contention that nothing important had been taken at Oak Ridge, Hickenlooper found it necessary to reveal that documents had been stolen at Los Alamos but that they had been recovered without any danger to security. The result was that by the following day, newspapers unfriendly to the Commission were carrying stories of two thefts of atomic secrets, not one. These accounts left the impression that the Commission's crumbling security system had now collapsed. The implication was a pressing need to return to military control.[74]

On Wednesday when the *Sun* story broke, the New York *Times* carried reports of Joint Committee activity on the six pending bills to reorganize the Commission. On Thursday and Friday the demand for military control swelled to a chorus including the tasteless gratuities of Representative Thomas and searing criticisms from "an unnamed high Government official." The same person categorically denied that the Los Alamos incident was the source of the Oak Ridge story; "to his certain knowledge" secret documents were missing at Oak Ridge. Lilienthal's ambiguous statement that nothing important had been taken did not help much to refute the charge. A newspaper report of an interview with Menke, the new security officer at Oak Ridge, tended to confirm suspicions that the Commission was reluctant to deny that any documents might be missing. In view of the hundreds of thousands of classified documents in the Oak Ridge files, the Commission's reluctance to make a categorical statement was understandable, but it fed the flames of controversy.[75]

By the end of the week both nerves and tempers were raw. With the unfriendly press already asking questions about the Von der Luft-Wallis case, Lilienthal was uneasy about the fact that the two former sergeants were still not under arrest more than two months after the theft had been discovered. Even more alarming was the news on Friday that Von der Luft had gone to Canada, a fact which might make arrest difficult. Several telephone calls to J. Edgar Hoover and Attorney General Tom C. Clark brought Lilienthal sympathy but not much reassurance. He had still to reckon with General Groves, who had been absent from a meeting of the Military Liaison Committee on July 2 to discuss the Von der Luft-Wallis affair.[76]

Lilienthal did not have to wait long. That same Friday evening one of Grove's officers called on Volpe and Jones to demand answers: when the Commission had learned of the Von der Luft-Wallis case and why the Government had delayed prosecution so long. Annoyed by the tone of the request, Volpe asked the officer whether by chance he had learned anything about the disappearance of documents when he had been stationed at Oak Ridge. The officer did not miss the implications of that remark, nor did Lilienthal fail to see in the incident further evidence of Groves's hostility. On

Saturday morning Brereton tried to reassure Lilienthal by suggesting that Groves was merely attempting to collect information for a forthcoming appearance before the Joint Committee.[77]

Lilienthal found this explanation hard to accept, but Groves made his forthcoming appointment with the Joint Committee the reason for requesting a special meeting of the Military Liaison Committee with the Commission on July 14. Reporters had been calling him about the Von der Luft-Wallis case and about missing documents at Oak Ridge. He needed to know the facts. Lilienthal replied that the Von der Luft-Wallis case had been discussed during the Commission's July 2 meeting with the committee. What puzzled him was why a reporter would hold information of this nature until some convenient time for release instead of reporting it at once to the FBI. After further discussion of the details of the Von der Luft-Wallis case, Groves suggested that he and the Commission issue a joint statement that the violation of security regulations had not resulted in the disclosure of weapon information. Groves thought such a statement might stop the efforts of the press to drive a wedge between him and the Commission.[78]

Unfortunately for all concerned, the incidents of the preceding weeks had already had that effect. Lilienthal was convinced by Groves's remarks at the meeting that the General had talked with Thomas and the press. At five-thirty that afternoon the Commissioners and General Brereton entered Secretary Robert P. Patterson's office in the Pentagon. It was no longer possible to work with Groves, Lilienthal told the Secretary. Groves wou' have to be replaced on the Military Liaison Committee. Patterson took the request calmly. He asked only that the Commission allow him a few days until Congressional investigations at Oak Ridge had been completed.[79]

By the following Tuesday, when the Commissioners met with the Joint Committee, tempers had cooled and it was possible to examine the situation as a whole. Initially some of the members of the committee showed an impatience to learn what the Commission had done to correct the deficiencies which Teeple had reported at Oak Ridge in June, but Lilienthal was not to be stampeded. He insisted on reading a prepared statement which attempted to put the subject of missing documents in context. He explained that late in 1946 the Commission had requested the Manhattan District to provide complete inventories of all its property, including classified material. When the Army objected that it had no comprehensive inventory and could not possibly complete one before takeover, the Commission had reluctantly accepted inventories only of weapons and fissionable materials. The Commission had assumed that the District's security procedures were effective and extended them on a temporary basis. Only after some experience and investigation did the Commission discover that there were some inventories of classified documents and that these indicated some documents were missing. Lilienthal wanted to make clear that "the lax security conditions" referred to by the Joint Committee reflected a situation inherited from the Manhattan District.[80]

The discussion following Lilienthal's statement quickly dispelled images created in newspaper stories of dramatic thefts of secrets from a leaky security system. Rather, Lilienthal contended, most of these stories were distorted accounts of discrepancies which Commission personnel had themselves discovered. From the discussion emerged the understanding that the Commission now had custody of millions of documents for which only a partial inventory existed. Because no records of destruction had been made in many instances, thousands of documents presumably destroyed were still technically unaccounted for. It was also clear that some documents created by the Commission since January, 1947, also fell into these categories. There were simply too many documents too widely scattered and passing through too many hands to expect an exact accounting of every one at all times. In this context it was true that documents were missing at Los Alamos, Oak Ridge, and Chicago, but Lilienthal stressed there was no evidence that any, except those in the Von der Luft-Wallis case, had been illegally removed.

The session with the Joint Committee on July 22 seemed to calm Congressional nerves and marked at least a temporary end to sensational newspaper stories on security. That same day Representative Chet Holifield, a member of the Joint Committee and staunch supporter of the McMahon bill in 1946, in a floor speech attacked the recent attempts to discredit the atomic scientists, and especially those who had supported the McMahon bill. He denounced the Thomas article and the distortions of the Von der Luft-Wallis incident, but his main concern was a point-by-point rebuttal of a recent *Times-Herald* article attacking Edward U. Condon, director of the National Bureau of Standards. It was always reassuring to have support from Congress on security matters, and perhaps the renewed interest of Thomas's committee in the Condon affair meant that the Commission might enjoy a respite from that kind of attack. The shadow of security still hung heavy over the Commission's daily activities, but the worst of the storm seemed to be over.[81]

After their confirmation in April the Commissioners had embarked with high spirits on their first venture as directors of the nation's atomic energy program. The forthright decisions to refurbish and enlarge production and weapon facilities had been a good start, but the complex issues of research and development proved much less tractable. The conflicting demands of the laboratories, the contractors, and the public made it increasingly difficult to find clear-cut answers to policy questions. In many ways the General Advisory Committee under Oppenheimer's leadership had been of immeasurable help, but the superior experience and prestige of the advisory body also limited the Commission's freedom of action. Even more dangerous was the apparent hostility in military and Congressional circles represented by Groves and Thomas. In a few weeks the Commission had descended from the high hopes of April to the half-hidden threats and dangers of July. In the face of a challenge to its very existence, the Commission would have to do more than protect itself. Somehow it would have to prove itself capable of the leadership the times demanded.

THE PEACEFUL IMAGE

CHAPTER 4

By the summer of 1947 the Commissioners had some measure of the challenge they faced in directing the nation's atomic energy program. First, the Commission was required by law and necessity to give top priority to the production of fissionable materials and weapons. But if the Commission were to achieve any success in giving atomic energy a peaceful, civilian image, there would have to be a clearly defined, forceful plan for research and development, not only in the Commission's laboratories, but also in industry and the universities. Unlike the needs of national security, the goals of research and development were neither obvious nor tractable. In the Federal Government as a whole, research policy was still in a period of transition from the prewar system of private research grants to the new structure of the 1950's providing for massive Federal support. Until Congress could decide whether to establish a national science foundation, the Commission by default would bear a large share of the responsibility for Federal research policy; and it was always harder to break new ground than to follow familiar paths.

Devising a research and development policy would have been difficult for an experienced organization. For the fledgling Commission in the summer of 1947, it was a dismaying task. Still unresolved were the nature and function of the national laboratories, the role of basic research in the Commission's activities, the future course of reactor development, the extent of international cooperation in scientific research, and the prospects for nuclear power. All these questions would haunt the Commission during the rest of 1947.

Further complicating the Commission's task were the inevitable distractions and preoccupations of building a new organization. The administrative structure for headquarters and field operations was not yet complete, and key positions in the staff were still vacant. Without the guidance of experienced staff, troublesome gaps in administrative procedure persisted. Especially difficult were the problems of security, raised by the requirement for large numbers of new employees and complicated by publicity over clearances and missing documents during the spring of 1947.

In the months ahead, the Commission would have to find some way, despite these handicaps, to make the peaceful image of atomic energy a reality.

INGREDIENTS OF A RESEARCH POLICY

Both the General Advisory Committee and the scientific community were sympathetic with the Commission's predicament, but impatience was fast replacing sympathy. The Commission's failure to come to terms with the broad aspects of research and development policy was provoking some private expressions of concern. John R. Dunning, the forceful leader of the gaseous-diffusion project at Columbia University during the war, was anxious to get on with a practical demonstration of nuclear power. Louis J. Ridenour, a prominent physicist who knew Robert F. Bacher personally, urged his friend to demand that the Commission speed up the declassification of fundamental research data and support independent research in the nuclear sciences.[1]

Perhaps the most damaging blow to the Commission's image was its failure to release radioisotopes to scientists in foreign countries. The General Advisory Committee had taken a strong stand on this issue, and John H. Manley in June had recommended a proposal which would be responsive to some of the Commission's concerns but still accomplish the purpose. Limited quantities of specified isotopes would be available only for research purposes, to qualified scientists in specified institutions. The scientists would be required to describe the health and safety measures they would use, to report the results of their research within six months of completion, to agree to use the materials for no purpose other than those stated in the application, and to permit other qualified scientists free access to the institutions in which the research was done.

As June slipped by without action, the scientists renewed their appeals to Bacher. In addition to a formal statement from the Federation of American Scientists, Bacher received a personal plea from his friend Charles C. Lauritsen at the California Institute of Technology. Lauritsen reported in Europe "a somewhat exaggerated idea of the control which the Army and Navy exert over science in this country." The recent American emphasis on secrecy in scientific research and the apparent American refusal to abandon its nuclear monopoly of radioisotopes for fundamental research was beginning to damage relations between American and European scientists. Albert Stone, a scientific attaché in the London embassy, related a conversation with Niels Bohr, who urged the release of radioisotopes. Even if they were only in the form of bottle washings, Stone wrote, they would be "one of the most useful, convincing, and friendly things we can do." When the Commission took no action by late July, discontent among the scientists began to spill over into the press.[2]

Expressions of concern also came to Bacher in private conversations and correspondence with Oppenheimer and Manley. They attributed much of the trouble to a lack of rapport between the Commissioners, the staff, and the committee. The committee, meeting only once every two months, could not expect to keep up with the details of daily operations. Worst of all, the committee thought that the Commissioners had scarcely begun to understand the fundamentals which underlay the committee's recommendations.[3]

Bacher conveyed these concerns as tactfully as he could to his fellow Commissioners and to Carroll L. Wilson, individually. He wrote Oppenheimer on July 22 that he had discussed the agenda for the committee's next meeting with James McCormack, James B. Fisk, Wilson, and Manley. He had arranged for two sessions with the Commission, one at the beginning and one at the end of the two-day review. This would provide a good opportunity for full briefings by the Commission staff and for a careful exposition of committee views. Lilienthal had also agreed to permit Manley to attend Commission meetings on subjects of concern to the committee if that would help to bridge the gap.[4]

At the committee's opening session with the Commissioners on July 28, Oppenheimer turned almost at once to questions of research policy. He was particularly concerned about the Commissioners' reactions to his suggestion at the previous meeting that the Commission issue a statement giving "a realistic evaluation of atomic power." When Lilienthal questioned its purpose, Oppenheimer explained that something had to be done to counteract the growing misconception that economic nuclear power was imminent. It was bad enough when men in public affairs and representatives of industries with a potential interest in atomic energy voiced such unwarranted optimism; it was dismaying when lack of understanding brought forth such views from atomic scientists as eminent as Dunning. Lee A. DuBridge warned that the opinion was growing among scientists that there was no valid reason for the absence of practical nuclear power other than the Commission's failure to act. Lilienthal doubted that one pronouncement would correct the misunderstanding and thought it might have the effect of discouraging young people from choosing the nuclear sciences as a career. He was willing, however, to consider such a release if Oppenheimer wanted to present it in writing.[5]

Later in the morning, after the Commissioners had left, the committee came back to the power statement. All agreed that the central point was that large-scale power production would require all available nuclear fuel, which would mean perfecting the breeder reactor and then accumulating a "nest egg" of fuel while development of the power reactor continued. This would be "a long, complicated, difficult" process. So engrossed were the members in the subject that they talked through their lunch hour and turned to other matters only when the Commissioners returned at two o'clock. Somehow during the late afternoon Oppenheimer and Manley put the finishing touches on the draft, which was then the first item discussed at the evening session. After a few comments on the wording and its possible effect, James B. Conant moved quickly to a decision to send the statement to the Commissioners the following day. Other aspects of research policy filled the evening session: declassifying basic nuclear data, determining the limits of classification, considering the possibilities of a central Commission laboratory, opening the doors to private research on unclassified subjects, and supporting such research in the universities. The committee finally adjourned for the night, almost fourteen hours after the start of the morning session.

On the morning of July 29 most of the Commissioners were at the Pentagon to discuss a draft report of the Bikini evaluation board with the Joint Chiefs of Staff. Saving the power statement until the Commissioners had returned, the committee spent the morning discussing research policy with Fisk and his aides. The committee was particularly interested in Fisk's plans for Clinton and their relation to the possibility of a central laboratory. Fisk explained that he had considered a variety of possibilities for Clinton, including management by industrial contractors like the Standard Oil Development Company and the Kellex Corporation, but he had concluded that the scientists at Clinton would work more congenially with an academic institution. The University of Chicago had operated the laboratory during the war. Many of the scientists at Clinton were originally Chicago employees or students; furthermore, a contract at this time with Chicago would also be a step in the direction of a central laboratory, since it would place both Clinton and Argonne under the same contractor. DuBridge agreed this was an excellent solution if a central laboratory were impossible. Fisk maintained that it would take too long to build additional facilities at Argonne and that many of the Clinton people would not like to move. Conant feared that Fisk's proposal would kill the chances for a central laboratory and would encourage the Clinton scientists to stay at Oak Ridge. Glenn T. Seaborg doubted that an independent Clinton would provide close enough coordination with Argonne for difficult chemical research, such as developing the Redox process. When Hartley Rowe asked whether Fisk intended the Chicago contract to be a permanent or interim arrangement, Fisk admitted that it would be permanent, but he conceded that if contract negotiations with Chicago failed, Clinton would have to be abandoned. Conant said he rather hoped this would happen because it would keep open the possibility of the central laboratory.

When Lilienthal, Pike, and Strauss returned from the Pentagon at noon, they were hardly in a pleasant mood. Most of the briefing on the Bikini report had been a bore, but they had straightened in their chairs when the Bikini board came to its recommendations. Without intending to criticize the Commission, the board urged the Joint Chiefs to reconsider whether the military should not have a representative on the Commission, whether the armed forces should not control all fissionable material after production, whether they should participate in designing and testing nuclear weapons, and whether they should not control all information related to use of weapons.[6]

As the Commissioners read Oppenheimer's draft on civilian power, they realized for the first time its sweeping implications. In correcting the current public misconception, the committee intended to state flatly that "it does not appear hopeful to use natural uranium directly as an adequate source of fuel for atomic power." The shortage of uranium ore and the consequently even greater shortage of uranium 235 made a really significant nuclear power supply economically prohibitive. Furthermore, the cost of reenriching reactor fuel by existing means of isotope separation was likewise prohibitive. The only hopeful approach was to develop high-temperature

breeder reactors, which would require about ten years of metallurgical, engineering, and chemical research. Even if this research proved successful, it would take decades to accumulate a stockpile of nuclear fuel sufficient for a strong power industry.[7]

The draft struck the Commissioners like a sledge hammer. Strauss found it so pessimistic that he doubted the Commission would ever be able to get adequate appropriations from Congress. Waymack thought the statement would mean nothing to the general public and would not advance the understanding of atomic energy. Pike, with the morning session with the Joint Chiefs clearly in mind, argued that this was no time to demolish hopes for nonmilitary applications of atomic energy. The Commission was on trial. The Atomic Energy Act had been "written in a rare moment of selflessness"; things had changed since the summer of 1946, and not for the better.

Conant and Oppenheimer, however, insisted on what was to them the fundamental point: it might take time to educate the public, but both the Congress and the people should begin to face realities. The lack of public understanding was damaging the Commission's stature and was preventing responsible leadership outside the Commission from making an accurate assessment of a difficult question.

In the long discussion which followed, Conant and Oppenheimer were willing to consider changes in wording, but they would not yield on the central idea. The Commissioners succeeded only in introducing minor revisions which made the point that raw material costs *seemed* prohibitive only *at present,* and adding a paragraph to stress that, while research on breeders continued, radioisotopes could be expected to bring many benefits to science and industry. The discussion ended only when Strauss proposed that the Commission take time to consider the statement during the two months before the October meeting.

Lilienthal had had little to say during the meeting except to insist upon the final paragraph on radioisotopes. The truth was that he was almost too shocked to speak. Even when the statement came from such eminent men as Oppenheimer, Conant, Seaborg, and Isidor I. Rabi, he could hardly believe it was true. He recognized there were difficulties and uncertainties, but how could anyone be sure they were so great? He admitted to himself that it would be a service to the Commission to deflate the current overoptimism, but there were larger political implications. Such a statement would answer those who criticized the Commission for not making satisfactory progress in developing atomic energy and foreigners who thought the Commission was preventing them from meeting critical needs for electric power. But it would also provide handy ammunition to the advocates of a return to military control and that "might well have finished off the rather fragile life of civilian direction of this project." [8]

As if there had not been enough unpleasantness for one day, Wilson wanted the Commissioners to use the few remaining hours after the session with Oppenheimer's committee to consider the last of the reinvestigation cases
inherited from the Manhattan District. Although machinery was being set up to review difficult cases as suggested in the Alexander-Finley report, the Commissioners would have to act personally on those cases which had been hanging fire since January, 1947. The subject for the afternoon was the complicated case which had been pending at Brookhaven for months. The report by a special review panel of outside experts recommended clearance but it stressed the risks inherent in such action. Lilienthal always found security sessions painful, and this one was unusually distressing since Strauss seemed about to end the Commission's enviable record of unanimity. At last, when no further discussion seemed profitable, the Commission voted four to one to accept the panel's report. The remaining cases were no easier to decide. Sandwiched in between other business, they soaked up every free moment during the last week of July and the first week of August. Of the thirteen cases considered, the Commissioners decided to defer action on four, pending further investigation, granted clearance to three individuals, and denied clearance to six, of whom three were recommended for further administrative hearings.[9]

None of the Commissioners would ever forget the anguish of those August days in the stuffy conference room on Constitution Avenue. The painful hours of discussion, the soul-searching analysis, the struggle to do justice, all took a heavy toll in physical and emotional strain. Fortunately there was promise of relief. Earlier in the summer, Lilienthal and Fisk had planned a western trip centering on the first meeting of the research council, to be held at the Berkeley laboratory. Ernest O. Lawrence had generously arranged to hold some of the meetings at the private encampment of the Bohemian Club in the redwood forests north of Berkeley, where the S-1 committee had met in September, 1942. There would be a tour of the Berkeley laboratory, probably one of Lawrence's traditional dinners at Trader Vic's, and after a year's postponement a first visit to Hanford before heading home.

COMPLETING THE ORGANIZATION

One last-minute chore before the western trip was to ratify Wilson's plans for completing the staff. With Carroll L. Tyler and Wilbur E. Kelley already on the job at Los Alamos and New York, Fletcher C. Waller, the new director of organization and personnel, had concentrated in July on filling the remaining field manager posts. Weeks of patient inquiry and interviewing had produced some promising candidates, but none of them seemed available under the $14,000 salary ceiling. After the discussion of this subject with the Joint Committee in March, 1947, Wilson was reluctant to raise the issue again, but the only alternative seemed to be to offer a higher salary. After informal discussions Hickenlooper seemed satisfied with a letter in the record explaining the Commission's predicament, and Wilson moved quickly to land his quarries. As manager of operations at Oak Ridge he had succeeded in recruiting John C. Franklin, vice-president in charge of maintenance and engineering for Trans World Airlines. Forty-three years old, Franklin had attended Stanford and Harvard Business School before entering the business world. Wilson's candidate for the Hanford post was Carleton Shugg, a dynamic vice-president of the Todd Shipyard Corporation. Following his inspection trip to the Commission's field installations in May, 1947, William Webster had recommended his old friend and Annapolis classmate for the Hanford job. Wilson was impressed with Shugg's qualifications, but Shugg had to be convinced he should accept the offer.[10]

There were still no outstanding prospects for the Chicago post, but further delay was impossible in view of the administrative demands generated by plans for new facilities at the Argonne, Berkeley, and Ames laboratories, all of which would be under Chicago's jurisdiction. Simply to hold the office together Walter J. Williams had sent Alfonso Tammaro to Chicago in June. Tammaro, a former Manhattan District officer, had been one of the first persons on the Commission's payroll in 1946, when he became a contracting officer. Late in July Wilson agreed to appoint Tammaro as acting manager at Chicago. Wilson also announced that Tammaro would take over Williams's responsibilities at Chicago on August 31; Franklin would pick up his burdens at Oak Ridge on September 15.[11]

During the first week in August, Wilson also completed two major assignments to his Washington staff. After months of searching for a director of the statutory division of engineering, he decided to appoint Roger S. Warner, Jr., his principal recruiter for the post. During the war Warner had served as an engineering coordinator at the Sandia extension of the Los Alamos laboratory, at the Bikini tests in 1946, and finally on Wilson's headquarters staff in 1947. A second appointment made critical by the security crises of June and July was that of Admiral John E. Gingrich as director of security and intelligence. Gingrich, a Navy hero in World War II, had served as aide to Secretary James V. Forrestal and as assistant chief of naval operations. The appointment of a naval officer was certain to please Commissioner Strauss, who had a keen interest in security and had in fact suggested Gingrich for the position months earlier. Gingrich was a close personal friend of Forrestal's and also had the support of Admiral Sidney W. Souers, the first director of the Central Intelligence Group, who as a Commission consultant had recommended combining the security and intelligence functions in one office. The Commission hoped that Gingrich would bring the necessary stature and prestige to the position and would be able to make some headway in building a permanent security and intelligence operation.[12]

CLINTON AGAIN

The main purpose of the Berkeley meeting scheduled for mid-August, 1947, was to come to some conclusions about the fundamental shape and direction of the Commission's research and development program. It was obvious that any decisions on that subject would depend upon the patterns which might emerge from the chaos in the Clinton Laboratories at Oak Ridge.

If anything, the situation at Clinton was more confused in August than it had been in May. The announcement of Monsanto's decision to withdraw and Eugene P. Wigner's to return to Princeton left the laboratory with neither a functioning organization nor a leader. With no direction, many of the scientific staff spent their time in discussions deploring the present and speculating on the future. Three months after Monsanto's decision to withdraw, Fisk had still not found a successor. The University of Chicago was still a leading contender; but there was a second possibility in the new Oak Ridge Institute of Nuclear Studies, an association of fourteen Southern universities which hoped to make Oak Ridge a regional research center. The new association seemed especially attractive because its directors included men who had distinguished themselves in the nuclear sciences, such as Wigner, Jesse W. Beams of the University of Virginia, and Frederick Seitz, a University of Pittsburgh physics professor whom Wigner had hoped would succeed him as laboratory director.

Both institutions expressed an interest in the contract late in July, and by early August Fisk and Wilson had Commission approval of the ground rules for negotiation. The contract was to be for three or four years and the fee was not to exceed 6 per cent of the estimated annual operating costs. On August 12, Fisk and Spofford G. English, formerly a Clinton chemist and now on Fisk's staff in Washington, met with William B. Harrell and Warren C. Johnson of the University of Chicago and a group of scientists from the laboratory. When the meetings ended the next day, there was optimism on both sides that a strong research laboratory could be built under Chicago's management. On August 14, a meeting with William G. Pollard, executive director of the Oak Ridge Institute of Nuclear Studies, led to the conclusion that the new Southern regional association was not yet prepared to assume so great a burden as operation of Clinton involved. But all parties, including Harrell and Johnson, agreed that there should be close cooperation in scientific activities at Oak Ridge between the Commission, the university, and the new institute. Pollard hoped that eventually, perhaps when the proposed four-year contract with the university expired, the institute might be able to take over as operating contractor.[13]

An all-day session in Washington on August 28 confirmed the tentative conclusions of the Oak Ridge meeting. The university should operate the laboratory if a satisfactory contract could be negotiated, and the institute would work closely with the laboratory as a regional center by providing a program for graduate training in the nuclear sciences, taking responsibility for the training school still being operated by the laboratory, and helping the associated universities to develop their own graduate research facilities. The university's board of trustees accepted the broad terms of the proposal on September 2, and the public information officers of the Commission and the university drafted press releases for issuance on the fourteenth to inform the public that the new Commission-university-institute relationship would take effect on November 1. All that remained was negotiating a contract and finding a director for the laboratory.[14]

REACTORS AT CLINTON

The lack of firm leadership was not the only difficulty at Clinton in the summer of 1947. There had still been no clear instructions from Washington to indicate the priority of research projects. The efforts of Wilson and Fisk during the spring to decide the fate of the high-flux and Daniels reactors had been thwarted by the General Advisory Committee's opposition to strengthening Clinton and the Commission's juggling of plans in an effort to keep Monsanto at Oak Ridge. The confusion of late May persisted through the summer. Monsanto, as a caretaker operator, had little interest in the future of Clinton, and the Commission was reluctant to set a new course until it had selected a new contractor.

There was good reason to believe that the high-flux reactor would be a part of any plan the Commission might approve. But until the Commission settled the questions of where it would be built and who would build it, Alvin M. Weinberg and the Clinton scientists had to restrict themselves to the fundamentals of design. By the summer of 1947 it seemed clear that the reactor would use pressurized water as moderator and coolant. The point at issue during the summer became the design of the fuel elements, especially the amount of uranium 235 to be used and the effect of that specification on designs of the chemical plant that would process the spent fuel elements from the reactor.[15]

Prospects for the Daniels reactor were even less hopeful, but Farrington Daniels and C. Rogers McCullough chose to ignore the unpleasant rumors from Washington. Until Wilson or the Commissioners notified them officially that the project was dead, they would forge ahead as if the start of construction were imminent. As funds dwindled and morale declined, it became even more difficult to maintain the pretense of Commission support. Finally on June 16, Daniels, in the role of consultant, wrote Lilienthal directly. He was facing a crisis with the loss of both Wigner and Monsanto. But there was still real enthusiasm among the engineers at Clinton, he said, and he hoped that the Commission would authorize the procurement of needed materials for the reactor and permit one of the other participating companies to take over the contract. Listing the many advantages he saw in building the reactor, he concluded: "Although further study and delay would, of course, lead to the design of a better pile, we believe that the present design will be satisfactory and safe and that it will provide the best and quickest way of obtaining the information which is needed for the design of other piles and for the development of atomic power in general." [16]

Lilienthal's reply was merely an acknowledgement, but Daniels was hopeful he would now get some action. Charles A. Thomas wrote him privately that he thought the letter was effective. McCullough reported that the Commission's representative at Clinton predicted a decision within several weeks. In the meantime there would be no decision on ordering beryllium oxide bricks for further experiments. McCullough feared that the Commissioners themselves had no ideas on the subject and were leaving the decision to the General Advisory Committee, the members of which, according to McCullough, knew nothing about the project and probably opposed constructing a power reactor immediately.[17]

McCullough's estimate was not far from the truth, but when Daniels met with the Commissioners on July 8, their intentions still were not entirely clear. Wilson did say that the high-flux reactor had first priority and that the Commission could not state when it would authorize design and construction of a power reactor. On the other hand, the Daniels project had not been abandoned. Obviously disappointed, Daniels was nevertheless grateful that the Commission had not terminated the project completely and would permit component development and other basic studies to continue. After the meeting Daniels sent McCullough an enthusiastic telegram. McCullough had been right that an unfavorable report from the General Advisory Committee had been the source of the trouble, but the Commission's attitude had been cordial and positive. The group at Clinton could continue the work it was doing, and

Daniels felt "much relieved." Ralph P. Johnson, who had just joined the Commission as Fisk's deputy, wrote that "Daniels departed moderately happy. I have an uneasy feeling that an evil day has been postponed." [18]

MILITARY REACTORS

The future of Clinton also rested in some degree on the fate of the projects set up by the military services to develop nuclear propulsion systems for aircraft and naval vessels. The Navy officers under Captain Hyman G. Rickover had impressed many at Oak Ridge with their diligence and energy during their year-long study project. But Rickover had now taken his naval officers on an extended tour of other Commission laboratories, and there was as yet no indication that anything more would come of the effort. Admiral Earle W. Mills told Williams that he was willing to keep them working on nuclear propulsion systems on their return if the Commission thought it wise. Williams, impressed by Rickover's industry if not by his diplomacy, urged Mills to do so.[19]

Engineers from Fairchild and other aircraft companies were still attempting at Oak Ridge to understand the implications of nuclear power for aircraft design, in the NEPA project supported by the Army Air Forces. Those at Oak Ridge outside the project were more than ever convinced that NEPA was going nowhere. Until the aircraft engineers understood that there was something more to building a nuclear-powered airplane than devising an airframe compatible with a reactor of "reasonable" specifications, there was little hope for progress. Within the Air Force itself there was enthusiasm for nuclear power. General Curtis E. LeMay told the Commission and the Military Liaison Committee on July 16 that the Air Force believed any future war would have to be fought without benefit of advanced bases. For bombers carrying heavy atomic weapons that meant a combination of long range and high speed which only nuclear power could provide. The first question, however, was whether NEPA was using the right approach. Both Conant and Vannevar Bush had their doubts.

In a meeting of the Joint Research and Development Board's policy council with Conant's committee on atomic energy on July 30, no one questioned the Air Force's argument that it needed nuclear power for long-range bombers, but the goal of completing such a propulsion system in five years seemed unrealistic. Conant, Oppenheimer, and Crawford H. Greenewalt agreed that the Air Force effort would never succeed, despite all the money and pressure put on engineering development, until the basic physics of the reactor were understood. Furthermore, they argued, NEPA should be part of the Commission's reactor development program, and not isolated in a special project at Oak Ridge.[20]

The committee commended the Air Force for its interest in nuclear power for long-range bombers, but recommended prompt termination of the NEPA project at Oak Ridge. In its place the committee urged a coordinated research and development effort directed by the Commission on a high-temperature reactor system. The Commission should take over the project from the Air Force and find a highly qualified aircraft company to develop design criteria for the airframe. Then the Commission could begin to investigate the fundamentals of the reactor system.

The Navy fared better than its sister service in the meeting with Conant's committee. Admiral Mills, saying nothing about Rickover or Clinton, described the contract the Bureau of Ships had awarded to General Electric for paper studies of a ship propulsion system. Groves had helped him get the project started with a small contract in the summer of 1946, before the Commission took over, and the Commission had authorized $30,000 to continue the work, with the stipulation that the number of scientists assigned be cut in half. Conant's committee recommended that the feasibility study be continued and that the Bureau of Ships be permitted to negotiate research and development contracts on a heat transfer system suitable for a naval reactor. The committee thought, however, that the Navy should make sure that any activity beyond the initial paper study was acceptable to the Commission.[21]

Neither the Navy nor the Air Force could take much comfort from the meeting. If Clinton's future depended on these projects, its fate was uncertain indeed.

BOHEMIAN GROVE

After eight months in the hubbub of Washington, the Commissioners could hardly wait to get away for their Western trip. Bacher had already departed for several weeks of observation and conversation at Los Alamos and for a vacation in Colorado. Lilienthal wrote Lawrence, his host, that Congress would adjourn soon and that he expected "the 'atom-secret' scares and alarms, which replaced the flying saucers, will have been replaced by other sensations in a few days." Leaving such distractions behind, he was looking forward to at least a week in San Francisco before the meeting convened on Monday, August 18. Bacher was coming with McCormack from Los Alamos. The other Commissioners were traveling by train. The laboratory directors, who made up the research council—Walter H. Zinn from Argonne, Frank H. Spedding from Ames, Philip M. Morse from Brookhaven, Norris E. Bradbury from Los Alamos, C. Guy Suits from Schenectady, and Wigner representing Clinton—all expected to be on hand in Berkeley on Monday morning.[22]

Four days in the mountains of the California coast range with Lawrence were all Lilienthal needed to restore his spirits and energy. When he returned to Berkeley on Sunday evening, August 17, to join his fellow Commissioners and the staff, he was looking forward to the meeting with the laboratory directors. Early in the morning he rode with Lawrence in the motorcade which took the party north through the redwood groves to the Bohemian Club camp on the Russian River. Oppenheimer and each of the Commissioners were assigned private rooms and the rest of the group moved into the rustic but pleasant accommodations. Fisk had promised there would be no discussion of administrative matters and he kept his word. With no formal agenda, the group could set aside the distinctions of rank and position to consider as individuals the future course of nuclear research and development.[23]

Initially the points at issue were those the General Advisory Committee had previously raised in May and July, 1947. Oppenheimer, in his usual tactful way, could voice the need for positive Commission leadership in support of basic research in the nuclear sciences, in removing the trammels of security from research activities, and in easing the dissemination of technical data. Fisk, although he accepted Oppenheimer's aims, nonetheless could express the reservations which he and Wilson felt about moving too swiftly. Should the Commission continue to approve research projects and proposals from the national laboratories piecemeal? Would it not be preferable to define the areas of basic research which the Commission would support and then establish a consistent pattern for financing both basic and applied research in the laboratories? On such questions the laboratory directors with their individual perspectives and interests could contribute to the discussions. The Commissioners could enjoy the rare opportunity of listening to the debate free from the usual pressures for decisions.

The immediate subject of the conversations was the Commission's own program, but the wider context must have been evident to those present. Through the spring and summer of 1947, *Science* and the *Bulletin of the Atomic Scientists* had followed step by step the rambling hearings and protracted debate on the National Science Foundation bill. Less than two weeks earlier President Truman had vetoed the compromise measure originally introduced by Senator H. Alexander Smith of New Jersey. Although regretting the veto of a bill designed to give direct support to basic scientific research, the President had reluctantly concluded that the proposal was "a marked departure from sound principles for the administration of public affairs."[24]

From the unhappy history of the Smith bill the group at the Bohemian Grove could draw several conclusions. One, which Fisk no doubt found pertinent, was that defining the Government's role in supporting such activities was neither an easy task nor one which could be taken lightly. If the administrative structure was difficult to design for the traditional scientific disciplines, how much more care would be necessary in establishing procedures for such a new branch of science as atomic energy? On the opposite side, Oppenheimer could argue that the veto of the Smith bill destroyed chances of establishing the National Science Foundation for at least another year. Under these circumstances, it was perhaps more urgent than ever that the Commission take the lead in supporting basic research in the nuclear sciences.

The majestic openness of the California setting and the informality of the participants encouraged a broad discussion of many subjects. By design, there were no formal decisions, although Zinn later informed his staff at Argonne that he thought the Commission would be willing to entertain proposals for certain limited unclassified research. The greatest value of the conference came from the free exchange of ideas and the mutual understanding of problems, whether they were those of the General Advisory Committee, the Commission, the staff, or the laboratory directors. Donald Cooksey, Lawrence's faithful assistant, thought that the refreshingly informal sessions, punctuated by good meals, including heavy breakfasts of ham and bacon, light lunches of salad and cheese, and good, big dinners with plenty of red meat, were "of inestimable value to the country." [25]

FOREIGN DISTRIBUTION OF ISOTOPES

The only note of discord at the Bohemian Grove came on Tuesday morning, August 19, when the Commissioners met privately to debate the long-pending proposal to permit foreign distribution of radioisotopes.[26] Despairing of unanimity, Lilienthal gave Strauss the opportunity to explain in full his opposition to the proposal. Strauss conceded that he was unhappy as a minority of one and that he had attempted to bring his thinking into line with that of the other members of the Commission. But after reviewing all the arguments advanced for foreign distribution he continued to believe that the burden of proof rested upon those who advocated exporting isotopes. Foreign scientists, he said, were not all on the side of the democracies in the international political argument; nor was it possible to buy their good will by authorizing the distribution of radioisotopes abroad. The radioisotopes produced in the Clinton reactor were the equivalent of thousands of years of cyclotron production. By distributing isotopes in large quantities abroad, the Commission would be committing a breach of security comparable to that of publishing the Smyth report. Strauss did not argue that the isotopes would help foreign nations build weapons, but they would be useful in biological and metallurgical research, plutonium chemistry, and other fields which could add to the warmaking potential of other nations.

The majority did not yield to Strauss's arguments. For Waymack the shipment of radioisotopes abroad would be a small part of the Marshall Plan, which had become a prime instrument of United States foreign policy. Bacher held that radioisotopes were already in use and would be generally available relatively soon. He thought the United States could in the meantime earn a large measure of good will by authorizing foreign distribution and thereby countering the growing sentiment throughout the world that the United States was returning to isolationism. Pike maintained that the conditions imposed on foreign distribution would amply protect the interests of the United States. Lilienthal added to Waymack's justification the argument that foreign distribution would advance scientific knowledge and perhaps even produce effective methods for treating cancer.

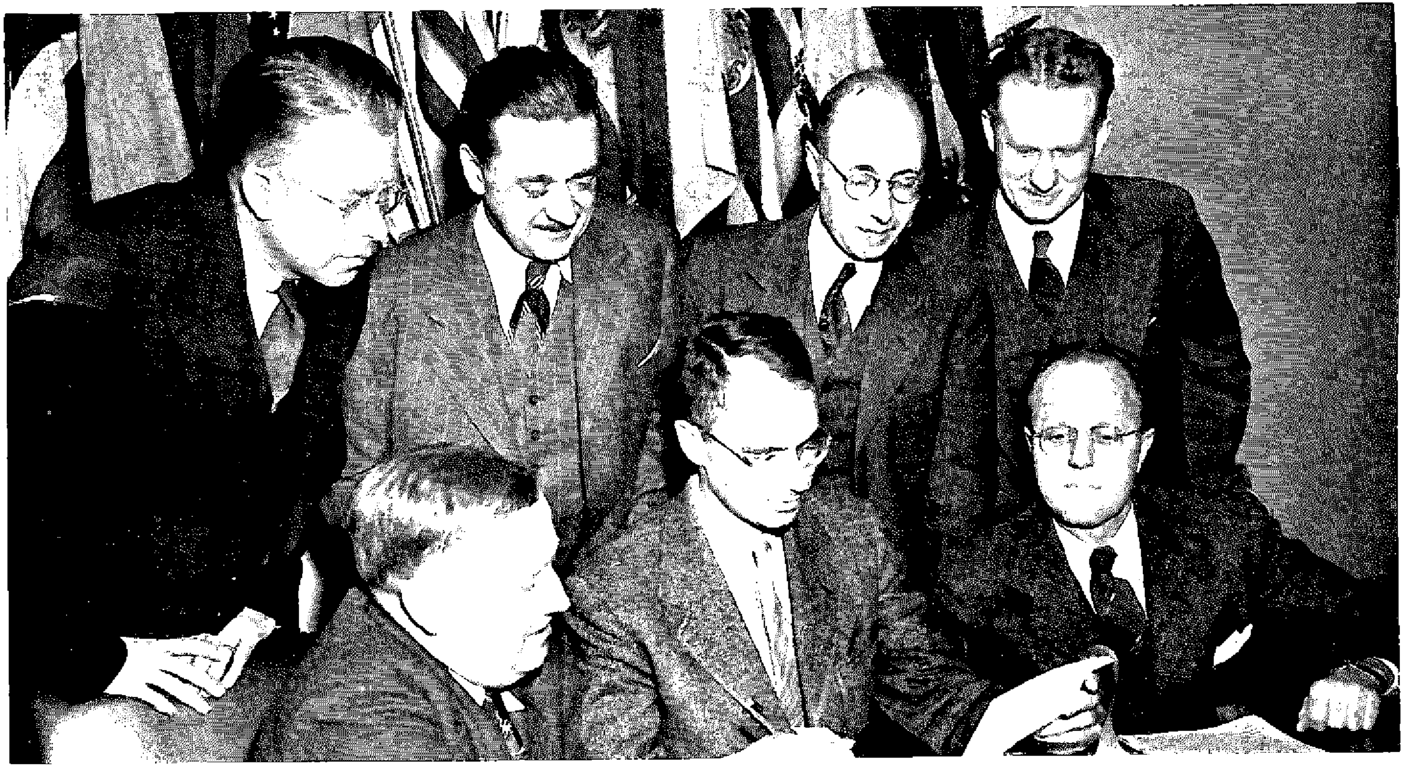
Now the informal atmosphere which Lilienthal had tried to encourage in Commission meetings was painfully absent. By a vote of four to one the Commission agreed to forward its recommendation to the State Department. As a concession to Strauss the Commission agreed to include the arguments advanced both for and against the recommendation.

Lilienthal was uneasy about the forcefulness of Strauss's dissent. His insistence upon the right to present his position to the State Department suggested an unwillingness to accept a majority decision. It was hard to imagine how the Commission could continue to operate as a team if a single member were to attempt to reverse the formal decisions of the majority. Strauss himself regretted that he had no alternative but dissent, an option he seldom exercised. Perhaps the President's announcement of the decision in a message to the Fourth International Cancer Research Congress in St. Louis on September 3 would settle the issue once and for all.[27]

A POLICY FOR RESEARCH

From Fisk's perspective the issue of isotopes distribution had long since moved beyond his horizon into the higher realms of Commission concern. Of greater moment in his mind were the implications of the Bohemian Grove meeting for the Commission's policy on basic research. Sentiment was growing in the General Advisory Committee for a broad interpretation of the Commission's responsibilities in supporting basic research, perhaps going even beyond the nuclear sciences to include related disciplines, now that the National Science Foundation bill had failed. Fisk also heard the appeals from the laboratory directors at the California meeting for ever-increasing support of new and exciting research projects. Back in Washington, similar pleas from individual scientists in the universities were piling up on his desk and he was still faced with disposition of the proposal from the Office of Naval Research, which he had sidetracked earlier in the summer.

A physicist himself, Fisk understood that scientific progress depended on support of research, but his sternly disciplined and logical mind would not



WIDE WORLD

LABORATORY DIRECTORS WITH THE GENERAL MANAGER, JANUARY 18, 1947 / In the front row from left to right are Frank H. Spedding of Ames, Iowa, Carroll L. Wilson, and C. Guy Suits of Knolls. Standing from left to right are Ernest O. Lawrence of Berkeley, Philip M. Morse of Brookhaven, Eugene P. Wigner of Clinton, and Walter H. Zinn of Argonne.

THE GENERAL MANAGER MEETS WITH HIS STAFF / Carroll L. Wilson and his principal staff in the headquarters building, Washington, in the summer of 1947. Left to right: Kenneth E. Fields, James B. Fisk, Fletcher C. Waller, Paul W. Ager, G. Lyle Belsley, Carroll L. Wilson, Wilbur E. Kelley, Walter J. Williams, Herbert S. Marks, and Paul M. Green. In the right corner, Richard O. Niehoff and John A. Derry.

U. S. ARMY

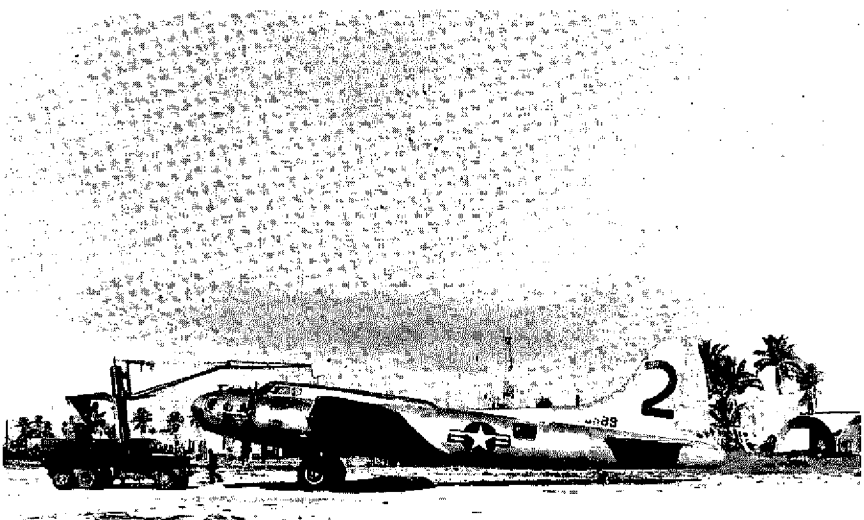
THE GENERAL RETIRES / Army Chief of Staff Dwight D. Eisenhower congratulates Leslie R. Groves on his promotion to Lieutenant General on January 26, 1948, a few days before Groves's retirement.

U. S. ARMY

A NEW CHAIRMAN FOR THE MILITARY LIAISON COMMITTEE / Major General Thomas H. Green, Judge Advocate General, U. S. Army, administers the oath to William Webster (left) in the presence of Secretary of Defense James V. Forrestal (center) on September 22, 1948.

U. S. ARMY

PREPARING FOR *SANDSTONE*, APRIL–MAY, 1948 / One group of the thousands of military and civilian personnel required for construction projects at Eniwetok in early 1948. In the background is one of the three shot towers for the Commission's first weapon test series.



U. S. ARMY

GATHERING DATA FROM *SANDSTONE*, APRIL–MAY, 1948 / A crane operator removes a filter from a B-17 drone aircraft. The B-17 had flown through the radioactive cloud, exposing the filter to pick up test debris for later analysis.

permit him to accept the kind of free-wheeling and haphazard program which would result from simply approving the more appealing projects which happened to reach his desk. The Bohemian Grove meeting had convinced him that he would have to act firmly to forestall the dangers of a slapdash research program; but if he were to avoid the chaos of free competition for the Commission's limited research funds, he would have to devise a formula which others had despaired of finding. It was a matter of defining criteria and proceeding to logical conclusions. Fisk first asked his deputy, Ralph P. Johnson, to help him circumscribe "the boundary of the Commission's proper business." There was no difficulty pinpointing the inner areas for support, such as research on the production of fissionable materials and weapons; but as they moved out to peripheral areas where direct applicability to the Commission's program became ever less evident, how could they draw the line? [28]

The answer emerged slowly in September, 1947, in a new concept which Fisk called "the area of availability." As he had explained it, there were unique materials, facilities, and information which by law were under the Commission's control. In principle, at least, these resources would occasionally be in excess capacity and to the extent that they were excess they could be made available for fundamental research. Thus Fisk proposed to define the boundary of Commission support as the outer limit of the area of availability.

The idea was sufficiently abstruse to require a few examples of its application. The large-scale production of radioisotopes was unique to Commission facilities and had been accomplished with little extra effort or expenditure. Excess research space in the Clinton reactor could appropriately be made available through the Oak Ridge Institute, as could similar research facilities at Argonne to the participating universities. Fisk even thought the Commission might finance the construction of small water-boiler research reactors in various parts of the country, and he thought he could defend the use of the Brookhaven research reactor for private experiments. At the same time private institutions would have to provide the experimenters and any necessary management organization. Since particle accelerators and cosmic ray equipment were not required for Commission work at Brookhaven, private institutions would have to finance the construction and operation of such equipment.

Beyond the area of availability was the limitless domain of subsidy, in which fell the great majority of grants-in-aid, scholarships, fellowships, and the Office of Naval Research program. Fisk had no precise formula for this area. He urged the Commission to select certain sub-areas for support and within them handle proposals in a uniform way. He wanted the Commission to "choose with care the territory it intends to occupy, and to count up the resources it has available to do the cultivation." As Fisk saw it, the production of radioisotopes could be strengthened and expanded. The associated institutions at Argonne and Clinton could be encouraged to support research to the maximum extent possible. A few small research reactors could be built and the machinery for declassification and publication of technical information improved. The file of pending requests for small grants-in-aid for basic research could be cleaned out, "most of the replies being in the negative." The Navy request would be denied and at Brookhaven and Berkeley support would be cut back to the area of availability.

Fisk's proposals had the merit of being logical and specific enough to serve as a practical guide in selecting research projects for support. They would also, as Johnson remarked, permit the division of research to serve as a responsible guardian of the public purse against the enthusiastic raids of ambitious scientists. But the formula would hardly produce a vigorous and growing research effort.

Fisk's suggestions did not please the General Advisory Committee when it assembled in Washington on October 3. Sharing Oppenheimer's views at the Bohemian Grove, the committee was more than ever convinced the Commission should support research not only in its own facilities but "especially in the universities and other research establishments." Furthermore, the committee now thought the Commission should support research in fields relating to atomic energy and not limit its efforts to basic nuclear science as it had suggested in July. The failure to establish the National Science Foundation, even if only temporary, had left it up to the Commission to step in. The nation's superiority in atomic energy depended upon "the virility of its basic science." Strong support of research would help to alleviate the existing shortage of scientific manpower and would provide the public with some tangible evidence of the peaceful image of atomic energy. The committee told the Commissioners that it had not pressed this matter earlier because it recognized the need to attend to more urgent tasks, but it believed the time for action had come. "In fact we feel further delay will cause damage to science and result in a growing disappointment in the achievements of the Commission." The amount of money needed—ten to thirty million dollars—would not be large; nor would it disrupt existing Commission programs, because most of it would be spent in private institutions. The committee's statement pulled no punches, but it remained to be seen whether Fisk would venture beyond the safety of his logical construct, the area of availability.[29]

BIOLOGY AND MEDICINE

The issues Fisk was trying to resolve embraced all the scientific disciplines, but his own responsibilities extended only to the physical sciences. The wartime laboratories had initiated biomedical research only when it became apparent that nuclear research and development would involve hazards of unprecedented scale and complexity. Throughout the war biomedical studies had been important but ancillary activities. Under its limited wartime authority the Army could do little more than provide adequate health and safety measures in the laboratories and production plants. Having minor significance in the Manhattan project, biology and medicine never enjoyed the status of the physical sciences.

At least temporarily the Commission accepted the Army's approach to biology and medicine. In establishing the General Advisory Committee the Commission decided to limit membership to physical scientists and engineers, with the understanding that the biomedical sciences would have representation on a separate but nonstatutory advisory group.[30] During the first weeks of 1947 Wilson could do little more than assemble the Army's advisory committee on biology and medicine to review the existing projects and to recommend a budget for the coming fiscal year. The interim committee, consisting of the leaders of biomedical projects in the major laboratories and private institutions, assembled in Washington on January 23 under the direction of Dr. Stafford L. Warren, who as a colonel had directed the Manhattan District program. The committee found the results of wartime research impressive, particularly in pilot studies of the biological effects of radiation, the physical measurement of radiation of various types, and the development of protective measures. But existing projects had scarcely begun to provide the biological data needed to protect workers and the public in peacetime research and technology.

In addition to the existing projects, Warren recommended much more research on radiation effects and the exact toxicity of substances commonly used in atomic energy activities, the mode of entry of such substances into the human body, and the types of biological changes produced. He also saw the need for an intensive study of the hazards in production operations and development of new preventative measures. As a stopgap the Warren committee recommended a budget of $5.9 million in fiscal year 1948 in fifteen Commission laboratories and private institutions. About half this amount should go to Argonne and the University of Rochester. The other national laboratories should each receive roughly $500,000 and each of the other private universities about $100,000.[31]

It was relatively easy for the experts to come up with recommendations but, as Wilson learned in other areas, it was something else again to evaluate the proposals of those who did not have to administer them or fight for appropriations. Fundamentally Wilson's problem was identical to Fisk's: to establish a policy which would enable the Commission to formulate a logical and defensible research program. For assistance Wilson turned in March to Frank B. Jewett, president of the National Academy of Sciences. The result was the appointment of a medical board of review consisting of seven specialists in biology and medicine under the chairmanship of Dr. Robert F. Loeb.[32] Following a week of meetings in Washington, the board prepared a comprehensive research plan. Paralleling Fisk's approach, the board cited the Commission's unique responsibilities in its own installations. In the area of applied research, which included the biological effects of radiation and all forms of detection, protection, and treatment of employees and the public if exposed, the board urged the Commission to provide liberal support of research in its own installations. Certain unclassified studies bearing on radiation effects should be supported in private institutions. The Commission was also asked to provide substantial training opportunities in recognizing and controlling radiation hazards and providing isotopes at nominal prices for independent biomedical research.[33]

Beyond the central core of applied research, the board saw a need for collaboration with other Government organizations, particularly the U. S. Public Health Service and the armed forces. Here the Commission should offer the use of its equipment and materials, and of its staff as teachers, lecturers, and consultants. Beyond the Federal Government the Commission could offer the universities use of its unmatched equipment and unique conditions for observation in the national laboratories. It could furnish materials to university researchers and declassify and publish research reports. Most important of all were training opportunities which would encourage students to select the biological sciences as a career.

The board's recommendations suggested the need for full-time staff support in the Washington headquarters. In addition to an advisory committee for biology and medicine which would perform its functions on a permanent basis, the board urged the appointment of a medical director. The Commission first agreed to appoint the new advisory committee and turned to Loeb's board for candidates. It took time to balance the membership in terms of specialties and geographic distribution but by the late summer of 1947 the roster was complete.[34] The committee which assembled for its first meeting on September 12 under the direction of Dr. Alan Gregg, director for medical sciences for the Rockefeller Foundation, included seven distinguished physicians and biologists, four of whom had served on the medical board of review. By this time Wilson was completing his plans for a division of biology and medicine and had a list of twenty-five candidates for the position of director. From five candidates recommended by the committee, the Commission selected Dr. Shields Warren, professor of pathology at the Harvard Medical School. Like Gregg, Warren had been a member of the medical board of review and had been chief of the naval medical team which investigated the effects on personnel of the bombing of Hiroshima and Nagasaki. Warren did not want the job but reluctantly agreed to accept until the Commission could find a permanent director. Thus by the end of October, 1947, the Commission had leadership for an effective research effort in the biological sciences.[35]

THE FUTURE OF NUCLEAR POWER

No one could argue that the Commission had taken aggressive action in the first eight months of 1947 to foster basic research in the physical and biological sciences. If the General Advisory Committee found this fact disconcerting, it was deeply troubled by the Commission's failure to take hold in reactor development. The committee's extended discussion with the Commissioners at the meeting of July 19, 1947, convinced Oppenheimer of the need for further exploration of the probable impact of nuclear technology. The Commissioners had seemed unwilling to face the situation, and Oppenheimer had the uneasy feeling that some of the facts underlying the committee's pessimistic prognosis on the future of nuclear power might be inaccurate. Enrico Fermi and Cyril S. Smith had found time during a visit to Los Alamos in August to revise the committee's draft. The principal change was to delete the unqualified prediction that reactors fueled with natural uranium would never be efficient power producers. Fermi and Smith preferred to suggest that such a power reactor was conceivable but that its limitation lay in the inefficient use of nuclear fuel. Although they retained the view that the development of efficient power reactors and the accumulation of significant quantities of nuclear fuel by breeding would require decades of hard work, they advocated language which would acknowledge the ultimate possibility. They also favored a statement pointing up the extreme concentration of energy in a given weight of fuel as a unique advantage of a nuclear power system.[36] They hoped that their revisions would give the statement "a somewhat more optimistic tone."

Although the Fermi-Smith draft, in Oppenheimer's words, did not have the "dismal tone" of the July version, it evoked little enthusiasm among the Commission staff. Edward R. Trapnell, one of the Commission's senior public information officers, conceded the need for such a statement, but he found the committee's phrases too cryptic and too brief. The oblique references to raw materials, he suggested, might set off a world-wide scramble for uranium ore. And if the efficient use of nuclear power proved as remote as the committee contended, how could the Commission explain its concerted efforts to corner foreign ore sources? Would not the statement suggest that the United States, as the world's leading producer of conventional power, was attempting to establish a monopoly for the future? The fleeting reference to breeding also troubled Trapnell. The Government had never released a word on the breeding principle. Trapnell predicted that the reference in the committee's proposed statement would need some further explanation and might provoke headlines reading "Atomic Advisers Promise Power In Ten Years."

Wilson cited Trapnell's arguments in a memorandum urging the Commissioners to take a cautious approach.[37]

The Military Liaison Committee took a strong position favoring release of the report. General Kenneth D. Nichols explained that the report had its origins in a similar statement which Oppenheimer had prepared for the United States delegation to the United Nations Atomic Energy Commission. In Nichols's opinion the report would help to offset some feeling in Europe that the United States was depriving other nations of needed power by not developing nuclear energy for power purposes. The statement might encourage European nations to sell uranium ore to the United States. Nichols also thought the American public should have a realistic picture of the prospects for nuclear power. Waymack was not convinced that the public would understand the report; but others at the meeting, including Bacher, Admiral William S. Parsons, and Groves believed the statement would be effective without compromising security.[38]

When the General Advisory Committee met on October 3, 1947, Bacher told the members that the Commission favored a full statement from which classified information could be later deleted. The problem was that any mention of raw material needs or the principle of breeding would produce questions quickly leading to classified information. Waymack thought the Commission would either have to issue a rather cryptic statement and stick to it or face a major change in classification policy. The discussion was inconclusive and the committee decided to consider the matter again in November.[39]

As adopted by the committee on November 23, 1947, the five-page statement on atomic power described some of the complex economic factors involved in building a nuclear power system. These included the need for high-temperature operation, new materials for components, long fuel cycles, high specific power, and a low net consumption of fissionable materials. Two reactors then under development, presumably the high-flux and the fast-breeder, would probably produce atomic power within two or three years; but neither could conceivably be thought of as an economical producer of power. The outlook would probably be brighter if low-grade ores proved plentiful or if breeding should be possible. Since the engineering difficulties associated with breeding were enormous, the best hope seemed to lie in increasing ore supplies through geological research and prospecting. On the assumption that breeding would not prove practical in the immediate future, atomic power would not compete with conventional fuels in the United States except in high-cost regions unless the cost of uranium concentrates could be brought appreciably below $100 per pound. In any case construction costs would always be higher for plants using nuclear fuel than for those operating on conventional fuels. In summary, the committee did "not see how it would be possible under the most favorable circumstances to have any considerable portion of the present power supply of the world, replaced by nuclear fuel before the expiration of twenty years." [40]

A COURSE FOR REACTOR DEVELOPMENT

Inevitably the power statement reflected the Commission's own plans for developing nuclear reactors. Still clouded by uncertainties, the subject involved not only technical matters but administrative questions. Should the Commission establish a centralized laboratory? What was the future of Clinton? What role should the Commission have in determining the course of reactor development in the laboratories?

For the moment centralization seemed dead, and the Commission had yet done little to weld the haphazard array of individual laboratory projects into a coordinated effort. Conant had expressed his growing concern at the General Advisory Committee meeting on October 3. He could understand, he said, the Commission's efforts to encourage independent action in the laboratories, but he argued that someone in Washington headquarters would have to stand at the helm, perhaps as deputy director of research. In view of the military interest in nuclear propulsion systems for naval vessels and aircraft, Conant thought the Commission should draft Lawrence to direct work on power reactors. Lawrence could do the job in a hurry and make sure that the fissionable material diverted from bomb production actually was used in power reactor systems. Rabi feared Conant's proposal would exacerbate the already touchy feelings of reactor personnel in the laboratories and would negate the committee's plea for orderly, coordinated development.

Seaborg took a technical view of the question. He could understand Fisk's and George L. Weil's arguments for extensive component development before full-scale power reactors were attempted, but he thought the best way to identify the technical problems of a high-temperature power reactor would be to build one. Farrington Daniels had convinced him that committee opposition to the high-temperature reactor at Clinton had been interpreted as disapproval of the direct approach and as a lack of confidence in industrial participation. Seaborg suggested as a new form of the direct approach that Westinghouse be asked to develop a high-temperature power reactor.

Smith liked Seaborg's idea of bringing industrial engineers into reactor development but he did not believe a company like Westinghouse would do the job on the "quick and dirty" basis which Conant suggested. Oppenheimer had misgivings about industrial participation at this stage. Both he and Fermi believed the scientists had much work to do before the engineers could design a power reactor. On the other hand, Fermi liked the idea of bringing in Lawrence, whose enthusiastic leadership might draw together the dissident groups in the various laboratories. Again leadership seemed the answer to the Commission's problems.

Fisk and Weil in their cautious way had come to something like the same conclusion. Before the October meeting of the General Advisory Committee, Fisk gave Oppenheimer a copy of his proposal to establish a reactor development committee composed of experts from each of the laboratories. The chairman, a recognized authority on reactors, would evaluate the laboratories' proposals. Although it would reflect the views of the laboratories on technical matters, the committee would be directly responsible to the Commission through the division of research. Thus, Fisk hoped to retain scientific initiative in the laboratories and at the same time provide some centralized control in Washington.[41]

After discussing the Conant and Seaborg proposals, the committee found an obvious solution. Oppenheimer and Rabi suggested almost simultaneously that the committee recommend establishing the reactor development committee with Lawrence as its chairman. The straight-laced style of Manley's minutes could not conceal the reaction: "This was greeted with enthusiasm by many of the members, since it would accomplish the purpose of introducing the virility felt necessary, and would not violently interfere with the orderly development of a well-coordinated reactor program." Conant agreed to drop his "quick and dirty" approach.

In its final form on October 5 the committee's recommendation endorsed Fisk's proposal and nominated Lawrence as chairman.[42] How the new group could be both an operational and an advisory body was not clear, but the committee was confident it could bring order out of chaos. A well-directed program would isolate technical problems and reveal ways in which private industry could participate in reactor development. The new organization would help the Commission to concentrate its efforts on the most important projects. The Commission should immediately authorize construction of the fast-breeder reactor at Argonne. It should not waste its time on projects like the Daniels reactor, which would do nothing more than demonstrate the obvious fact that electrical power could be generated from atomic energy. The committee favored instead materials and component studies which would contribute to the design of ship and aircraft propulsion systems. There should be more effort on a high-temperature power reactor and some study of using natural uranium as fuel. In response to one of Oppenheimer's suggestions, the committee recommended a facility to produce nuclear fuels in the forms needed for the various reactors.

THE REACTOR DEVELOPMENT GROUP

The Commissioners accepted most of the committee's recommendations, but the idea of a new advisory body on reactor development hardly seemed practical. The idea of giving an *ad-hoc* advisory group operational responsibilities presented administrative difficulties. The committee's recommendation also carried an implication the Commissioners were not willing to accept, namely that the lack of progress in reactor development was the result of defects in the organizational structure. The trouble, they thought, had stemmed rather from their preoccupation with production and weapons. The Commissioners saw the solution in quick action within the existing organization and asked Wilson to assign responsibility within the staff.[43]

There was no question where that responsibility lay. Fisk had claimed it from the beginning, and his idea had sparked the committee's recommendation. His proposal to the Commissioners on October 24 was a compromise. On the one hand he did not abandon the idea of establishing a reactor development committee. He thought it could serve an important function in encouraging communication between the laboratories, and it was even possible that when general consensus existed members of the committee on their own authority could see that decisions were carried out in the individual laboratories. On the other hand, Fisk recognized the need for staff responsibility. Under his revised proposal he would be chairman of the new body and Weil would be executive secretary. The Commissioners showed little enthusiasm for the committee but seemed willing to accept it if Fisk believed it would help.[44]

Fisk lost no time in carrying out the Commission's mandates. He was already exploring with the laboratories the design of a small research reactor suitable for university projects. On November 8 he appointed the members of the new reactor committee and set the date for the first meeting just nine days later. Perhaps to remove any fears among the Commissioners that the new body would have program responsibilities, Fisk chose to call it the reactor development "group" rather than "committee." The membership included those in charge of reactor development in the laboratories: Zinn and Winston M. Manning from Argonne; Harvey Brooks from Schenectady; and Weinberg, Gale Young, and Harold Etherington from Clinton.[45]

When the reactor development group assembled in Washington on November 17, Weil opened by giving a general survey of the Commission's efforts to date. On the recommendation of the General Advisory Committee, the Commission was about to approve the engineering design and construction of Zinn's fast-breeder reactor at the new Argonne laboratory. For more than eighteen months the Argonne group had been conducting the fundamental research necessary to determine the feasibility of a preliminary design which Zinn had completed in January, 1946. Zinn now proposed a reactor composed of thin rods of highly enriched uranium 235 clad in aluminum tubes interspersed with other rods of uranium 238 and surrounded by a large hollow cylinder of uranium 238 in which neutrons from the fission reaction, hopefully, would breed more plutonium than the uranium 235 consumed in the reaction. Zinn had also found a commercial source of sodium-potassium alloy, which would be used to remove heat from the reactor, and his engineers had built and tested the components of the cooling system. Zinn estimated that the reactor would cost $2.6 million and would require the diversion of 40 kilograms of uranium 235 from the weapon stockpile. He hoped the return on this investment would be a fair demonstration of the possibility of breeding.[46]

Weil could also report some progress on the intermediate-power-breeder reactor which General Electric was studying at Schenectady. North of the city at Sacandaga, General Electric had started construction of experimental facilities which would simulate the operation of the power reactor core just at the point of criticality. Even with the best of luck the "zero power pile" would not be ready for operation before 1948 and construction of the intermediate-power-breeder was far in the future.[47]

Weil had even less reason to be enthusiastic about the situation at Clinton. Still without a new contractor or a director, the laboratory drifted on an aimless course. For technical reasons Wilson and Fisk had killed the Daniels reactor but still had not informed Daniels of the decision in so many words. Overlooking the technical difficulties in the design, Daniels could not believe that the Commission could refuse to sponsor a project which had the support of an impressive segment of American industry. Members of the power pile division at Clinton did not share Daniels's confidence, however, and the future of their group was the prime topic of discussion in the laboratory. Equally uncertain were the prospects for the high-flux reactor. The laboratory's solid accomplishments in establishing the general specifications for the reactor had apparently failed to impress the Commission, which had done nothing to resolve the critical question of the reactor's location. Weil's request for still another review of the project in October, 1947, had brought from Miles C. Leverett an anguished remonstrance. Nothing had changed since Hood Worthington and Smith had visited the laboratory in the spring of 1947; another review would further delay the start of construction for a year. Weil himself did not view the high-flux in such a promising light, and he saw nothing encouraging about the existing projects to develop a civilian power reactor. The best he could say was that the laboratories had begun some of the fundamental studies which would have to be completed before any intelligent design of a power reactor could be started.[48]

It was not surprising that the discussions in the reactor development group turned in other directions. When the group met with the Commissioners and others later on November 17, they heard appeals from Admiral Mills for support of a nuclear-powered submarine and from General Laurence C. Craigie, chief of research and development in the Air Force, for nuclear-powered aircraft. The joint meeting provoked much discussion of nuclear submarines and led the group to conclude that such a project deserved a high priority. Now that Daniels's project was dead, the power pile division at

Clinton would be the obvious group to study the feasibility of a submarine reactor system.

Under the circumstances it seemed difficult for the reactor development group to come to any other conclusion. Certainly the results were comforting to Fisk and Weil, whose greatest concern was that the laboratories would fritter away their meager resources on premature reactor design. Now there was some reason to expect that research activities in the laboratories would help to produce a reactor of practical value.

Fisk told the General Advisory Committee on November 21 that the group's balance sheet of reactor projects gave the Navy effort a high priority. Oppenheimer and other committee members who had visited Oak Ridge on October 17 agreed that this might be a suitable assignment for the power pile group at Clinton. Wary as usual of hasty decisions, Fisk warned that a heavy commitment to one type of reactor might preclude work on other systems of interest to the committee. He expected the reactor development group to examine all the possibilities before the Commission committed itself on any particular project. He was also reluctant to act in the face of rumors that the Air Force was about to make a definite proposal for nuclear propulsion for aircraft. He thought this might require the full-time attention of one scientist who preferably should be a member of the reactor development group.

The General Advisory Committee was not enthusiastic about Fisk's suggestions but saw that they did contain an element of hope. At least the reactor development group was willing to take some initiative. The group would never have the authority which a strong individual like Lawrence might have exercised or which might have resulted from establishment of a central laboratory; but if it could build a reactor program around the Air Force and Navy requirements, that would be a start.

THE FATE OF CLINTON

While the General Advisory Committee considered the Commission's role in supporting basic research and the future of nuclear power, other events were undermining one of the assumptions on which the committee recommendations rested. The group seemed to take for granted that the Commission had settled the future of the Clinton Laboratories by selecting the University of Chicago as the new contractor to replace Monsanto. The public announcements from the Commission and the University on September 25 seemed final enough, but subsequent events began to show the sands were shifting.

For one thing, contract negotiations took time. There were certain fundamental issues which only Fisk or his superiors could decide. What would be the contractor's responsibility for administering personnel policy, reimbursing costs, and preparing reports? At what point would the Commission step in to fix salary levels, determine personnel standards, or audit the contractor's purchase orders? Harrell for the University and Wilson for the Commission could devise acceptable agreements on these points, but accommodation did not come quickly. Beyond fundamentals was a host of details. How could the Clinton personnel retain Social Security rights as employees of a nonprofit educational institution? How would the contractor's fee be calculated? What patent rights would the contractor retain? By early November, 1947, Wilson and his Oak Ridge staff had agreed on the general provisions of the contract, but the draft was far from a finished product.[49]

By this time Harrell and his associates at Chicago had additional worries. Fisk had approached the University during the summer of 1947 with the idea that it could provide the leadership and talent necessary to make an

effective laboratory out of the dispirited scientists at Clinton. Now, within weeks of the time the University was to take over from Monsanto, Harrell had been unable to find a director for the laboratory, much less appoint an administrative staff. Several candidates had refused the offer and one who was interested had been unacceptable to the Clinton scientists. Harrell could do nothing but continue the search. In the meantime, with no signs of rescue in sight, the Clinton scientists sank deeper into the mire of despair. Without a program and without leadership, many scientists set their own course and pace. Unless Chicago could take over soon, there would be nothing left of the laboratory but the ramshackle buildings from World War II.

Privately Lilienthal and the Commissioners were beginning to doubt the wisdom of selecting Chicago for the Clinton assignment. True, Harrell and his associates on the business side of the University seemed capable enough, but there were no signs of widespread support for the enterprise in the University. Lilienthal was growing increasingly uneasy about Robert M. Hutchins's pronouncements on atomic energy. The Chicago chancellor had accepted the Clinton contract on the grounds that it would provide a way for private industry and educational institutions to enter the world of atomic energy, a position which implied distrust of Government control. But beyond the public relations impact of this larger issue, Hutchins seemed to have little interest in Clinton. His estimates of the imminent and profound effect which atomic energy would have on political and economic institutions suggested at best a superficial understanding of the nuclear sciences and technology. While Lilienthal appreciated Hutchins's moral sensitivities about the atomic bomb, he was puzzled by the chancellor's tendency "to build up logical oversimplifications, as a college senior might." Lilienthal, suspecting that the Commission's research program was overbalanced on the academic side, was beginning to respond to the appeals of Daniels and others for participation by American industry. He used the occasion of a speech before the Detroit Economic Club in October to announce the formation of an industrial advisory panel under the chairmanship of James W. Parker of the Detroit Edison Company. Early in November, during a visit to Knoxville and Oak Ridge, he explored informally with Union Carbide officials the possibility of the company's taking over the Clinton contract to make it a strong industrial laboratory.[50]

Lilienthal's suggestion hardly inspired enthusiasm in Clark E. Center and other Carbide engineers in Oak Ridge. Getting Clinton back on the track was not an attractive assignment, but it did offer a solution to an increasingly dangerous situation. Ever since the Commission had taken over from the Army, Carbide had been snarled in union troubles at Oak Ridge. The main difficulty from Carbide's point of view was that dual management had given the labor unions an opportunity to compete for higher benefits. Although in late 1946 unions affiliated with the Congress of Industrial Organizations had won the bargaining elections in the Carbide-operated K-25 gaseous-diffusion plant, workers in the Clinton Laboratories under Monsanto had chosen to be represented by a union affiliated with the American Federation of Labor. No sooner had Carbide signed a one-year contract with the CIO affiliates on December 9, 1946, than Monsanto signed one granting superior benefits in several respects to the AFL workers in the laboratory. For almost a year Carbide had been under ceaseless fire from the CIO to renegotiate the contract. More than thirty negotiating sessions with the union had produced no agreement. In accordance with the terms of the new Taft-Hartley Labor-Management Relations Act, the CIO on October 9 had formally notified Carbide of its intention to renegotiate any extension of the one-year contract due to expire on December 9, 1947. In November the union had strengthened its hand by winning decisively a bargaining election requested by the AFL union for representation of the workers at K-25.

At the same time, Carbide was feeling pressure from the opposite side as the Commission attempted to formulate a labor policy. Recognizing that a strike in an atomic energy plant could not be tolerated, the Commission was moving cautiously under considerable pressure from the labor unions toward some form of compulsory arbitration of labor disputes. At a meeting with the Commissioners on October 23, George A. Felbeck, a Carbide vice-president, had joined officials representing the Commission's other major contractors in agreeing to accept arbitration, provided it was limited to financial matters, such as contract provisions for wages, holiday pay, and overtime. The Commission itself disliked arbitration because it seemed to suggest Commission interference in traditional labor-management discussions, but the no-strike principle ultimately left no other choice.[51]

Tension increased during the first weeks of December as the Carbide-CIO negotiations dragged on with no sign of settlement. On December 4, the union membership voted its committee strike authority, and the Government began preparations to invoke the emergency provisions of the Taft-Hartley Act. Only a last-minute break in the deadlock on December 8 and a union agreement to continue negotiations after the contract expired avoided a strike. Not until the new contract was signed on the afternoon of December 11 did the Oak Ridge staff relax the emergency procedures arranged for operation of the gaseous-diffusion plant in the event of a walk-out.

A strike had been avoided but the threat had shaken both the company and the Commission. Williams told a special session of the Joint Committee on December 17 that a sudden shut-down of the gaseous-diffusion plant as the result of a strike might have done permanent damage to production facilities. Senators Hickenlooper and Bricker were concerned enough to press the Commissioners for suggested legislation to bolster the Taft-Hartley Act. Commissioner Pike thought the company and the union had pushed the dispute beyond the deadline in order to test the new labor act and the Commission's determination not to intervene in the quarrel. Strauss and Forrestal did not take such a detached view, although they were not ready to recommend specific legislation. For its part, Carbide had decided that in order to bring labor peace to Oak Ridge, it would be willing to take over the Clinton contract from Monsanto. When Oppenheimer heard this news, he called Rabi and Wigner, neither of whom could assure him of Carbide's abilities to manage an academic research laboratory.[52]

BLACK CHRISTMAS

Within the Commission the fate of Clinton now rested with Wilson. The labor incident had demonstrated the dangers of having two contractors and two unions at Oak Ridge. Carbide's desire to take over Clinton was even more ominous. Would Carbide withdraw if the Commission insisted on bringing Chicago into the laboratory? The university had just received a refusal from the sixth candidate for the directorship. Warren C. Johnson, a Chicago chemistry professor who had been a research director at Clinton during World War II, had agreed to serve as temporary director; but as late as December 5, Franklin complained that the university had not requested a single clearance or sent one member of its permanent administrative staff to Oak Ridge. By the middle of the month Harrell had several of his staff in Oak Ridge and was making arrangements to take over the payroll, insurance, and purchase orders, but there was as yet no permanent director, no laboratory policy or plan. Within a matter of days the extension of the Monsanto contract would expire, and Wilson had no assurance that the new contractor would be as well prepared as the old one to direct the laboratory.[53]

There was little time to think through the issues. At this late hour replacing Chicago with Carbide would shock the laboratory personnel, who had been anticipating a university contractor for months. But Carbide offered an attractive solution in several ways. The firm hand of an experienced industrial contractor might, for example, bring some much-needed discipline to the laboratory. Beyond the selection of the contractor were other questions which could hardly be posed in the crisis atmosphere of late December. If Carbide took over, what would happen to reactor development at Clinton? What would be the impact on Weinberg's plans for the high-flux reactor? There would be no chance to meet with the reactor development group. The General Advisory Committee had scheduled a special meeting on weapon matters in Chicago on December 29, but that was almost too late for a decision. There was even some doubt the Commission could meet on the subject because Lilienthal had been bedridden with influenza since a speaking engagement in Chicago on December 16, and both Waymack and Pike had gone home for the Christmas holidays.

Wilson and Fisk were in an awkward situation. Men of lesser poise or determination might have panicked under the pressure, but Wilson in his cool analytical way was determined to make the best possible choice under the circumstances. By Monday afternoon, December 22, he was talking hourly with Franklin in Oak Ridge. There were further discussions of the Clinton contract with Williams and his assistant, Richard W. Cook. By Tuesday afternoon Wilson was ready to suggest the Carbide alternative to Lilienthal by telephone. He told Lilienthal that the choice was to stick with Chicago, an ever-less-promising alternative, or to bring Carbide into Clinton. In the latter case Wilson intended to transfer all reactor development work, including the high-flux, to Argonne. The decision would probably please the General Advisory Committee but would devastate the Clinton scientists.

Wednesday, December 24, Wilson devoted almost exclusively to the Clinton question. There were several meetings with Bacher, Fisk, Williams, and McCormack and long-distance calls to Franklin at Oak Ridge and Strauss in New York. At one-fifteen Wilson told Franklin to call Harrell in Chicago and ask him to come to Washington on Saturday, December 27. Early on the twenty-sixth Wilson asked Roy B. Snapp, the Commission's new secretary, to arrange for a Commission meeting at Lilienthal's home in Rockville, Maryland. Strauss had returned from New York to join Bacher in providing a quorum. Wilson explained the background of the negotiations with Chicago and the university's failure to build a management team for the laboratory. Franklin, reflecting Carbide's views, argued that the personnel policies of an industrial and an academic contractor were inherently incompatible and would produce nothing but trouble at Oak Ridge. Fisk reviewed the issue of centralization, the need to replace Monsanto, and the quest for a new contractor. Bacher reported that Oppenheimer and the General Advisory Committee still favored a central laboratory and, failing that, preferred to see reactor development divided between Argonne and Brookhaven rather than between Argonne and Clinton. The conclusion seemed inescapable. Chicago would be asked to withdraw. Monsanto would be asked to continue temporarily until Carbide could arrange to take over at Clinton.

The unpleasant news reached Harrell and his associates officially in the meeting in Wilson's office on Saturday. The Chicagoans were dumbfounded.

They were prepared to discuss the final mechanics of transfer, but under the circumstances there was little to say. Wilson did his best to be gracious in an awkward situation. Now the news was out, Wilson had to act. There were hasty telephone reports to Waymack and Pike, a call to Dayton postponing a scheduled visit to the new Monsanto plant. Fisk was off to Oak Ridge with the unenviable task of breaking the news to Weinberg and his associates. Wilson himself left for St. Louis to persuade Thomas to hang on for a few weeks until Carbide could take charge.[54]

Fisk did his best but the Clinton scientists hardly received him as a Santa Claus. In the laboratory conference rooms his patient but firm explanations brought anger, sarcasm, and disappointment. In the round of Oak Ridge Christmas parties the Commission's director of research felt himself excluded from the warmth and cheer of the holiday occasion. When Wilson arrived on December 30, he found the same bitterness beneath the outward courtesy of the scientists. Whatever their intentions, Wilson and Fisk were betrayers of confidence and destroyers of dreams. Perhaps they never heard the cutting jingle improvised at a New Year's Eve Party, "1947 B.C. (Before Carbide)," in Oak Ridge. To the tune of "Deck the Halls," the group sang raucously: "Pile research is not for us'ums / Leave it for our Argonne cousins /Engineering is for us'ums / We're a bunch of dirty peons. / Fisk considered many factors /Then he stole all our reactors. / Now the New Year's here to greet us / Can the bastards really beat us?"[55]

YEAR-END REFLECTIONS

It was perhaps ironic that the same week the executive secretary of the Federation of American Scientists was drafting a letter of birthday greetings to the Commission with congratulations for "the excellent progress the Commission has made in reorganizing the atomic project on a peacetime basis." Oppenheimer on New Year's Eve was drafting a letter to the President. (Conant had suggested that this might establish a precedent which would give the General Advisory Committee a strong voice in the future.) He wrote of the staggering difficulties the Commission had faced one year earlier. He expressed cautious but genuine confidence that there had been real progress in twelve months, but he could not hide the fact that there had been fumbling and frustration. Lilienthal, still at home weak from his recent illness, spent the evening in a sentimental reverie with his journal. He called it a year of pain but with moments of exhilaration. Both the pain and the exhilaration were the products of a courageous attempt to bring new ideas and techniques to bear on the terrifying issues of the atomic age. Not even Lilienthal thought the Commission had distinguished itself in sharpening the peaceful image of the atom. Hopefully the failures as well as the successes had provided good lessons for the future.[56]

CALL TO ARMS

CHAPTER 5

It was Bastille Day in 1947, a day when free men the world over recalled a classic overthrow of outmoded institutions and old oppressions in western Europe. Secretary of State George C. Marshall, speaking to the Governors' Conference in Salt Lake City on that July afternoon, found the revolutionary theme pertinent to his remarks. Living in revolutionary times, Marshall saw the nation poised at a critical moment in world history, facing a decision which would affect the world for generations. "There is no blinking the fact," he said, "that this country now stands at a turning point in its relations to its traditional friends among the nations of the Old World. Either it must finish the task of assisting these countries . . . or it must reconcile itself to seeing them move in directions which are consistent neither with their own traditions nor with those of this country." The second alternative, in other words, would result in a repudiation of the revolutionary spirit of 1776 and 1789.

In private, according to newsmen, Marshall explained the crisis facing the nation in the plain language of a soldier. Western Europe was on the verge of disintegration, and the Soviet Union stood ready to pick up the pieces. Britain itself might fall. The situation in Greece was so grave, despite President Truman's emergency offer of military and economic assistance in April, that there was little assurance the struggling nation would not slip behind the Iron Curtain.[1]

But could the United States accept the new responsibilities which the postwar crisis was thrusting upon it? Defending the free world would mean a heavy commitment of national will and resources. The nation would have to rebuild its armed forces, and the military services would have to find some way to replace traditional rivalries with new patterns of unified action. Likewise, if the atomic bomb was to have a significant place in the national defense, the Commission would have to resolve some of its differences with the Pentagon. An effective atomic arsenal would require more uranium ore, new and more efficient plants for producing fissionable material, a rejuvenated weapon laboratory at Los Alamos, mass-production techniques in weapon fabrication, field tests for new weapon designs, and resolution of the old dispute over the custody of weapons in stockpile. These were the tasks the Commission faced during the last six months of 1947 in answering the call to arms.

THE OLD ORDER CHANGES

This was not the first time that the threat of foreign aggression provided the necessary stimulant for reforms in the structure of the Federal Government. To many high in the councils of the Government, World War II had demonstrated the need for fundamental changes in the defense establishment, including unification of the armed forces, coordinated procurement of essential materials and supplies, establishment of a national intelligence organization, unified direction of military research and development, and creation of new channels for Presidential decision.

Although President Truman had advocated creation of a single defense department late in 1945, Congress still had taken no action on this controversial subject in early 1947. The hearings and floor debates in Congress during the first months of 1947 centered around the authority of the Secretary of Defense and the status of the Air Force, Marines, and naval air arm. The National Security Act, signed by the President on July 27, 1947, reorganized the military departments "to provide for their authoritative coordination and unified direction under civilian control but not to merge them." The Secretary of Defense was given powers of general authority, direction, and control, and presumably would be the only official in the military establishment with Cabinet rank. But with no departmental organization of his own, the Secretary would have the unenviable task of guiding the activities of the sub-Cabinet Departments of the Army, Navy, and Air Force, all of which were part of an ambiguous entity described as the National Military Establishment. The new act provided a statutory basis for the Joint Chiefs of Staff, created the War Council, and moved the Research and Development Board and the Munitions Board into the National Military Establishment. While the joint bodies were advisory to the Secretary of Defense, their composition made it likely that their advice would be the product of negotiations by service representatives.[2]

The sweeping provisions of the National Security Act extended beyond the military services to broader aspects of the national security structure. To provide for better coordination of national security affairs above the department level, the Act created the National Security Resources Board, the Central Intelligence Agency, and the National Security Council. The Board would advise the President on coordinating all military, industrial, and civilian mobilization. The Agency would advise the Council on intelligence matters related to the national security, and correlate and evaluate intelligence information in the Government. The Council, a major policy advisory group, would include the President, the Secretary of State, the Secretary of Defense, the three service secretaries, the chairman of the resources board, and other heads of Executive departments and agencies as appointed by the President.

It would take President Truman some time to fill the posts created by the new legislation, but in late July there was little doubt who the new appointees would be. Robert P. Patterson's resignation as Secretary of War indicated that James V. Forrestal, once a critic of unification, would become the first Secretary of Defense. Kenneth C. Royall would succeed Patterson as Secretary of the Army, John L. Sullivan would follow Forrestal as Secretary of the Navy, and W. Stuart Symington would be the first Secretary of the Air Force. Since both General Dwight D. Eisenhower and Admiral Chester W. Nimitz would be retiring by the end of 1947 or shortly thereafter, there were good prospects for entirely new military leadership in the critical years ahead. In the summer of 1947 the Soviet threat had been sufficient in a few weeks to spark changes which had been years in the making. World War II was fast becoming history, and the nation's destiny was passing to a new order of leadership.

RELATIONS WITH THE MILITARY

The growing international tensions of which General Marshall spoke had an impact on the thinking of the Commissioners, as renewed interest in producing fissionable materials and weapons in the spring of 1947 indicated. The ominous clouds on the international horizon had postponed the dawn of a new day in which atomic energy would serve the cause of peace rather than the demands of national defense. The Commissioners would have to give much more attention to the military aspects of atomic energy than Lilienthal had expected and would have to spend much more of their time in consultations with civilian and military officials of the defense establishment, mainly the Military Liaison Committee.

Unfortunately for both sides, the Commission had not made a good start in its relations with the committee. The bitter struggle for confirmation and the succession of security crises in the first months of 1947 made it difficult for the Commissioners to concentrate on defense needs and to establish routine working relationships with the committee. Once the two groups started meeting regularly in April, 1947, there was some opportunity to exchange ideas and to develop personal relationships to replace the formalities which usually set the tone in official correspondence.[3] General Lewis H. Brereton, the committee's chairman, knew that General James McCormack was an outstanding officer, and Lilienthal soon discovered that Brereton was a reasonable and effective administrator. For a knowledge of atomic energy development up to that time, few officers could meet the qualifications of General Leslie R. Groves or Admiral William S. Parsons, both members of the committee. Admiral Thorvald A. Solberg, although not directly involved in the Manhattan Project, had long been interested in applying nuclear energy to naval ship propulsion. Admiral Ralph A. Ofstie and Colonel John A. Hinds were both officers of experience and ability.

The long list of varied items on the agenda for the April 30 meeting had indicated the wide range of topics which would be the subject of discussion in succeeding months. In addition to the major policy issues, such as plans for producing fissionable materials and weapons, the two groups faced many administrative matters of lesser import but still of substance. One of these was the policy on access by military personnel to Restricted Data. The committee found it difficult to understand the Commissioners' opposition to broadening access. It seemed that the Commission had the exaggerated idea that its control of atomic energy information was a sort of sacred trust which took precedence over even military requirements. The Commission, for its part, had trouble visualizing the need for clearing thousands of military personnel for access to Restricted Data. Just how many clearances were required was a matter for continuing discussion, although the Commission did agree to accept military clearances, provided the procedures for personnel investigation met Commission standards.

Other areas of the Commission's responsibility had military implications which had received little systematic study during World War II. McCormack reported to the Commission that the armed forces had done little since the war to appraise the techniques and effectiveness of radiological warfare and the defenses against it. He urged that the Commission take the lead in exploring the scientific aspects of radiological warfare and that the Commission raise with the Military Liaison Committee the question of military responsibility for investigating the subject. In October, 1947, the Commission sent the committee the results of a preliminary study conducted at Oak Ridge and requested the military services to participate in the work of a scientific panel on radiological warfare.[4]

Another matter of great concern within the Commission was the long-range detection of nuclear explosions. Like radiological warfare the subject had received some attention in military and scientific circles during and after World War II. But as Commissioner Strauss pointed out in April, 1947, there was no evidence that the military services had set up any system for continuous monitoring of radioactivity in the atmosphere. Such a system would be the best method of detecting an atomic weapon test in another nation. With the Commission's approval, Strauss set out to investigate.

William T. Golden, his administrative assistant and a former naval officer, soon discovered that no monitoring system existed. Although many Government organizations had an interest in the subject, none had primary responsibility. A special committee, organized at the Commission's request by the Central Intelligence Group, confirmed this fact in May, 1947. The committee reported that, although techniques already existed for detecting distant explosions by sonic, seismographic, or air-sampling methods, at least two years would be required to develop an effective network of detection stations.[5]

Strauss and his fellow Commissioners refused to believe that some sort of detection system, however far from perfect, could not be established in a few months. A formal request to the Military Liaison Committee in June and Strauss's personal appeal to Forrestal, Royall, and Eisenhower in September placed the responsibility for long-range detection squarely in the hands of the Air Force. How long it would take to set up an effective monitoring system was still uncertain.[6]

If the Military Liaison Committee was the Commission's contact with the armed forces on the policy level, the Armed Forces Special Weapons Project served the same function on the operational level. Established by Secretaries Patterson and Forrestal under General Groves's command early in 1947, the new organization was to be responsible for all armed forces' participation in developing the military uses of atomic energy. The joint directive clearly anticipated the ultimate unification of the military services, but it was difficult to write a charter for the organization before Congress had acted. In the interim Groves carried on as best he could without a formal charter, for the most part limiting his activities to ordnance work at Sandia with Corps of Engineers officers. As General McCormack well knew, operations at Sandia were far from satisfactory in the first half of 1947, but there seemed little chance for improvement until the service secretaries had clearly defined the functions of the Armed Forces Special Weapons Project.[7]

Early in April Groves had submitted to Eisenhower and Nimitz a draft charter for the special weapons project. Like the joint directive, the charter proposed that the commander have direct access to the Army Chief of Staff and the Chief of Naval Operations, a concession Eisenhower was willing to make. Not acceptable was the proposal that the unit have special command functions. The revised draft which Eisenhower and Nimitz approved on July 8, 1947, limited the commander to staff functions except in the particular areas of ordnance work and technical training of military personnel at Sandia. Since it was now clear that the National Security Act would create a separate department for the Air Force, the charter provided for representation of the Army Air Forces.[8]

The charter was not everything Groves had hoped for, but at least it gave him a toehold on the operational as well as the policy side of the atomic weapon effort. From his place on the Military Liaison Committee he could prod the Commission on producing fissionable materials and weapons. In the special weapons project he could make sure the military services would have the nuclear weapons they needed in time of crisis.

NEW LIFE AT LOS ALAMOS

Who would have custody of the stockpile was a live issue in the summer of 1947, but a more immediate question was whether there would be a stockpile to control. Certainly no man was more concerned with that question than was Carroll L. Tyler, the new manager of the Commission's vast western empire called Santa Fe Directed Operations. Tyler had faced tough assignments before. During World War II he had helped Vannevar Bush administer contracts for the proximity fuse. The Commission had hired him for his demonstrated ability to manage industrial contractors on a complex technical job involving extraordinary specifications and an incredible time schedule. But Tyler knew from his trip through the western installations in June, 1947, that his wartime job was child's play by comparison. From the decaying ruins of a war project he was expected to build a modern and reliable complex of laboratories and plants for developing and producing nuclear weapons.

The magnitude of his task must have struck him anew as he arrived in Los Alamos on July 16, 1947, to take up his duties. Like thousands before him, Tyler followed the lonely road north of Santa Fe along the Rio Grande, across the one-lane wooden bridge at Otowi, then northwest toward the Indian town of Española, and up the winding canyon road to the ramshackle sentry house, wooden gate, and barbed wire barricade, where military police were still standing guard. Driving west onto the mesa, the new manager followed the dusty road through the tangle of warped plywood hutments, time-scarred Quonset huts, and ugly warehouses with paint peeling off their sides. At the center of town he could see on the right the beginnings of the commercial center just east of the log buildings which had been part of the ranch school before the war. Ahead were two wooden overpasses leading over the high barbed-wire inner fences to the technical area on both sides of the road.

It was hard to believe that these crumbling temporary buildings surrounded by oil drums, cable reels, and mud-caked Army vehicles housed one of the world's famous scientific laboratories. A few hundred yards farther west the road fanned out into the residential area, a conglomeration of ten different types of prefabricated plywood homes, converted barracks apartments, temporary hutments, and trailers. The Army had just completed the first three hundred permanent homes in the western area, but most of the town's 7,000 inhabitants still lived in temporary wartime buildings. There were few paved streets, no sidewalks, and almost no private telephones. One low rambling wooden building served as the town's only school, and church services were still being held in the old post theater until an Army chapel could be hauled in from Santa Fe. Residents did their daily shopping in the commissary and the post exchange and made other purchases by mail order. It was evident that living conditions in Los Alamos would not help to attract talented scientists to the laboratory.[9]

When Tyler took over from the Army commander on July 17, he had less than four hundred Commission employees to manage the weapon activities at Los Alamos and a half dozen other sites. A year earlier at Los Alamos alone the Army had maintained a work force of more than 5,000 troops and civilians. Many of the former Army jobs were now the responsibility of the Zia Company, which a local construction contractor had organized in 1946. Zia's 3,300 employees did everything from running the schools and the power system to fixing leaking faucets for housewives and purchasing supplies for the laboratory. Administration and research in the laboratory was the responsibility of 1,200 employees of the University of California, under the direction of Norris E. Bradbury. The university also had more than three hundred scientists and technicians at the Sandia Base. For a management job of this magnitude, Tyler's staff was much too small, but he could not even consider reinforcements until additional housing was available.

The one bright spot in the picture in the summer of 1947 was morale among the scientists in the laboratory, if not that among the housewives in the town. Since the April, 1947, meeting with Oppenheimer and the weapon subcommittee, the scientists had found a sense of purpose and were doing important work despite the handicap of inadequate laboratories. The caliber of research impressed Commissioner Bacher during his summer sojourn in Los Alamos. He was especially interested in the theoretical and experimental work on the design of the new weapons which would be tested in the spring of 1948. Long discussions with Marshall G. Holloway and Hans A. Bethe generated hopes that the new weapons would give a much greater explosive yield than the wartime weapons. The new design also promised a relaxation of some of the more troublesome specifications for the existing weapons and hence greater efficiency in the production plants. Edward Teller's descriptions of the laboratory's theoretical work on a thermonuclear weapon also had exciting possibilities.[10]

In the summer of 1947 one could feel new energy, and with it new ideas, surging through the laboratory. A new sense of mission had replaced the spiritless make-work of 1946. The turnover of personnel was slowing down, and Bradbury was giving a new team of relatively junior scientists a chance to show what they could do. The work was challenging. Creating a stockpile of atomic weapons required not only the resumption of many of the activities established during the war, but also substantial new efforts to standardize operations, improve the quality of existing weapon models, and develop new ones.

Only those who had some conception of the intricacy of atomic weapons could appreciate the challenge. The tasks involved were much closer in scope and complexity to those of developing and building a modern airplane than to those of turning out artillery shells. An atomic bomb approached a small airplane in size, and its flight characteristics on the way to the target were important. Inside its ballistic case it carried an incredible array of precision instruments, electronic gear, exquisitely machined and plated mechanical parts, expertly cast shapes of high explosives, and a core of fissionable material resembling the most ingenious Chinese puzzle. Production and assembly of atomic weapons at Los Alamos would have been a challenge even if there had been well-established processing techniques and assembly lines, but nothing of the sort existed in 1947, or even during the war, for that matter. A small group of exceptionally talented scientists working with a minimum of physical resources had managed to build a few atomic bombs on a laboratory scale almost entirely by empirical methods. Now most of those scientists were gone; they had left behind them no production lines or printed operating manuals, but only a few assistants, some experienced technicians, some laboratory equipment, and a fragmented technology recorded in thousands of detailed reports.

In every area of the laboratory, the problems were the same in 1947. A few people had seen a specific process or assembly performed during the war, but so few units had been produced, often by cut-and-try methods, that no one could be sure that the processes were really reproducible. For example, the high-explosive lenses had worked in the implosion devices at Alamogordo and Nagasaki in 1945, but just what should the specifications be for lenses in existing models? Could the wartime components be reproduced exactly, even if that were desirable? Would lenses produced at Inyokern by the same process have the same properties as those produced at Los Alamos? Would lenses produced in 1945 behave the same way in 1947 or 1948? Was it possible to improve the quality of lenses in the process of producing additional stocks without delaying the creation of a weapon stockpile or reducing the reliability of the weapon? Or for that matter, were the wartime lenses really reliable, or had the scientists just been lucky? What could be done to improve the components for new weapons under development? During the summer and fall of 1947 the men of X division looked for answers to these questions as Melvin L. Brooks experimented with new casting methods, Leonard E. Hightower improved production techniques, and Arthur W. Campbell broke the desert calm with test firings at Anchor Far Point and Q-5 site.[11]

The pressures were just as great in M division, which was responsible for the nuclear heart of the weapon. In the spring of 1947 the main task had been to clean up the specifications for the standard nuclear cores and to write systematic manuals which technicians and military teams could use in assembling and testing them. During the summer the emphasis turned toward perfecting techniques and increasing production of standard components, developing the new Mark 4 weapon, and studying possible alternatives which might be used in the devices to be tested in the spring of 1948. Raemer E. Schreiber had charge of testing dozens of critical experiments in a new remotely controlled building, which eliminated the hazards in what had been the deadly game of "tickling the dragon's tail."

CMR division had to handle the steady stream of requests from all parts of the laboratory for chemical processing and analytical services and still maintain the wartime production lines for purification and fabrication of uranium and plutonium metal. Soon after the war General Groves had planned to transfer these production activities to Oak Ridge and Hanford, respectively, but until suitable facilities could be built at the production sites, Los Alamos had to carry the load. In the summer of 1947, the CMR division had to set aside most of its plans for research on process improvement in order to meet the demands for fissionable material for the stockpile and for test activities. Although Bradbury's goal was to make Los Alamos exclusively a research laboratory, a large share of the laboratory's effort through the rest of 1947 went into restarting and maintaining production operations for the components and materials needed for stockpile weapons and those under development.

Bradbury's hope for liberating his staff from production activities rested with Z division, the branch of the laboratory established at Sandia Base on the outskirts of Albuquerque. Los Alamos was to do research and laboratory development of new weapon designs and production techniques; Z division at Sandia was to work out engineering details, establish production lines at various sites, and with assistance from the armed forces set up routine methods for assembling, testing, and maintaining weapons in a ready state. Much of this was a dream even as late as the summer of 1947. Inadequate facilities, a severe shortage of trained personnel, and an uncertain chain of command all made work at Sandia a frustrating experience.

Uncertainties in organization were particularly distressing. There was a distinct advantage in locating engineering and production activities near Kirtland Field and Albuquerque, but separation from the main laboratory at Los Alamos tended to subordinate the status of Z division. Until the autumn of 1947 all administrative actions had to go through Los Alamos, and until regular air service was established between Los Alamos and Albuquerque, Sandia personnel had to invest a full day of travel to attend a short meeting on the Hill. Furthermore, the Sandia operation had grown up gradually out of necessity, without any formal statement of its relationship to Los Alamos. Robert M. Underhill, in charge of business affairs at the University of California, wrote Bradbury in June, 1947, that in his opinion the university never contemplated operations anywhere but at Los Alamos. He considered Sandia a shoestring operation covered neither by Government contract nor by insurance; he wanted the university relieved of any connection with Sandia and the project turned over to the Armed Forces Special Weapons Project.[12]

OPERATIONAL RESPONSIBILITIES

The joint responsibilities of the military and the Commission at Sandia were another source of confusion. True, General Groves now had a charter for his organization, but how this was to be interpreted at the operating level at Sandia was far from clear. In the summer of 1947 Groves had ten officers from a special engineer battalion assigned at Sandia to learn the art of weapon assembly and testing, but just what was the boundary between their work and that of Z division personnel, who were employees of the Commission's contractor at Los Alamos? The Commission had established the principle in December, 1946, that it would assume custody of all atomic weapons and fissionable material, but how did this square with the fact that custody of such materials at Sandia remained with a military officer?

These questions came to a head when Tyler arrived at Los Alamos to take up his new duties. As the Commission's senior representative, he expected to have administrative control of all activities at Los Alamos and Sandia. Since the military would have no authority at Los Alamos after July 16, Tyler's responsibilities there were clear. But it was not so easy to write a directive for Sandia. There was at least a semblance of Commission custody of weapons and weapon parts in the fact that Colonel Gilbert M. Dorland, who had personal responsibility for weapon materials at Sandia, took his orders on this subject directly from Carroll L. Wilson. Dorland's superior in the military chain of command, however, was General Robert M. Montague, commanding general of Sandia, who in turn reported to Groves as head of the Armed Forces Special Weapons Project.[13]

General McCormack and his staff in the division of military application tried to keep the issue in a practical perspective. All that really mattered from their point of view was that reliable atomic weapons be ready when they were needed. With this idea in mind, McCormack proposed a short directive to Tyler requesting him to assume personal responsibility for stockpile items at Sandia. He would make regular inspections and reports to the general manager and control access to stockpile items. General Montague would be responsible for providing storage facilities and their physical security. Tyler would be requested to work out the details with General Montague.

The Commissioners readily accepted McCormack's draft, but the Military Liaison Committee refused to let McCormack slide over the sticky questions of custody. In a meeting on August 13, 1947, Brereton recommended a directive spelling out in detail the precise division of responsibilities between Tyler and Montague. When Wilson complained that in defining such a division the Commission inevitably would be circumscribing Montague's authority, Brereton suggested that the military and the Commission issue a joint directive. General Groves had a simpler solution: the Commission and the Secretary of Defense should ask the President to transfer all weapons and weapon parts to the armed forces. In a way, Groves had raised a valid point. Section 6(a) of the Atomic Energy Act provided that the President could direct the Commission to deliver to the armed forces such fissionable material and weapons as he deemed necessary in the interests of national defense. The President could also authorize the armed forces to produce or acquire atomic weapons.

The trouble with Groves's suggestion was that it threatened to raise the old clichés about civilian or military control of atomic energy. Wilson reminded the committee that the President had settled the question of custody in the executive order transferring the atomic energy program from the Manhattan District to the Commission. Brereton, however, seemed to remember that Lilienthal had implied his willingness to transfer custody eventually to the armed forces in the interests of national security. Since neither Lilienthal nor Bacher was at the meeting, that question could not be settled. Groves observed that Tyler could not really assume responsibility for the stockpile unless he assumed command of the troops guarding it.[14]

At this point McCormack's deputy, Navy Captain James S. Russell, tried again to propose a joint directive. Russell said he would be glad to work out a joint order with Groves and send it to Tyler and Montague for their comments. Pike accepted the idea for the Commission and Groves, while making clear his dissatisfaction, agreed to try.

Russell's suggestion proved a good one. He and Groves agreed on a draft the following day, and both Tyler and Montague concurred, with only minor differences of opinion, within a week. The directive itself accurately reflected the complex administrative relationships at Sandia and proved an effective working arrangement. The Commission had compromised by conceding its contention that it should have unilateral and complete authority on matters of weapon custody. Yet for the Military Liaison Committee the directive missed the important point. The military services seemed to be in the dangerous position of not having instant access in times of crisis to the most powerful weapon in the national arsenal.[15]

The Military Liaison Committee could not overlook this danger. On September 4, 1947, Brereton wrote to Secretaries Royall and Sullivan for their support of an effort to gain military custody of the atomic stockpile. The results were not encouraging. Although Secretary Sullivan offered Navy support, there were rumors that Eisenhower wished to avoid raising the issue. One could guess from Eisenhower's previous reactions to the civilian-military control issue, especially during the legislative debate on the McMahon bill in 1946, that he preferred the pragmatic approach to custody advocated by McCormack. His reply to Brereton recognized the Commission's responsibility and the need for ultimate transfer to the armed forces. He suggested an agreement recognizing both points of view.[16]

For the Military Liaison Committee, however, the subject was not one for negotiation. In a letter to the Commission on November 12, Brereton declared that "in order to insure that all interested agencies of the Armed Forces are prepared at all times to use the available bombs, it is necessary that they have actual custody of the completed weapons." The Commission was asked for its formal opinion.[17]

ACTIVITIES AT SANDIA

If the scientists and military personnel at Sandia were ever aware of these larger issues, they could not think much about them; they had too many immediate concerns. By the summer of 1947 Sandia was just beginning to get back on its feet after the Bikini tests and the departure of many of the wartime staff for civilian jobs. Now there were signs of regular activity and progress. Glenn A. Fowler at last had been able to complete facilities at the remote Salton Sea base, where drop tests of new weapon models would be conducted. The engineering group under Richard A. Bice was making progress on mechanical mock-ups of standard weapon stockpile models so that accurate specifications for procuring components could be written. Similar mock-ups of components for the new Mark 4 weapon helped to determine the precise size, location, and function of each small part.[18]

Learning by doing was the technique Arthur B. Machen used in training the officers of the special engineer battalion in assembling and testing weapons. In addition to its production and training activities Machen's group was developing standardized handling and test equipment. Other groups under O. L. Wright and Alan N. Ayers wrote detailed engineering manuals and subjected proposed weapon components to every conceivable test. In short, Sandia's job was not just to assemble weapons or to train military personnel, but also to create simultaneously with these operations a new technology, including technicians, instruments, tools, and textbooks.

The successive waves of demands on Sandia, first to assemble weapons from existing wartime components, then to procure new components for additional weapons of the same models, then to develop new weapon models, and finally to design weapon devices for the 1948 test series, all but swamped the small staff serving as an extension of the Los Alamos laboratory. Robert W. Henderson, serving as temporary director at Sandia, found it difficult to hire scientists and technicians when the only personnel office for the laboratory was in Los Alamos. Even when he found promising candidates, the long wait for a security clearance imposed an impossible financial burden on those seeking employment. He managed to find some buildings outside the security area where he hoped new employees could work on unclassified projects while they were awaiting clearance. But before he could get the Commission to approve the idea, the military took the facilities for other purposes. A further obstacle to recruitment was the shortage of suitable housing for civilians at Sandia. Through the autumn of 1947 Henderson continued to complain to Bradbury about the delays in housing construction, while the Corps of Engineers argued with builders about details of contract terms. There was no questioning the fact that it was at best difficult for civilians to control operations in a military installation. Henderson and his associates were completely dependent upon General Montague and his military organization for their day-to-day existence, and there were some who said the scientists were making a hopeless attempt to perform functions rightly belonging to the military. Groves did not help matters by telling his officers at Sandia that Commission fumbling would soon put weapon activities back in the hands of the military, where they belonged.[19]

In these circumstances it was perhaps understandable that the morale of civilians in Z division was low. Some were convinced that Montague gave the military preferential treatment in housing and technical facilities at Sandia. To others the caliber of military personnel assigned to weapon engineering and assembly operations at Sandia suggested that the Army was not much interested in making a success of the venture. On the other side, the civilians seemed unreasonably suspicious and therefore uncooperative to some of the military, especially to the Air Force officers who tended to think of themselves as an innocent third party caught in the crossfire between the civilian scientists and the Army.

Bradbury, a hundred miles north of the troubles at Sandia, could afford a broader perspective. He had been in the weapon business long enough to know that there would always be clashes of this nature and that the momentary animosities did not make effective cooperation over the long term impossible. Bradbury saw some of Sandia's difficulties as the growing pains of a new site, but he recognized the handicaps of Sandia's lack of status and reputation. In June, 1947, he had predicted that Sandia would be subject to continual sniping from both the military and the Commission unless a very senior man with considerable prestige were found to head the organization. Despite his abilities and conscientious efforts, Henderson did not enjoy the complete confidence of either group. Bradbury had wisely suggested that not he, but the several authorities in Washington who would have to accept the Sandia director's decisions, should make the appointment. That, however, was easier said than done in Washington in the summer and fall of 1947. In November, Henderson was still hanging on, doing the best he could to rebuild the nation's nuclear arm.[20]

PLANS FOR SANDSTONE

In the bureaucratic labyrinths of Washington it was easier to avoid some of the direct confrontations with the military which Henderson faced at Sandia.

Certainly there was great potential for conflict in planning for the 1948 weapon tests, which President Truman approved on June 27, 1947. Weapon testing, like development and custody, was an activity of great concern to the military, and it could hardly be successful without military cooperation. Fortunately, however, the Commission was not burdened with an existing organization and its inherent complications in planning for the test. Equally important, it had in General McCormack and his deputy, Captain Russell, two men who knew how to get things done in the military services.

The week following the President's decision, McCormack asked Russell to assemble information for the key decisions on test planning. Russell headed west with his staff for a meeting in Los Alamos on July 9 with Bradbury and John H. Manley. Everyone agreed that the tests would be strictly scientific. Los Alamos would provide technical leadership; the military services, the supplies and logistics; the Commission, the funds and the test weapons. The

Commissioners readily accepted the idea of giving Los Alamos responsibility for technical direction, and by mid-August Bradbury had outlined these responsibilities in some detail. The laboratory would provide the technical director and other aides, prepare the test weapons, provide specifications for the firing areas and towers, and conduct analyses of data collected with the help of the armed forces.[21]

Just as critical in the operation was the role of the armed forces. The job of assembling the task force of almost ten thousand men at a remote Pacific atoll more than four thousand miles from the continental United States had dimensions only the military could contemplate. The operation would require a fleet of ships, harbor facilities, housing, recreational facilities, temporary laboratories, and tons of scientific equipment. With his Pentagon experience Russell had no trouble establishing working relationships with the Joint Chiefs of Staff. He served as the Commission's representative on a planning committee which recommended a special task force under the Joint Chiefs to conduct the tests. By the middle of September, 1947, the committee had rough blueprints for a joint task force and had recommended the appointment of Lieutenant General John E. Hull as task force commander. McCormack was especially pleased with Hull's appointment. With an outstanding reputation in the Army, Hull had served as chief of operations in the War Department and had just been appointed commander of Army forces in the Pacific, a position which would make him especially effective in marshaling military resources for a Pacific test. By this time Russell had also secured the appointment of Darol K. Froman of the Los Alamos laboratory as scientific director.

Late in September the three men joined a party of scientists and military officers to visit possible test sites in the Pacific. There was no question that the site would be somewhere in the Marshall Islands, a chain of lonely atolls in the vast reaches of the central Pacific. The primary concern was to find an island large enough for towers and instrumentation for three test shots and remote enough from inhabited areas to reduce the hazards from radioactivity. The choice fell on Eniwetok Atoll, three hundred miles from the naval base at Kwajalein. The atoll itself provided an excellent harbor for large ships and was favorably located in terms of prevailing winds and ocean currents. It would be necessary to evacuate one hundred forty islanders from Eniwetok but this appeared feasible.[22]

With the site selected, Russell could concentrate on detailed planning. Appointed test director by the Commission on October 14, he assisted the Joint Chiefs' committee in defining the role of the armed forces in the test. The schedule called for moving the first construction forces to Eniwetok early in November, 1947. Temporary housing for construction workers would be ready before the end of the year. Large portions of the major construction would be completed before the main body of scientists arrived about March 15, 1948, one month before the date for the first shot. The total costs, estimated to be about $20 million, had been allocated between the Commission and the armed forces. General agreement had also been reached on security, communications, radiological safety, meteorology, and supply functions. Before the end of October the Commission had accepted most of these proposals and Russell was ready to start work.[23]

PRODUCTION PLANNING

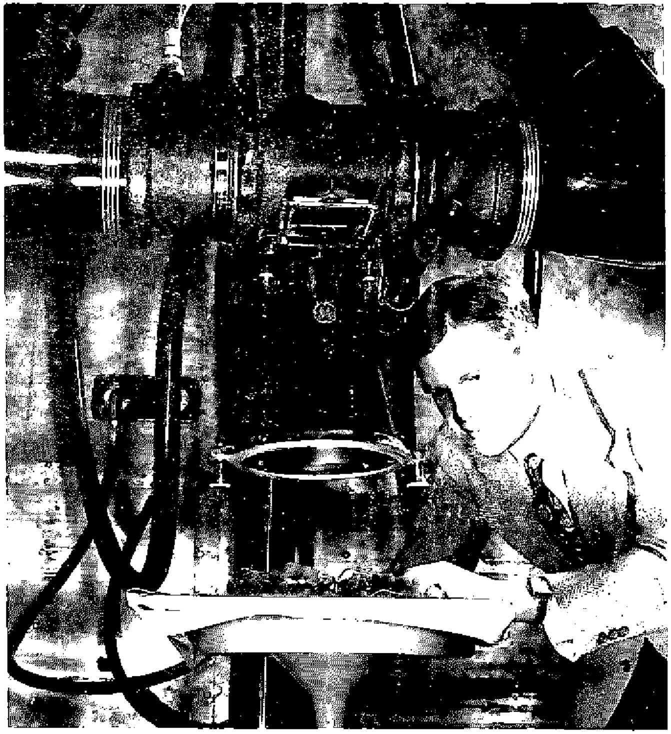
Whatever the accomplishments of the scientists, engineers, and military officers at Los Alamos, Sandia, and Eniwetok, the strength of the United States nuclear arm depended upon a steady flow of fissionable material from the production plants at Hanford and Oak Ridge. Although Oak Ridge had its share of problems, production operations were not one of them. The trouble-free performance of the gaseous-diffusion plants promised a reliable supply of uranium 235. Plutonium production was another matter. In a meeting with the Military Liaison Committee on July 18, 1947, Carroll Wilson had explained the Commission's plans for replacing the production reactors, which were showing all the signs of old age. Expansion of the graphite moderator blocks in the central region of the reactors was bending the fuel tubes to such an extent that it might soon be impossible to push the uranium slugs through the reactor. Corrosion of the fuel tubes also seemed to be accelerating, and there had already been one instance of a leak which permitted the cooling water to flow into the graphite.

The Commission was absolutely dependent on the Hanford reactors, not only for plutonium, but also for polonium 210, which was used in neutron initiators in weapons. The short half-life of polonium made continuous operation of the reactors imperative. Walter J. Williams had developed with General Electric engineers at Hanford a plan to build two new reactors near two of the old ones. The replacement reactors could be completed relatively quickly and at modest cost because they would be able to use existing water treatment facilities, each large enough to supply a good-sized city. Williams estimated that one replacement reactor could be completed in eighteen months and a second in twenty-four months. Two completely new reactor complexes, which would take an extra year or more to build, would be started before the replacement units were completed.[24]

In the intervening weeks some doubts about Williams' proposal began to emerge. During a visit to Hanford, Admiral Parsons, a member of the Military Liaison Committee and a veteran of the wartime project, found reason to differ with Williams' assessment of the situation. Contrary to earlier reports, Parsons discovered that the existing reactors were not expected to fail quickly without warning but would rather grind slowly to a halt under the gradual accumulation of maintenance problems. There was even some reason to believe that the existing reactors could be operated indefinitely, in which case there would be no cooling water facilities for the replacement reactors. A violent explosion in one of the old reactors, even if unlikely, might spread so much radioactivity that the replacement unit could not be operated. Parsons was also concerned that in its haste to construct replacement units the Commission was preventing design improvements, including those which would extend the life of the new reactors.[25]

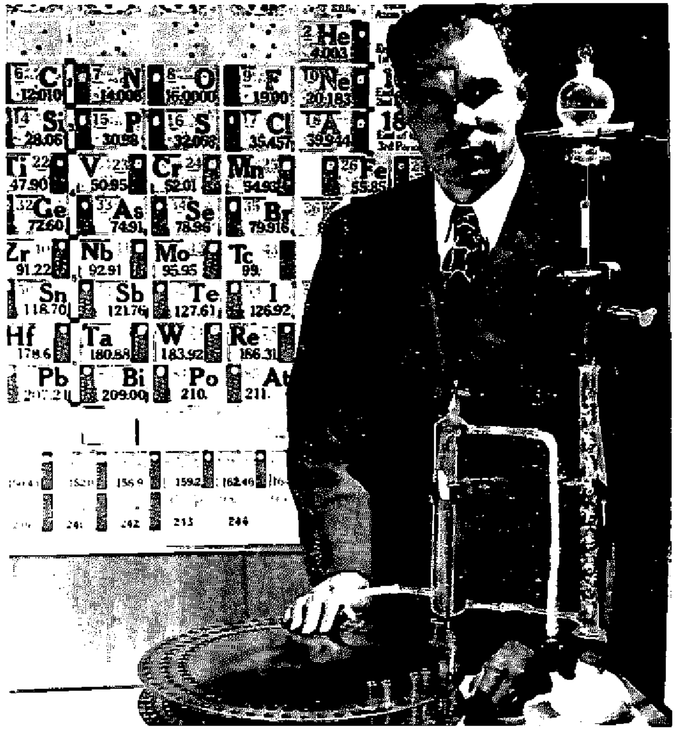
It was difficult to challenge the opinion of an expert like Parsons. The best Lilienthal could do was to suggest that the other members of the Military Liaison Committee accompany the Commissioners on their visit to Hanford after the Bohemian Grove conference. When the train reached Pasco, Washington, on the evening of August 22, Admiral Solberg and two junior officers were awaiting the Commissioners' arrival. The technicalities of reactor design and operation were something Lilienthal could not pretend to understand. He was more interested in finding in the Hanford laboratories examples of nuclear research which would demonstrate to the layman the peaceful promise of atomic energy. Solberg, however, was in his element. He found Williams' briefing on the unsatisfactory conditions at Hanford "a rather sad story" of slow progress, administrative timidity, and security clearance difficulties. Solberg thought General Electric management at Hanford was still weak and he tended to agree with Parsons's reservations about building replacement reactors.[26]

Solberg was even more concerned about the slow progress on Redox. Even under the best circumstances successful development of the process on a production scale involved extraordinary difficulties. By comparison, the bismuth phosphate process used during the war to recover plutonium from the Hanford reactor slugs was a simple matter, depending upon the chemists' time-honored practice of dissolving materials and separating their components by precipitation. In contrast, Redox would use a relatively new technique called solvent extraction, employed up to that time only on a laboratory



BROOKHAVEN NATIONAL LABORATORY

RADIATION BIOLOGY AT BROOKHAVEN, 1948 / Arnold H. Sparrow prepares *Trillium* bulbs for irradiation.

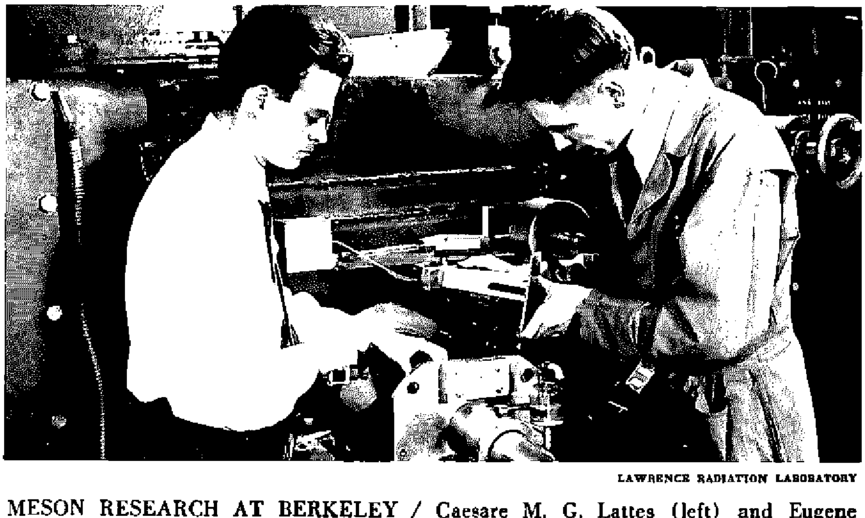


UNITED PRESS INTERNATIONAL

TRANSURANIUM RESEARCH / Glenn T. Seaborg and the elution apparatus used to separate newly created transuranium elements.

LAWRENCE RADIATION LABORATORY

THE 184-INCH CYCLOTRON BEGINS OPERATION / Robert L. Thornton, Ernest O. Lawrence, and Edwin M. McMillan (left to right), reading instruments at 12:15 A.M., November 1, 1946.



LAWRENCE RADIATION LABORATORY

MESON RESEARCH AT BERKELEY / Caesare M. G. Lattes (left) and Eugene Gardner place photoemulsion plates on the target probe of the 184-inch cyclotron in March, 1948, a few days after the first detection of mesons at the University of California Radiation Laboratory.

scale for difficult separations. Solvent extraction operated on the principle that two materials could be separated from each other by mixing them with two solvents which themselves were immiscible and which would each dissolve one of the materials and not the other. Separating the solvents therefore separated the materials. Experiments using packed columns for solvent extraction had proceeded during World War II on a laboratory scale. The columns consisted of small vertical glass tubes containing a bed of coarse solids. Counter-current flow of the solvents through the column containing a solution of materials from the fuel slugs facilitated mixture of the materials and selective extraction of the uranium as well as the plutonium in the irradiated slugs. Wartime research had revealed many difficulties in the process but had led to the conclusion that some organic solvent such as hexone would be most effective in solvent extraction.

There was no lack of activity on Redox in the Commission's laboratories. The remnants of Glenn T. Seaborg's wartime research group at Argonne were remodeling experimental equipment consisting of glass columns 1 inch in diameter. General Electric chemists at Hanford were planning to begin experiments with 3-inch columns, using a nonradioactive solution. The new General Electric laboratories at Schenectady planned to study the basic chemistry of the process, with emphasis on the chemical properties of hexone. Scientists at the Clinton Laboratories hoped to develop a process for extracting uranium 235 from the fuel used in the high-flux reactor. The Standard Oil Development Company was investigating an entirely different approach which would use small tanks fitted with mechanical mixing devices as a substitute for the packed columns. Research on the mixer-settler system suggested the possibility that all the work on packed columns might be abandoned.[27]

The lack of coordination alarmed Solberg. Each of the research groups seemed to be defining the problem in its own way. Neither General Electric nor the Commission seemed to have any general plans or goals; instead the approach seemed to be to let each group work on its own in the hope that something useful would turn up. Solberg found that only Williams had the practical engineering sense which led him to worry about such mundane problems as the specifications for commercially produced hexone and the reliability of pumps to be used in the production facilities. The trip did nothing but confirm Solberg's worst fears about Hanford. The result was a formal request from the Military Liaison Committee that the "diminishing expectation of rapid progress on the development of the Redox process" be the subject of the next joint meeting with the Commission, scheduled for September 24, 1947.[28]

In response to criticisms from Parsons and Solberg, Williams agreed to meet informally with the Military Liaison Committee on September 23 to discuss the difficulties at Hanford before the session with the Commission. Groves quickly took charge of the meeting and began directing his questions to Williams, who did not hesitate to speak up. When Groves asked why the

Commission had allowed Redox work to drift, Williams replied that Redox had drifted under Army direction and that only under Commission leadership had a clear course of action been plotted. Williams' plans to bring experienced engineering and construction contractors to Hanford and his expressions of confidence in the Commission's staff at Hanford did not impress Groves. The General observed that three years, the time Williams thought necessary to build a Redox plant, had been sufficient to complete the entire Manhattan project. Williams stuck to his guns. He claimed that the Redox project was at last off dead center and that the plan to build replacement reactors would guarantee production at Hanford.[29]

Lilienthal, returning from a speaking engagement in Indiana on Tuesday morning, hurried directly to his office from Union Station. A few minutes later in a Commission meeting Williams reported his stormy session with Groves. The briefing might help the Commissioners avoid trouble in the meeting that afternoon with the Military Liaison Committee, but for the moment all they could suggest was that Williams prepare a written report summarizing the encounter.[30]

Having already discussed the technical details with Williams, Groves could address his remarks to the policy issues in the meeting with the Commissioners on September 24. He observed that inefficient production methods developed under wartime pressures and adopted as a makeshift by the Commission suggested the wisdom of reducing weapon requirements to a minimum, at least until Redox and other processes could be devised to make better use of the dwindling stocks of uranium ore. It would be desirable, he said, to have ten times the existing number of weapons in stockpile, but the Commission would have to consider the price it would have to pay in terms of wasted raw materials if the existing plants were used to produce the necessary uranium 235 and plutonium. In Groves's opinion, the most pressing need was to get the Redox plant in operation. Because he had considered Redox ready for engineering development in the summer of 1946, he could not understand Williams's estimate that it would take three years to get the plant in operation. These factors had led him to suggest a special review committee under Warren K. Lewis of MIT to evaluate the Redox projects. More than once during World War II Groves had called for advice from a special Lewis committee in times of crisis.[31]

The Commission wanted to avoid any specific commitments until it had a better understanding of the situation. It would be months before the Commission staff would provide for an independent review of the Redox processes as Groves had suggested. But there was no question of the Commission's determination to increase production of fissionable materials and to find new sources of uranium ore. Since midsummer Wilson had been trying to strengthen the raw materials effort. He had appointed an advisory committee on raw materials to study the prospects for ore procurement and had accepted the committee's recommendation for the position of director of a new headquarters division of raw materials. At the same time research on Redox and construction of replacement reactors at Hanford would get top priority. At least on production planning the Commission and its military advisers were now moving in the same direction.[32]

STRENGTHENING PRODUCTION OPERATIONS

The indispensable role of the production plants at Oak Ridge and Hanford in the national defense effort explained the determination of Wilson and Williams to find exceptional men to direct operations at the two production sites. Months of careful recruiting had resulted in the appointment of Carleton Shugg as manager at Hanford and John C. Franklin as manager at Oak Ridge.

Shugg arrived at Hanford on Labor Day, 1947, ready for action. Wilson had told him to accomplish a multiple increase in plutonium production at Hanford within five years. In the wartime shipbuilding industry Shugg had earned the reputation of a hard-hitting expediter. It had never occurred to him that any job was really big enough to take five years, and he was determined to make every day count at Hanford. On the day he arrived, Shugg took the measure of Hanford leadership. On the Commission side, in David F. Shaw and William P. Cornelius, he found eager young men with construction experience who thought General Electric was not giving new construction sufficient priority. Many of the General Electric staff, especially those who had worked for du Pont, were more than competent in technical matters, but Shugg thought too many of them saw their future at Hanford as an idyll of quiet living rather than a challenging endeavor.

The next morning Shugg began the shock treatment. By asking for facts and figures on construction progress, he quickly demonstrated that General Electric was not following activities closely. On Wednesday he demanded immediate overtime work, beginning that very day, on a temporary building for construction design forces. He understood complaints that the demand was arbitrary and unreasonable, but he hoped it would bring home to General Electric that speed was imperative.

What many people at Hanford did not realize was that they were facing a construction project of monumental size. The biggest task would be to build new production reactors to replace the deteriorating wartime models. Equally urgent was the need for the Redox plant, which would rival in size the chemical separation buildings constructed during the war. There were also plans to build at Hanford a plant to purify plutonium as metal and fabricate it into weapon shapes.[33]

The Hanford project, involving as many as five reactors, promised to become the largest peacetime construction undertaking of the Federal Government, but the exact dimensions of the job were not yet fixed. The number of reactors to be built would depend upon whether the Commission decided to replace each of the existing reactors or simply to construct new and more efficient units. Construction of the Redox plant would certainly have to await the development of a feasible process. As for the plutonium fabrication facility, General Electric had scarcely begun to consider the design. Whatever the decisions in Washington, Shugg agreed with Williams that he should give first priority to housing, both in Richland for permanent residents and in the area north of the village for construction workers. In Richland the Jones-Atkinson Company had already started constructing 450 precut plywood homes and 500 permanent residences of concrete block. Shugg arranged to haul barracks by barge on the Columbia River from the former naval air station at Pasco, Washington, and from the wartime construction camp at Hanford. By

the end of September there was living space for more than 1,000 workers at the North Richland camp. The number of employees jumped during October from 3,000 to 5,000, an increase held down by the continuing shortage of barracks and mess halls.

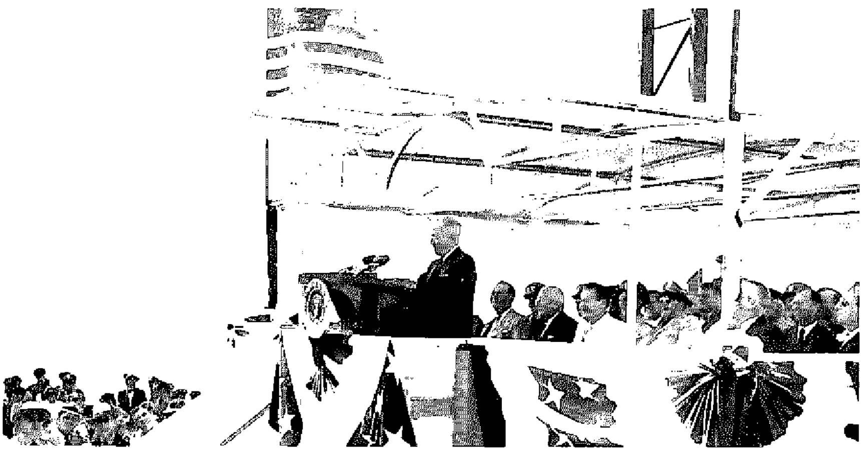
In the meantime, General Electric engineers were renovating the existing reactors, performing preventive maintenance, and improving operations. To forestall the effects of corrosion, maintenance teams replaced damaged equipment, including some of the long aluminum tubes in which the fuel elements were placed for irradiation. New types of fuel slugs were designed to withstand the effects of longer irradiation at higher power levels than had been attempted during the war. No one knew how much longer the reactors would continue to operate; but steady progress on renovation in the autumn of 1947 suggested, as the Military Liaison Committee contended, that the reactors would fail gradually, if at all, and not suddenly without warning.

Under the circumstances the Commission found it difficult to select the best plan for reactor construction. Williams had argued it would save both time and money to build replacement reactors near the existing units. But, as the Military Liaison Committee suggested, the replacement reactors without their own water cooling facilities would then have no value unless the original units failed. They would also be vulnerable to an operating accident or enemy air attack. When the Commission discussed the issue in Washington early in October, Williams persisted in his belief that the replacement reactors were necessary. In his estimation the overriding requirement to have at least one production reactor in operation at all times to provide short-lived polonium 210 for weapon initiators demanded construction of the replacement units. The Commission's decision was tentatively to build three replacement units and eventually two new production reactors, with the understanding that initially construction would begin on only one replacement reactor and one completely new facility to be known as "H." [34]

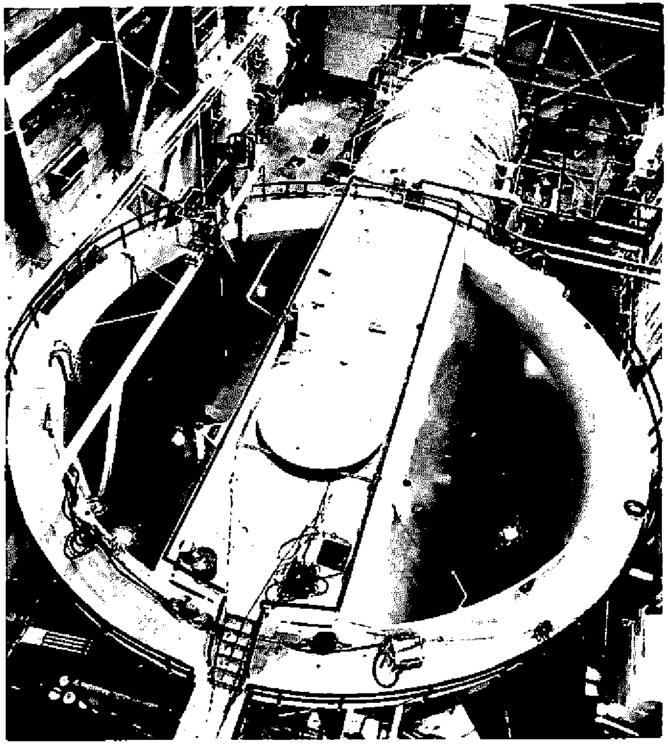
The pressures at Hanford left Shugg little time for the Redox project

KNOLLS ATOMIC POWER LABORATORY

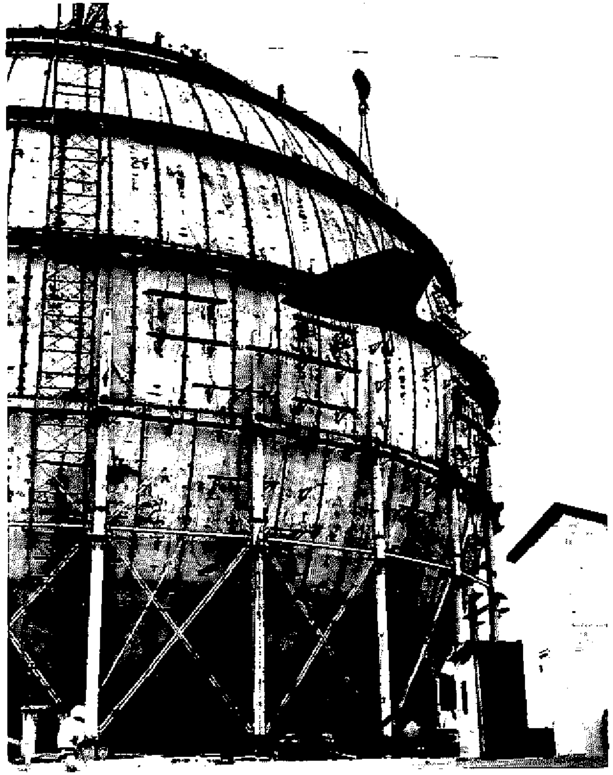
PLANNING THE DEVELOPMENT OF NUCLEAR-POWERED SHIPS / Captain Rickover with General Electric and Government officials in Schenectady, summer, 1946. Left to right: C. Guy Suits, John J. Rigley, Hyman G. Rickover, Leonard E. Johnston, and Harry A. Winne.



KEEL LAYING FOR THE WORLD'S FIRST NUCLEAR SUBMARINE / President Truman speaks at ceremonies at Groton, Connecticut, on June 14, 1952. Gordon Dean is in the first row on the far right.



SUBMARINE THERMAL REACTOR, MARK I, IDAHO / The land-based prototype as it appeared in 1954. The reactor is located within the portion of the submarine hull surrounded by water.



GENERAL ELECTRIC COMPANY

SUBMARINE INTERMEDIATE REACTOR, MARK A, WEST MILTON, NEW YORK / The huge sphere which would contain the prototype reactor nears completion early in 1953.

in the fall of 1947. Certainly there was little evidence that the various laboratories studying solvent extraction methods would concentrate on a practical Redox process without some firm leadership. Yet the Commission showed little enthusiasm for a high-powered committee which Groves had suggested to review the project or for assigning administrative responsibility to one Commission official, as Admiral Solberg advocated. For the remainder of 1947 Redox research at Argonne, Clinton, Schenectady, and Hanford followed independent courses. If anything, the Commission moved away from, rather than toward, consolidation of effort. The Standard Oil Development Company began experiments with mixer-settlers in solvent extraction, and the Kellex Corporation agreed to build both a small-scale pilot plant and the main plant, as well as train operating personnel. It was not yet clear how Kellex could accomplish its assignment until the fundamental process had been defined.[35]

By comparison Franklin faced a somewhat easier task at Oak Ridge. The gaseous-diffusion plants K-25 and K-27, completed at the end of the war, continued to perform with unexpected efficiency. Before the end of 1947 Carbide and Carbon began centralizing at Oak Ridge equipment for manufacturing the barrier tubes through which the uranium hexafluoride gas diffused in the isotope separation process. The only dark spot on the Oak Ridge production scene was continuing labor unrest, which reached a climax in December, 1947, in the threat of a strike during contract negotiations. Following the Commission's sudden decision to transfer the operating contract for the Clinton Laboratories to Carbide, Franklin had more problems than he could handle at the laboratory, but he could take comfort in the ever-increasing production at K-25.[36]

RAW MATERIALS

Ultimately the production chain led back to the source of raw materials. This was the domain of John K. Gustafson, the distinguished mining engineer and executive who became the first director of raw materials in the fall of 1947. Once he had obtained an emergency security clearance and reviewed the records of the raw material effort in Wilbur E. Kelley's New York office, Gustafson knew he had a challenging task. It shocked him to discover that the nation's huge investment in atomic energy, now approaching $5 billion, rested on the production of uranium ore from one mine deep in the Belgian Congo and another small source in the sub-Arctic regions of Canada. The richer veins of the Shinkolobwe mine were already exhausted. To keep operations going at lower levels, the operators had to pump out as much as thirty thousand gallons of water per day. The Canadian mine near Great Bear Lake was at best a small source and was subject to the handicaps of seasonal operation.

Gustafson knew he could not do much to increase foreign ore receipts immediately. Congo procurement fell in the province of the Combined Development Trust, established during World War II to allocate production between the United States, the United Kingdom, and Canada. In September, 1947, Wilson found occasion during a visit to the United States by Belgian officials for an informal discussion of the Commission's ore needs on the one hand and Belgian interest in peacetime nuclear technology on the other. Until the Commissioners and the State Department could resolve some of the uncertainties in the delicate relationships with the British as well as the Belgians, Gustafson could not hope to increase Congo receipts. In the spring of 1947 there had been some interest in extracting uranium as a byproduct from gold mining operations in South Africa. Mining engineers sent to South Africa reported to the Commission that uranium ore extraction was technically feasible. Again diplomatic considerations required a cautious approach and the State Department had recommended no direct overtures until General Jan Christian Smuts returned home from his visit to London for Princess Elizabeth's wedding in November, 1947.[37]

Even on the domestic scene Gustafson found arguments for caution. General Groves told Gustafson it had been his policy to exploit foreign sources and thereby conserve what little domestic ore might exist in the United States. During World War II the Manhattan District had obtained relatively small quantities of uranium concentrates produced in vanadium mills on the Colorado Plateau, but these operations had ended with the war effort. Gustafson was not even certain the Commission could grant contracts for domestic exploration and procurement. He could read the strong language of Section 5b(5) of the Atomic Energy Act as Congressional intent that only Government agencies such as the Geological Survey and the Bureau of Mines should produce such highly strategic materials.

More persuasive than these admonitions was Gustafson's conviction that domestic ore production was imperative. He saw no other way to maintain the flow of uranium through the gaseous-diffusion plants at Oak Ridge and the Hanford reactors. Neither was there much hope for domestic source development by Government agencies alone. Because there were no proven uranium ore reserves in the United States, exploration would be the first task. To supplement exploratory work by the Bureau of Mines, Gustafson and his assistants laid plans for public announcement of incentives for exploration and production. At best it would be several years before the incentives would affect deliveries to the Commission's production facilities.

In the meantime Gustafson's staff set about providing the mills necessary to process ore mined on the Colorado Plateau. The Commission purchased an excess mill at Monticello, Utah, from the War Assets Administration and a vanadium plant at Durango, Colorado, from the United States Vanadium Corporation. Steps were also taken to reactivate the Colorado mills at Naturita, Uravan, and Rifle. To assure successful extraction of uranium from the low-grade ores of the plateau, Gustafson negotiated a contract with the Dow Chemical Company to supplement research already in progress at the Massachusetts Institute of Technology and the Battelle Memorial Institute in Columbus, Ohio. Gustafson hoped that announcement of incentives in the spring of 1948 would start the flow of domestic ore to the Commission's processing mills.[38] The production chain still had some weak links, but with some patience and work Williams and Gustafson expected to meet reasonable requirements for weapon production.

TROUBLE IN EUROPE

As President Truman entered the House Chamber on November 17, 1947, the ugly steel girders overhead could not have escaped his notice. Installed during World War II to support the sagging roof and skylight, the huge beams traversing the chamber were designed to hold the structure in place until the return of peace made reconstruction possible. Now more than two years after the end of the war, the beams still scarred the architecture of the chamber as a nagging reminder that the pursuit of peace so far had been a failure.

In opening this special session of Congress, the President used some plain and sober words to describe the events which had postponed the advent of world peace and national prosperity. In the spring of 1947 he had called for emergency measures to bolster Greece and Turkey against communist subversion. He admitted that the massive transfusion of money and resources had not restored the two allies to health, but it had at least prevented their death from the communist infection. The President's opening words sounded the alarm: "the future of the free nations of Europe hangs in the balance. The future of our own economy is in jeopardy." Still struggling to reestablish economic and political stability after the ravages of the war, western Europe faced another winter of cold and hunger, a prospect which swelled the ranks of communist rioters. For France, Austria, and Italy, the President needed $597 million to keep the three nations alive until spring. The burden on the United States would be heavy. Despite increased farm and industrial production, severe shortages in food, fuel, and housing threatened a bleak winter even for Americans. The growing demand for scarce commodities had pushed fuel prices up 13 per cent, clothing up 19 per cent, and retail food up 40 per cent in one year. New requirements for European recovery in Truman's estimation called for controls over prices and wages as well as rationing of consumer goods.[39]

Equally alarming in the week before Thanksgiving, 1947, was the hostility which punctuated debate in the United Nations. The hardening position of the Soviet Union destroyed hopes for agreement on such important issues as the international control of atomic energy and threatened the very existence of the organization itself. In a speech before the Woodrow Wilson Foundation in New York on November 10, Bernard M. Baruch pleaded for a new effort to save the United Nations. The next morning General Eisenhower, the Army Chief of Staff, made a similar appeal in his testimony before the President's Air Policy Commission in Washington. The commission, appointed during the summer under the chairmanship of Thomas K. Finletter, had already completed two months of intensive hearings, which gave representatives of the aircraft industry, the commercial airlines, and transportation associations an opportunity to describe the stagnation and decay which afflicted civilian aviation in the United States.[40]

Eisenhower's testimony on Armistice Day marked the beginning of two weeks of hearings on military aviation. The highlight of the testimony came on the day of the President's special message to Congress. General Carl A. Spaatz, the Air Force Chief of Staff, declared that until the United Nations became an effective agency of world peace, the United States had no choice but to maintain adequate defense against aggression. To Spaatz "the barest minimum necessary for our security" was an Air Force of 70 combat groups reinforced by 22 separate and specialized squadrons. The 70-group force would require almost 7,000 ready aircraft with more than 8,000 in reserve, about 400,000 military personnel, and 150,000 civilians. With its 1948 appropriations the Air Force could not hope to maintain more than 55 combat groups and might have to cut back to 40 if Congress accepted the Administration's 1949 budget.

General Spaatz's remarks were of special interest to John A. McCone, a West Coast industrialist, whose companies had built ships and aircraft during World War II. As a member of the Finletter commission, McCone concentrated on the military aspects of aviation. At the Air Force's request the Atomic Energy Commission had authorized Admiral Parsons to brief McCone on the Commission's activities. Thus Finletter's group was assured the latest information on nuclear weapons even though the subject could not be discussed in public hearings.[41]

How much the military services could rely on nuclear weapons in an emergency was still far from certain. Much to the dissatisfaction of the military, the Commission still retained complete custody of every atomic weapon. Not until November 14, 1947, did Lilienthal receive from General Brereton a formal recommendation from the Military Liaison Committee that "all weapons now in stockpile and completed weapons and parts thereof, when ready for stockpiling, be delivered to the Armed Forces at the earliest practicable date." Lilienthal's immediate reaction was that Commission custody rested on an executive order and that the issue involved policy decisions by the President and not by the Commission or the Secretary of Defense. Wilson raised the more practical question of whether it was technically feasible to transfer the stockpile to the military. This was something General McCormack would have to study.[42]

Admiral Solberg raised the subject of custody the following week in a meeting with the Commission. Lilienthal was not prepared to debate the issue, but he was willing to discuss it informally. The argument, he said, seemed to be that the military could not rely on nuclear weapons unless military personnel had had experience in handling, storing, and maintaining them. Lilienthal chose to find this contention perplexing in view of the difficulties the armed services had experienced in obtaining weapon information from the Manhattan District immediately after World War II. Because Groves was not present Lilienthal was perhaps indulging in a facetious remark, but he did succeed in conveying to the military officers a lack of enthusiasm for the proposal.

The Commission had its own complaints about existing relationships with the military at Sandia. Strauss had just told the Commission that the Eighth Air Force and the Armed Forces Special Weapons Project in a few days would conduct a training maneuver involving atomic weapons. Only by chance had Strauss learned of the plans; there had been no opportunity to designate Commission observers. Lilienthal was willing to accept the explanation that the failure to notify the Commission was an oversight, but he let Solberg know that the Commission expected closer liaison in the future.[43]

The Commission was in no hurry to reach a decision on custody and had no intention of acting before the staff had studied the subject thoroughly. As often happened on weapon matters, the request for a study moved down the chain of command from the Commission through McCormack and Tyler to Bradbury at Los Alamos. Bradbury never hesitated to speak plainly. He reminded Tyler that the weapons in the stockpile were still more laboratory devices than production models. Assembly and testing still required scientists with laboratory instruments more than technicians with check lists. The existing models had been developed during the war and were marginal in engineering design. The new Mark 4 weapon, which was intended to be a production model, would remain a question mark until the forthcoming test at Eniwetok was completed. Bradbury doubted the armed forces had the kind of talent required to maintain the stockpile in a ready state, and he disagreed with the argument that preparedness required actual custody. Adequate training with dummy components was one thing, custody of active material something else. Bradbury also found disturbing the laboratory's unstable relations with the Armed Forces Special Weapons Project. He distrusted the obsession with secrecy that pervaded the project, and he bridled at the assumption that the Commission was merely a service and procurement organization for an operation the military intended to control.[44]

Perhaps one reason for the Commission's unhurried approach to the custody question was the possibility that General Groves might soon be replaced either as a member of the Military Liaison Committee or as commander of the special weapons project. His reassignment would remove from the scene one of the most forceful advocates of military custody. Lilienthal learned on December 1 that Secretary Royall had been discussing Groves's future with General Eisenhower. There was some thought in the Pentagon of replacing him as a member of the Military Liaison Committee. Lilienthal suggested that Groves might better be relieved of the special weapons command. In any event, the future of the special weapons project seemed uncertain. Early in January, 1948, Charles F. Brown of Forrestal's staff recommended abolishing both the Commission's division of military application and the Armed Forces Special Weapons Project, their functions to be transferred to a more powerful Military Liaison Committee and to the individual services.[45]

On January 16, 1948, Vannevar Bush, James B. Conant, and Oppenheimer spent four hours discussing the situation with Forrestal and Royall. Oppenheimer later wrote Lilienthal that he had a strong impression that Forrestal would take some action. Lilienthal knew it would be a delicate matter to relieve a man of Groves's stature and ability from activities in which he had played a dominant role, but Lilienthal was convinced that some kind of a change would be desirable. While waiting for Forrestal to act, the Commission learned on February 2 that General Groves planned to retire from the Army on February 29 to enter private business.[46]

Whether Groves's departure would actually make it easier to settle the question of custody remained to be seen. Anything the Commission and the military services might do further to unite their efforts in building a stockpile of nuclear weapons would be welcome. Certainly international developments had enhanced the value of a nuclear arsenal. After the collapse of the London foreign ministers' conference in December, 1947, the Truman Administration had prepared for trouble in Europe. Congress passed an interim foreign aid bill to assist Austria, France, and Italy. The President early in January requested a staggering total of $8.6 billion to finance European recovery for fifteen months. Reports were coming from Berlin that the Soviet Union intended to force the Allies from the city. Finletter's Air Policy Commission released a hard-hitting report supporting the Air Force's seventy-combat-group plan on the assumption that the United States should be prepared for a full-scale air attack by the Soviet Union, presumably with nuclear weapons, by January, 1953. A theoretical monopoly of the atomic bomb could not much longer serve as the rationale for miserly defense budgets providing military forces structured on World War II technology.[47]

The Commission had succeeded in large measure in putting its own house in order since the summer of 1947. New efforts to procure uranium ore and improvements in the chain of production plants would assure a larger supply of fissionable materials in the years ahead. Los Alamos and Sandia had taken on new life, and new weapon designs were ready for testing in the Pacific. New leadership in the Armed Forces Special Weapons Project and the Military Liaison Committee might strengthen ties with the military services. Now if the Commission could settle the troublesome question of weapon custody and if the weapon tests scheduled for early 1948 proved successful, the United States might soon have an impressive arsenal of nuclear weapons. With the armed services, the Commission was responding to the President's call to arms.

NUCLEAR ARSENAL

CHAPTER 6

By February, 1948, both the Commission and the military services had good reason to believe that the nation could have a significant stockpile of atomic weapons within a matter of months. The growing threat of communist aggression in Europe and the Middle East suggested that the nuclear arsenal would come none too soon. The accomplishments of 1947, however, had not removed all the uncertainties still lurking on the horizon. No one could be sure that the spring tests at Eniwetok would fulfill the hopes of the Los Alamos scientists. Even if the tests proved successful, it would be difficult to translate the technical achievements into usable weapons unless the military establishment could unite its own forces and strengthen its ties with the Commission. New leadership in the Military Liaison Committee and the Armed Forces Special Weapons Project would help. Perhaps it would then be possible to settle the question of custody, to formulate new requirements after the Pacific tests, and to accelerate the production of fissionable materials and weapons. These concerns would preoccupy the Commission until the summer of 1949.

CHANGE IN COMMAND

The worsening international situation in the first week of 1948 gave the Military Liaison Committee cause for anxiety over the question of custody. As yet there had been no reply to the committee's letter of November 12, 1947, recommending transfer of the weapon stockpile to the military as soon as practicable. At the committee's regular meeting with the Commission on February 4, 1948, Pike said the Commission staff had prepared a technical study which the General Advisory Committee would consider during the coming weekend. He did not add that the same meeting would bring Robert Oppenheimer and James B. Conant to Washington and facilitate discussions with Vannevar Bush, and possibly with James V. Forrestal, concerning better relations between the Commission and the armed forces.[1]

Wilson and his staff had their study of custody ready when the General Advisory Committee convened in Washington on Friday, February 6. The report listed the military's arguments for transfer as the staff understood them. Fundamental was the contention that all weapons, including atomic bombs, should be available to the armed forces for instant use. The divided responsibility between the Commission and the military in the existing organization at Sandia invited confusion in an emergency. Furthermore, the ability to transfer military personnel anywhere on short notice promised greater flexibility in operation than the Commission could attain. Whatever the validity of these claims, Wilson and his staff found certain technical difficulties in immediate transfer of the stockpile. Their report followed closely the arguments Norris E. Bradbury had advanced in his letter to Carroll L. Tyler in November. Wilson concluded that the Commission should for the present retain custody of weapons and weapon parts but should reconsider the question sometime early in 1949. Both Isidor I. Rabi and Conant supported Wilson's study, and the committee voted unanimously to include a statement on custody in its report to the Commission. Just how and when these views would reach the Military Liaison Committee was something for the Commission to decide.[2]

Over the weekend the Commissioners first learned of the candidates the Department of Defense was considering as a civilian replacement for General Lewis H. Brereton as chairman of the Military Liaison Committee. Strauss was pleased to hear the name of Donald F. Carpenter, a vice-president of the Remington Arms Company, whom he had induced to serve on the Commission's Industrial Advisory Group. The second candidate was William Webster, a New England utilities executive and friend of Carroll Wilson.

Carpenter came to Washington that same week for a meeting of the industry group, and Bush over lunch at the Cosmos Club sounded him out about accepting the chairmanship of the Military Liaison Committee. Carpenter, who had been hypersensitive to the "merchants of death" label since he had joined the du Pont organization as a young man, expressed little enthusiasm. On Saturday evening, when the Commissioners joined the General Advisory Committee and the industry group for dinner at the Carleton Hotel, Carpenter's candidacy seemed to be common knowledge and more than one of the dinner guests urged him to accept. Strauss was particularly interested in Carpenter. By taking over as chairman of the Military Liaison Committee and as Forrestal's deputy on atomic energy matters, Carpenter could end the crippling hostilities between the Commission and the military and at long last weld the two organizations into an effective team for building the nuclear stockpile which each day was becoming more critical to national security.

Carpenter would need time to make up his mind, but Strauss thought he was more than half convinced.

There had already been talk of a successor to Groves as head of the Armed Forces Special Weapons Project. General Kenneth D. Nichols seemed the logical choice, but Strauss urged Forrestal to delay any decision on Nichols to avoid presenting Carpenter with a *fait accompli*.[3]

The prospects of reorganization of atomic energy activities in the military establishment revived Commission consideration of the custody issue. Wilson told the Commissioners on February 18 that the General Advisory Committee had agreed that there were objections on technical grounds to transferring the stockpile to the military services, but he hastened to add that policy considerations were probably more important. In other words, despite the transfer provision of the Atomic Energy Act giving the President control of atomic weapons, Wilson, like Lilienthal, still clung to the conviction that the future of civilian control of the atomic energy program somehow hung on the matter of civilian custody of the stockpile.

General James McCormack, always looking at the practical side, was uneasy about drawing too sharp a distinction between the technical competence of the scientists and the military assembly teams at Sandia. In the interest of harmony he suggested the Commission forego the temptation to embarrass General Groves over deficiencies in the new weapon storage sites then under construction. The Commissioners decided they should concentrate on the policy issues of transfer while McCormack and his staff would do all they could to advance the time when transfer of custody would be technically feasible.[4]

Later that afternoon, when the Commissioners met with the Military Liaison Committee, McCormack went out of his way to describe the progress in this direction at Sandia since Paul J. Larsen had taken over as permanent director. The best way to develop technical competence in military personnel was to assign more military men to Sandia. Admiral William S. Parsons agreed. He appreciated the dangers of permitting technicians to check the reliability of weapon components without any understanding of their operation, but he thought it was time to dispel the belief that only an Einstein could assemble or test an atomic weapon. He recalled the exceptional capabilities of many naval technicians during World War II. However the custody issue was resolved, Parsons saw a system of joint inspection by military and civilian personnel as the best guarantee of weapon reliability.[5]

Meanwhile Forrestal was trying to induce Carpenter to accept the liaison chairmanship. In a telephone conversation on February 17, Carpenter told Forrestal he could not be away from his job at Remington Arms for more than six months. This limitation did not seem to diminish the Secretary's interest in Carpenter's services. William Webster, the other leading candidate for the job, would not be able to begin work for at least that long. Perhaps the two of them could serve successive terms. The following week Forrestal brought additional pressure on Carpenter by calling Crawford H. Greenewalt, the president of du Pont. Greenewalt did not see how Carpenter could accomplish anything in six months, particularly in view of the problems he would face in bringing harmony to Commission-military relations. Forrestal admitted the assignment was tough, but he insisted Carpenter's services were imperative. The main difficulty, Forrestal thought, was the Commission form of organization provided by the Atomic Energy Act. He had long believed that an effective atomic energy program required the leadership of one man of exceptional ability. Perhaps eventually it would be possible to amend the Act, but in the meantime he needed to establish in one man of Carpenter's caliber the responsibilities which would assure steady progress in building a nuclear weapon stockpile.[6]

Forrestal's remarks made clear that he intended the reorganization of the Military Liaison Committee to be a first step in unification of the armed forces. A civilian chairman of the committee would quell interservice rivalry and incidentally might ease the Commission's concern about "civilian control" of the atomic energy program. At a meeting with the three service secretaries on February 25, Forrestal explained the new charter for the committee. It would consist of a civilian chairman, presumably Carpenter, and two members appointed by each of the service secretaries with Forrestal's concurrence. Forrestal said he expected the Military Liaison Committee to function generally on the level of the Joint Chiefs of Staff and the Research and Development Board, by exercising broad powers over all atomic energy activities of the National Military Establishment.[7]

Forrestal still had to convince Carpenter to take the job. As often happened, the final argument was an appeal to patriotism. The last week in February Forrestal sent Colonel John H. Hinds, a member of the Military Liaison Committee, to Wilmington, Delaware, where he met Carpenter secretly and related to him confidential information about the alarming military situation in Germany and eastern Europe. The newspapers were full of reports of a government crisis in Czechoslovakia and by the end of the week it was clear that Klement Gottwald had destroyed the last vestiges of democracy and established a communist dictatorship.[8] The implication of Hinds's message was that Carpenter could help his country by strengthening the nation's nuclear arm. Relenting, he agreed to go to Washington the following weekend. If he could assure himself that he had the support of the service secretaries and the Atomic Energy Commissioners, he would take the job.

On Friday evening, March 5, Carpenter waited in Secretary Kenneth C. Royall's office in the Pentagon as Forrestal, W. Stuart Symington, and John L. Sullivan arrived; Lilienthal and General Nichols, who was to be Groves's successor as head of the Armed Forces Special Weapons Project, joined the group. The dinner conversation ranged over a variety of subjects, including the President's civil rights program, but this provided only momentary diversion from the tension created by the news from Europe. In a cable from Berlin, General Lucius D. Clay reported "a subtle change in Soviet attitude, which I cannot define," but which gave him the feeling that war might come with dramatic suddenness. The reorganization of the Military Liaison Committee and the Armed Forces Special Weapons Project was coming none too soon. Constructive cooperation would have to replace the suspicions and recriminations which had crippled relations between the Commissioners and the Military Liaison Committee. The scientists and the military technicians at Sandia would have to come closer together to create a reliable weapon stockpile and to see that nuclear weapons were ready for instant use anywhere in the world. The discussion convinced Carpenter that he had a job to do. He would return to Washington by April 1 to take up his new assignment.[9]

It had been just a year since President Truman had sounded the alarm to avert communist aggression in the Middle East. As the Soviet Union consolidated its position in eastern Europe and threatened to extend its influence westward, Truman had called upon Congress for successively larger appropriations to rebuild western Europe and strengthen the nation's military defenses. Arthur H. Vandenberg, the Republican champion of the bipartisan foreign policy, had brought the Senate to its feet on March 1, when he supported the European Recovery Program as an undisguised counteroffensive against the march of communism. On March 11 the news of Jan Masaryk's alleged suicide brought home to Americans the tragic finality of events in Czechoslovakia. The same day Secretary Forrestal announced that he would meet with the Joint Chiefs of Staff over the weekend at Key West, Florida, to find ways of accomplishing the unification of the armed forces contemplated by the National Security Act of 1947.

That morning Truman called Lilienthal, Royall, and Nichols to his office without telling them in advance what he had in mind. The President was grim and emphatic. He had before him the papers for Nichols's appointment as head of the Armed Forces Special Weapons Project. He knew that Nichols and Lilienthal had differing philosophies on custody of nuclear weapons, but he would not tolerate the kind of squabbling that had prevailed in 1947. The two men would have to learn to work together. Both assured the President they were on the same team. Truman was already preparing a special message to Congress requesting legislation to establish universal military training. He expected the armed services and the Commission to respond to the emergency.[10]

PARTNERS IN ARMS?

For Lilienthal the key point in the President's remarks on March 11 had been his stress on civilian control of atomic energy. Nichols, however, left the

White House with the impression that Truman was above all interested in close cooperation between the Commission and the military. In Nichols's mind this meant just one thing: transfer of the nuclear stockpile to military custody. Others in the Pentagon shared Nichols's determination as the March crisis grew more tense. The three service secretaries joined forces after the Key West conference to ask Forrestal formally to take the question to the President. The Joint Chiefs of Staff added their support a week later. The Commission, however, was in no mood to press the issue. Strauss and Bacher told Forrestal on March 18 that transfer still presented many technical difficulties; they thought it was mainly a policy issue which the President would have to decide. In the meantime, the Commission would try to speed up the training of military assembly teams.[11]

However reassuring the Commissioners tried to sound, the growing crisis in Europe undermined their efforts to keep the discussion of custody on the policy level. A sharp exchange between General Clay and the Soviet representative on March 20 marked the end of the Allied Control Council. On March 31 Soviet authorities ordered inspection of all military trains moving from West Germany to Berlin. Nichols told a special meeting of the Military Liaison Committee with the Commission on April 1 that the situation in Berlin might well lead to war. He had already discussed with McCormack plans to speed up the movement of nuclear weapons to the new storage sites, where they would be less susceptible to destruction by a single enemy air attack or by sabotage. He was reviewing emergency procedures for transferring weapons and suggested recalling civilians who had been on weapon assembly teams during World War II.

Strauss warned Forrestal against permitting all of the weapon assembly teams to go to Eniwetok for the forthcoming *Sandstone* weapon test series. Strauss feared that a sneak attack on the small Navy task force in the Eniwetok lagoon might cripple or even destroy the nation's capability of assembling its nuclear weapons. Although Strauss's fears proved to be groundless, they showed the tension gripping those present. For a few minutes there was even talk of postponing the *Sandstone* tests to preserve the meager weapon stockpile and bringing the assembly teams back to the United States, where they would be ready for an emergency in Europe. Nichols was inclined to go ahead with the first test, but he thought it might be necessary to cancel the second and third shots if the European situation deteriorated further.[12]

The most critical task was to check the emergency transfer procedures at Sandia. After the Military Liaison Committee left, Wilson arrived for a regular Commission meeting. A few minutes' informal discussion convinced Wilson that he and McCormack should leave at once for Albuquerque and Los Alamos. Canceling a speaking engagement in Vermont, Wilson boarded an Army plane with McCormack the following morning. The first order of business at Sandia on April 4 was to find ways to speed up the joint inspection of equipment for the armed forces. Tyler, Larsen, and Bradbury were all helpful, and General Robert M. Montague agreed to press for completion of assembly facilities at appropriate air fields. Wilson spent the rest of the week with Montague on plans for the actual delivery of nuclear weapons to the armed forces in an emergency.

Wilson returned to Washington on April 12 fully convinced that there would be "absolutely no delay" in an emergency transfer. He told Carpenter, who was now on the job in Washington, that the Armed Forces Special Weapons Project had given him excellent cooperation and there was virtually perfect coordination between the two organizations. Much of the improvement in relations he attributed to General Nichols. The question of custody was another matter, but Wilson believed he had solved any remaining difficulties in emergency transfer.[13]

Carpenter had spent his first weeks in office trying to reorganize the Military Liaison Committee. He wished first of all to make certain that the organization would be a vehicle for unifying the efforts of the armed forces on atomic energy affairs, and that meant it had to have some authority worth unifying. In addition to making sure that competent officers were assigned, he insisted that each of the members have full authority to speak for his own service. Carpenter had no intention of letting the committee continue to function as a debating society for protagonists of the services. As another step toward unification he insisted that each member of the committee be fully responsible for one phase of the atomic energy program in the National Military Establishment, without regard to service distinctions. Initially the services found it difficult to accept either of these reforms, but Carpenter expected that in time he would be able to convince them that they could trust each other and work together.

Carpenter's interest in reorganization went far beyond the need to put his own house in order. There was also the important question of how the Military Liaison Committee would operate within the National Military Establishment. In the midst of an international crisis, the armed services were still struggling with the reorganization necessary to accomplish unification under the Secretary of Defense. Carpenter saw that the effectiveness of the committee would in large measure determine its role in the new establishment. Symington, with Generals Carl A. Spaatz and Hoyt S. Vandenberg, told Carpenter on April 10 that they thought the Armed Forces Special Weapons Project should report for operational purposes to the Chief of Staff of the Air Force. The best defense against this proposal would be a strong Military Liaison Committee setting policy for a rejuvenated organizaton at Sandia under Nichols's direction.[14]

Carpenter explained some of these considerations when he met with Lilienthal and Wilson on the day the general manager returned from Los Alamos. Another aspect of a more efficient Military Liaison Committee was better relations with the Commission. This Carpenter hoped to accomplish, first, by serving personally as a conciliator between the military and the

Commission and, second, by making clear to both sides their common objectives in developing the nation's nuclear arm. Carpenter was not certain that existing channels were providing the Commissioners and general manager with a true picture of field activities. He proposed to establish a review committee of outstanding scientists and engineers, acceptable to both sides, who would visit the laboratories and draft a set of long-range objectives toward which both the Commission and the military could work as a team. To head the panel Carpenter was calling on Oppenheimer, who already had extensive experience in preparing reports of this nature.

Carpenter's tact at the April 12 meeting was a model of the conciliatory approach he intended to bring to relations with the Commission. He told Lilienthal that the custody issue had a high priority in the Pentagon. He did not think the Commission could postpone a decision indefinitely. He listened patiently as Wilson waxed enthusiastic about the improved situation at Sandia and reiterated the Commission's reluctance to transfer the weapon stockpile to the military until the technical difficulties had been resolved. Carpenter seemed to appreciate the Commission's position even if he did not agree with it, and he suggested the Commissioners join the Military Liaison Committee in a trip to Sandia for a firsthand look at the problems of transfer. All agreed that any proposal to the President should be made jointly. Lilienthal was pleased that for once a meeting with the military had ended on a note of harmony, if not agreement. He told Forrestal on the telephone about Wilson's enthusiastic report from Sandia and assured the secretary that Carpenter had been an excellent choice as head of the Military Liaison Committee. When Carpenter reported to Forrestal, he mentioned his suggestion of a meeting at Sandia as a possible avenue for resolving the custody dispute. Forrestal liked the idea. Perhaps when the *Sandstone* test series was completed, a decision on custody would at last be possible.[15]

SANDSTONE

On March 16, 1948, four United States naval vessels dropped their destroyer escort in the central Pacific and slipped into the quiet emerald waters surrounded by Eniwetok Atoll. Once inside the ring of coral reefs three of the ships proceeded to the island of Eniwetok and dropped anchor off its western shore. The command ship U.S.S. *Mt. McKinley,* its masts bristling with antenna arrays, carried General John E. Hull, the commander of Joint Task Force 7, who surveyed the harbor dotted with cargo ships and boats. Ashore, temporary supply buildings, tent camps, and mess halls obscured the remaining buildings of the World War II base; the airfield, refurbished and enlarged, buzzed with small aircraft and C-54 cargo planes from Kwajalein.

Lying at anchor near the *Mt. McKinley* was a converted seaplane tender, the U.S.S. *Curtiss,* which the Navy had equipped with special facilities for storing and assembling the components of nuclear weapons. The *Curtiss* also served as headquarters for Captain James S. Russell, the test director, and Darol K. Froman, the scientific director of Operation *Sandstone*. The third ship in the task force was the escort carrier *Bairoko*, which Russell had commanded before he left sea duty to join the Commission as McCormack's deputy. The *Bairoko* housed the scientists in charge of radiological safety for the tests and provided a base for helicopter operations. The fourth ship in the convoy, the seaplane tender *Albemarle*, had continued northward across the lagoon with one destroyer and had dropped anchor off the island of Engebi near the northern end of the island chain. The *Albemarle* had been hastily refitted at Norfolk early in 1948 to provide laboratories for the Los Alamos scientists who would collect and analyze the mass of data produced in the test shots. In February the *Albemarle* had joined the *Curtiss* at Terminal Island, near San Pedro, California, where the weapon components and other test equipment had been loaded before the ships proceeded to Hawaii and Eniwetok.[16]

From the deck of the *Albermarle* the scientists could see the 200-foot steel tower rising above the island, now denuded of vegetation and bulldozed into a flat table a few feet above the sea. An inspection of Engebi revealed the impressive achievements of the Army engineers, Navy teams, and private contractor forces in completing the elaborate test facilities in little more than ten weeks. The zero tower rising above an asphalt apron 600 feet in diameter was nearly ready to receive the test device. Little more than a half mile away was a sturdy, reinforced concrete building which would house the electronic equipment for measurement of phenomena from the test detonation. Similar concrete structures at various distances from the tower were ready for installation of equipment to measure blast and radiation. Between the tower, instrument buildings, and the central control post, men of the special engineer battalion were laying miles of submarine cable. Five miles southeast along the coral rim of the atoll stood a second zero tower and a much shorter Navy radar tower which had been modified to house photographic equipment. Still farther south on the northwestern tip of the island of Runit was another set of towers which had been prepared for the third shot in the test series. Ten miles farther south were Parry Island, where the main control center for the test was located, and the main island of Eniwetok.

Within a few days Hull had inspected all the facilities on the several islands. Froman cabled McCormack in Washington that the General seemed completely satisfied with construction progress at Eniwetok. He was especially pleased with the work of the Army engineers under Brigadier General David A. D. Ogden. Poor communications had hampered operations to some extent, but most of the work was on schedule. Unloading of test instruments and equipment began soon after the task force anchored, and technicians began setting up the elaborate arrays of test instruments, recorders, and interconnecting cables. Froman thought morale was high within the test group despite the unnerving effects of a submarine alert the second night in port and disturbing news reports from Berlin.[17]

As the April 15 target date for the first shot approached, there was a last-minute flurry in Washington about public announcement of the event. The military services opposed any announcement until the entire test series was completed, and General Hull agreed that delaying announcement would make his task easier. The Commissioners, however, were convinced that news of the detonation would quickly leak through observers returning from the first shot or would be detected in some fashion by Soviet vessels skirting the outer perimeter of the Marshall Islands. At the last minute Carpenter worked out an agreement which provided for public announcement only after a delay sufficient to thwart Soviet attempts to pick up airborne samples of the radioactive cloud.[18]

By this time Froman had completed all but the last-minute checks of the test sequence. The assembly team aboard the *Curtiss* completed a dummy weapon, which was placed on a trailer and lowered overside into a tank landing craft. Once ashore, the trailer was hauled to the zero tower, where the dummy weapon was hoisted to the cab at the top and the firing circuits were attached. To test the firing circuits and to align the cameras, a bank of photoflash lamps was installed on the tower. The firing sequence proceeded smoothly and Froman felt certain they were ready for the real thing.

On the afternoon of April 14 the firing party went ashore on Engebi for the final check. The task force had already moved south across the lagoon to the control point at Parry Island. Checking hourly by radio with Russell and Froman at Parry, the firing party tested the circuits on the zero tower and instrument stations through the night. In the early morning hours of April 15 they left the island for the last time and sped away across the lagoon by aircraft rescue boat to the Parry control point. By this time General Hull had a final weather report and had determined that all personnel were out of the danger area. At minus one hour Alvin C. Graves manually gave the timing signal for starting the blast measurement equipment. Soon the first of eight B-17 drone aircraft began to take off from Eniwetok. Equipped with special filters the planes would circle the zero tower at various altitudes to pick up radioactive samples as they passed through the cloud. Fifteen minutes before zero Captain Russell obtained permission from General Hull to fire, and Graves started the sequence timer. At minus two minutes came the familiar command to adjust protective goggles or turn away from the zero point. At the ten-second signal the flood lights at the base of the zero tower went out, leaving only the red light at the top of the tower to be engulfed by the huge ball of fire which illuminated the entire atoll and was visible as far away as Kwajalein.

Within four minutes helicopters were in the air, heading for Engebi. Jumping from the helicopters on the southeastern tip of the island, technicians in protective clothing started a winch that reeled in a cable of samples from near the zero tower. By this time a landing craft had set off for Engebi from Eniwetok to operate by remote control a military tank on the island. The tank, stripped of excessive armor and equipped with a special scoop, was designed to collect samples of surface earth from various parts of the test island. Meanwhile the drone planes, all except one which had crashed just before the detonation, were being landed at Eniwetok by the mother planes still in the air. Crews used long booms to lift the air filter units from the radioactive planes. Samples divided in two lots were placed aboard waiting C-54 aircraft for the long flight to Albuquerque. Because many of the most significant fission products in the samples were short-lived radioisotopes, speed was critical. By using relays of planes in pony-express fashion, the Air Force was able to deliver the samples to the radiochemists at Los Alamos less than thirty hours after the detonation. Within a few days radioactivity on Engebi declined enough to permit the scientific group to recover the test equipment and begin the modifications and improvements for the second shot scheduled within two weeks at Aoman. The test group followed the same general procedures for the second and third shots, on May 1 and 15. Once the test information was air-borne for Los Alamos, it took the scientists only a few days to remove their instruments; within a week the military support forces were closing down the Eniwetok site.

For the relatively few people who knew what the scientists were attempting at *Sandstone*, the very fact that the test devices detonated was clear evidence of a stunning success. From the cryptic reports the rest of the world could gather only that the United States had detonated at least two test weapons and was satisfied with the results. A brief press release on April 19 announced the first detonation but gave no details. Hull, Russell, and Froman held a press conference in Hawaii on May 18, but they permitted the reporters to quote them only from carefully prepared written statements.[19] Even at Los Alamos detailed results were slow in coming. It would take weeks, if not months, to analyze the data collected. All the preliminary evidence, however, pointed toward success. The yield of the first test, for example, was equivalent to 37,000 tons of TNT, compared with about 20,000 tons for the Nagasaki weapon.

Not only did the tests seem to verify the new design principles developed by the Los Alamos scientists, but they also suggested promising courses of development for the future. In this sense McCormack saw *Sandstone* as the beginning, not the end of weapon development. The tests had opened a new realm of possibilities for nuclear weapons, and McCormack understood even before he saw the data from Los Alamos that full realization of that new potential would place unprecedented demands on financial and manpower resources. *Sandstone* also had important implications beyond mere technological developments. Under the able and efficient administration of Hull, Russell, and Froman, *Sandstone* had established a new standard for cooperation between the military services themselves, as well as between the military and the scientists. At a time of international crisis a solid demonstration of the benefits of unity was an accomplishment of no little importance.

AN ACCOUTERMENT OF POWER

At eight o'clock on Monday morning, May 24, 1948, an Air Force C-54 lifted off the runway at Washington National Airport for a nonstop flight to Kirtland Field at Albuquerque, New Mexico. Aboard were Carpenter, with his newly constituted Military Liaison Committee, McCormack, and all the Commissioners except Lilienthal. Their mission was the long-planned conference on weapon custody.

Shortly after lunch the plane arrived at Kirtland. Whisked off to a classroom at nearby Sandia Base, the visitors heard a briefing on weapon
storage facilities and visited one of the temporary storage igloos at Kirtland. On Tuesday morning they studied current bomb design and observed weapon assembly operations by military personnel. In the afternoon they saw how technicians were trained in inspecting, testing, and maintaining weapon components, activities which had come to be described by the general term "surveillance." On Wednesday morning the group flew to Santa Fe and proceeded by automobile to Los Alamos, where Bradbury and his senior staff were waiting.[20]

Bradbury had carefully prepared his remarks in an effort to avoid the emotional issues of civilian-military control. He concentrated on the practical need for speedy weapon development and reliable emergency transfer procedures. He began by saying that the nuclear weapon was far more sophisticated than conventional ordnance in terms of complexity, materials, and techniques. This had been true since 1943 but it was especially important at that moment. The *Sandstone* tests had rendered virtually every component of the existing stockpile weapons obsolete. Bradbury ticked off a long list of the modifications necessary to translate the results of *Sandstone* into hardware. The implications for custody were obvious. If the military services had custody of the stockpile, the Los Alamos laboratory could not simply send out replacement components. In many instances the entire weapon would have to be returned to Sandia for modification. In this sense transfer of the stockpile to the military would be only temporary.

Bradbury thought it was equally important to understand that responsibility for surveillance had to go with custody and that surveillance was an important aspect of weapon improvement. The complex technical activities of surveillance not only assured weapon reliability but also revealed the need or opportunity for modification. It seemed unlikely that even the best military personnel could master the developmental aspects of surveillance. If development needs suggested continued Commission custody, the requirements for emergency transfer did not, in Bradbury's thinking, support the arguments for military custody. Availability and reliability of weapons in time of crisis depended not on whether the men wore uniforms, but rather on effective procedures that could be worked out in advance.

The group heard the other side the following day at Sandia. Nichols, now a major general as commander of the Armed Forces Special Weapons Project, reiterated what he saw as the two "basic military principles" supporting military custody. The first was that in time of emergency each weapon considered a factor in a tactical plan must be in the control of a single military command. The second was that the device became a reliable weapon only when it had been disassembled, repaired, assembled, and handled by the men who would use it in battle. The military services had recognized these principles in 1946 in the decision to organize and train assembly teams and in the decision a year later to organize the special weapons project. The Military Liaison Committee, the Joint Chiefs of Staff, and the service secretaries had more recently recognized these principles in their advocacy of military custody of the nuclear stockpile.

Now that new storage sites were nearing completion at locations remote from Los Alamos, continued Commission custody seemed to Nichols even less realistic. The storage sites had been planned and constructed under military supervision. They were operated and protected by military personnel. Routine surveillance could and should be the function of the military. This would not, in Nichols' opinion, exclude the Commission from performing destructive tests and surveillance necessary for continual development of better components. For major modifications the Commission would refabricate components or provide replacements, but the military would perform minor modifications and repairs of weapons in storage. In short, Nichols rejected Bradbury's arguments for continued Commission custody and took an unalterable position favoring military custody of the stockpile.[21]

General Montague, the special weapons commander at Sandia, followed Nichols with a summary of Sandia activities which, he suggested, showed that in a practical sense the military teams were already performing all the essential functions of surveillance and custody. General Brereton, speaking as an Air Force representative, closed the presentation with the argument that strategic planning, including "prompt and large-scale use of these weapons," could be assured not by cooperation alone but only by "direct and exclusive control by the military forces." In Brereton's mind the March crisis in Berlin had made that fact clear.

Carpenter thought he had the basis for an agreement. Nichols and Montague had demonstrated that the military were capable of performing the accountability, protection, inspection, repair, and training functions of custody. He could meet Bradbury's point about the developmental aspects of surveillance simply by giving scientific teams access to the weapons in stockpile. In Carpenter's words, the technical and operational problems involved in transfer of custody were capable of solution. But the Commissioners did not share Carpenter's confidence. Strauss argued that the unsatisfactory condition of the new storage sites led him to doubt the military's ability on technical grounds. The larger issue, which the Commission still saw as civilian or military custody, was something only the President could decide. Carpenter readily agreed, but he continued to hope that the Commission and the National Military Establishment could go to the President with one recommendation for transfer. He followed this approach the following week after his return to Washington. He told Nichols to prepare a definitive recommendation along these lines, and he sent the Commission a summary of the Sandia meeting in a form which would conveniently permit them to assent to a joint recommendation.[22]

Carpenter's intentions were good but his method backfired. The Commissioners saw the draft minutes of the Sandia meeting as an effort to force them into a decision. An informal but pointed objection caused the Military Liaison Committee to withdraw the document as the official minutes of a joint meeting. Before acting, the Commissioners wanted to see a letter on its way from Bradbury citing specific examples of technical difficulties involved in military custody. There would also be an opportunity for the General Advisory Committee to review the decision at its regular meeting in Washington later the same week. Through its secretary, John H. Manley, who worked with Bradbury at Los Alamos, the committee could be expected to get full exposure to Bradbury's arguments.[23]

Actually the General Advisory Committee was not as firm as the Commissioners might have wished. In a session with Bacher on June 4, Oppenheimer began by ruling that the committee could take no formal position on whether custody should be transferred to the military but could only evaluate the technical difficulties of military custody or the hazards of emergency transfer. The conversation showed that the committee's general sentiment favored continued Commission custody; but when the committee came to what it considered its area of competence, the majority seemed to believe that it would be possible in time for the military to perform surveillance operations. True, Nichols had underestimated the technical complexities of transfer, but this did not mean they could not be resolved in time. As a compromise the committee suggested transferring a part of the stockpile, an idea of practical merit but not one likely to be acceptable to either side in a debate involving principles.[24]

The showdown came on June 18 when the Commissioners met in special session with the Military Liaison Committee. The document on the table was the memorandum Nichols had drafted for Carpenter. It summarized discussions at Sandia and the arguments for military custody. It concluded with a request that the Commissioners join the Secretary of Defense in recommending that custody be transferred to the military at the earliest practicable date. The tone of the memorandum was urgent and insistent. The

Berlin crisis was heating up again. The previous week Soviet troops had blocked all rail traffic between West Germany and Berlin for two days and had closed the Elbe River highway bridge for repair. In such a moment of crisis it seemed hazardous to leave the nation's most important weapon in the hands of civilians with no military experience. The day before the joint meeting Forrestal had met with the War Council at the Pentagon to discuss governmental reorganization necessary for waging atomic warfare. The council agreed that the custody question had to be settled first, that the Commission was "engaging in dilatory tactics," and that pressure was needed. Carpenter's inclination was to be less aggressive in demeanor but his experiences of the previous few weeks could not help but color his presentation.[25]

Lilienthal made it clear from the beginning that the Commission was not prepared to negotiate. With Carpenter's memorandum in hand, the Commissioners the previous day had decided they could not join Forrestal in a joint recommendation. Lilienthal discussed the policy question, and Bacher reviewed the technical difficulties of transfer. For almost two hours Carpenter sparred for an opening but there was none. The meeting was correct and business-like, but no agreement was possible. After the meeting Strauss called Forrestal and urged him to discuss the issue with the Commissioners before going to the President.[26]

Fortunately, disagreement did not lead to a break in communications. In exchanging informal views with Carpenter, Lilienthal was ready to accept Forrestal's invitation to discuss the subject, but he was in no mood for compromise. Already committed to civilian custody of the stockpile, Lilienthal saw recent events as confirming that conviction. He recalled a conversation a few weeks earlier with James E. Webb, director of the Bureau of the Budget. Webb in great agitation had told him that Forrestal seemed to be unable to control the Joint Chiefs in his attempts to unify the armed services. The day after the meeting with the Military Liaison Committee, Lilienthal and the Commissioners went to the Pentagon for a briefing on *Sandstone*. Lilienthal found it dull listening to reports he had heard several times before. What bothered him most was the enthusiasm Froman and Bradbury showed over the prospects for developing bigger and better weapons. This kind of attitude Lilienthal would have expected from a strategic bombing general, but he thought someone in the room might have expressed at least token regret over the necessity to develop weapons for indiscriminate mass destruction.[27]

The meeting with Forrestal and Carpenter on Wednesday noon, June 23, covered much of the ground of the previous week. Forrestal expressed his concern that the armed services be prepared to respond quickly to an international crisis. Lilienthal explained that tests had shown it would take no more than thirty minutes to get a message from the President to Sandia. Neither Royall nor John J. McCloy, who joined the group late, seemed to be aware of these emergency procedures. As Lilienthal described the very real dangers he saw in transferring custody to the military, he got the impression that Forrestal had never heard these countervailing arguments. When Forrestal raised the possibility of transferring weapons to bases in England, Lilienthal admitted the Commission could not maintain custody under such circumstances. The two leaders agreed on a meeting with the entire Commission just one week later.

The next day Soviet forces in Berlin severed the last link of ground communication between the city and West Germany as the last freight trains ground to a halt. Cutting off food and milk supplies, Soviet authorities ordered termination of most electric power transmission to the Western sector. The Allies' response was to step up the airlift which was already supplying the military garrisons in what seemed at first a token effort to supply needs of the entire population. Truman made it clear on June 28 that the United States was going to stay in Berlin. But further Soviet pressure might lead to war, and with few troops available to strengthen American forces in Europe, the President chose the obvious alternative of sending a group of B-29's to Germany and one to England.[28]

Forrestal's meeting with the Commissioners on June 30 produced nothing new in the custody argument except Royall's concern over the need to establish policy for the use of nuclear weapons. Lilienthal saw this as an attempt to treat the bomb as just another weapon, to use the argument over technical custody to confuse what he considered to be the fundamental question of military or civilian control. Before the group adjourned for lunch with General Eisenhower, Forrestal and Lilienthal agreed that each would prepare an independent statement setting forth his position for presentation to the President.[29]

Lilienthal was encouraged. He had succeeded in his efforts to bring the issue to Truman in a form which would give the President complete freedom of action. Earlier that morning Lilienthal had learned from Clark M. Clifford that Truman was determined to continue civilian custody. In the following days Lilienthal kept his hand close to the White House pulse. Carpenter had gone off to the Berkeley laboratory with Oppenheimer for the first meeting of the long-range objectives committee. Perhaps Carpenter took some comfort in Ernest O. Lawrence's vigorous support of military custody, but such sentiments in California hardly offset those Lilienthal was hearing in Washington. Webb, still grumbling over Forrestal's failure to bring the military services into line, told Lilienthal he was opposed to military custody and that Secretary of State George C. Marshall agreed with him. Webb offered to discuss the subject with Truman and to seek a delay on the decision. Lilienthal thought it would be best to have the meeting and let the President make the decision in a strong, well-reasoned letter to Forrestal. In effect, Lilienthal had been able to choose what for him was the most advantageous time for the meeting.[30]

Lilienthal was confident as he entered the President's office on July 21 with his fellow Commissioners. Deliberately he selected his seat in a strategic position before the President and maneuvered Forrestal into speaking first.

Instead of speaking himself, Forrestal turned to Carpenter, who with little experience in the high policy circles of Government, was attending his first Presidential meeting. Obviously nervous, Carpenter chose to read Forrestal's long memorandum to the President. As Truman squirmed in his chair, Lilienthal sensed Carpenter's tactical error. He made the most of it by opening his remarks in an informal conversational manner. He gave the President the Commission's paper on the technical aspects of transfer and concentrated on the policy issue of civilian control, which he knew would strike a responsive cord in the President.[31]

If there had been any doubt about the President's decision, the meeting on July 21 dispelled it. Two days later in a Cabinet meeting Truman told Forrestal he had decided against transfer and would issue a public statement. Truman said it would be possible to review the decision after the fall elections. The decision itself was disappointing enough; but Forrestal found it hard to accept the public announcement that he had been overruled, particularly when Truman chose to issue it in connection with the release of the Commission's fourth semiannual report to the Congress. Lilienthal saw the President's own hand in the words: "I regard the continued control of all aspects of the atomic energy program, including research, development, and the custody of atomic weapons as the proper functions of the civil authorities." Carpenter took the release to Forrestal's office. The Secretary was annoyed. Truman had not even given him the courtesy of an advance copy, and a formal letter from the President did not arrive until two weeks later. Carpenter tried to calm his chief. The important thing now, he said, was to see that the military services took every step to expedite the emergency transfer of weapons. Before the day was out, Carpenter had drafted instructions for the Secretary's signature.[32]

The President's decision had clarified the respective roles of the Commission and the military establishment, but it had not resolved important questions in Forrestal's mind. At lunch on July 28 he told Marshall, Royall, and General Omar N. Bradley of the difficulties he faced in carrying out his responsibilities without knowing whether the United States would use the atomic bomb in war. When Bradley said that the Joint Chiefs were studying the question, Forrestal suggested the need for two studies, one assuming that the bomb would be used and the other that it would not.

A second matter troubling Forrestal was the role of the armed services in atomic warfare now that the bomb was more clearly than ever before an accouterment of power. He had suggested to the three service secretaries on July 19 that their disagreement boiled down to the use of the atomic bomb. Navy Secretary Sullivan was willing to concede to the Air Force the responsibility for strategic warfare, but he did not think the Navy should give up the right to use nuclear weapons on certain targets. Forrestal had proposed a compromise under which the Air Force would have "dominant interest" in the use of the bomb while the Navy would be limited to strategic bombing under Air Force direction and to sorties on purely naval targets. In a memorandum to Sullivan two days later, Secretary Symington made clear that such a compromise would not be acceptable to the Air Force. Symington held that strategic air operations were the primary responsibility of the Air Force and that any naval air operations involving nuclear weapons should be under Air Force direction. This contention, Symington observed, removed any justification for Navy development of special equipment or organization.[33]

The burden of reconciliation as usual fell on Forrestal. General Bradley assured him on July 28 that the Joint Chiefs of Staff were developing policy on the use of nuclear weapons. The same day, after a conversation with General Vandenberg, Forrestal decided to recall General Spaatz and Admiral John H. Towers to active duty to review the issues in terms of recommendations from the Key West conference in March. Until Spaatz and Towers could complete their study, the issue could not be resolved. In the meantime, Carpenter wanted to avoid any commitment on the organization and responsibilities of the Armed Forces Special Weapons Project. He thought he detected in Pentagon discussions the efforts of the Air Force to place the special project "under them for operational command." He urged Forrestal to resist requests for reorganization until the roles of the Air Force and the Navy had been defined. The issues in that debate were finally drawn on August 9, when Navy Secretary Sullivan sent his formal reply to Symington's memorandum. Within two weeks Forrestal had the Spaatz-Towers report and was prepared to settle the question in a meeting with the Joint Chiefs of Staff at Newport, Rhode Island, on the weekend of August 20.[34]

The future of the special weapons project was at the center of the Newport debate. Carpenter revealed that he was considering various reorganization schemes, including the idea of abandoning the special organization altogether and letting each of the services assume responsibility for atomic energy activities. But, as Carpenter had told Forrestal, the future of the special project depended upon the outcome of the Air Force-Navy argument. As the discussion turned to the Symington-Sullivan memorandums, General Vandenberg sounded the note of compromise. Appearing far more flexible than Symington, Vandenberg claimed that the Air Force wanted an independent hand in the special project only until the Navy had developed specific capabilities for nuclear warfare. The outcome was a compromise. As an interim measure, General Nichols would report to the Air Force Chief of Staff in carrying out emergency war plans. The future of the special project and the Military Liaison Committee would await the completion of studies Carpenter had started. Each service would have exclusive responsibility for planning its primary missions, but in executing any mission the services could count on all available resources.[35]

Forrestal thus erected the fragile compromise that avoided one of the obstacles to the unification of the armed services. In the year since the

National Security Act had become law, Forrestal's hopes for unification had been far from realized, but he had inspired some major achievements in the face of profound changes at home and abroad. In that time the atomic bomb had emerged as the key to the nation's defense. An agreement, however tenuous, had been reached on nuclear roles and missions. Still, the future was fraught with danger and uncertainty. In the closing weeks of his six-month term, Carpenter pursued his organizational studies. Still not satisfied, he even explored the possibilities of amending the Atomic Energy Act to give the military services direct representation on the Commission. Commissioner Strauss thought the idea interesting, but it was hard to imagine how the issue could be raised without stirring the emotional fires of civilian-military control. At least for the moment it was reasonable to expect that in an emergency the Commission could transfer its weapons to the military services for prompt delivery on enemy targets.[36]

CONSOLIDATING OPERATIONS

High policy decisions in the Pentagon and Commission headquarters might well determine the shape and size of the nation's nuclear arm, but its fundamental strength depended upon the success of Wilson, Walter J. Williams, McCormack, and John K. Gustafson in building the nuclear stockpile. Living in a world of facts and figures, they struggled with requirements, costs, schedules, and estimates. Success lay not in magical shortcuts or clever theories but in careful planning and efficient performance.

As always, good production planning began with sound requirements, something hard to come by during the chaotic transitions of 1947. An exchange of correspondence with the military establishment in the fall of 1947 had resulted in a tentative schedule for bomb production for each of the five years beginning in 1948. Against this the Commission had matched its production resources. The result was a plan, which President Truman approved in April, 1948, to continue the production of fissionable materials at essentially the level authorized for 1947. Events in early 1948 suggested the need for higher requirements, but until results were available from the *Sandstone* tests, there would be no sound basis for planning. In effect, the directive authorized the Commission to produce all the fissionable material it could with existing facilities until the Joint Chiefs of Staff could formulate new and higher requirements.[37]

After studying Williams' production plans in March, 1948, Gustafson felt confident that available sources of raw materials would be sufficient for both production and research needs in the immediate future. Part of his optimism stemmed from a recent British agreement to allocate to the United

States all uranium concentrates available in 1948 and 1949 through the Combined Development Agency, as the tripartite procurement group was now called. This source alone would provide about 2,000 tons of uranium concentrates annually through 1950. There was, however, an inherent weakness in the American position. All of this material would come from the Shinkolobwe mine in the Belgian Congo, and continued procurement after 1950 would depend upon successful negotiations with the Belgians. The mine itself was vulnerable to sabotage and in any event would be exhausted by the end of 1952.[38]

More accessible sources were small by comparison. The Canadian deposit would not bring more than 150 tons per year. The only domestic ore immediately available was on the Colorado Plateau. In the spring of 1948 only a dribble of concentrates was coming from that source as a byproduct of the vanadium mills. Even after all the existing mills were acquired and renovated, the area probably would not produce more than 300 tons of concentrates annually. Although all ore bodies then positively located on the plateau would produce little more than 1,000 tons, inferred reserves were six times as much, and potential reserves in phosphate and shale deposits were many times that figure. Cost, not quantity was the issue. Gustafson estimated that the low uranium content and the high development costs for domestic ores would force the price of concentrates from American sources up to $20.00 per pound or higher, compared with $3.40 for Shinkolobwe material delivered in the United States. In a sense, the amount of uranium produced depended on how much the Commission was willing to pay for it.

By the end of March, 1948, Gustafson had formulated a domestic procurement plan with the help of his raw materials advisory committee. Underlying the plan was the assumption that new reserves could best be developed by competitive private industry under the stimulus of profits. This meant incentives in the form of a $10,000 bonus for the discovery of significant deposits and a guaranteed minimum price of $3.50 per pound of concentrate in high-grade ore, to be offered for ten years. Actually the incentives were to be more of psychological than practical value. Few, if any, domestic deposits were likely to qualify for the bonus. The guaranteed minimum price for high-grade ore was far below expected costs, but it could not be higher without jeopardizing the price the Commission was paying for Belgian Congo material. In any case, the incentives and the price schedule established for lower-grade ores of the Colorado Plateau made clear to the American mining industry that there was a domestic market for uranium. The Commission would help by getting all existing mills on the plateau back in operation and by financing an extensive search for additional ore by exploratory drilling. This plan, costing about $5 million per year, would increase concentrate production on the plateau from 100 to 300 tons per year without disrupting the economy of the area. In the meantime, Gustafson intended for security reasons not to disclose the Commission's interest in phosphates and shales until further research indicated that uranium extraction was feasible.[39]

The most promising foreign ore sources were in the Belgian Congo and the Union of South Africa. Wilson's assurances of technical assistance to Belgium during a visit by two Belgian officials in the summer of 1948 paved the way for successful negotiation in December for an additional 5,000 tons of uranium concentrates from Shinkolobwe. Interest in South Africa came from the fact that by 1953 that nation would be the largest potential foreign source, but diplomatic overtures were necessarily deliberate and unhurried. Having to deal with the United Kingdom as a member of the Combined Development Agency and with South Africa as a member of the British Commonwealth complicated Wilson's task of arranging discussions. In fact, there were other reasons for not moving too quickly. The confused political situation in South Africa suggested caution, and the relatively high price the Commission would have to pay for South African material threatened the United States bargaining position with the Belgians. Not until the summer of 1949 did Wilson complete arrangements for negotiations with the South Africans, to begin in November.[40]

The only other uranium source of any consequence was to be found in the waste tanks and chemical processing plants at Hanford. The Commission had given work on Redox a high priority in the summer of 1947, but the project languished for lack of firm leadership. Finally in June, 1948, Roger S. Warner, the director of engineering, put a review committee to work, and a new plan for Redox was ready before the end of the summer. The first decision was to abandon the idea of using packed columns in the solvent extraction process for the mixer-settler system which the Standard Oil Development Company had been investigating. Secondly, the independent efforts of the Kellex Corporation, Standard Oil, Argonne National Laboratory, and the Blaw-Knox Construction Company were all to be united under General Electric's control. With a clear purpose and some organization, Warner hoped that the first of three plants could be completed at Hanford in two years at a cost of $43 million. During the same period Kellex would try to develop a process to recover the uranium in the Hanford waste tanks.[41]

In the months before the *Sandstone* tests verified the design of new weapon types, plans for increased production wisely centered around Hanford. Unless Los Alamos could find a more efficient weapon than the Hiroshima model for uranium 235, the Hanford reactors would continue to be the principal source of fissionable material for weapons. The most obvious way to increase plutonium production was to restart B reactor, which had been shut down in 1946 to assure some production capability should the other two reactors fail. In March, 1948, Wilson reported his conclusion that neither of the reactors was likely to fail suddenly and that they would continue to operate for at least three years. With this assurance, the Commission in April authorized restarting B reactor, thus placing three reactors in operation by the summer of 1948.

Meanwhile, construction had started on the new DR and H reactors at Hanford. In March, 1948, when the reactor development group visited Hanford to discuss possible design improvements in the new units, there were more than ten thousand construction workers on the job. The main building for DR was already going up, and site clearing had started at H. In seven months Carleton Shugg had transformed Hanford into a beehive of activity, an accomplishment which suggested a bigger role for his talents. In August, 1948, Wilson called Shugg to Washington to serve as deputy general manager, and Frederick C. Schlemmer, the TVA engineer who had gone to Hanford as a consultant with Williams in the summer of 1947, took over at Hanford.[42]

Nowhere did the anticipation and achievements of *Sandstone* have greater effect than in weapon activities at Sandia. By the spring of 1948 Sandia had all but accomplished the transition from a makeshift branch of Los Alamos to a full-fledged laboratory in its own right. Regular routines and procedures were replacing the bickering and confusion of 1947. To some extent the new patterns simply demonstrated that the scientists and military personnel were learning how to work together, but new leadership was helping to speed the process. In Paul J. Larsen, the new director, the laboratory had a man of reputation and experience in applied research and development. In Colonel William M. Canterbury the Armed Forces Special Weapons Project had a knowledgeable officer who knew how to get along with people. To unite the efforts of the two groups, Larsen and Canterbury had established a research and development board, which would meet regularly to study assignments and plan activities. McCormack and his staff in Washington were at first uneasy about the lack of definition of the board's power and authority, but it soon proved an effective device for weaving together the scientific and military units into a single team. Equally important was the influence of George P. Kraker, who gave Tyler and the Commission for the first time an effective representative at Sandia. Kraker's job was to see that Sandia activities meshed smoothly with other parts of the Commission's production complex; and that meant, according to McCormack, even closer coordination with military personnel.[43]

Sandstone helped to pull Sandia together, not only by sweeping away the remnants of existing rancor, but also by giving the laboratory new goals which required a united effort. In May, 1948, even before the third *Sandstone* shot had been fired, orders from Bradbury completely revamped production schedules. So clearly had *Sandstone* verified the design of the new Mark 4 weapon that first priority would now go to production of components for the new model, even at the expense of completing current stockpile items. Fabrication of standard nuclear cores stopped immediately so that all fissionable material would henceforth go into new models. The day of tailor-made weapons was fading fast; with Mark 4 would come mass production of components and assembly-line techniques.[44]

The new technology which *Sandstone* made possible turned the Commission's sights from building on the past to striking out into the future. An increase of Sandia employment from 320 to 700 in seven months rendered the temporary buildings at Sandia Base obsolete. In August, 1948, the Commission approved the purchase of additional land for permanent buildings estimated to cost $15 million. Los Alamos was feeling similar pressures. With the old technical buildings crumbling beneath them, Bradbury and his associates had no choice but to look for a new laboratory site off the crowded Los Alamos mesa. By the summer of 1948 plans were well developed to build the new laboratory on South Mesa, with a high bridge over the canyon to connect the laboratory with the town. The proposal itself was ambitious enough, calling for $107 million for construction over a five-year period. There was a momentary drop in morale when the Commission, with the support of the General Advisory Committee, limited new construction to immediate needs, but it appeared certain that Los Alamos had a promising future.[45]

Just exactly what lay ahead Bradbury outlined for Tyler in September, 1948. There was still much to be done in analyzing the data from *Sandstone* and finding ways to use that information in new weapon models. *Sandstone* had already kindled interest in several new types of weapons and had raised hopes for a smaller, lighter weapon of standard design. Bradbury hoped that a series of studies already started would fix the general specifications of the new Mark 5 weapon within a year. In this way the talents of Los Alamos could be joined with those of the aircraft industry in designing a new bomber around its nuclear payload as an integrated weapon system. Once Los Alamos had determined the weight and size of the new weapon more than two years of research and development would be needed to ready the TX-5 for a test at Eniwetok early in 1951. The designation "TX," as McCormack liked to point out, meant "test" *and* "experimental"; both letters were necessary to indicate the kind of technological leap the new weapon would require.[46]

Bradbury was also planning other research with less direct application to immediate weapon requirements. He proposed research with the fast-neutron reactor "Clementine," basic studies of important weapon materials such as plutonium and tritium, construction with the help of John von Neumann of an electronic computer for theoretical studies, continued theoretical research on various approaches to a thermonuclear weapon, and further investigation of weapon design. Basic research in nuclear physics, chemistry, and biology would complete the transformation of Los Alamos from a task force of scientists with a narrowly defined mission into an applied physics laboratory.

To the extent Bradbury accomplished this transformation at Los Alamos, the task at Sandia became more clearly industrial. The University of California had never been happy with the extension of its Los Alamos contract to cover Sandia, and the increasingly industrial nature of the Sandia operation prompted the university to inform the Commission in December, 1948, that it wanted to withdraw from Sandia management within six months. The university's position was understandable, but it would not be easy to find a new contractor. Any other academic institution would have the same reservations as California's about the Sandia assignment. There were rumors that the existing Sandia staff might form its own corporation to operate the laboratory, but this would not bring new strength and experience to the organization. The best hope seemed an industrial contractor in the electrical, automotive, or aircraft industries. Wilson and Warner at once thought of the Bell Telephone Laboratories and consulted James B. Fisk, the former director of research who had close ties with the Bell organization. Oliver H. Buckley, president of Bell Laboratories and a member of the General Advisory Committee, thought the assignment would overload the laboratory with military research, but he agreed to let Mervin J. Kelly, his executive vice-president, study the situation at Sandia and Los Alamos.[47]

Kelly, a thoroughly professional and experienced engineer, knew what to look for at Los Alamos and Sandia. He observed operations, studied personnel records, and talked with the leaders. Not wishing to involve himself in formal written reports, he insisted on discussing his findings directly with the Commissioners. His report on May 6, 1949, did more than confirm Wilson's arguments for an industrial contractor; it also gave the Commissioners an impressive independent appraisal of the two organizations. Kelly had nothing but praise for Los Alamos. It was the finest Government laboratory in the nation. The staff was excellent, and the salaries and working atmosphere would draw the best young men in the country. The laboratory was well organized and efficiently administered, a solid tribute to Bradbury, Tyler, and McCormack. At Sandia Kelly found less to extol. The laboratory had improved tremendously since early 1947, especially under Larsen's direction. Most of the staff were eager, hard-working young men, but much of their output Kelly found amateurish and lacking the professional touch of a first-rate production organization. Kelly thought a good industrial contractor could bring Sandia up to Los Alamos's standards in twelve months.

In his presentation Kelly was careful to avoid any discussion of possible contractors, but his excellent performance did nothing but increase the Commission's determination to bring the Bell Laboratories or one of the other Bell subsidiaries to Sandia. A pending antitrust suit made the American Telephone and Telegraph Company more than reluctant to undertake a contract which seemed likely to draw on the resources of the whole Bell system, but assurances from the Attorney General and a personal request from President Truman removed the company's reservations. On July 11, 1949, the Commission announced that it was negotiating a contract with the Western Electric Company, an AT&T subsidiary, thus opening a new chapter in weapon activity at Sandia.

THE BATTLE REJOINED

All these efforts to consolidate and strengthen the Commission's production complex added up to substantial progress by the end of 1948. Arthur V. Peterson of the production division told the Commissioners on January 19, 1949, that inventories of feed materials, fissionable materials, and special products were well ahead of schedule despite several unforeseen breakdowns at Hanford and Oak Ridge. Only the previous week Wilson had discussed with the Commissioners a draft letter to the President authorizing fissionable material production for calendar year 1949. The letter would inform the President that the Commission was in the process of converting production to the new weapon models tested at *Sandstone;* the Commission would now be able to produce more weapons than had been required in the schedule which the Joint Chiefs of Staff had prepared late in 1947.[48]

There was, however, no room for complacency. The draft letter to the President evoked from the Military Liaison Committee formal notice that "the currently established military requirement for scheduled bomb production should be substantially increased and extended." The military had not yet been able to translate *Sandstone* results into firm requirements. In the meantime, the committee suggested the most profitable ways of modernizing the weapon stockpile and the approximate numbers of weapons of each type which should make up the stockpile on each target date of the existing schedule.[49]

The letter from the Military Liaison Committee illustrated the enormous importance which the armed forces now attached to atomic weapons. Forrestal, long a proponent of a strong nuclear arm, had returned from his last trip to western Europe more than ever convinced that the atomic bomb was the key to the defense of that part of the free world. He agreed with Winston Churchill that it would be dangerous to underestimate the military value of nuclear weapons. In the face of President Truman's severe limitations on defense spending, Forrestal saw the atomic bomb as a way of maximizing the nation's defenses with limited resources.[50]

If nuclear weapons were to have such a prominent defense role, they would have to be available in relatively large numbers and in practical sizes and weights, a possibility that had seemed remote before the *Sandstone* tests. General Nichols was one who did not accept the existing limits of weapon technology. He was willing to consider defense plans involving an ultimate stockpile of thousands, not just hundreds of weapons. In William Webster, who had succeeded Carpenter as chairman of the Military Liaison Committee and as Forrestal's assistant for atomic energy, Nichols found a new ally. Aware of the economic advantages of mass production, Webster did not let the size of the Commission's existing production facilities limit the range of his thinking. As for reducing weapon size and weight, the results of *Sandstone* had encouraged the military planners. The absence of new weapon requirements in Webster's letter to the Commission reflected anything but indecision and lack of enthusiasm in the armed services.[51]

However little the Commissioners may have known of this background, they had already sensed the demand for increased production of fissionable materials. Williams had explored the possibility of duplicating the Hanford and Oak Ridge plants at other sites for better security against military attack or sabotage. Hanford was especially vulnerable to air attack from the Soviet Union, but the cost and time required to build plants at a new site seemed prohibitive in the absence of definite military requirements. It seemed more reasonable, as Bacher suggested, to increase plutonium production by making changes in the operation of the existing Hanford reactors or even by enlarging the batches of irradiated slugs dissolved in the chemical processing plants at Hanford. Gustafson and Williams felt certain that they would have enough feed materials to operate four reactors at Hanford at the higher production levels.

As for the Oak Ridge plant, the relatively remote possibility of enemy attack or plant failure made duplication at another site unnecessary, but an addition to the existing plant had been a live possibility since 1947. A plant addition at Oak Ridge, particularly one using a new type of compressor, an improved barrier, and a simplified cascade design, would make possible the extraction of more uranium 235 from a given amount of raw material. Furthermore, these improvements would provide the additional capacity at much less than the equivalent cost of the original plant, even at existing prices, and would reduce the unit cost of uranium 235 produced. Before the end of 1948 Williams had Carbide and the Maxon Construction Company at work on engineering designs. Thus, when the Commissioners approved construction of the K-29 addition on March 9, 1949, Williams could predict that the new unit would be in production by the middle of 1951.[52]

All these topics were the subject of discussion when the Commission met with the Joint Committee on Atomic Energy on March 10, 1949. Under the leadership of Brien McMahon, the new chairman in the Eighty-first Congress, the committee was taking an unprecedented interest in the Commission's production plans. Some saw in McMahon's energetic leadership an effort to create in the eyes of the American people an image of himself as "Mr. Atom." Faced with reelection in 1950, McMahon was appearing whenever possible as a speaker on atomic energy and had recently created a stir by suggesting that the United States reveal the number of nuclear weapons in its stockpile as a way of deterring the Soviet Union from reckless action in Europe. McMahon's motivation, however, was more than just political. The world situation profoundly disturbed him, and he was determined to see that the Congress, through the Joint Committee, held high the atomic shield—even if the Commission failed to do so. In short, McMahon hoped to make the Joint Committee an instrument of national policy.[53]

Aiding McMahon in this effort was William L. Borden, the committee's new executive director. Borden was an intelligent young man with some of the talents and intellectual ability which had made James R. Newman so valuable to McMahon in the legislative battle for the Atomic Energy Act in 1946. Like Newman, Borden was a graduate of the Yale Law School and had proved himself capable of independent thinking and articulate writing. Ever since he had seen a German V-2 missile streak past his B-24 bomber while returning to England from a raid in November, 1944, Borden had been obsessed with the frightening dangers modern technology posed for American security in the postwar world. His book, *There Will Be No Time,* written while he was still in law school, stridently proclaimed the need for a revolution in strategy which recognized that cities, industry, and land armies would

be obsolete in the lightning atomic warfare of the future. Borden argued that national defense should have precedence over all internal problems; a united armed force should be ready for instant retaliation with atomic weapons against sneak attack. The choice, he had said in 1946, was between a strong America and no America.[54]

Some of the intensity of Borden's dedication to national defense showed through in his discussion with the Commissioners. He was particularly concerned about plans for the new production reactors at Hanford and about progress on Redox. Wilson assured him that the Commission was studying the best way to use the new DR reactor, which was now almost complete. There was little chance the reactor would be used as a replacement for D, which was now operating well, but graphite expansion in F was reaching dangerous proportions. Perhaps it would be necessary to tie the F waterworks to DR. If F continued to operate, Wilson said it would still be possible to build another waterworks near DR, which would place five reactors in operation (including H, to be completed in the summer of 1949).

Wilson was candid in saying that technical difficulties were continuing to prolong development of the Redox process. He explained the decision in the summer of 1948 to switch all development of the solvent extraction process to the mixer-settler system when it appeared that the packed columns would have to be 50 or 60 feet high. By November engineers had revised the column height to 35 feet, and a review committee had decided that either packed columns or mixer-settlers would work. To assure a correct choice, the Commission had asked the du Pont Company to have some of its best engineers review the entire Redox project. Their recommendations would be in by April 1, 1949. The hearing went pleasantly enough, but there was no disguising the fact that McMahon and Borden would continue to press for greater production.

It was also likely that renewed pressures would come from the military. McMahon had stated his intention to raise the same sorts of questions with the service secretaries. Perhaps he was only waiting for a new Secretary of Defense to replace Forrestal. Lilienthal was already uneasy. He distrusted "what is sonorously called 'the requirements of the Joint Chiefs of Staff,' " as if there were something sacred about their pronouncements. The joint letter for the President authorizing 1949 production was ready for signature, including the added phrase that the Joint Chiefs did not consider current production adequate even if the number of weapons produced exceeded the 1947 schedule. Lilienthal reminded the Military Liaison Committee on April 8, 1949, that any substantial increase in weapon requirements might push production above authorized levels. Such an increase would require Presidential approval, and Lilienthal did not see how he could make such a recommendation without having some knowledge of the war plans on which it was based.[55]

Lilienthal's anxiety must have stemmed in part from Forrestal's resignation as Secretary of Defense. His spirit broken by the heavy weight of his duties, Forrestal was then in the Bethesda Naval Hospital in a state of deep depression. The Commission's first meeting with Louis A. Johnson, the new Secretary of Defense, did not help to allay these concerns. Lilienthal found in the new secretary a callous self-confidence bordering on the flippant. It was bad enough that Johnson seemed more interested in contract awards than policy issues; the Secretary's supreme confidence in the Joint Chiefs and the sanctity of their opinions—inviolate even to Presidential criticism—was downright unbearable. The next day, when he and Johnson presented the joint letter to the President at the White House, Lilienthal found momentary assurance in Johnson's statement of admiration for the Commission's accomplishments and his promise of cooperation, but new signs of trouble soon appeared. General Nichols had renewed his campaign for military control of the atomic energy enterprise, and a forthcoming Joint Committee hearing with the Joint Chiefs in mid-May seemed likely to generate new military requirements for nuclear weapons.

Higher requirements in themselves did not bother Lilienthal; the Commission would do its best to meet any goal based on sound planning and Presidential approval. What he feared was an arbitrary demand from the Joint Chiefs in a form the President could not effectively challenge. The result, he told Truman on May 11, might be a new threat to civilian control. Truman's sharp response to that warning was reassuring, but Lilienthal was determined to keep up his guard. So sensitive had the issue become that the Commissioners spent several sessions in May discussing the need to replace military officers on General McCormack's staff with civilians, a significant action in view of the Commissioners' high regard for McCormack and Russell.[56]

To some extent Lilienthal was using the requirements issue to sound the old alarm against military control. He knew as well as anyone that Wilson's staff worked with the military in developing requirements and that these were based in large part on the capacity of the Commission's production plants. Certain elements of the procedure, however, did cause friction even at the staff level. Although the Commission never questioned the right of the Military Liaison Committee to any atomic energy information, the great amount of detail requested in some cases aroused the suspicion that the military officers were trying to second-guess the Commission's staff. Furthermore, Webster and Nichols made no effort to disguise the fact that they were building requirement figures on the Commission's capacity to produce. In the spring of 1949 the Military Liaison Committee scheduled visits to the major production sites with the avowed purpose of determining the maximum production of existing facilities and the relative advantages of arbitrary, multiple expansions of existing capacities. In Oak Ridge on May 19, Webster and Nichols took this approach in discussing with George T. Felbeck and other Carbide officials the economic advantages of building still another gaseous-diffusion plant, to be called K-31, at the Oak Ridge site. Webster used the information gathered in the field for preparing the new requirements which he sent to the Commission on May 26, 1949.[57]

Webster thought his approach eminently practical and saw no reason to apologize for it. To Lilienthal, it embodied all that he had found objectionable in negotiations with the military. Webster was ordering atomic weapons like mess kits or rifles. Just how the new requirements would fit into larger strategic and political considerations was to be of no concern to the Commission.

Even worse, Webster's methods suggested to Lilienthal and others an arbitrary approach, not based on military planning but on rule-of-thumb estimates to be dignified as formal recommendations by the Joint Chiefs. Unfortunately for both sides, the Commission was excluded from an understanding of the complexities which Webster and his associates faced in drawing up requirements. The capacity of the Commission's production facilities was only one factor. Far more difficult to estimate was the requirement for nuclear weapons, depending as it did on such complicated variables as Air Force targeting plans, options in weapon size, and improvements in weapon design still evolving from the results of the *Sandstone* tests.[58]

Only the most extraordinary circumstances forestalled a prompt reaction from the Commission. The day Webster's letter arrived, the Commissioners were attending the first of a series of hearings before the Joint Committee, stemming from Senator Bourke B. Hickenlooper's charges of "incredible mismanagement." Not until June 23 did the Commissioners find time to consider a reply. Wilson explained on Friday, June 24, that he could meet the requirements approved by the President in April with four reactors (B, D, F, and H), but that the May 26 request would require a waterworks for DR and a new gaseous-diffusion plant at a cost of at least $230 million. Lilienthal was quick to remark that such an expansion would certainly require Presidential approval, and he thought it important to avoid any step "that might narrow the area of exercise of judgment by the President." He had already discussed that danger with Frank Pace, the new director of the Bureau of the Budget; on the Commissioners' instruction, Wilson arranged a meeting with Webster in Pace's office on Monday afternoon.[59]

The military demand for a "substantial" increase in production put the determination of production goals in a new context. As long as requirements stayed within the capacity of existing or planned facilities, the Commission could negotiate with the military establishment to determine the final recommendation to the President. But the May 26 request, going beyond existing construction plans and authorization, left no basis for decision. McMahon made this dilemma clear in a letter to Secretary Johnson on July 14. In the past, military requirements had "merely reflected an estimate of what the Atomic Energy Commission was capable of producing with existing or planned facilities—and did not reflect an independent judgment as to what we need in the event of war." That independent judgment, McMahon and Borden argued, should stem from the proposition that strategic bombing with atomic weapons was "the keystone of our military policy and a foundation pillar of our foreign policy as well." In this sense McMahon and Borden believed the nation could never have enough atomic bombs and could well afford a "substantial" increase in production.[60]

Lilienthal worried about translating that word "substantial" into specific requirements. If, as McMahon suggested, the decision involved fundamental national policy, some device was necessary to collect all the pertinent factors for the President's consideration. The solution emerged from Wilson's discussions with Webster and Pace. On July 26, Truman signed a letter to Admiral Sidney W. Souers, executive secretary of the National Security Council, directing him to undertake a complete review of plans for producing fissionable materials and atomic weapons. To assist Souers in his study, the President was establishing a special committee consisting of the Secretaries of State and Defense and the Chairman of the Atomic Energy Commission. The President's directive made clear that all members of the committee were to have access to all pertinent information, regardless of sensitivity. This provision assured Lilienthal that the Joint Chiefs' requirements would be subject to discussion and criticism.[61]

To Lilienthal's mind the Presidential directive was a new victory for civilian control of atomic energy. Amid the tribulations of the Hickenlooper investigations and the debate over technical cooperation with the British in July, 1949, the Commission's accomplishments in meeting its military responsibilities were comforting. Not only had the Commission apparently increased production faster than the military could develop firm requirements; it was now forcing the military to base its requirements on sound planning consistent with national policy.

There were also a few hopeful signs on the international scene in July, 1949. The Berlin airlift had broken the Soviet blockade and a new government in West Germany was in the making. The United States Senate had ratified the North Atlantic Treaty, establishing a new partnership for the defense of western Europe. Secretary of State Dean G. Acheson, returning from a foreign ministers' conference in Paris, had declared that "the position of the West had greatly grown in strength, and that the position of the Soviet Union in regard to the struggle for the soul of Europe has changed from the offensive to the defensive." [62] The Administration, as well as the Commission, had done much since Secretary Marshall's Bastille Day appeal in 1947 to extend American defenses against aggression to western Europe and the Middle East. The nation now had an arsenal of nuclear weapons. Behind its atomic shield the nation seemed secure, at least until the Soviet Union could break America's monopoly of the atomic bomb.

ATOMIC POWER
QUANDARY AND QUAGMIRE

CHAPTER 7

The decision in late December, 1947, to centralize reactor development at Argonne had shocked and dismayed Oak Ridge. Alvin M. Weinberg, the thirty-two-year-old director of the physics division at the Tennessee laboratory, bitterly stigmatized relocating the high-flux and the Navy reactor projects—both of which he thought ready for engineering—as an act which would delay reactor development for two years.[1] At Argonne Walter H. Zinn viewed his enlarged assignment with no enthusiasm. His laboratory was engaged in moving from several locations in Chicago to the new site southwest of the city. Here he hoped to build in the near future his experimental fast-breeder reactor. C. Guy Suits and Kenneth H. Kingdon at Schenectady impatiently watched the construction of the General Electric Research Laboratory and the adjacent Knolls Atomic Power Laboratory. Their intermediate-power-breeder reactor was a challenging and ambitious project, but at least it could proceed undisturbed by the move toward centralization.

Whether at Oak Ridge, Argonne, or Schenectady, reactor engineers and physicists faced a host of unknowns. They lacked vital data on nuclear constants and on the behavior of metals and coolants under prolonged radiation. They had to develop components such as pumps, control mechanisms, and shielding. During the stress of war they had found it necessary to take calculated risks on safety, a course not acceptable for a technology which was to become part of the civilian economy. The obstacles in developing reactors were real, but so was the sense that their conquest would be exhilarating. For those at Oak Ridge the worst blow was that they had been barred from adventure.

LOCATION OF THE HIGH-FLUX

The key to the centralization plan was the decision to locate the high-flux reactor at Argonne. During January, 1948, Zinn studied the feasibility report which Weinberg's group had prepared on the Clinton high-flux reactor. He thought Argonne was too near Chicago for an experimental reactor operating at 30,000 kilowatts. Furthermore, Clinton had planned an integrated complex consisting of the reactor and a chemical processing plant. Zinn was even more certain that the Chicago area was a poor location for handling highly radioactive fuel.[2] Having wrestled with questions of reactor safety since 1942, Zinn was himself an expert on the subject. But he did not have to depend upon his own views. The design and location of the high-flux would be the concern of the Commission's reactor safeguard committee.

That committee had already considered two reactors. At Schenectady in early November, 1947, Kingdon's group had reviewed the design of the intermediate-breeder, a 30,000-kilowatt, sodium-cooled reactor. Design and development were still preliminary, but Suits and Kingdon were anxious to select a site so that further work could meet the requirements of an actual location. Obviously the nearer to Schenectady, the easier for General Electric personnel to use the reactor; otherwise the company's role might be reduced to operating the reactor rather than performing research. The result, the committee was persuaded, would be disastrous to the leadership of the United States in atomic energy. Recognizing that any recommendation had to be tentative until further work had been completed, the safeguard group had concluded unenthusiastically that a location near Schenectady might be acceptable. The committee next had visited Argonne, where in late January, 1948, it had found the laboratory acceptable for the 1,000-kilowatt reactor and its chemical processing facility, provided that the amount of plutonium and fission products generated in the reactor were limited. In considering both reactors, the committee studied not only the chance of accidents, but also the risk of sabotage.[3]

The safeguard committee gathered at Oak Ridge on February 8, 1948, to consider the high-flux reactor. The experienced and talented group served under the leadership of Edward Teller who, among his other activities during the Manhattan days, had studied the possibility of accidental criticality in the uranium separation plants. Now at the Institute for Nuclear Studies at Chicago, Teller was an engaging and energetic chairman. Few people had a better understanding of the complexities of reactor development than John A. Wheeler, a physicist at the Palmer Physical Laboratory at Princeton. Wheeler had published with Niels Bohr in September, 1939, a significant paper on the mechanism of nuclear fission and had served as a member of the engineering council at Chicago which had guided the work on the production piles at Hanford. Joseph W. Kennedy, chairman of the department of chemistry at Washington University at St. Louis, brought to the group a brilliant grasp of chemistry and experience at Los Alamos; to these he added a vigorous sense of humor. Chemical engineering was the speciality of Manson Benedict from Hydrocarbon Research, Incorporated. Colonel Benjamin G. Holzman, chief of the geophysical sciences branch of the Air Force, provided experience based on several years as a meteorologist. Oldest of the group was Abel Wolman of Johns Hopkins University, whose field was public health and sanitary engineering. Energetic and articulate, he was familiar with Commission activities through his service on other committees which had studied safety problems. It was a strong body and well versed in those various fields which Oppenheimer genially described as "general deviltry" when he and the General Advisory Committee recommended establishing the group.[4]

For two days the full committee, except for Wheeler, heard Weinberg, Miles C. Leverett, John R. Huffman, and other members of the laboratory present plans and drawings for the construction and operation of the high-flux reactor. Listening closely were Zinn and Eugene P. Wigner. Wigner's interest stemmed from his part in selecting water as the coolant and moderator, and in designing the fuel elements. The fissionable material was to be an aluminum-uranium alloy rolled into sheets which were to be clad with aluminum. In the slang of the designers, the alloy was the meat, the cladding the bread, and the combination the sandwich. Eighteen sandwiches were to be brazed to aluminum side plates and together would comprise an assembly. Each sandwich was about .06 inch thick and separated from its neighbor by a distance of .117 inch, through which the water coolant and moderator passed. It was important to minimize buckling which might block the flow of cooling water and lead to overheating. Wigner had thought of curving the fuel plates to give the assembly greater strength. The reactor core was to be surrounded by beryllium, which would reflect neutrons and conserve them for experiments. To everyone it was clear that Clinton had designed a sophisticated reactor, able to provide large quantities of thermal and fast neutrons for testing reactor materials, furnishing the nuclear and engineering data indispensable to the development of advanced reactors, and yet sufficiently flexible for performing biological experiments. Its chemical facilities would supply information on the complicated problems of processing used fuel. Moreover, the laboratory was constructing a full-scale reactor mock-up to test the mechanical reliability of high-flux components and under Wigner's leadership had considered safety aspects of the design. In January, 1947, the staff had reported to him that reactors could operate at Y-12 with no greater risks than those often associated with more conventional industries.[5]

The risks worried Teller and his colleagues; patently the high-flux reactor and the chemical processing plant had not been designed with Argonne in mind. Any accident releasing the fission products built up in the fuel elements could be hazardous to the 4 million people of the nation's second largest urban center. What Zinn had suspected was confirmed. Perhaps recognizing the impact of its report, the committee pointed out that so far it had considered each reactor individually. Possibly a different approach was needed, one dealing with the entire reactor effort, including chemical processing and radioactive waste disposal.[6]

The General Advisory Committee considered the safeguards report when it assembled in Washington on April 23, 1948. Zinn and Wolman were also present to give their opinions. Wolman outlined the safety arguments which the advisory committee accepted reluctantly. Isidor I. Rabi recognized the importance of the safety factors, but was dissatisfied with the lack of precise data. He thought there ought to be a formula into which values representing various aspects of safety could be inserted. Wolman was doubtful. In his opinion the unknowns were too many and the hazards too great. Zinn saw the real danger as the scattering of radioactive fission products built up in the fuel elements during reactor operation. These products could only escape through a failure of the fuel cladding, perhaps by rupture from a sudden shock, perhaps by melting from a rise in temperature. The most likely cause of an increase in temperature was an interruption in the coolant flow. Even if the reactor were shut down, fission products during their decay gave off heat. Without the circulating coolant to remove the decay heat, the cladding could melt. But in terms of safeguard criteria, Zinn thought a heavy-water, natural-uranium research reactor of 5,000 kilowatts, or a high-flux reactor of 1,600 kilowatts, would be safe for a laboratory. As matters now stood, the high-flux reactor could not be built at any Commission laboratory. Zinn warned that he needed a decision for the high-flux; otherwise the interest of designers would fade. He left no doubt that he favored a proving ground; eventually one would be needed to test more advanced and higher powered reactors. He saw the testing station as a Commission enterprise not identified with any one laboratory.

The advisory committee did not like separating the high-flux from the central laboratory. To Cyril S. Smith the two facilities were inseparable. To Oppenheimer progress in reactor development depended upon building the high-flux at Argonne, a possibility he would not exclude until additional design had been completed. Smith and Enrico Fermi agreed: perhaps the answer lay in some emergency arrangement for flooding the reactor. Rabi and Glenn T. Seaborg saw no reason why the reactor could not be located at Argonne, leaving the chemical processing facilities for a remote site. Fermi, Hood Worthington, and Smith as members of the subcommittee on reactors drew up the sense of the discussion: to prevent delay in reactor development, the Commission should try redesigning the high-flux for Argonne and begin the search for a proving ground.[7]

MILITARY PRESSURES

January, 1948, had little more than begun when Vannevar Bush, vacationing in Hobe Sound, Florida, received a letter from General Carl A. Spaatz, Chief of Staff of the Air Force. As he opened the envelope the chairman of the Research and Development Board must have had some idea of what Spaatz wanted. During the summer James B. Conant's committee on atomic energy of the Research and Development Board had criticized the NEPA effort to propel aircraft by atomic energy, and had advised a new approach which would place the Commission in charge of a unified program. Spaatz had not liked the recommendation and he hoped to enlist Bush in an effort to reverse it. Perhaps he could compensate for Conant's cool scientific approach; perhaps he could stress to Conant the importance of coupling the engineering resources of the aircraft industry to the research abilities of the Commission.[8] To one as familiar with the Washington scene as Bush, there was no need to mention that Conant was a member of the influential General Advisory Committee as well as the chairman of the Research and Development Board's committee.

No such difficulties appeared to hamper Navy development of a nuclear-powered submarine. Conant's committee had recommended that the Navy Bureau of Ships consult with the Commission about organizing the project. Before reporting his plans to the Commission on January 20, 1948, Admiral Earle W. Mills, chief of the bureau, and Captain Hyman G. Rickover had discussed with General Electric officials the possibility of a broad development effort, one part of which would be to demonstrate the feasibility of an intermediate reactor for submarine propulsion. They also had indications that Westinghouse was interested in reactor work at Argonne.

Mills's recommendations to the Commission focused on speed in obtaining a naval propulsion plant. Research would be necessary but engineering was more important. To hasten development Mills proposed that his bureau act as the Commission's agent in organizing and supervising the project. The group of Navy officers assigned this responsibility would have a dual status in both the Commission and the bureau.

On development plans for the naval plant, Mills urged greater effort on feasibility studies at both Oak Ridge and Schenectady. He called for more research on shielding, structural materials, fuel assemblies, and heat-transfer and power-generation systems. An integral part of his plan was a rigorous educational and training course for personnel from the Navy and industry. Thus qualified engineers and technicians would be available when an industrial organization was ready to start detailed design of the submarine reactor. Mills contemplated actual construction of only one experimental reactor, but selection of the design would have to await the outcome of preliminary studies.[9]

The General Advisory Committee considered both the Air Force and Navy projects on February 6, 1948. Never enthusiastic over aircraft nuclear propulsion, the advisory committee agreed that the Commission should make no decisions on NEPA before a study had been completed. Response to a Navy reactor was more favorable. Smith, for example, thought that a Navy project offered a concrete goal which would stimulate reactor development, but Mills's proposals on organization drew fire. Hartley S. Rowe saw in the Bureau of Ships's plans for administration an uncomfortable resemblance to those impeding NEPA. Conant added to the general feeling of skepticism by pointing out that the committee on atomic energy, which had met the preceding day, had concluded that Mills was pushing too fast. The view found ready acceptance in the advisory committee. Still, Seaborg was sympathetic to Mills's eagerness to bring in an industrial organization. Westinghouse, in Seaborg's opinion, would add the needed touch of industry to reactor development, provided its participation would not interfere with a central laboratory.[10]

Commission action did not differ greatly from the recommendations of the advisory committee. On February 18, 1948, the Commission agreed to a study of NEPA, and Carroll L. Wilson, after some weeks of negotiation, persuaded Walter G. Whitman, head of the department of chemical engineering at MIT, to direct a study to be called the Lexington project. The Whitman group was to provide a report in the fall. The Commissioners delayed action on the Navy project, mainly because the Bureau of Ships and the Commission staff needed time to formulate plans for cooperation.[11]

In the Bureau of Ships, Captain Rickover completed plans for the studies and research necessary for a nuclear submarine. He described the Navy reactor effort as largely one of studies by engineers: two or three at Knolls working on liquid-metal-cooled reactors and about twenty at Oak Ridge investigating high-pressure, water-cooled systems. These men designing reactor components had uncovered large areas in which information was lacking. Even worse, many of these fields were not under investigation. To meet these deficiencies, Rickover proposed preliminary engineering on liquid-metal, water-cooled, and gas-cooled reactors by General Electric, Westinghouse, and perhaps a third company. But studies were not enough, and Rickover went on to compile a formidable list of tasks, of which corrosion analyses, engineering designs, shielding development, and neutron measurements were only a few.[12]

Mills and Rickover were determined men who understood what they wanted and knew how to make their views heard. Mills was one of a number of persons asked to address the annual symposium on underseas warfare meeting in Washington on April 2, 1948. It was an audience of influential scientists, many of whom were outside the Government. An eloquent extemporaneous speaker, thoroughly familiar with his subject and deeply convinced of the Navy's cause, Mills depended upon an outline, notes, and a speech written earlier by Rickover. As Commissioner Strauss completed his introduction, Mills stepped forward. After asserting the military importance of the nuclear submarine, Mills moved on to what had been done. Not much, was his blunt verdict. Oak Ridge and Knolls were doing paper work. Contrary to public opinion, perhaps less than 1 per cent of the design of a nuclear propulsion plant had been completed. For this state of affairs he blamed the Commission. If the effort were given high priority, and if the Commission and the Bureau of Ships could decide how to handle the project, the nation could have a nuclear submarine in the mid-1950's. But the Commission had to move. The main obstacles lay in engineering, and industry could solve these quickly.[13] Mills sat down and a sorely tried but imperturbable and composed Lewis Strauss returned to the lectern. He glanced back at Mills: "I never thought an old friend would do that to me."

Mills's presentation had been dramatic, but it did not spur the Commission as much as he had hoped. On April 22, 1948, the Commissioners agreed that Zinn should be encouraged to make the Navy project one of his first assignments. As part of the reactor development effort at Argonne, Zinn would assign separate teams to investigate systems using water, gas, and liquid metal as the heat-transfer medium. The most promising design would receive further study as part of the laboratory's effort on power reactors, with the ultimate aim of building an experimental ship propulsion plant. The Bureau of Ships could help by loaning personnel to Argonne and by taking on some engineering work. Eventually the Commission and the bureau would have to devise procedures for administering a contract with the company that would design and construct the experimental plant. Embodied within the cautious phrasing of the Commission's position was the Delphic promise that the Navy effort would be prosecuted "with the high priority commensurate with the importance of the project." [14]

On May 4, 1948, a Navy delegation including Rear Admiral Thorvald A. Solberg and Rickover went to Argonne to explore working relations between the laboratory and the Navy. Zinn said he expected the Navy group from Oak Ridge to arrive in August, and assured his visitors that he understood the high priority of the assignment. Quickly the Navy officers raised their key issue: the participation of industry. Since the Commission had authorized General Electric at Schenectady to perform some work on a liquid-metal-cooled Navy reactor, the officers thought that the company should be given the task of independently designing a reactor and propulsion plant. Zinn did not object, but he pointed out that it was a decision only the Commission could make. As for Westinghouse, that company already had a contract with the Bureau of Ships to study ordinary water as a coolant and was negotiating with Zinn to provide technical personnel and services for reactor work at Argonne. Arguing that at this point no reactor type could be ruled out, Solberg and Rickover brought up the gas-cooled system. Zinn agreed that the Bureau of Ships should study the final report on the helium-cooled Daniels reactor and arrange for any necessary work on blowers, valves, and heat exchangers.[15]

Mills approached Lilienthal on May 12 to ask that General Electric undertake the design of a complete liquid-metal-cooled reactor and propulsion system. In the program council General James McCormack thought that adding a high-priority reactor project at Knolls after centralizing reactor development at Argonne would be rubbing salt into the wounds of Oak Ridge. A competitive project at Knolls might also give Argonne trouble in recruiting personnel. George L. Weil, chief of the Commission's reactor branch, recognized the manpower shortage. He doubted that General Electric could carry both the intermediate-power-breeder and a Navy project. If the choice were his, he would drop the breeder and concentrate on the submarine reactor.[16]

Along with Argonne and the Commission, General Electric was feeling the Navy pressure. For over two hours on May 14, Wilson and his staff talked with Harry A. Winne and Suits. Despite the Navy's insistence, they wanted to continue with the intermediate breeder. If they were directed to take on a Navy project on the grounds of national security, they would comply; but this decision would sacrifice the intermediate breeder since they did not have the manpower or facilities for both. Besides, the intermediate reactor was to be a flexible test facility, a capability they would lose in a reactor restricted to the dimensions of a submarine hull. Winne and Suits had a further argument: technology from the intermediate breeder could be applied to a Navy reactor, but a Navy project would add nothing to the knowledge of breeding. Then too, shifting the focus at Knolls from industrial applications to military purposes would inevitably entail a loss in morale. As Winne and Suits viewed the situation, the best plan was for another company—say, Westinghouse—to take on a Navy project. General Electric would cooperate fully.[17]

James B. Fisk presented the case to the General Advisory Committee on June 4, 1948. Cyril Smith continued to favor a Navy reactor as a good incentive for reactor development, but Conant, Rabi, and Worthington were not so sure. Adding to the workload at Knolls they believed might retard reactor development even more. Conant saw Navy influence on General Electric, and from the NEPA example, he doubted whether military pressure was the best way to spur reactor development. In any event, the committee was not convinced of the military need for a submarine reactor although, observed Oppenheimer, the Navy had presented the arguments often enough.[18]

Mills and Rickover had no intention of quitting. On June 16, 1948, they joined a group of Naval officers in a meeting with Bacher, Waymack, and Pike at Commission headquarters. After his colleagues had set forth the advantages of a nuclear propulsion system for urgent military missions, Mills reviewed the recommendations of the Chief of Naval Operations, the Secretary of the Navy, the Research and Development Board, and the Military

Liaison Committee. All had urged a high priority for a nuclear-powered submarine. It was possible to have such a vessel by the mid-1950's, when guided missiles carrying atomic warheads would be available. Together the submarine and missile could give the nation a major defensive weapon. To Bacher's and Wilson's doubts that General Electric could carry both an intermediate-breeder reactor and a Navy project, Mills expressed optimism gained from a recent trip to Schenectady. Because in many characteristics—neutron flux, power density, and control—the two reactors would be similar, General Electric would not have to increase its efforts greatly. Mills was satisfied with the work at Argonne, but bringing in General Electric would make possible a better choice among the possible approaches to nuclear submarine propulsion.[19]

The Commission was unmoved. On July 28, 1948, Wilson wrote Mills that the Commission could not justify a second full-scale project. Mills expressed his disappointment in a reply to Lilienthal on August 2. He saw no hope that the Commission's approach would give the nation an operational nuclear submarine "in that minimum time which a project of such importance to the national defense warrants." In an appeal to Secretary of the Navy John L. Sullivan, Mills claimed that the Commission's action conflicted with the recommendations of several boards and committees for strong industrial participation. To balance the Commission's theoretical approach to reactor development and to supplement the work at Argonne, Mills wanted to give certain tasks to industry. He would still have to depend, however, on the Commission for technical information and for access to test facilities. "It is hoped that the recent designation of Captain H. G. Rickover, USN, as liaison officer with the AEC will lead to this cooperation." [20]

Captain Rickover was not an unknown quantity. With a gift for trenchant observations on any subject, Rickover had won a reputation in the Bureau of Ships and in the Commission as a man who got results. Mills also did not relax. Through the Navy hierarchy he moved again to bring pressure upon the Commission. The battle was not over.[21]

CENTRALIZATION—COLLAPSE

Assigning the high-flux and Navy projects to Argonne did not mean that all reactor work stopped at Oak Ridge. Until personnel and equipment could be moved to Argonne, work would continue even if the luster were gone. In early 1948 Stuart McLain came to Oak Ridge from Wayne University in Detroit, where he had been a professor of chemical engineering. He found the situation confused. Leverett, head of the technical division, had resigned to be replaced by Merlin D. Peterson. Both McLain and Peterson were chemical engineers, but in dividing up responsibilities McLain took over reactor work.

He found morale poor. The uncertain future of the high-flux and the laboratory under a new contractor left the group listless. At nine o'clock one March morning McLain met with his staff. In two hours they compiled a list of jobs that needed to be done, so many that McLain discovered that his shortage was of men rather than projects.

One subject of great interest was the metallurgy of zirconium, which appeared to be highly resistant to corrosion. Earlier that metal had been ruled out for reactor use because of the high probability of capturing thermal neutrons, but now the picture was changing. Stimulated by an inquiry from Albert R. Kaufmann of MIT, Herbert Pomerance at Oak Ridge in 1947 had examined zirconium more closely. The results of his work were fascinating. It appeared that hafnium—present to a few per cent in commercially pure zirconium—was the culprit. Remove the hafnium and zirconium no longer possessed the same appetite for thermal neutrons. From a metal of limited promise for thermal reactors, zirconium became one of great potential. Weinberg hailed the work of Pomerance as "probably . . . the most useful discovery of the last two years in any AEC laboratory." Admittedly the task of removing hafnium from zirconium was difficult, for the two elements were chemically similar.[22]

McLain saw a more immediate challenge in fabricating beryllium as a reflector for the high-flux. While the metal had good nuclear characteristics, it was brittle and hard to shape. He also decided to resume work on the mechanical mock-up of the reactor. This would shed light on several unknowns, particularly on the hydraulic system. The way in which his group settled to work convinced him that it was best by far to forget politics and devote full time to the job at hand. He called this philosophy the engineering approach.

Not everyone had the same outlook. Some people at Oak Ridge refused to accept the loss of reactor work and began a campaign to overturn the decision. Their strategy was to propose for their laboratory a low-power version of the high-flux reactor. Such a project might receive Commission approval because it would not need elaborate water-cooling systems or expensive and complicated chemical and metallurgical facilities. Weinberg was enthusiastic over the possibilities. Once the laboratory got a new reactor, the shackles of centralization would be broken. Weinberg saw a future for Oak Ridge in reactors because of the history of Berkeley, where one accelerator had led to others. The first step was the most important. To his delight, Weinberg discovered that Zinn did not interpret centralization as giving him the power to veto the reactor plans of other laboratories.[23]

With increased confidence Weinberg began to move. His plan for Oak Ridge he related to Zinn at the April, 1948, information meeting at Brookhaven, one of a series of gatherings at which scientists from the several laboratories met to give papers and hold discussions. Weinberg proposed that

Oak Ridge and Argonne each construct a research reactor, with the high-flux located in some remote area. On May 20, 1948, he offered Zinn another idea. Although the high-flux could probably be redesigned so as to meet the safety standards for either laboratory, Weinberg thought the reactor was too big and powerful for Zinn's research needs. Even if a redesigned high-flux could be built at Argonne, Zinn would still want a low-power research reactor. It might make more sense, Weinberg wrote, to build the high-flux at Oak Ridge and a research reactor at Argonne. While the Tennessee laboratory would concentrate on solid state physics, the Illinois laboratory would stress reactor design, and both groups would work together.[24]

In Wilson's office on May 29, 1948, Weinberg, C. Nelson Rucker, and several others from Oak Ridge presented their case. Rucker wanted to construct a low-power version of the high-flux reactor for research and isotope production. For economy he proposed to build the reactor in one of the Y-12 buildings, even if this location meant separating the facility from the radioactive chemistry work at the X-10 site. Wilson and John C. Franklin objected that expediency and minor economy were hardly good grounds for planning a strong laboratory. Weinberg founded his arguments on the need of Oak Ridge for neutrons. A large part of the laboratory research was already limited by the low neutron flux from the old X-10 reactor. If Oak Ridge were to be strong in research and the center of isotope production—as the Commission had promised—a new research reactor was necessary. Wilson and Fisk must have listened uneasily as Weinberg used the Commission's pledge for a strong Oak Ridge as an attack on centralization. However, Zinn was responsible for reactor development and would have to be consulted. On June 9, 1948, Fisk wrote Zinn to ask whether there was a reactor design suitable for Oak Ridge. If so, could the reactor be built without interfering with other reactor projects? Fisk also suggested that Zinn and Weinberg work together on the research reactor requirements of both laboratories.[25]

At Argonne on June 14 and 15, Weinberg and Zinn dealt with Fisk's questions fairly easily. They agreed on a modified high-flux reactor for each laboratory. Although both reactors would be based upon the high-flux design, they would operate at power levels to be determined by the reactor safeguard committee. Weinberg and Zinn did not think that building these units would penalize reactor development. Constructing the two reactors would provide valuable experience for the high-flux itself. Furthermore, close cooperation between Oak Ridge and Argonne would yield dividends by bringing more people into reactor development. Unlike Zinn, Weinberg had to justify a reactor at Oak Ridge. From discussion with Zinn and Fermi he decided to rest his case on the laboratory's responsibility for producing radioisotopes.[26]

Rucker listened with interest to Weinberg's report on his Argonne trip. Because the Commission and Carbide were in the midst of selecting an architect-engineer to plan the new laboratory facilities, Rucker thought the time was ripe to press for a decision. He suggested on June 18 that Fisk meet with representatives of Argonne and Oak Ridge for further talks.[27]

The two laboratories were redesigning the high-flux to meet the criteria set by the safeguard committee. One hazard was that a reactor core might melt down if the flow of cooling water were interrupted. Since the core was to be submerged in a tank of water, the designers had to determine whether natural convection would be sufficient to remove the heat before meltdown. Zinn ran several tests in which an electrically heated fuel element in a tank of water was carried to temperatures above those expected during reactor operation. The results were favorable. Of particular importance to Zinn was the fact that Teller witnessed one of the tests. Teller was also serving as a consultant on a redesigned high-flux which, operating at 10,000 kilowatts rather than 30,000 kilowatts, might be suitable for Argonne. As an additional safety factor, Argonne was thinking of housing the reactor in a structure which would contain vapor and gases. A major difficulty was preserving the integrity of the containment while providing access for personnel and equipment.[28]

At Hanford in June, the Teller committee tried to frame the problem of reactor siting in mathematical terms. Simply stated, the higher the power level the greater the area over which control was needed. Ideally a reactor location should meet three criteria: complete Commission control over the immediate area; a population of less than 10,000 in the surrounding country; and no installations vital to the nation's defense in the region.[29]

The formula caused Zinn to pause. He had promised Weinberg a reply to Fisk on a reactor for Oak Ridge, but the reactor safeguard committee once again had forced a review of the Commission's reactor plans. On July 23, 1948, Zinn wrote a long letter to Fisk. There were three projects to consider: the high-flux and the research reactors for the two laboratories. Zinn dealt with the high-flux first. Since no Commission installation met the safeguard criteria, Zinn was inclined to strip away the pretense that the effort was going ahead. If the work were stopped, there would be no need to uproot Oak Ridge people and move them to Argonne. He would carry on with reactor development as best he could, using experimental data from research and production reactors. Of course, if the Commission decided to acquire a reactor proving ground, Argonne would be glad to work on the high-flux. Zinn stressed that he did not consider it his role to pass on the reactor plans of other laboratories. In his opinion, a good design for a reactor suitable for Oak Ridge did exist, but only the Commission could decide whether to construct it. Turning to Argonne, Zinn was not certain what power level and reactor type would be acceptable to the safeguard committee. Admitting the impact of safety factors on reactor planning, Zinn did not think the concern unreasonable. Realistically he observed: "I am inclined to the opinion that for a nation with the land space of ours and with the financial resources of ours, adopting a very conservative attitude on safety is not an unnecessary luxury."[30]

The attempt to centralize reactor development at Argonne had collapsed. One reason was the irrepressible spirit of the scientists at Oak Ridge. Fisk's announcement of the decision during the Christmas holidays of 1947 had been devastating, but a mere declaration of policy could not suddenly halt research that already had momentum. Indicative of the resurgent spirit of the laboratory was the exuberance with which Weinberg was proposing one reactor after another. Moreover, Zinn had weakened centralization further when he insisted upon limiting his authority to activities at Argonne. He did not intend to settle policy questions which were Washington's responsibility. This he made clear on July 23, 1948, in returning to Fisk a sheaf of questions which only Washington could decide. Centralization might have made sense in terms of coordinating research activities; but if it meant that one laboratory was to pass on the proposals of another, then the idea had failed.

ORGANIZATION AND THE NAVY

If the hopes for centralization were now dead, Wilson and Fisk would have to devise some new principle of organization for reactor development. Long before Zinn sent his letter from Chicago, Wilson had been pondering changes in the Commission's organization. He had never regarded the administrative structure as rigid, and he had encouraged comments from such close associates as Fisk and McCormack. Reactor development in particular had never lacked for criticism. At the General Advisory Committee meeting on February 8, 1948, Oppenheimer had spoken of the tension between reality and desire. The continued lack of progress on reactors had only deepened that feeling. On June 5, Oppenheimer had delivered to the Commissioners a stinging indictment of the agency's structure, particularly of reactor development. On this subject Oppenheimer had summed up the attitude of his committee: "We despair of progress in the reactor program." Harsh as these words were, the committee was only adding the force of its prestige and impatience to changes already being planned.[31]

Some of the changes Wilson was considering had come from the Navy's efforts to organize development of a submarine propulsion plant. One of the principal concerns for Mills and Rickover had been the creation of a structure that would give industry a larger role than was possible under the 1948 centralization plan.

In this conviction the Navy officers had support from the Commission's own industrial advisory group, a small number of industry and utility executives who had taken the temporary assignment of surveying the Commission's activities for commercial opportunities. After observing activities at Argonne, Isaac Harter, chairman of the board of Babcock and Wilcox Tube Company, had expressed his concern over the lack of balance between physicists and engineers in the Illinois laboratory. Unless Zinn brought engineers into the submarine project early, Harter feared that the physicists might overlook the best design for the reactor.[32]

Donald F. Carpenter, also at one time a member of the industrial advisory group, had similar worries. Now serving as chairman of the Military Liaison Committee, Carpenter visited Argonne in August, 1948, along with members of a special committee he had appointed to examine the long-range objectives of the atomic energy program. Like Harter, Carpenter feared that the lack of engineering experience at Argonne would delay the Navy project. Zinn seemed to understand the difficulties of the assignment, but he was wary of bringing private industry into the early design work. Carpenter did not agree that an industrial contractor would necessarily assign mediocre engineers to the project, and he left the discussion with the disconcerting impression that Zinn was not aware of the high priority the Navy had assigned to the Argonne project.[33]

Fully convinced that Argonne needed more engineering perspective, Carpenter was not prepared to let the matter rest until Wilson and Fisk reorganized the Commission's reactor development program. Back in Washington Mills and Rickover cited a lack of Commission interest in the Navy project as the real source of trouble. At Mills's suggestion Carpenter proposed a meeting with Wilson and his staff. The purpose was to convince Wilson that the Commission and the Navy should jointly select one or more companies to start development of the reactor with the understanding that a contract for building the propulsion plant would follow. Mills and Rickover recommended a contract with General Electric, but they also wanted to consider Westinghouse.[34]

Wilson was reluctant to accept the Navy proposals at the meeting on August 25. The general manager and his staff were then deeply involved in the throes of reorganization. These plans included the establishment of a division of reactor development with responsibility for Argonne and reactor work at other Commission laboratories. Wilson hoped soon to appoint a director of the new division, and he wished to delay a decision on the Navy project in the meantime.

A more fundamental objection to the Navy proposal was Wilson's dissatisfaction with General Electric's performance at Hanford. Furthermore, Wilson had received from General Electric a letter stating that the company did not want the Navy project. Wilson's statement contradicted the Navy's understanding of the company's position. Rickover read a statement from Winne that "within the limits of available manpower and facilities the General Electric Company is willing and anxious to design and build a reactor suitable for use in a naval vessel."

When Fisk objected to putting so much reactor effort into naval propulsion, Mills and Rickover pointed to the danger of allowing the experience and knowledge of General Electric to evaporate. The company, they claimed, was willing to accept the assignment, and Zinn agreed that more than one approach was healthy. When the discussion turned to Argonne, Rickover stated that Westinghouse had authorized him to say that the company was anxious to design and build a Navy reactor.[35]

Obviously the Navy had to clarify General Electric's position. On September 3 Winne and his staff explained to Rickover in Schenectady their plan to complete the intermediate-power-breeder as the first shore-based prototype for the submarine. The company would then construct a second reactor on land or on a ship. If the second were on land, still a third would be needed for shipboard tests.

The open-ended nature of the proposal troubled Rickover. He also saw possible significance in a recent opinion of Carpenter's long-range objectives panel which cast doubt on the prospects of breeding, particularly at intermediate neutron energies. Perhaps the company's strong interest in the Navy project was an attempt to buttress the sagging fortunes of the power breeder. Rickover also realized that intermediate reactors would require more fissionable materials than those using slow neutrons. Thus for a given amount of fissionable material, the Navy could operate fewer submarines powered with intermediate reactors. For all these reasons, Rickover warned Mills not to become too deeply committed to the General Electric proposal. The best course would be to fight for a larger role for the company in the project. Once that struggle was won, the Commission and the bureau could decide where the company should place its efforts.[36]

WILSON DRAFTS A PROGRAM

All these discussions in the spring and summer of 1948 had made Wilson acutely aware of the need for some clear directions in reactor development, and he gave this subject his personal attention. It was not easy to weave into a coherent pattern the strands from Argonne, Oak Ridge, and Knolls, together with those held by the Navy and the Air Force. Wilson decided to confine his analysis to the next two or three years; to predict further was impossible. On production reactors, he called for a major effort for improved development and design. Because General Electric was already so heavily committed, he thought another organization should be assigned to the task.

Wilson found exploration of nuclear power heavily biased toward breeding. Although the growing supply of uranium was making this less important, Wilson thought that Zinn's fast reactor and the Knolls intermediate project were too far along to be canceled. Yet, if Zinn's reactor could not be built at Argonne, the project became less attractive. He concluded that General Electric should push the Knolls reactor vigorously and, if the company could do so without interfering with this project, take on the design and construction of an intermediate reactor for the Navy. Power reactors fueled with natural uranium Wilson saw as a neglected field, but certainly worthy of study. Production of isotopes was important to many parts of the Commission's program, but analysis was needed to determine whether this purpose justified building a special reactor, or whether existing facilities were adequate. Little was required on the Air Force–NEPA effort except materials studies; certainly design and construction of an aircraft reactor were premature. The Navy effort at Argonne, Wilson thought, was ready for help from Westinghouse on engineering design.

The final reactor in Wilson's survey was the high-flux. Testing materials and proving the technology of controls, coolants, and other reactor components would be the two main uses of the high-flux which, since it was to advance reactor technology, Wilson called the "reactor's reactor." Fundamentally he questioned both purposes. The Argonne and Knolls reactors could be adapted to testing components. Furthermore, the high-flux would not meet all the requirements for testing materials. The reactor itself was of experimental design. Even with top priority, it would be at least two years before operation could begin and even longer before results from testing materials would become available. Wilson thought that possibly a Hanford reactor might be modified to provide the neutron fluxes needed for testing materials. He concluded that there was no reason to rush into acquiring perhaps 400,000 acres for a remote proving ground.

Wilson also wanted to investigate the need for an isolated chemical separation plant to process used reactor fuels. He saw a vigorous reactor program as dependent upon a variety of research and development efforts in several locations, all coordinated in a definite program. Wilson sent his summary to the program council on September 20, 1948, in preparation for later talks with Zinn.

On the same day Bacher directed a memorandum on reactor development to his fellow Commissioners. He admitted that progress had been disappointing and slow; the reasons he found were at least partly technical. Effects of radiation, corrosion, and high temperatures upon materials, to name but a few difficulties, had proved far more serious than expected. In addition, he believed that preoccupation with producing fissionable material and weapons had preempted talent which might otherwise have been used to attack reactor problems. Bacher saw progress in the two new production reactors at Hanford which incorporated several technical advances. The Los Alamos fast reactor was providing important information for this type, and the Brookhaven research reactor was nearing completion. Nonetheless, the need for a reactor development program was pressing. The main parts of this effort he saw as the high-flux, the submarine reactor, the Zinn fast breeder, and the Knolls intermediate breeder. Unlike Wilson, Bacher deemed the high-flux reactor urgent and, because of the restrictions established by the reactor safeguard committee, felt that a proving ground was imperative. Above all Bacher wanted to avoid protracted discussions.[37]

Wilson asked Zinn on September 28 to come to Washington. The two men spent much of Saturday, October 2, discussing reactors. On October 5 Wilson lunched with Bacher. That afternoon Wilson spent in the recesses of the Cosmos Club on Lafayette Square where, in the rooms once known to Dolley Madison, he recast his reactor program. Many of his ideas of September 20 remained, but the influence of others was evident. On materials testing, the possibility of using Hanford reactors was to be studied, but the high-flux reactor—now designated the materials testing reactor—was advanced to the status of a major project. From the higher standing of the high-flux, it followed naturally that the remote proving ground gained importance. Specifications, plans, and surveys were to begin at once on a schedule permitting the Commission to exercise a choice by February 1, 1949.[38]

For further advice Wilson met in New York on October 11, 1948, with Whitman of the Lexington project; Oliver E. Buckley, president of the Bell Telephone Laboratory and a new member of the General Advisory Committee; Crawford H. Greenewalt, president of du Pont; Charles A. Thomas of the Monsanto Chemical Company; and Eger V. Murphree, president of Standard Oil Development Company.

Wilson wanted candidates for the position of director of reactor development, and opinions on his program. Greenewalt sent his impressions to Wilson a few days later. He thought that chemical problems were far more important than Wilson had indicated; such at least had been the du Pont experience during the Manhattan days. Nor did Greenewalt believe there were enough competent physicists and engineers available to man so many reactor projects. Zinn, for example, would be saddled with three reactors. Zinn was undeniably competent, but he might be spreading himself so thin that none of his projects would go well.[39]

Wilson had done nothing to relieve the uncertainty at Oak Ridge. Disturbed by the lack of information from Washington, Franklin finally wrote Wilson on October 14 to request that he or someone from Oak Ridge be present during the final discussions. He wanted to understand the basis for the decisions, and he obviously felt that the laboratory was receiving shabby treatment. Nearly a year had elapsed since the Commission had stripped Oak Ridge of the high-flux reactor. Still the Commission had not decided whether to build the reactor, where to put it, or who would undertake the task.[40]

A QUESTION OF SAFEGUARDS

Wilson's efforts to chart a course for reactor development would help the laboratories judge the feasibility of their own plans; but Argonne, Oak Ridge, and Schenectady could not move much beyond the planning stage until the Commission somehow settled on criteria for determining where the proposed reactors might be safely operated. Experience had shown that these questions were highly technical and very complex. If there were to be answers, they were mostly likely to come from Teller and the reactor safeguard committee, which would meet in the fall of 1948.

Zinn's first concern was reactor power levels at Argonne. He wanted to know what the committee would accept for a fully moderated thermal reactor and for a research reactor based on the high-flux design but with additional safety features. Would the safeguard group object to a high-flux research reactor operating at 2,500 kilowatts? Zinn suggested the committee focus on reactor operations at Argonne, for he did not intend to build a chemical processing plant at his laboratory.[41]

The Oak Ridge group hoped the committee would consider a 3,000-kilowatt, high-flux research reactor which could be modified to reach the original design power of 30,000 kilowatts. As Weinberg pointed out, the committee had never been asked to evaluate reactors at Oak Ridge. Bacher

and Fisk asked Weinberg to prepare data for the September meeting of the Teller committee and to assemble information on costs, schedule, and engineering requirements for the Commission and the General Advisory Committee. While all of this was encouraging, Weil could not promise that the committee would take the time for a formal answer.[42]

Schenectady was pressing for approval of a nearby site for the intermediate-breeder reactor. According to Kingdon, preliminary grading at the site should soon begin if the reactor were to go into operation in late 1950. In November, 1947, the reactor safeguard committee had flown over possible sites near Schenectady. The one Suits liked was about twenty miles north of the city, near the village of West Milton. For an independent opinion Wilson had turned to Carleton Shugg, manager of the Commission's Hanford office. Shugg's comprehensive site study, completed on July 30, 1948, had confirmed the advantages of West Milton. Winne asked for authorization on September 7 to acquire the site and begin construction.[43]

Kingdon, with help on theoretical problems from Harvey Brooks, had prepared an impressive report on the intermediate reactor. The critical assembly, located at Sacandaga near Schenectady, was functioning well and providing what both men hoped would be all the nuclear data required, not only for the specific intermediate reactor under design, but also for others of the same general type. Experimental work was under way on two types of fuel, and the laboratory, while slightly behind schedule in exploring the qualities of the sodium coolant, was encountering no real difficulty. The only somber reports came from Hanford, where radiation tests were casting some doubts on the possibility of breeding at the neutron energies planned for the intermediate reactor.[44]

The reactor safeguard committee was also to consider Zinn's suggestion that the Commission acquire a remote proving ground. One of the most promising possibilities was uncovered by Carl H. Giroux, a special assistant to the Chief of Engineers of the Army who had served as consultant to the safeguard group. Giroux in June, 1948, suggested the Fort Peck area in northeastern Montana. Population density was low, the land was generally poor for farming or grazing, water was abundant, and electric power was available from the Fort Peck dam. Zinn guessed that perhaps five reactors might be built on the proving ground over the next ten years. Perhaps an area of about 100 square miles would be needed for a number of reactors which might total 500 megawatts. Water and power supplies he found difficult to estimate; some reactors might require comparatively little cooling water and some might even produce power. The only danger Zinn saw was that the Commission, by assuming large numbers of reactors and no improvements in the handling and disposal of chemical wastes, might draw up requirements so rigid that no place in the United States could satisfy them.[45]

On September 8, 9, and 10, 1948, the reactor safeguard committee studied documents, heard briefings, and discussed the thorny problems of reactor safety. Perhaps the easiest of the subjects was the testing ground. Acknowledging that nearness of population centers had conditioned their earlier considerations of reactor projects, the committee over Teller's signature formally recorded itself "most enthusiastically in favor" of a large and remote proving ground.[46]

Not so easy were the questions which Zinn had asked. After four hours of deliberation, Teller presented a statement which, he remarked, was not what the committee wished to say, but what it was forced to say. In the light of existing knowledge, the committee was not likely to recommend a reactor power level at Argonne greater than 1,000 kilowatts. In dismay, Huffman searched for ideas that might have permitted a higher power level. The committee could only suggest better automatic and foolproof safety devices, but these would have to be demonstrated. To Huffman this response amounted to suggesting construction of a 1,000-kilowatt reactor to demonstrate the devices before building at Argonne a 1,000-kilowatt reactor with the devices. The only grounds the committee could see for increasing the power level would be a directive from the Commission stating that the international situation required more risks. The committee, explained Teller, was uneasy over hazards within 12 miles of a reactor operating at 1,000 kilowatts, and afraid of potential danger within 24 miles of a 4,000-kilowatt reactor. Although the committee would not take the responsibility for recommending a higher power level, they believed that a 1,000-kilowatt reactor—perhaps more than one—could be built at Argonne. Only the preceding April, Zinn had told the General Advisory Committee that, based on his interpretation of the safeguard criteria, a heavy-water-moderated, natural-uranium research reactor of 5,000 kilowatts or a high-flux reactor of 1,600 kilowatts would be safe for Argonne.[47] Now he faced restrictions which left him less leeway.

Because the agenda was full, the committee refused to consider the question of building the high-flux at Oak Ridge, but Weinberg now proposed two sites in the Cumberlands some 20 miles from the gaseous-diffusion plants.

How, he asked, would the committee compare a 2,000- to 4,000-kilowatt research reactor at the laboratory with a 30,000-kilowatt reactor at one of the Cumberland locations? Teller replied, speaking only for himself, that the larger reactor 20 miles from the laboratory would be more likely to receive approval.[48]

General Electric's West Milton site raised two questions for the Teller committee: one on general zoning regulations for reactors operating at considerable power levels, and another on applying these standards to West Milton. In the abstract, the committee decided that two concentric zones should surround each reactor site. The zone nearest the reactor would be a controlled area—one in which an accident could cause acute danger. While the radius of the controlled zone could be determined by a formula based on power operating level, such was not the case for the second zone. Designated the "hazard area," this zone was determined by the type of reactor and by meteorology, hydrology, and seismology. Within this zone the danger from an accident was considered small; thus population and industry would not be excluded. Applying these criteria to West Milton, the committee recognized that Schenectady, Albany, and Troy would be at the outer edge of the hazard zone. More development work on the reactor would be necessary before the committee could give its final judgment, but the West Milton site looked acceptable.[49]

STRUGGLING TOWARD DECISIONS

The reactor safeguard committee had been helpful on technical matters, but the policy decisions would still be difficult. The reservations the Commissioners expressed on September 10 in approving the West Milton site illustrated some of the problems. General Electric's proposal was clear enough and seemed to meet the technical criteria which Teller's committee had established. Assurance of safe and effective operation, however, seemed to involve other matters. Waymack suggested the need for frequent safety reviews, and Bacher urged the Commission to ask General Electric for a formal statement that the company had approved the site. Lilienthal was so concerned that he insisted upon discussing the company's views directly with Winne and Suits. On September 21, Lilienthal warned Winne that approval of the site was not a commitment to build the reactor. Bacher expressed his concern that operating restrictions imposed by the location at West Milton might limit the value of the project. Strauss added his view that the Commission would not let financial commitments override considerations of safety. General Electric could hardly interpret the Commission's action as a blanket approval of the proposal.[50]

The committee's recommendation of a remote proving ground raised new questions about the high-flux. Weil suspected that engineers would be more likely than physicists to use the reactor at a remote site. This thought suggested the possibility of redesigning the reactor to make it more useful for testing materials, and dropping some of the proposed facilities for basic research. Informal conversations convinced Weil that others shared his reservations. Only after a long meeting with twenty-six other reactor experts in early October did Weil decide that the basic design was adequate.[51]

Weinberg himself had introduced a new uncertainty by proposing to build a 15,000-kilowatt model of the high-flux in the nearby Cumberland mountains of Tennessee. On October 11, Weinberg told Shugg, now in Washington as deputy general manager, that building the high-flux at a remote site would result in still another Commission laboratory and place still greater demands on the limited supply of skilled manpower. The meeting did nothing to raise Weinberg's hopes. It seemed to him that Washington meddling had plagued the high-flux from the start. Now he heard rumors that Zinn was losing interest in the project, which supported almost a hundred scientists and technicians at Oak Ridge. The next day Weinberg wrote Zinn to suggest that the two laboratories carry the high-flux as a joint venture, with as little intervention as possible from Washington.[52]

The decision, when it came, offered Weinberg some consolation. True, the high-flux would be built at a remote testing station, but the project would be a joint effort of Argonne and Oak Ridge. Weinberg's group at Oak Ridge would be responsible for the design; Argonne would take over engineering and construction. Franklin was disappointed when he received the news from Wilson by telephone on October 29. Oak Ridge had lost the high-flux and would have only a secondary role in its development. He feared a loss of morale and the departure of most of the Oak Ridge physicists engaged in basic research. Only after a few days' reflection could he appreciate the fact that, after all, the high-flux would now be built and that Oak Ridge would have a part in it.[53]

Zinn and Weinberg promptly set up a three-man steering committee under McLain to direct the joint project. The selection of McLain was Zinn's decision, for Wilson and Weil knew little about him. Reporting to McLain were Marvin M. Mann of Oak Ridge and Huffman of Argonne. Both were thoroughly familiar with the high-flux and were to serve as project leaders at their respective laboratories. Mann's speciality was gathering nuclear data through critical assemblies, while Huffman's concern was design, materials testing, and procurement. McLain, Mann, and Huffman had the immediate responsibility; Zinn and Weinberg would resolve any differences. The organization was ready but, as Zinn warned Shugg, effective work could not begin until a site was chosen.[54]

The Commission was moving toward selecting the reactor proving ground. Ralph P. Johnson had outlined site requirements for the program council on September 17, 1948. First among the reactors Johnson listed the high-flux, followed by reactors for isotope production, Navy propulsion, and breeding, and finally and far into the future, for aircraft propulsion. The council estimated requirements for water, electric power, and fuel processing facilities. During the fall of 1948 the division of engineering under Roger S. Warner studied a score of sites. Of these the most promising seemed to be Fort Peck, Montana. Secretary of the Interior Julius A. Krug, a friend of Lilienthal's from TVA days, saw no objection to Fort Peck, provided the reservoir and Willow Creek would not be contaminated. Admiral John E. Gingrich of the division of security found Fort Peck reasonably secure from air and ground attack. The reactor safeguard committee found Fort Peck the best choice, but warned that no site on any main river system was desirable unless provision were made for containment or disposal of radioactive wastes.

Impatient of delay, Shugg was ready to accept Fort Peck even though Zinn was still dissatisfied and was looking for a location closer to Los Alamos. The main thing in Shugg's mind was to get started on construction. Despite his efforts, the Commission failed to act before the end of 1948. By that time Warner had been able to draw on other Government agencies for ideas, and the U. S. Geological Survey had found several advantages in a location near Pocatello, Idaho. Now, as Shugg feared, there would be further delays. In the meantime, development work was picking up on the fast-breeder, the high-flux, and the submarine reactor, all of which were destined for the testing station. The Commission had taken some forward steps in deciding which reactors it would build, but the failure to select the remote site posed a continuing threat to steady progress in reactor development.[55]

A REACTOR FOR THE NAVY

As Rickover was probing the role of General Electric in the Navy effort during the late summer of 1948, Harold Etherington completed a preliminary study of a water-cooled reactor. Most of the data he had gathered as director of the power pile division at Oak Ridge. He had focused the effort on a submarine reactor which could be constructed by using conventional industrial techniques as much as possible. Analyzing calculations and test results from several sources, Etherington and his group concluded that a water-cooled thermal submarine reactor was feasible, provided they could master problems of control, corrosion, fuel element fabrication, shielding, and the breakdown of water under irradiation. Except perhaps for the design of reactor controls, the selection of metals for reactor components promised the greatest challenge. Metals for structural parts would have to absorb few neutrons, resist corrosion, and maintain integrity under irradiation. The same desirable qualities were needed in fuel cladding. For both uses, beryllium and

WIDE WORLD

SEEKING AGREEMENT ON ANGLO-AMERICAN COOPERATION / David E. Lilienthal meets with Secretary of Defense Louis A. Johnson (center) and Secretary of State Dean G. Acheson (right) on July 27, 1949, before a hearing with the Joint Committee on Atomic Energy.

ROBLEY L. JOHNSON

COMMISSION OFFICIALS AT HANFORD, SEPTEMBER, 1949 / Deputy General Manager Carleton Shugg (right) discusses production matters with Hanford Manager Frederick C. Schlemmer (center) and Deputy Manager David F. Shaw.

WIDE WORLD

PRESIDENT TRUMAN GREETS PRIME MINISTER ATTLEE, DECEMBER 4, 1950 / Attlee arrives in Washington to discuss the atomic bomb and Korea.

UNITED PRESS INTERNATIONAL

OLD FRIENDS, JANUARY 5, 1952 / Truman and Churchill at the Washington National Airport. The British leader had come to discuss several aspects of Anglo-American relations, among them atomic energy. Foreign Secretary Anthony Eden stands on the steps.

zirconium were the leading candidates. On the basis of available data, beryllium seemed to possess the best nuclear properties while zirconium appeared more resistant to corrosion. As yet Etherington had no grounds for selecting one over the other.[56] Moreover the study was admittedly preliminary, and Argonne was still considering other coolants.

The Westinghouse Electric Corporation was the logical choice as the industrial contractor to develop a pressurized-water submarine reactor. The company had long been interested in entering the nuclear energy field. In June, 1948, Westinghouse had signed a contract with the Bureau of Ships for Project Wizard, a heat-transfer study based on water. Project Wizard was somewhat similar to General Electric's Project Genie, a study of sodium as a heat-transfer medium. Rickover and Mills had thought of bringing in a third company—perhaps Allis Chalmers—to work on a high-pressure gas-cooled reactor, but Wilson was hardly prepared to go so far. In his thinking, Westinghouse development of a water-cooled reactor was the main effort for the Navy.[57]

Zinn had long understood that after Argonne had designed a water-cooled reactor, an industrial contractor would take on detailed engineering, construction, and operation. But Zinn saw Navy pressure and the Westinghouse-General Electric rivalry as forcing the pace of development. He wanted to be certain that Westinghouse did not weaken the growing competence of Etherington's Navy group. Furthermore, Zinn wrote Shugg on November 8, "There is some justification for the opinion that the reactor program has in the past lacked sufficient firmness and concreteness of purpose." Zinn thought Argonne had gone far toward remedying this situation, and he did not want to see the gains jeopardized.[58]

Not until December 10 did Charles H. Weaver of Westinghouse sign a letter contract committing the company to construct a thermal submarine reactor propulsion plant, designated as Mark I. Westinghouse had already surveyed the Pittsburgh area for a suitable plant site and had selected the Bettis airport, some 8 miles from East Pittsburgh.[59] The company understood that the first Navy reactor would be a land prototype built somewhere on the Western plains.

While Westinghouse, the Navy, and the Commission had reached agreement, General Electric's role was still uncertain. During the fall of 1948, Kingdon and Suits had proposed to continue work on the intermediate breeder and to add the construction and testing of a full-scale mock-up of a submarine power plant. Experience from both projects would help the company in building a full-scale reactor system which, for greater flexibility, would be placed on a surface ship. Both Shugg and Rickover questioned the proposal and wondered if it were motivated in part by a desire for more laboratory facilities. In Schenectady on December 9 Rickover convinced General Electric to postpone the decision on whether to build the land- or ship-based unit. In the meantime, the company would prepare cost estimates and schedules for both an intermediate reactor and a thermal-neutron plant for submarine propulsion.[60]

To a certain extent Shugg's actions were properly those of a director of reactor development. Blunt, plain-spoken, decisive, and energetic, Shugg possessed qualities needed for the task. Wilson considered the arrangement temporary, but he was finding it easier to get Commission approval for the reactor program than to recruit a director to carry it out.

A DIRECTOR AND A PROGRAM

Wilson presented his reactor proposals to the Commission on October 19, 1948. He had built his plan around four projects: the materials testing reactor, as the high-flux was now known; the Zinn fast-breeder; the intermediate breeder at Schenectady; and the Navy-Argonne submarine propulsion reactor. Three of these would be constructed at the remote proving ground. Wilson noted that General Electric's cost estimates for the intermediate breeder were increasing and included some facilities which he and McCormack thought unnecessary. Furthermore, Navy interest in a General Electric project could add to the Commission's capital outlay. Bacher favored resisting the Navy pressure and holding General Electric to the intermediate reactor. On the aircraft propulsion reactor, Wilson promised to make recommendations based on the September report of the Lexington group. Oak Ridge, however, could carry on some experimental work.[61]

The General Advisory Committee considered Wilson's plan in late October, 1948. At Oppenheimer's suggestion, the members divided the subject into categories: aircraft reactors, the testing ground, and the over-all program. Conant and Oppenheimer thought a joint Commission–Air Force organization was decidedly premature. They were still not convinced that a nuclear-propelled aircraft was important. In the fifteen years of expensive development forecast by the Lexington report, many factors such as new metals or more powerful chemical fuels might lessen the urgency of nuclear propulsion. In view of the high cost in manpower, fissionable material, and money, the committee agreed with the Lexington group that the decision should be a matter of national policy. On Navy reactors Buckley spoke the mind of the committee in observing that one project was enough for the present. Wilson's remarks on a testing ground evoked no enthusiasm.

All of the committee felt that the Teller group had exaggerated the consequences of a reactor accident and perhaps without adequate justification had retarded reactor development. Fermi warned against separating reactor operation from development. He recalled that such a division had almost led to failure during start-up of the Hanford reactors in 1944. Perhaps, however, organizing the testing station as a branch of a reactor development laboratory could lessen the evils he foresaw. To Oppenheimer and the rest of the committee, Fermi's idea seemed sound: obviously Argonne should be closely linked to the testing station.[62]

The committee accepted the Commission's program, but without enthusiasm. For Fermi reactor development had lost its savor. The exciting and zestful days when a small group of men could plan, design, and operate a reactor to perform their own experiments were passing, and in their stead were mounting numbers of regulations unleavened by any measure of vigor. It was not strange that he should feel this way. He, like most members of the General Advisory Committee, could recall the excitement of years when vision and daring had brought so much. Against this past he saw the Commission's program marked by caution, hesitancy, and weakness.

The advisory committee had helped Wilson to clarify his ideas. Before seeking a final approval from the Commissioners, he decided to add a study of a homogeneous reactor. For months Weinberg had been pressing hard for exploration of a homogeneous system, in which the fuel would be fissionable material carried in a circulating slurry. This approach avoided the high cost of fabricating fuel elements and offered the possibility of continuous chemical processing of the fuel. The main difficulty would probably lie in finding some material for the reactor vessel and piping that would withstand the highly corrosive fuel slurry. Another potential problem was bubbling, which might occur if the fissionable material concentrated unevenly in the slurry and caused hot spots. Still, the potential benefits of the homogeneous system seemed to outweigh the disadvantages. Furthermore, including the reactor would give Oak Ridge an interesting new project.[63]

The Commission approved Wilson's reactor plan on November 10, 1948, but not without some qualifications. Bacher advised Wilson to make sure that the laboratories understood the difference between the four reactor projects and other studies. He was thinking especially of the Navy study at Schenectady and the aircraft work at Oak Ridge. The Commission would provide reasonable support for these efforts, but they could not be permitted to interfere with the four-reactor plan.[64]

Wilson was having difficulty finding a director of reactor development. He enlisted the aid of others but the uniform failure of his efforts was depressing. To Murphree, Wilson wrote on December 17: "Personally, I have found it very discouraging that there seemed to be so few people with the necessary qualifications and the pioneering urge among the many industrial people with whom I have discussed this matter and whom I have considered." The solution was nearer at hand than Wilson realized. Lawrence R. Hafstad was growing weary of his position as executive secretary to the Research and Development Board.[65] Wilson, McCormack, Fisk, and Johnson knew of Hafstad's restlessness and of his qualifications as a physicist and as director of research at the Applied Physics Laboratory of Johns Hopkins University. Their persuasions had been unsuccessful until Admiral Mills learned of the matter. To Mills, Hafstad had two important qualifications. He had been an able executive secretary and, perhaps even more important in the Admiral's view, believed in the need for a nuclear submarine. Hafstad, convinced of the importance of the position, accepted Wilson's offer of January 12, 1949. It was virtually Mills's last effort to advance Navy reactors. In ill health, he was forced to resign in March, 1949.

SELECTING THE IDAHO SITE

Hafstad's first assignment from Lilienthal was to examine the plans for a testing station. To help in the final choice between the Idaho and Montana sites, Warner had brought in a Detroit engineering firm, Smith, Hinchman and Grylls. After comparing such factors as isolation, drainage, climate, and population, the Detroit firm early in February, 1949, issued an opinion favoring Pocatello. A formal report, containing more data, would follow but the first evaluation would enable the Commission to act.

If the Commission could acquire the Navy reservation near Pocatello, active site work for the materials testing reactor could begin within the year. On February 14, the program council recommended that the Commission acquire the Navy land. Teller's committee had already studied the topographic, seismic, and meteorological reports of the Idaho area and concluded formally, on February 17, that Pocatello was acceptable. The following day the Commission approved the location. Strauss, with his Navy connections, felt confident that the chief of the Bureau of Ordnance, under whose jurisdiction the Navy was operating its Pocatello site, would prove reasonable. The only jarring note, and that in a minor key, was that Senator Brien McMahon, the new chairman of the Joint Committee, had learned only recently of plans for the site. The Commission, mainly through the explanations of Bacher and Shugg, was successful in smoothing McMahon's sensibilities in an executive session on March 14.

Shugg as always was anxious to move ahead. The testing station, he pointed out to the program council, was the Commission's first major field enterprise, and he wanted careful planning. Hafstad, who was well satisfied with Warner's work on the site selection, asked him to handle organization and planning. Warner's main obstacles were the Navy, which was reluctant to release the land, and the Montana Congressional delegation, which deplored the Commission's choice of the Idaho site. In an effort to settle the issue, the Commission issued a press release on the Pocatello site on March 1 and announced on April 4 that Leonard E. Johnston, then manager of the Commission's Schenectady office, would be the new manager at Idaho. Montana, however, was not ready to give up.

In response to the Montana complaints, the Joint Committee held open hearings on April 14 and May 10 to question the Commission and Smith, Hinchman and Grylls. After bringing out the fact that until the survey the Montana site had been the favored choice, Senator James E. Murray introduced affidavits to show that the company's representatives had been in the town of Glasgow, near Fort Peck, for but a single snowy day in January when a visit to the site was impossible. Embarrassing as the situation was, however, the selection of Pocatello was never seriously threatened. In May, 1949, the Commission selected a contractor to drill a test well for fresh water at the Naval Proving Ground near Arco, Idaho. Within a week the Idaho Falls newspaper jubilantly announced that Johnston would soon establish his headquarters in the town's best hotel. Now all the Commission had to do was acquire 400,000 acres of Idaho desert, about half of which was still held by the Navy.[66]

IMPLICATIONS OF THE LEXINGTON REPORT

One subject Hafstad could not long avoid was the aircraft reactor. Wilson had asked William Webster of the Military Liaison Committee on December 8, 1948, for military justification of a billion-dollar, fifteen-year effort to produce the first nuclear-powered aircraft. Aircraft nuclear propulsion, and particularly the NEPA effort at Oak Ridge, had been a subject capable of rousing strong emotions. In the summer of 1948, Carpenter, then chairman of the Military Liaison Committee, had reported that NEPA personnel had damaged their own cause by appearing critical of the efforts of others, assertive and argumentative in defense of their own. Oppenheimer and Conant had delivered a stinging rebuke to the Air Force and NEPA at a December meeting of the committee on atomic energy of the Research and Development Board. Turner A. Sims, vice-president and general manager of NEPA, had described the rationale of the project: "No matter how large our stockpile of atomic bombs may be, this stockpile would become the tragic Maginot line of forlorn hope, if the bombs remained undelivered over the targets where they would damage the enemy's war-making capacity to the utmost." Such a contingency could arise, Sims declared, if American overseas bases were lost.

William L. Borden, executive director of the Joint Committee staff, had read the Lexington report with interest. In his view, unless a formal commitment were made to go ahead with a nuclear aircraft, very little would be done. What, he asked Hafstad on March 24, 1949, was involved in implementing the Lexington recommendations? What if NEPA were given an overriding priority? Hafstad called for perspective. The Commission was doing research and development for the project while waiting for a reply on the military justification. A crash program, Hafstad believed, would shorten the time to nuclear flight only a little, and would disrupt the rest of the reactor effort. A carefully balanced program, he thought, could supply for the next few years the required information for an aircraft reactor.[67]

ARGONNE AND WESTINGHOUSE

On December 16, 1948—six days after Westinghouse accepted the assignment to work with Argonne on the submarine thermal reactor—Zinn met with industry and research representatives to discuss fabricating fuel elements. The two best metals for cladding were beryllium and zirconium. The chief diffi-

culty with beryllium was getting a sound billet. The major cause of cracks in extruded billets seemed to come from impurities in the ingots; perhaps careful quality control was the answer. Zinn saw zirconium as possibly superior in metallurgical and mechanical qualities, but its nuclear properties were still not well known. For both metals, high purity was essential.

The question of cladding material was still open on February 17, 1949, when Etherington laid out a work schedule for the project. Because Argonne's assignment called for studies of liquid-metal-cooled, gas-cooled, and water-cooled reactors, Etherington had decided to carry out a three-phase effort for each type. The first phase would be a survey to reveal critical areas for research. In the second phase these areas would be examined in some detail to determine the extent of the work needed. From this analysis Etherington thought it would be possible to choose one reactor. The final phase would be a detailed report from which an engineering company could make working drawings and build a land-based prototype. It was not necessary that all phases for each reactor begin and end simultaneously, but as Etherington saw the schedule, a preliminary choice should be possible during September, 1949.[68]

Etherington and the power pile division had completed a preliminary study of a water-cooled reactor in September, 1948, and similar but less elaborate reports followed on other possibilities: helium-cooled, beryllium-moderated; sodium-cooled thermal; and bismuth-alloy-cooled. The trend toward water-cooled reactors was evident from the Westinghouse work on heat-transfer characteristics of water and a list of assignments Etherington recommended on May 12, 1949, for the company. He included corrosion tests of beryllium and zirconium, as well as other materials, at the temperatures, water velocities, and heat fluxes expected in the naval reactor. Control rod and systems development, pump testing, and reactor mock-ups to check thermal stress in fuel elements and cores, were some of the other areas which Argonne should prepare to turn over to Westinghouse.[69]

SHIFTING GOALS AT SCHENECTADY

While Argonne and Westinghouse were developing the Navy propulsion system using thermal (or slow) neutrons, and Argonne was also working on the fast breeder, General Electric at Schenectady was concentrating on a reactor using neutrons in a carefully selected intermediate energy range. The approach had certain attractions. Unlike the thermal reactor, the intermediate type promised to breed more fuel than it consumed, an advantage of no mean importance because of the shortage of uranium. Further, the core would be larger than the fast reactor's, a feature which would make easier the removal of heat for use in producing power. As Brooks had explained at a colloquium in March, 1948, preliminary data—all that were available—showed that neutrons of slightly higher velocity than thermal avoided capture by plutonium; this process, since it did not cause fission, did not directly produce energy.

Experiments at Schenectady, however, did not demonstrate the expected breeding advantages at relatively low neutron energies. A group under W. Rudolph Kanne had irradiated special foils of plutonium in the Hanford reactors. Both the irradiation and the chemical and nuclear analysis of the foils took months of exacting work, and preliminary results were not encouraging. Thoma M. Snyder and another group of General Electric scientists had exposed foils to neutrons within the critical assembly for the intermediate reactor at Sacandaga. These results too were disheartening.[70]

During the irradiation experiments, General Electric was also developing pumps and fuel elements and investigating the characteristics of sodium as a heat-transfer medium. Henry Hurwitz, Jr., was directing research on a fuel element in which a ring of uranium was set in a wafer of beryllium, a series of rings and wafers making up the active part of the fuel. The idea was interesting because it used beryllium both as a moderator and as a structural element. Another team, under Kenneth A. Kesselring, was exploring an approach in which uranium was placed in small pin-like tubes. These pins were spun at high temperatures above the melting point of uranium so that the metal would be evenly distributed over the inside wall of the pin.

As General Electric's search for an advantageous neutron energy moved toward the higher end of the energy spectrum, the reactor's value for power generation declined. This fact left the Commission with the question of whether the necessary research on fuel element and component development was worth the effort. After studying the feasibility report which General Electric submitted in early 1949, Weil raised two questions for Hafstad. Should the company slow down its design and construction work on the breeder until the data were conclusive? If, as appeared likely, breeding was not feasible, how important was the project?[71]

Kingdon saw several reasons to continue development of the intermediate reactor. It could be useful in exploring breeder possibilities for much larger reactors, testing fuel elements, generating electricity for a utility system, and providing engineering data for a Navy propulsion reactor. By May, 1949, Zinn and Weinberg completed their analysis of the General Electric report. To Weinberg the difficulties the intermediate-breeder reactor had encountered strengthened his confidence in the homogeneous reactor, which Oak Ridge was then developing. Zinn took a different view. Observing that the Commission's efforts had so far accomplished little, he concluded: "Temporizing on decisions because not all of the corners have been swept out, because our program doesn't stand on the highest imaginable hill of endeavor, may at the moment not be the sensible thing to do." He thought the Commission should authorize the reactor.[72]

PROGRESS ON THE MATERIALS TESTING REACTOR

Although the Schenectady project was in trouble, the materials testing reactor under the leadership of McLain and the steering committee appeared under control. There were technical difficulties, but these were part of any reactor project. The most critical matter was the beryllium metal for the reflector. At Oak Ridge, Peterson, scanning the reports of his technical division, found that the breakage rate of extruded beryllium shapes was unacceptably high. The continued failure to find a solution was ominous. Broken surfaces, whether from machining or from hidden defects, would increase the rate of corrosion. Corrosion products could block the flow of cooling water through a few passages and cause a dangerous increase in temperature.

On November 1 and 2, 1948, at New York and Boston, personnel from Oak Ridge, the Commission's New York office, and MIT explored the matter of quality control and coordination. As improved measures were put into effect, and as Kaufmann at MIT continued to experiment with extrusion techniques, Oak Ridge restudied the reactor design. Changing the dimensions of the basic beryllium units composing the reflector might at least ease fabrication difficulties. But to solve them McLain's steering committee turned to James L. Gregg, professor of metallurgical engineering at Cornell. On February 18, 1949, in Hafstad's office Gregg discussed strategy with McLain and others who were struggling with the problem. According to Mann's schedule, if the materials testing reactor were to become fully operational in early summer of 1951, extrusion of beryllium had to begin by mid-September, 1949.

The two major problems were casting sound ingots and extruding them into billets. Kaufmann noted improved efficiencies in the Commission-owned beryllium metal casting facilities at the Beryllium Corporation plant at Reading, Pennsylvania. For better extrusions Gregg suggested using a 2,750-

ton press in a war surplus magnesium plant at Adrian, Michigan. Some agreed with Weinberg that less powerful presses would be adequate, but Kaufmann, who had wrestled with the problem for some time, sided with Gregg. The more powerful press might be needed to meet the construction schedules, particularly if development work indicated the need for high pressures. By mid-May, 1949, Mann was able to report that initial results at Adrian seemed encouraging. Of growing interest was the fact that improvements in powdered and pressed beryllium metallurgy might offer another production method [73] in which great flexibility of shapes might be possible.

Although the technical difficulties seemed to be yielding, the confusion in Washington was continuing. In early January, 1949, Bacher returned from a visit to Chicago and reported that Zinn was worried about selecting a contractor for the reactor. Oak Ridge was inclined toward a choice which Bacher felt was not strong; in his view only General Electric or du Pont possessed the necessary capability. General Electric, however, was already heavily engaged in Commission work. To Shugg's inquiry, Greenewalt of du Pont on January 7, 1949, would only promise that Granville M. Read, the company's chief engineer, would review the plans. Read sent men to Oak Ridge to interview Huffman and McLain and to inspect the mock-up. After studying Read's report, Greenewalt telephoned Shugg on February 28 that Read's cost estimate was far too low. The following day Wilson and Shugg went to Wilmington where Greenewalt told them the reactor would cost more than it was worth and probably was not reliable enough for continuous operation as a testing facility. The Commissioners listened sympathetically to Wilson, Shugg, and Hafstad on April 7. Even admitting, as Bacher believed, that du Pont was looking for more maturity and dependability than could reasonably be expected in an experimental reactor, the company's conclusions could not be disregarded.[74]

Hafstad had already suggested to Zinn a meeting of leading reactor personnel at Argonne to discuss feasibility and costs. To Zinn a better place was Oak Ridge, where the mock-up could be used to illustrate the size and scale of some of the parts. In preparation McLain gathered the various cost estimates, including those of du Pont and one made by his steering committee. The difference was striking. The du Pont estimate was $51.6 million, compared with the $18.1 million estimate of the steering committee. Zinn opened the two-day Oak Ridge meeting on April 25, 1949, by outlining the intention to build simply and add facilities as needed. Weinberg covered the nagging question of the dimensional stability of the fuel assemblies. Two days of talk and a successful demonstration of the mock-up satisfied nearly everybody that more experimentation was not worth while; the next step was to build the reactor.[75]

One who remained unconvinced of the need for the materials testing reactor was Charles W. J. Wende of the General Electric operation at Hanford. Wende did not believe the reactor would be finished in time to help the Navy project at Argonne, the Zinn fast breeder, or the intermediate reactor at Schenectady. The urgency of the materials testing reactor he saw as the result of Oak Ridge zeal. He believed the Hanford capabilities were being overlooked because of the Commission's policy of assigning research and development work to the national laboratories. The Commission would do well, Wende wrote Hafstad, to use Hanford research facilities and talent and to postpone the materials testing reactor until a hard-bitten survey could clearly show the need for the project.[76]

While Wende had doubts, Oak Ridge had none. From the view of the laboratory personnel, the meeting had been an outstanding success. The mock-up had worked perfectly, demonstrating not only the control and hydraulic systems, but also the important fact that Oak Ridge had overcome the confusion and uncertainty of earlier years. The Commission had also promised the laboratory a nuclear reactor of modern design, a commitment not yet fulfilled. Casting up these reasons, along with the potential savings in money and personnel, Rucker and Weinberg decided to reopen once again the question of building the reactor at Oak Ridge. Weinberg felt diffident since he was working with Zinn as a partner on the project. Yet Weinberg thought that if the savings in money and time were real, Zinn would accept the proposal. Over the signature of George T. Felbeck, vice-president of Carbide, Oak Ridge sent its arguments to Wilson on May 19, 1949.[77]

SUMMER APPRAISAL

By the summer of 1949, Hafstad was fully aware of the problems facing him. The delay on the reactor testing station bordered on the comic; the difficulties facing the intermediate breeder and the materials testing reactors were troublesome. Perhaps of all the projects, the one proceeding most smoothly was Zinn's fast reactor, which had now received the more formal designation of experimental breeder reactor. Despite the pressures upon him, Zinn had been able to maintain close contact with his reactor team. On January 25, 1949, the Commission had approved a contract with the Austin Company of Cleveland for detailed design of the reactor. Technical progress was also keeping pace with administrative decisions. Leonard J. Koch had devised a core test unit to subject fuel rods to heated liquid sodium. Results from hundreds of hours of testing showed that the coolant at high temperatures did not cause distortion of the fuel rods. The core test unit, simulating as it did a part of the proposed actual reactor core, was also proving useful in testing the motors and gears of the mechanism needed for sharp acceleration and deceleration of the control rods. Detailed work on fuel elements, on the sodium-potassium coolant, and on the control mechanisms was progressing, if not with the speed that Zinn and others hoped, at least without revealing difficulties so serious as to jeopardize the project.[78]

The General Advisory Committee began its three-day meeting on June 2 with a large contingent from General Electric present to consider the intermediate-power-breeder reactor. After Suits had described the extent of the company effort, Kingdon covered the design features, with stress on the flexibility of the core arrangement. Brooks and Snyder reported on the latest results of breeding measurements. Although the quality of the data had improved, prospects were still poor for breeding at the originally selected neutron energies. Hans A. Bethe, advising General Electric on the project, remarked that he was inclined to favor going to higher energies, although additional fissionable material would be required. It was not an easy matter to decide. If the schedule for the intermediate breeder were to be maintained, a decision had to be made before complete data were available. Winne argued for proceeding. The reactor would yield experience on engineering and control and would demonstrate to the public safe operation. Furthermore, from the intermediate reactor it would be possible to proceed to a submarine project.

Having heard the General Electric delegation, the committee talked with Hafstad and Rickover. Hafstad turned first to the Schenectady reactor. Foremost in his analysis was the fact that General Electric had a strong group working on the project. If breeding should prove impractical, then to maintain the momentum, changing the goal to Navy propulsion might be justifiable. At the moment, however, the reactor program seemed responsive to the national interest. The Zinn fast breeder and the intermediate reactor were exploring the possibilities of civilian power. Argonne and Westinghouse were meeting military requirements for the Navy through the submarine project, and the experimental facilities of the materials testing reactor would help the Air Force. The weakest of the projects, thought Hafstad, was the materials testing reactor, which had suffered one blow after another, first from the du Pont cost estimates, then from the Wende letter, and finally from the Felbeck proposal to move the reactor to Oak Ridge. Of these the most serious was reconsideration of the Oak Ridge location. Hafstad believed the proposal would reopen the question of the need for the reactor proving ground and require going back over the dreary course with the reactor safeguard committee.

Fermi disagreed with Hafstad's analysis. To him the urgent need for a strong, flexible test facility to develop reactors made the project the most important of the lot. Cyril Smith, accepting Fermi's reasoning, added only that the Schenectady reactor ranked next in importance because it brought to bear the talents of a strong engineering group. Although the committee members understood Rickover's explanation of the Navy's need for submarine propulsion, they were not convinced that two Navy projects were necessary.

For a time the committee discussed whether one reactor might meet several needs. Hafstad maintained that keeping the momentum of those working on the projects was a valid defense of the four-reactor program.

Although Oppenheimer agreed that the reactor program could not suffer many more changes, the results of the meeting must have disappointed Hafstad. Oppenheimer recommended that the Commission proceed with the Schenectady reactor and leave to General Electric the decision of whether to emphasize power or breeding, so long as the necessary fissionable material were available. The Argonne-Westinghouse Navy reactor received committee approval but with the admonition that the Commission should try to prevent the development of another laboratory similar to Knolls. Despite Hafstad's warning, the committee urged the Commission to explore the possibility of an Oak Ridge site for the materials testing reactor. For one moment Oppenheimer proposed to broaden the issue. If the materials testing reactor could be built at Oak Ridge, if the intermediate reactor could be constructed at West Milton, then perhaps Zinn should place the fast breeder at Argonne. Hafstad had warned Oppenheimer that procrastination by the Navy in making the Pocatello site available might delay the fast breeder.[79]

A few days after the General Advisory Committee adjourned, Hafstad reviewed the results with Shugg. Although Hafstad was willing to consider postponing a decision on the materials testing reactor for a year, Shugg thought the Commission should consider the matter. Hafstad met with the Commissioners on June 13 and 14, 1949, and described the Wende, Felbeck, and advisory committee proposals. Wende's suggestion of greater utilization of Hanford's testing capability was useful, but hardly the answer to the long-range problem. Felbeck's Oak Ridge proposal probably overestimated the savings in time and money, and Hafstad doubted whether the site would be suitable for the reactor without relaxation of the safeguard criteria. Nonetheless, he could not disregard the advisory committee's recommendations.[80]

By the time Hafstad met with the Commission, Henry D. Smyth, the Princeton physics professor and veteran of the Manhattan project, had replaced Bacher as the Commission's scientific member. Smyth then decided to attend the General Advisory Committee meeting scheduled for July 14–15, 1949, at Berkeley, California. The main reason, Smyth wrote John H. Manley on July 12, was to present the Commission's decision that the acquisition of the Idaho reactor testing station should continue and that the Zinn reactor should be built there. He opposed construction of the materials testing reactor at Oak Ridge.[81]

At Berkeley Smyth explained that the previous committee meeting had raised questions about the committee's enthusiasm for the reactor program and particularly for the materials testing reactor. The committee admitted some reservations but hoped that no evidence of anxiety had found its way into any of the committee reports. The uncertainty had arisen over the growing expense of the reactor program, the rate of progress, and genuine doubts about the military justification for the Navy and Air Force reactors. Some concern also stemmed from the shift from the centralized laboratory principle to the idea of an isolated test station. Nonetheless, the committee could point to its approval of the four reactors and a reactor testing station.[82]

By the summer of 1949 the reactor program was finally taking shape. Rickover was impatiently prodding Etherington's Navy reactor division at Argonne to make greater use of Westinghouse facilities and to recruit additional experienced reactor designers. Etherington had concluded that by far the greatest amount of the work in his division would be on water-cooled reactors, although a little effort would be given to a gas-cooled reactor study to support helium heat-transfer work by the Allis-Chalmers Manufacturing Company. It was now fairly certain that the Navy reactor, the Zinn fast breeder, and the materials testing reactor would be built at the reactor testing station. Huffman had been worried that bubbles in the lava beds might affect foundation work, but a visit to the Idaho site reassured him. He had noticed with interest that although Arco, the nearest town, was small, it was on the main road into the best fishing country. With growing assurance, once the materials testing reactor had a firm location, McLain's steering committee had made another cost study and found that $21.5 million was their best judgment—less than half the du Pont estimate. At Oak Ridge, Weinberg was preparing a proposal for a small liquid-fueled homogeneous reactor which would generate 20 kilowatts of electric power. As for the Schenectady reactor, the Commission had authorized resumption of site work near West Milton. Wilson's request for a military evaluation of the NEPA–Air Force project was as yet unanswered. Toward the end of August, Hafstad's reactor program looked in reasonably good condition.[83]

PRIORITIES

To Hafstad the Soviet detonation of August, 1949, meant many things, among them the place of his four reactor projects in an atomic energy program which would be increasingly geared to national defense. He expressed disappointment to Rickover over the progress at Argonne on the Navy reactor, a project which now above all had to be pushed vigorously. Hafstad wondered whether the Argonne Navy project should be shifted to Westinghouse, although he realized that the strength of the company in this area was as yet untried. As he understood it, Argonne ranked the experimental breeder first in its efforts, followed by the CP-5 research reactor, the materials testing reactor, and finally the Navy reactor. Rickover urged giving the Navy work at Argonne the first priority, strengthening Westinghouse in technical personnel, and establishing a long-range Navy reactor project at Schenectady which would rank immediately after the intermediate breeder.[84]

Zinn gave his opinion on October 13. First priority went to the submarine reactor; although Zinn had seen no careful analysis and heard no qualified military expert on the subject, he assumed nuclear propulsion would be vital to the Navy if a war were to break out in the next five or ten years. Second place went to the materials testing reactor. Even if it could not be completed in time to benefit the Navy project, it could be useful in providing data for the aircraft reactor, as well as materials for weapons. The experimental breeder ranked third in Zinn's list. This reactor still seemed to be the best and quickest means of measuring breeding possibilities at fast-neutron energies and of obtaining experience with liquid-metal coolants. The intermediate breeder was in last place. The breeding possibilities were not good, and although they could be improved by going to higher neutron energies, to do so was to approach the range which the fast breeder would explore. The fact that sodium was the coolant rather than sodium-potassium did not make a great difference. If however, the intermediate breeder effort were shifted to submarine propulsion, the Schenectady project would share first priority with the submarine thermal reactor.[85]

Hafstad agreed that military projects had to be stressed. On the other hand, with the staff at Zinn's disposal, Hafstad believed that the materials testing reactor should not fall too far behind. Military requirements, if not military reactors, accounted for the priority of tasks given to General Electric. Winne had asked on August 22 for permission to increase the effort on the submarine intermediate reactor, but not until November 9 did he receive a formal reply. Until the Commission had fixed the scope of an expanded atomic energy program, General Electric should first assist Hanford, then work on the intermediate breeder, and third, study the intermediate Navy reactor.[86]

The influence of the Soviet detonation, in its broadest perspective, was the subject Eugene P. Wigner chose for a speech at the Oak Ridge information meeting of October 24–26. Few were better qualified to deal with such a broad subject. Wigner had headed the Oak Ridge laboratory during the difficult days of early 1947, he had influenced the design of the materials testing reactor, and he had been a major consultant on reactors. Yet, as Weinberg said in his introduction, Wigner was far enough away from the program to be above the details. Wigner came soon to the main question. Why had the hopes of reactor development, so high in 1944, been denied? He suggested that weapons had received the higher priority; yet this was not the whole story. More important, he thought, was the fact that the Americans no longer had German competition. Reactors had also become expensive. More money meant more time spent in justifying decisions, in elaborate precautions to be certain that the expense was wise, and in overdesign to protect the funds invested. These were the expenses of experimentation. Finally, Wigner saw that reactor development had suffered from failure to attract the undivided attention of first-rate scientists. Of all factors the most important seemed to him to be the lack of competition. The Soviet detonation, whatever else it had done, had at least brought back rivalry. Now there was a race and a spur. "We will stop glorifying our past," said Wigner.[87]

RESEARCH: NEW APPROACHES TO A NEW AGE

CHAPTER 8

Louis J. Ridenour, dean of the graduate school at the University of Illinois, was a peppery scientist who did not hesitate to express his views on public policy. He had been active in the scientists' movement to win support for the McMahon bill in 1946, and in the spring of 1947 he had badgered the Commission through his friend Robert F. Bacher to support the foreign distribution of radioisotopes. Now, in the spring of 1948, he was really angry. In a stinging letter to Lilienthal, he spoke of grave shortcomings in the Commission's leadership, stemming, he thought, from a reluctance "to engage in acts which might be unpalatable to ultraconservative members of the Congress or of the armed forces."

Ridenour made clear the heart of his dissatisfaction. It lay in what he saw as the Commission's continuing failure to exercise leadership in fostering research. As evidence he cited current rumors that the Commission would not come to the aid of the Office of Naval Research, whose funds for high-energy accelerators were being trimmed by Congress, and the Commission's reluctance to support basic research except in a few of the nation's largest universities. "If General Groves were in your position," Ridenour warned, "and he had done what you have done, . . . I should long ago have attacked him publicly." [1]

On the surface Ridenour's charges made some sense. James B. Fisk, the Commission's director of research, had not yet answered the Navy's appeal of June, 1947, for help in funding the completion of high-energy accelerators at a dozen universities. He had taken only a few tentative steps toward providing the kind of financial support which would permit the universities to make nuclear physics a part of their curricula. Even in those branches of nuclear physics and chemistry which did not require expensive equipment like accelerators, the Commission had offered very little encouragement in 1947. Fisk had extended a few contracts with the larger universities to continue the sort of applied research which the Army had financed during the war, but these represented no important commitment for the future.

These cautious moves reflected Fisk's interpretation of his function as director of research. He thought his first duty was to serve the general manager as staff adviser on the scientific aspects of all Commission activities. He would coordinate the long-range plans of the Commission's laboratories, but he had no intention of creating a staff in Washington to review the details of every research project proposed. Certainly Fisk rejected any suggestion that he might become the administrator of a Federal program to finance scientific research in the universities until the National Science Foundation could be established. The Atomic Energy Act seemed to speak directly to that point in outlawing grants-in-aid and prohibiting the division of research from awarding contracts. In enunciating his principle of "the area of availability" in 1947, Fisk had warned the Commission that only with great caution should it support basic research, either in the national laboratories or in the universities.[2]

If Fisk had qualms about using Commission funds to support basic research, the question was a central issue for Shields Warren, who became the first director of biology and medicine in October, 1947. The very nature of the wartime programs had relegated the life sciences to a support function in industrial health and safety, and the initial organization of the Commission hardly suggested a more prominent role. So completely did the physical sciences dominate both the division of research and the General Advisory Committee that the Commission early recognized the need for both a separate division and a special advisory committee for the life sciences. Most of 1947 had slipped by before the division and its committee were established, and even then they could not claim the prestige and influence of their counterparts in the physical sciences. Warren and the committee were likely to face an uphill fight in convincing the Commission that it should support more than an industrial health program in the life sciences.

THE NATIONAL LABORATORIES

One fact was clear by the end of 1947: The Commission intended the national laboratories to be the backbone of its research program. In theory at least, the national laboratories had the potential of becoming a new type of research institution in which both the Government and the universities could participate. The Government could meet the exceptional needs of the nuclear sciences by providing and retaining title in the buildings and equipment. The universities in the region of the laboratory would furnish the scientists and the leadership which would assure the kind of academic environment deemed necessary for research. But would the laboratories really become regional research centers, as the Army's advisory committee on research and development had intended in 1946? Rumors about a centralized laboratory staffed with Government scientists in 1947 did not suggest that the Commission was enthusiastic about regional facilities open to university scientists. Even if the Commission fulfilled its promises and supported the national laboratories, some scientists would be dissatisfied. After all, was it not still a general assumption that only universities and private institutions could provide the proper climate for basic research? [3]

Certainly the Commission had yet done little to convince most scientists not associated with its activities that it could create such a climate. The change of contractors at the Clinton Laboratories had not inspired confidence. Despite assurances from Union Carbide that the company intended to stress basic research now that reactor development had been transferred to Argonne, the Commission's decision to turn the laboratory over to an in-

dustrial contractor suggested to many scientists how little the Commission knew about managing research. Few at Oak Ridge, not even the indomitable Alvin M. Weinberg, had much faith in Carbide's ability to build a new Oak Ridge National Laboratory on the ruins of Clinton. Some scientists at Oak Ridge were talking of resigning and others were scheduled to move to Argonne. Weinberg and those remaining at Oak Ridge would have little more to work with than the obsolete X-10 research reactor, used mostly for producing radioisotopes, and the crumbling temporary buildings from the wartime project. The Commission had promised to build a new laboratory at Oak Ridge, but by March, 1948, the Commission had not yet selected an architect-engineer, and Carbide had still not found a director for the laboratory.[4]

The future of Oak Ridge looked dismal, but it was a mistake to assume, as some scientists did, that the Oak Ridge malady was infecting all the Commission's laboratories. Quite the reverse: Oak Ridge seemed a dark spot in an otherwise bright picture. At the Argonne National Laboratory there was every reason for optimism. Ideally located near a major city, tied to one of the nation's leading universities, and blessed with a strong director in Walter H. Zinn, Argonne seemed to have everything in its favor. The laboratory was already rising on the new site in Du Page County, southwest of Chicago, and the sudden decision to centralize all reactor development at Argonne appeared to guarantee the preeminence of the institution in the Commission's future. Zinn's chief concern was an embarrassment of riches. He could not yet gauge the effect of concentrating reactor development at the laboratory. Perhaps, as some of the participating universities feared, there would be a shortage of time and resources for the kind of basic studies that would make Argonne a useful research center for universities in the Midwest.[5]

The fledgling Brookhaven National Laboratory, though lacking the wartime foundations Argonne enjoyed, was not worrying about the inroads of

Commission requirements. Like Argonne, Brookhaven could rely on experienced leadership in Philip M. Morse, its director, and in men like Lee A. DuBridge, Henry D. Smyth, and Isidor I. Rabi, who served on the board of Associated Universities, Incorporated, the sponsoring group of nine institutions in the Northeast. Demonstrating keen perception of the ways of Government, the Brookhaven leaders made an asset out of an apparent liability—namely, that the laboratory had been created in the 1946 interregnum between Army and Commission control. As a new laboratory, it would not have to shake off the remnants of responsibility for applied research which haunted Oak Ridge and Argonne. Brookhaven could be from its beginning a national laboratory in the true sense of that term: a regional research center providing the kinds of experimental facilities the individual member universities could not afford, supplementing university research projects, and offering training opportunities for graduate students and young faculty.

The Brookhaven leaders had taken a chance and moved to establish their new laboratory before the Commission came to power. Capitalizing on their knowledge of General Groves's lack of confidence in his successors, the scientists in the Northeast had selected the Long Island site, formed their corporation, and negotiated a contract with the Army by the end of 1946. In a sense, all the Commission had to do was sign the contract and provide the money. The Brookhaven leadership had already made the policy decisions the Commission would never have been able to reach in the chaos of 1947.[6]

This kind of foresight gave the new laboratory some real momentum in 1947. It could quickly recruit a staff of talented scientists, many of whom were disgusted with the lip service paid to basic research in large corporations or discouraged by the disintegration of Government laboratories after the war. Under Lyle B. Borst, a former Clinton physicist, plans quickly developed for the new research reactor, around which all nuclear research at Brookhaven was expected to revolve. Supplementing the reactor as a source of radiation and subnuclear particles would be several "electronuclear machines" or accelerators which M. Stanley Livingston, a student of Ernest O. Lawrence, was planning to build. Commissioner Pike had broken ground for the reactor on August 14, 1947, and Livingston had arranged to purchase a 60-inch cyclotron and a horizontal Van de Graaff generator capable of producing high-energy protons. By the end of 1947 Brookhaven was taking on the semblance of an operating laboratory.[7]

The only other large center for nuclear research in the United States, at the University of California, Berkeley, did not enjoy the formal title of a national laboratory. The discrepancy reflected not a lack of prestige but an unusual degree of independence which Lawrence had established before World War II. He had built the Radiation Laboratory with university funds and with financial help from private sources. The 37-inch cyclotron and the giant magnet for the 184-inch machine were in the laboratory in 1941, when the Government first showed an interest in using them for experiments in uranium isotope separation. After the war, the Government was obliged to restore them to their intended purpose, basic research in high-energy physics.

Lawrence, however, was among the first to understand that the extraordinary costs of research in this new field would require Government support. Although the Government already had a sizeable investment in buildings and equipment on university property, much better insurance of Commission support was Lawrence's world-wide fame as inventor of the cyclotron and foremost pioneer in its development. If the Commission intended to support research in high-energy physics, it would have to plan for a large investment at Berkeley.[8]

None of the Commission's other research installations bore the formal title of "National Laboratory," perhaps because they did not at that time have any extensive facilities open to scientists in the region where they were

located. The Los Alamos Scientific Laboratory was a major center for basic research, but its activities were almost completely related to weapon development. Although there had been some hope in the Commission that General Electric's Knolls Atomic Power Laboratory would become a regional development center, that idea faded as Knolls moved toward submarine work, which was highly classified. The Commission's laboratories at Iowa State College and the University of Rochester had important missions but ones too specialized for a national laboratory.

Clearly the national laboratories in 1948 had no single mission or organizational structure. The differences in some respects were the accidents of circumstance, but they served Fisk's purpose in keeping open all options for a research policy. He could reasonably claim that by strengthening the national laboratories he was helping to support basic research. The question was whether the national laboratories alone could foster the kind of achievement that most scientists assumed to be the exclusive product of the university or private laboratory. Until he had more evidence on the question, Fisk would continue to favor the national laboratories without ruling out the possibility of research contracts with the universities.

Practical experience in 1947 had demonstrated the advantages of a deliberate, tentative approach to a research policy. For the moment it might have pleased scientists like Ridenour if Fisk in the spring of 1947 had quickly responded to the Navy's request for research funds and committed the remainder of his 1948 budget to whatever research projects the universities could reasonably justify. But such action might well have proved irresponsible. Fisk had only $10 million for fiscal year 1948, and he had been granted only $15 million in the 1949 budget requests. Impulsive generosity in the summer of 1947 might have spawned commitments to relatively weak projects in 1948. Not only might they have wasted money; even worse, they might also have squandered the talents of the few people trained in the nuclear sciences.

Perhaps enduring attacks like Ridenour's was the price the Commission would have to pay to assure that it was making the best possible use of a scarce national resource.[9]

PROBING THE MICROCOSMOS

Administrative principles and budget realities had their part in determining the Commission's place in American science in the postwar period, but equally important were the broad currents within science itself. The end of the war in 1945 made it possible for scientists to resume their pursuit of the exciting ideas which had appeared on the horizon of discovery in 1939. The years of conflict had built up new anticipation in basic research, not only by forcing a delay in accomplishment, but also by providing in technological development new methods and tools for research. No single theme could adequately describe the scope and variety of this scientific endeavor in the late 1940's, but as it affected the Commission's activities, it was primarily an interest in probing the microcosmos.

In the physical sciences, the discovery of nuclear fission in 1938 had opened new possibilities for exploring the heart of the atom. No longer a solid, homogeneous mass, the nucleus had been discovered to be an intricate composite of still smaller "particles." If man were to understand the fundamental nature of matter, he would have to penetrate the mysteries of the nucleus. For this adventure the scientist would need fission reactors and particle accelerators of unprecedented size and complexity, tools which only the Government, and most likely the Commission, could provide. From this research would come not only a new understanding of the nucleus, but also new elements which man himself would add to the panoply of nature.

In the life sciences, there was a similar probing of the microcosmos. Like the nucleus for the physical scientist, the living cell became the center of interest for the biologist in his search for a scientific understanding of life. Like nuclear physics, genetics and cytology had been young but exciting sciences before the war. By 1945 the Manhattan project had created for science an almost limitless supply of radiation. No longer dependent upon minute quantities of radium or cumbersome and expensive X-ray machines, the biologist and the physician had oceans of radiation in reactors and a virtually free supply of radioisotopes which could be used as radiation sources or as radioactive "tags" for studying life processes. These cheap, inexhaustible sources of radiation revolutionized the biomedical sciences in the postwar period and served the scientist as he probed the secrets of the cell and the mechanisms of genetics.

THE ACCELERATOR: KEY TO THE NUCLEUS

Had not World War II intervened, the early 1940's would have been a golden age of physics. Both theory and experiment had concentrated attention on the atomic nucleus, and Lawrence's cyclotron had provided a feasible means for revealing its contents. Like many great inventions the cyclotron was not only ingenious in conception but simple in principle. Electrostatic generators, such as the Cockcroft-Walton and the Van de Graaff, depended upon a single high voltage to energize the particles and were therefore limited by the amount of voltage which the insulators could sustain. An obvious alternative to the direct-voltage device was one in which the particles were accelerated by a series of electrodes, each carrying a relatively low voltage. Even the simplest

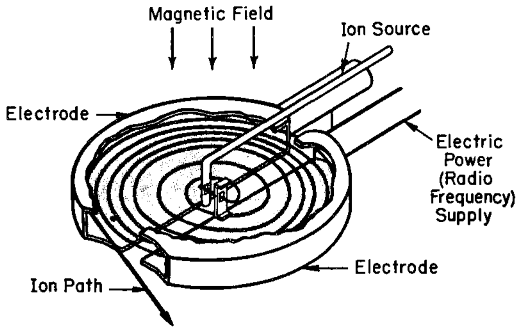


Figure 1. A schematic diagram of the cyclotron. The magnetic field forces the ions into a curved path. As the electrode voltages accelerate the ions, they follow a path of ever-increasing radius until they emerge from the machine.

machine, however, which would accelerate particles in a straight line through several hollow cylindrical electrodes, involved complexities in voltage control that were essentially insuperable in prewar technology.[10]

Lawrence saw that he could avoid the difficulty of multiple electrodes by placing the particles in the field of a large electromagnet. The magnetic field would cause the particles to move in a curved path, requiring only two electrodes, shaped like halves of a round pillbox between the magnet poles. By alternating the charge on the electrodes at the proper frequency, Lawrence realized, he could cumulatively increase the speed of the particles as they moved in a spiral path through the fields created by the magnet and the electrodes. (Figure 1) Particles introduced near the center of the cyclotron would spiral in tight orbits at low energies and in successively larger orbits as they picked up speed. Thus the particles would be able to keep in step with the accelerating voltage no matter what their energy. In other words, the particles, whatever their speed, would be resonant with the single accelerating frequency. The resonance principle made possible the acceleration of protons to energies of more than 10 million electron volts (mev) with oscillators delivering modest amounts of power at frequencies common to the electronic circuits of those days.

Starting with the first verification of the resonance principle by Livingston in 1931, Lawrence and his associates built successively larger cyclotrons culminating in the "Crocker" machine, completed in 1939, with pole faces 60 inches in diameter. This device became the prototype for standard cyclotrons built by many universities before the war for accelerating light, positively charged particles such as protons or deuterons.[11]

The acceleration of electrons was not a major concern at Berkeley in the 1930's, but work done elsewhere had implications for accelerator development by the end of the war. Donald W. Kerst at the University of Illinois and

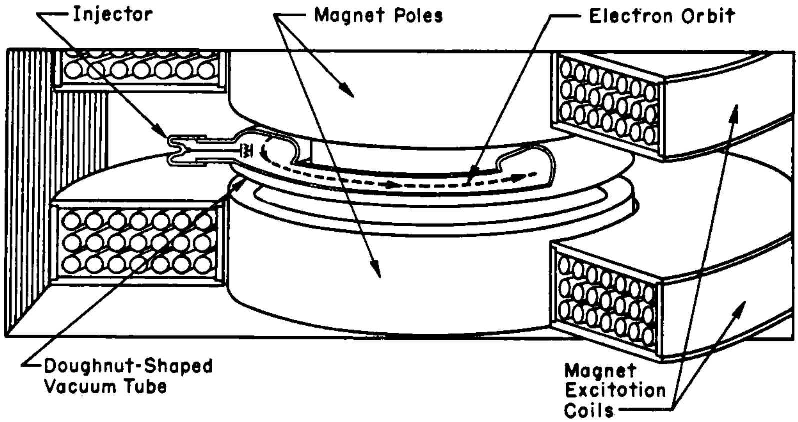


Figure 2. A schematic drawing of a betatron magnet and vacuum chamber, showing the electron orbit and the central magnet core which supplies flux for acceleration.

for a time at General Electric was the primary architect of the electron accelerator, called the "betatron." Like the cyclotron, the betatron used a magnetic field to force the particles into an orbit. Kerst chose, however, to accelerate the electrons not with electrodes but with an electromagnetic force induced by the changing flux of a central magnetic core. In a sense, the orbiting electrons themselves formed the secondary winding of a transformer in which the accelerating voltages were induced. (Figure 2) Another distinctive feature of the betatron was that it kept the particles in an orbit of constant radius by increasing the strength of the guide field as the energy of the electrons increased. This feature of the betatron permitted Kerst to confine the electrons to a small doughnut-shaped vacuum chamber between the magnet poles. By 1940 Kerst had accelerated electrons to 2.3 mev in the betatron at Illinois.[12]

The particle energies achieved in the cyclotron and betatron represented a substantial advance in the study of nuclear physics, but even by 1940 the pace of research was pressing against the limitations of these machines. In the cyclotron higher energies would require magnets and vacuum chambers of staggering size, as the dimensions of the 184-inch magnet at Berkeley suggested. The ultimate limitation of the cyclotron, however, appeared to be the increasing mass of the accelerated deuterons at energies above 25 or 30 mev. As the particles approached relativistic energies in the large cyclotrons, their increase in mass would slow them and disrupt the resonance upon which successful operation depended. In the cyclotron this phenomenon posed what could be called the relativistic barrier. In the betatron the limiting factor was electron radiation. Because charged particles radiated energy when forced into orbits at high velocities by a central accelerating force, energy losses from radiation overrode additional increments of power as the particle energy increased. The 100-mev betatron which General Electric completed in 1945 was already approaching the limits for this kind of machine.

SKIRTING THE RELATIVISTIC BARRIER

By the end of World War II two new developments had promised a way to bypass the limitations of the prewar accelerators. The first, a product of wartime research in electronics, was the resonant-cavity oscillator which made possible the generation of large amounts of power (several megawatts) at very high frequencies (several thousand megacycles). The second was a discovery as fundamental as Lawrence's conception of the cyclotron. In 1944 Vladimir I. Veksler of the Lebedev Physical Institute in Moscow and a year later Edwin M. McMillan, then at Los Alamos, independently proposed a new principle for accelerating particles as they reached relativistic energies. The discovery was that small variations in the speed of particles would be automatically corrected if the frequency of the accelerating voltage were kept reasonably in step with the equilibrium speed of the particles. Applying the principle to the cyclotron, McMillan reasoned that a particle crossing the gap between the electrodes too early would receive some acceleration, which would push it into a wider orbit and cause it to reach the second gap more nearly in phase.[13]

In describing this new principle of "phase stability" McMillan proposed to apply it to a new type of electron accelerator, which he called the "synchrotron." This new device would combine the accelerating system of the cyclotron with the ring-shaped, pulsating guide field of the betatron. A radio-frequency electrode would replace the cumbersome, expensive magnet core as the accelerating device. Although the electrons in the ring-shaped vacuum chamber would move at a constant speed close to the velocity of light, differences in their masses would cause them to follow different paths within the guide field and thus to arrive at the electrode at varying times. The electrode, operating under the principle of phase stability, would maintain the electrons in the proper orbit. Then, if the operator slowly increased the strength of the guide field, the electrons would move in a tighter orbit, only to be restored to the proper orbit with additional energy supplied by the radio-frequency electrode. In this manner phase stability could be used to increase the mass and hence the energy of the electrons to values far exceeding those possible in the betatron.

McMillan also saw the possibility of using phase stability in the cyclotron. If, as the speed of the particles approached the speed of light, the frequency of the accelerating voltage were gradually decreased, phase stability would assure that the particles stayed in step and continued to accelerate. Changing the frequency of the accelerating voltage, however, would disrupt the slower-moving particles spiraling out from the central source and destroy the cyclotron's ability to accelerate them in a continuous stream. Instead, the cyclotron would have to use short bursts of particles, perhaps several hundred bursts per second, with the accelerating voltage swinging from the initial to the lower frequency as each bunch of particles approached relativistic speeds. In pulsed operation, the cyclotron would produce fewer particles than in continous operation, but it would accelerate them to higher energies and would be better able to produce particles of one specific energy.

Phase stability and better high-frequency oscillators would also renew interest in the linear accelerator. In fact, phase stability had made possible the operation of the earliest machines of this type even though the principle had not yet been explicitly recognized. McMillan's discovery assured operation of the linear accelerator at higher energies; its linear arrangement avoided the difficulties cyclotrons encountered at relativistic energies; and the new oscillators opened the possibility of effective control. As the thoughts of physicists began to turn once again to pursuits of peace, Veksler and McMillan had opened the door to new opportunities in high-energy physics.

BUILDING FOR HIGHER ENERGIES

McMillan's discovery had shown physicists how they might accelerate particles to relativistic energies, but the idea alone did not explain the exuberance with which the scientists rushed to cross the barrier into unexplored territory. The new realm of physics would be exciting and worth studying. Their expectation lay in the results of cosmic-ray experiments and certain theoretical studies that had been going on since the early 1930's. At very high altitudes, reached by mountain-top expeditions, balloons, and airplanes, physicists had discovered tremendous showers of high-energy particles, mostly protons, sweeping into the earth's atmosphere from outer space. Experiments had already demonstrated that the cosmic-ray particles, having many times the energy of those produced in the laboratory, could bring about some extraordinary changes in the atomic nucleus.

During this same decade, in 1935, the Japanese physicist Hideki Yukawa had predicted the existence of a subnuclear particle which might explain the enormous force binding the atomic nucleus together. He gave the particle the Greek name "meson," implying that it had a mass intermediate between the heavy proton and the very light electron. Within two years cosmic-ray experiments had revealed the existence of a particle very much like Yukawa's hypothetical "meson," except that it did not react strongly with an atomic nucleus as physicists had expected.[14] The discovery made clear that a substantial increase in deuteron energy, to perhaps 300 mev or more, would make possible the production of mesons in the laboratory and might solve the mystery of the meson's behavior. Cosmic-ray research had provided a new goal for physics and McMillan had offered the means for reaching it.

Two months before McMillan sent his paper on phase stability to the *Physical Review,* he had suggested the idea to Lawrence. At the time Lawrence was planning to overcome the relativistic barrier in the 184-inch cyclotron simply by applying more power to drive the protons through the barrier. McMillan addressed his remarks to his own plans for a high-energy betatron, but his comments applied equally well to the cyclotron. "Brute force" methods, he thought, were acceptable only if he could find no neater solution. Phase stability seemed the answer. Lawrence, though cautious, was willing to investigate the suggestion. Instead of building the 184-inch machine as a fixed-frequency cyclotron, he would consider making it a pulsed machine using the synchrotron principle.[15]

Maintaining the wartime pace of the laboratory, Lawrence immediately ordered design studies for the synchrocyclotron. Before the end of 1945 the Berkeley staff was designing an experiment to simulate the synchrotron principle in the 37-inch machine. Successful results in the spring of 1946 gave new impetus to the reconversion of the 184-inch magnet for accelerator work. Driving hard through the summer and early fall of 1946, the Berkeley group had the 184-inch ready to operate on November 1. The next day Lawrence dashed off a note to his old friend Warren Weaver in New York: "We obtained 200 million volt deuterons last night. The 184 inch performed beautifully." The immediate success of the machine demonstrated not only the caliber of Lawrence's team but also the soundness of the synchrotron principle. Within a few years Carnegie Tech, Chicago, Columbia, Harvard, and Rochester would have synchrocyclotrons constructed with funds from the Commission and the Office of Naval Research.[16]

Equally swift was scientific reaction to McMillan's proposal for the electron synchrotron. In November, 1945, he wrote Lawrence that he was designing the new machine to be built at Berkeley to generate 300-mev electrons and perhaps produce some mesons. The existence of such particles suggested to McMillan that neutrons and protons "cannot really be considered as simple indestructible units, but have a possibility of change, and may even have a fine structure of some sort." By January, 1946, McMillan had completed the design of the magnet for the synchrotron, and in May the Berkeley laboratory announced the start of construction. Scientists at other laboratories did not wait for the completion of McMillan's machine to test the synchrotron principle. Two English physicists had a small 8-mev electron synchrotron in 1946 and General Electric had a 70-mev machine working well early in 1947.[17]

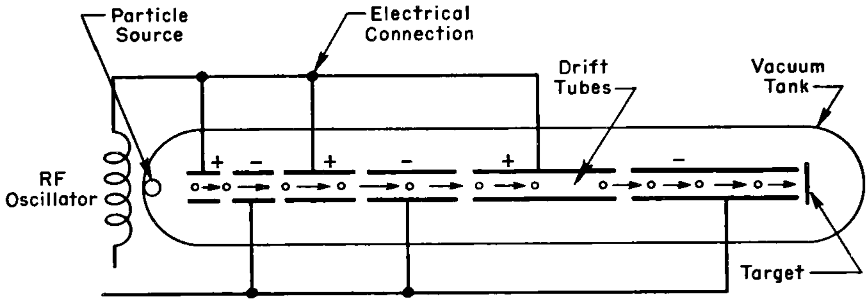


Figure 3. Schematic drawing of the linear accelerator. Voltages on the drift tubes are alternated so that the ions are accelerated as they move toward the target.

McMillan was not the only Berkeley physicist at Los Alamos in the spring of 1945 who was looking for a way to bypass the relativistic barrier. Luis W. Alvarez saw in the magnetron tube, developed for wartime radar equipment, a solution to the high-frequency power requirements for the electron linear accelerator, which Wilbur W. Hansen had been studying for a decade before the war at Stanford University. (Figure 3) The linear machine would avoid the losses from electron radiation in the betatron. McMillan's discovery of phase stability canceled the advantages of the linear machine for electron acceleration, but Alvarez thought it might still be the quickest way to produce high-energy protons. When he returned to Berkeley in 1945, he had a proposal designed to win quick support from Lawrence and Groves. Alvarez thought he could get started quickly and at low cost by building a short section of a linear accelerator which could later be extended to generate 300-mev protons for producing mesons. He also proposed to use surplus military radar sets to generate the radio-frequency voltages for the electrodes, or "drift tubes" as they were called in the linear accelerator.[18]

With prompt approval from Lawrence and Groves, Alvarez set about acquiring the radar sets and some staff early in 1946. He was particularly fortunate in recruiting Wolfgang K. H. Panofsky, an imaginative young physicist who had just left Berkeley to join the Bell Laboratories. From the outset Alvarez showed himself a true disciple of the Berkeley style in research, with its stress on hardware and practical results and an impatience with interesting but marginal theoretical studies. Alvarez did not yet have a clear enough idea of the accelerator's design to know whether the Army radars would be useful, but they gave his group something to work with. By January, 1947, Alvarez and Panofsky had assembled most of the essential components

for a 40-foot accelerator designed to produce 32-mev protons. The Commission endorsed the project on January 22.

In the following eighteen months the Berkeley group worked to turn these components into an operating accelerator. These tasks ranged from such theoretical studies as Panofsky's calculations of beam dynamics to such practical matters as fabricating grids to keep the beam in focus as it crossed the gaps between drift tubes. By the time the accelerator was ready to operate in the summer of 1948, several smaller machines were already operating or under construction at other universities and other approaches to high-energy proton generation looked promising; but Alvarez's linear accelerator could still prove useful in research and accelerator technology.[19]

LOOKING TOWARD THE BILLION-VOLT RANGE

Soon after McMillan set forth the synchrotron principle in the summer of 1945, William M. Brobeck, Lawrence's trusted engineering designer, began to translate McMillan's idea into blueprints for a new proton accelerator. Brobeck saw that even with phase stability, the cyclotron had already reached its practical limits. A cyclotron ten times more powerful than the 184-inch would require a gargantuan magnet with pole faces 60 feet in diameter. A much more practical approach was to adopt the ring-shaped magnet which McMillan had proposed for the electron synchrotron and to increase the field strength of the magnet sufficiently to confine protons, the most effective projectiles for high-energy physics. The ring would have an immense radius, depending on the desired energy of the protons, but the relatively small cross-section of the beam would greatly reduce the dimensions of the magnet and the vacuum chamber at any point on the ring.

Before the end of 1946, Brobeck had completed a preliminary design

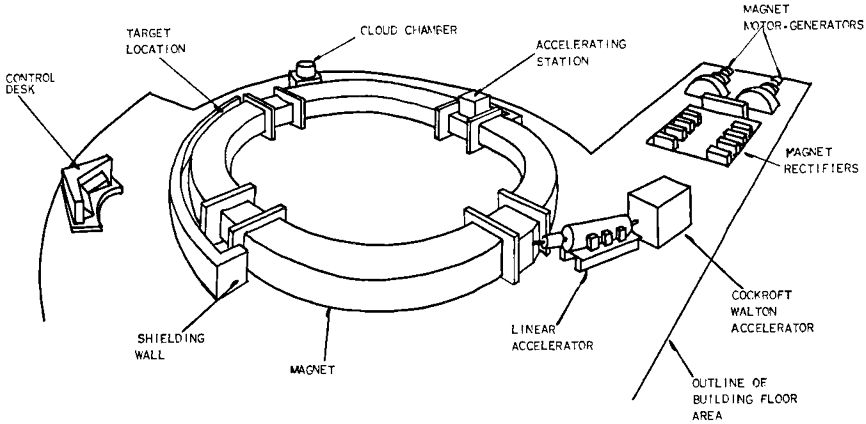


Figure 4. A schematic drawing of the bevatron.

for a synchrotron capable of accelerating protons to 10 billion electron volts (bev). The magnet ring would consist of four quadrants on a radius of 80 feet, each quadrant consisting of a series of magnet blocks standing 9 feet high and 15 feet wide. (Figure 4) Between the pole faces would be the vacuum chamber, 4 feet wide and 6 inches high, in which the protons would circulate. An unusual feature of the design was the four "straight sections" connecting the quadrants. These sections would contain no magnets and would thus give access to the vacuum chamber for injecting the protons, inserting vacuum pumps, installing the radio-frequency accelerating equipment, or extracting the proton beam. To minimize the range of proton velocities the machine would have to accommodate, Brobeck proposed to install a 4-mev horizontal Van de Graaff accelerator at one of the straight sections. The entire installation would cost about $25 million and would take four or five years to build. By the summer of 1947, Brobeck had revised the magnet gap dimensions and lowered the cost estimate to $10 million, but the essential plan remained the same. Since the accelerator would be in the bev range, he proposed to call it the "bevatron." [20]

McMillan's discovery had also stimulated scientists in other laboratories to consider building proton synchrotrons of the ring-magnet design. At the University of Birmingham in England, Marcus L. E. Oliphant had proposed a ring-type proton accelerator in 1943, long before Veksler and McMillan had propounded phase stability. In 1947 the Birmingham group, capitalizing on Oliphant's work, had ordered components for a 1-bev machine.[21]

At Brookhaven interest in high-energy physics first found expression in a meeting called by Jerrold R. Zacharias of MIT in the spring of 1947. Although the large graphite reactor was expected to be the principal research facility of the laboratory, the Zacharias committee proposed construction of accelerators in two categories: those too expensive for a single university to build and those which would supplement fundamental research either in the physical or biological sciences at Brookhaven. In the first category they placed a large proton accelerator, either a synchrocyclotron or a synchrotron. A 60-inch cyclotron, resembling the Crocker machine at Berkeley, would fill the second need.[22]

The most important requirement for a strong accelerator program was people, and in this respect Brookhaven was particularly fortunate. To head the accelerator department the laboratory had obtained the services of M. Stanley Livingston, who had fabricated some of Lawrence's first experimental cyclotrons. Now at MIT, Livingston was one of the outstanding authorities on accelerators in the United States. A second Lawrence disciple at Brookhaven was G. Kenneth Green, whose lean frame suggested that he had the same kind of drive and enthusiasm for work that motivated Lawrence. A sharp mind, coupled with an engineer's sense of the practical, made him a valuable member of the group. John P. Blewett, quiet and scholarly in contrast to the exuberant Green, brought to the project several years of experience in accelerator development at General Electric. Leland J. Haworth, a big, friendly physicist from the Midwest, was a continual source of strength, although his duties as assistant director of the laboratory prevented him from giving full time to accelerators.

Initially Livingston felt certain that the laboratory needed a large synchrocyclotron, but the more Green and Blewett learned about the studies at Berkeley and Birmingham, the more interested they became in the proton synchrotron. Rabi had visited Berkeley as a member of the General Advisory Committee and had come back to Brookhaven ecstatic about the synchrotron. It would certainly be a gamble to build the machine, especially since the design had never been tested even on a small scale with protons. The greatest question was whether a magnet ring 50 feet or more in diameter could be built accurately enough to keep the proton beam in focus as it traveled millions of times around the ring. The slightest error in design, the slightest distortion might destroy the beam entirely. Could a new laboratory like Brookhaven afford a $10- or $20-million gamble?

The Brookhaven physicists were inclined to take the chance, but they had no intention of being reckless. They would build their first synchrotron no larger than necessary to give it a distinct advantage over the synchrocyclotron. To assure a really good producer of mesons, they would need something over 2.5 bev. This energy was substantially below the 10 bev Brobeck was

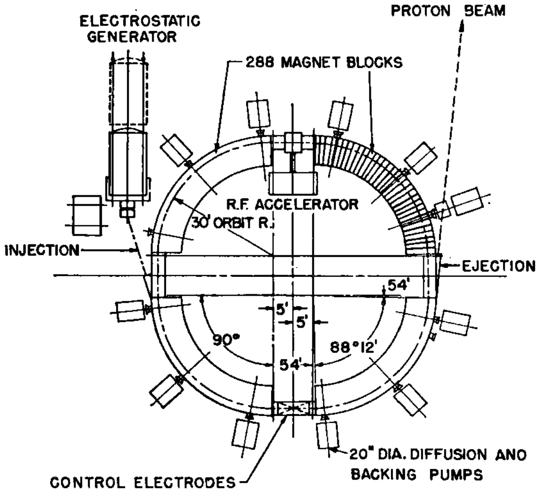


Figure 5. Plan view of the cosmotron showing the magnet blocks arranged in quadrants. The four straight sections accommodate equipment for injecting, accelerating, controlling, and extracting the ions.

planning for the bevatron, but the Brookhaven scientists concluded that they could always build a larger machine if their first proved successful. Before the end of 1947 Livingston and his associates had established the design parameters for a 2.5-bev machine. Similar to the Brobeck design in that it would use the large ring magnet with four straight sections, the Brookhaven design incorporated new features which Livingston hoped would be improvements. (Figure 5) In place of the huge, square "H"-shaped magnets of the Berkeley design, the Brookhaven machine would use "C"-shaped magnets which would provide great efficiency with a minimum use of steel, the largest single cost item in a big accelerator. The Brookhaven group also devised a new type of radio-frequency system to supply the accelerating voltage and a new system for automatically controlling the amount of voltage applied. Thus by the end of 1947 both Berkeley and Brookhaven had completed design proposals for a proton synchrotron in the bev range.[23]

CREATING FOR DISCOVERY

The interior of the atomic nucleus was not the only new realm which the wartime effort had opened to the nuclear scientist, nor was the high-energy accelerator the only instrument at his disposal. The feverish dash for the weapon in the mid-1940's had left in its wake the raw material for years of research and study. As they completed their wartime assignments, both physicists and chemists would turn to the thousands of interesting investigations they had set aside during the war. Before 1945 ended, many were carrying the war's unfinished business in the basic sciences back to their university laboratories.

In many respects, Glenn T. Seaborg, the young chemist who had gone to the Metallurgical Laboratory from Berkeley in 1942, faced the same prospects open to thousands of his colleagues in exploiting the research opportunities which the Manhattan project had created. What set Seaborg apart from the others was exceptional ability as a director of team research, a keen sense of what was significant in a mass of scientific data, and a determination to make a name for himself in the annals of science. He had made a good start, establishing himself as a codiscoverer of an element before the age of 30. In all the history of science only a few men had earned the distinction of discovering one of the building blocks of nature and even fewer had more than one element to their credit. Seaborg was in a good position to break all records in element-discovery. He had the knowledge and means at his disposal to create new elements and in the process "discover" and name them. This strong personal motivation sparked some extraordinary accomplishments in opening new realms for science and technology in the postwar world.

In a sense, there was nothing very difficult about creating new elements. Seaborg and many of his associates at the Berkeley Radiation Laboratory knew that bombarding heavy atomic nuclei with deuterons, alpha particles, or neutrons was likely to lead to heavier elements. The production of neptunium and plutonium had provided steppingstones to new discoveries. Even during the war it was possible for Seaborg to pursue his interest in element-creating. The ultramicrochemical techniques he and his staff had developed for processing minute quantities of plutonium would permit him to continue his search for heavier elements with quantities of material of no consequence to the war effort. He could send a few micrograms of plutonium to his friend Joseph G. Hamilton, who directed the operation of the 60-inch medical cyclotron at the Crocker Laboratory in Berkeley. After exposing the sample to bombardment by helium ions in the cyclotron, Hamilton could send it back to Seaborg for analysis at the Metallurgical Laboratory.[24]

Seaborg knew enough about the structure of the atomic nucleus to be confident that the samples contained new elements awaiting discovery, but how could he prove they were there? How could he observe the chemical or physical properties of a substance he could not see? One answer seemed to lie in the time-honored techniques of chemistry. In the early decades of the century, chemists had used the periodic table to predict the properties of undiscovered elements. Knowing what to look for, the chemist was more likely to make the discovery. Seaborg could use this approach if he knew the "chemical family" to which his new elements belonged. This was not an easy matter to determine at the upper end of the periodic table. Seaborg's best guess was that the new elements might be members of a "uranide" family, all having properties similar to uranium, as neptunium and plutonium did.

When occasional efforts to detect new elements in Hamilton's samples failed to produce any results after more than a year of study, Seaborg and his associates began to suspect they were on the wrong track. In seeking a new relationship, they saw significance in the fact that lanthanum fluoride had served as an effective carrier of plutonium in one of the oxidation-reduction processes the group had developed for recovering plutonium from the Hanford reactors. If lanthanum had chemical properties similar to plutonium, perhaps the uranium family was similar to the lanthanides. This seemed extraordinary, for the lanthanides were a strange family of elements which

55 Cs	56 Ba	57-71 La Series	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt
87 Fr	88 Ra	89-103 Ac Series	(104)	(105)	(106)	(107)	(108)		

Lanthanide Series	57 La	58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	44 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
Actinide Series	89 Ac	90 Th	91 Pa	93 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	(99)	(100)	(101)	(102)	(103)

Figure 6. The lanthanides and actinides in the periodic table of the elements.

had no regular place in the periodic table. They were usually depicted on a separate line at the bottom of the periodic chart with an arrow pointing to the one space between barium and hafnium. The lanthanides were transition elements whose special chemical properties were explained by the arrangement of electrons filling an inner orbital shell.

Suppose, Seaborg asked himself, the transplutonium elements fell in a second transitional series, also missing electrons in an inner shell? In this case the first of these elements, called actinium, might be similar to lanthanum; the second, cerium, similar to thorium, and so up the series. (Figure 6) This hypothesis would explain why he had not been able to isolate the suspected new elements with his plutonium separation techniques, which depended on a series of oxidation-reduction steps. The new elements would be similar to europium and gadolinium in the lanthanide series. These elements were known to be very stable in only one oxidation state, the +3. Now Seaborg had a new set of properties to look for.[25]

Seaborg was ready to test his new theory in July, 1944. He asked Hamilton to expose about 10 micrograms of plutonium nitrate to the beam of helium ions in the 60-inch cyclotron, on the supposition that some of the plutonium nuclei would absorb the proton pairs to form element 95 or 96. When the samples arrived, Ralph A. James, a recent graduate at Berkeley, dissolved the target material in acid and used the standard oxidation-reduction process with lanthanum-fluoride carrier to remove the fission products and plutonium. If, as Seaborg had predicted, the new element could not be oxidized to the +6 state, it would be concentrated in the final precipitate.[26]

Now Seaborg and his group resorted to a second test to prove the existence of the new element. It was common knowledge in the laboratory that most heavy elements were radioactive. Furthermore, each had characteristic radioactive properties. It was easy to determine that the concentrate emitted both alpha and beta particles, the former perhaps indicating the presence of the new element and the latter coming from the few remaining fission products. To determine the energy of the alpha particles, Seaborg went to Albert Ghiorso, a young electronics engineer who had become an expert in such measurements. Using a simple ionization chamber Ghiorso determined that there were 500 disintegrations per minute with an energy equivalent to a range of 4.75 centimeters in air. Later measurements showed the half-life of the material to be 5 months. From their knowledge of nuclear processes, Seaborg's group surmised that they had produced a new element with an atomic number of 96 and an atomic weight of 242 (or 96^{242} in the physicist's notation). Further experiments would have to confirm the deduction.

This confirmation came before the end of 1944 from other experiments which the Seaborg team had arranged for insertion in the Hanford and Oak Ridge reactors. It seemed possible that long exposure to the very large neutron flux in the reactors would lead to the formation of both elements 95 and 96. When Leon O. Morgan and James analyzed the samples in the closing weeks of 1944, they found two alpha emitters, both of which behaved like actinides. Ghiorso's measurements revealed one of the alpha emitters to have a range of 4.75 centimeters; the other, 4.05 centimeters. The first confirmed the earlier detection of element 96; the second indicated the presence of element 95.[27]

Still working under the rigid security restrictions of wartime, Seaborg and his associates could not announce their discovery in the customary way through the scientific journals, but they prepared for the day when publication would be possible. To the discoverers fell the privilege of naming their discovery. To recognize the relationship of the actinides to the lanthanides, the Seaborg group proposed to call element 95 "americium," after its analagous lanthanide, europium. Element 96 would be known as "curium," corresponding to its lanthanide analogue, gadolinium, after the Finnish rare-earth chemist Johan Gadolin. It was also necessary for security reasons to describe the discovery of elements 95 and 96 in terms of cyclotron rather than reactor irradiations. Although 95 had actually been first detected in samples exposed in reactors, the Seaborg group had to use a later experiment, involving the exposure of uranium 238 in the 60-inch cyclotron, to establish the discovery in the open literature.[28]

Significant as the discoveries in 1944 were, they marked only the beginning of research on transplutonium elements. As preliminary research often did, the first experiments revealed impressive obstacles to future progress as well as new incentives. For one thing, much larger samples than those produced in the cyclotron were needed to obtain truly definitive results and to provide source material for building even heavier elements. For another, the chemical similarity of the actinides, and particularly the difficulty of raising americium or curium above the +3 oxidation state, ruled out the separation processes the Seaborg group had devised for plutonium. There was always hope that one of the alternate processes under study at the wartime laboratories would prove effective, but in the meantime Seaborg's team proceeded as best they could with existing techniques. As the war came to a close in the summer of 1945, Burris B. Cunningham, one of Seaborg's senior researchers, succeeded in isolating microquantities of americium 241, but the techniques relied heavily on ingenuity and persistence.[29]

Study of separation processes other than oxidation-reduction continued for more than a year after Seaborg and his group returned to Berkeley in the fall of 1945. The best hopes seemed to be in ion-exchange processes, which Waldo E. Cohn and Frank H. Spedding had tried during the war to separate lanthanides. Stanley G. Thompson, who had had a leading role in developing the oxidation-reduction process, brought some first-hand knowledge of ion-exchange methods with him when he returned to Berkeley. The attractive features of the process were that it automatically selected the various elements to be extracted, it was relatively fast if somewhat tedious, and it required only very small quantities of material. It depended on the unique ability of certain organic polymers or resins to adsorb lanthanide ions in aqueous solutions. When the adsorbed material was placed in the top of a column containing more of the polymer, the various lanthanides were dissolved (or eluted) in a definite order by a solvent dripped slowly through the column. (Figure 7)

The Seaborg group needed almost a year of research to determine whether the ion-exchange process would work with actinides. After experimenting with a variety of polymers and solvents Louis B. Werner and Isadore Perlman were ready for the first effort to separate curium and americium in July, 1947. In a column 50 centimeters high and 8 millimeters in diameter filled with the polymer Dowex-50, they used ammonium citrate as the solution to elute many small samples of the two elements. They could then identify the samples by their characteristic alpha activity. A new multichannel pulse

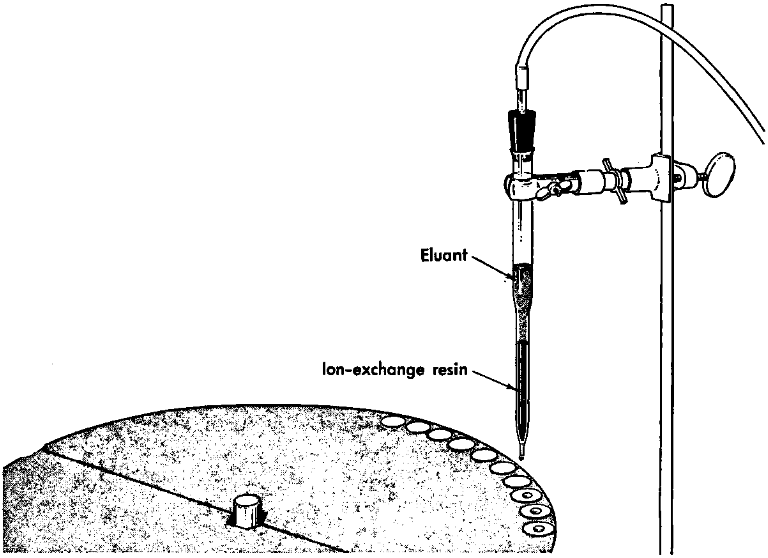


Figure 7. Equipment used for elution experiments. Successive drops of eluant are collected on the small discs.

analyzer which Ghiorso had developed was of great help. The analyzer, containing 48 channels, each set for a different voltage threshold, could automatically sort out and count the number of disintegrations at many specific energies. A plot of these data revealed the various elements present in the samples. By using the elution techniques with the ion-exchange process and Ghiorso's multichannel analyzer, Seaborg's group was prepared to separate any of the actinide elements. They had established the foundations of a new technology for the postwar world.[30]

RADIATION AND THE PLANT WORLD

Studies of radiation effects on plant life long antedated the Manhattan project. Since the turn of the century biologists had been subjecting various plant species to X rays and to gamma rays from radium sources. The findings, however, had been largely restricted to observation of gross effects, without any very precise definition of the amount of radiation received or its wavelength. Radium sources were almost prohibitively expensive for biological work, and the use of X-ray machines imposed severe limitations on the duration of exposure and the number of plants irradiated. Not until the 1920's had scientists amassed enough fundamental data and agreed upon sufficiently standardized units of measurement to claim the establishment of a new discipline called radiation biology. Even then, published data rested on conceptions related more to the physical than the biological sciences, as demonstrated by the common practice of describing the mechanism of radiation damage as an "ionizing effect."[31] Helpful as this conception was in establishing standards, it described only in physical terms what were essentially biological phenomena.

On the eve of World War II, enterprising young biologists were beginning to move beyond such expedients in an effort to describe radiation effects in biological terms. In attempting to explain not only what radiation did to plants but also how it produced such effects, biologists with enough courage to try could find intriguing questions, whatever their special interest or approach. Among the various subdisciplines in the field, the study of cells, or cytology, was perhaps the most promising. Since the cell was the fundamental unit of all life, it seemed likely that the mechanism of radiation effect would be explained in terms of changes produced in the cell.[32]

Among the many biologists intrigued with this idea was Arnold H. Sparrow, a young Canadian who had gone to Harvard on a research fellowship in 1942. After a wartime stint with the Office of Scientific Research and Development, Sparrow returned to his research at Harvard on the effects of radiation on plant cells. From his earlier research he had concluded that plant cells were most likely to be sensitive to radiation during division, particularly during the process of meiosis, which halved the number of chromosomes in forming reproductive cells. For his experiment Sparrow selected *Trillium erectum*, a type of Appalachian mountain lily frequently used in genetic experiments. *Trillium* had the advantage of large anthers, which produced many mother pollen cells; it also had a small number (10) of large chromosomes, which reacted in a relatively uniform manner during meiosis. Except for a 160-kilovolt Coolidge-tube X-ray machine, the experiments required only the usual equipment of the cytologist's laboratory: slides, stains, microtomes, and microscopes.[33]

To finance his research at Harvard, Sparrow had applied in 1946 for a three-year fellowship from the American Cancer Society. The private research grant was the accepted mode of supporting scientific research, and the great public interest in using atomic energy in cancer therapy suggested the cancer society as a likely source of support. Another possible source was the Atomic Energy Commission. Early in 1947 George B. Kistiakowsky, the Harvard chemist who had worked at Los Alamos, mentioned to Sparrow the opportunities at the new Brookhaven laboratory. Late in June, a week before Sparrow was to begin his fellowship, he received a definite offer to join the biology department at Brookhaven. There was perhaps some risk in committing one's future to as untried an institution as a national laboratory, but a visit to Brookhaven convinced Sparrow that the advantages far outweighed the dangers. The resources of the Long Island laboratory promised to surpass both in staff and equipment the headiest dreams of the university scientist.

When Sparrow arrived at Brookhaven in the summer of 1947, there was as yet little evidence of the facilities which had been promised him. The biology department was housed temporarily in a former post exchange; work was only beginning on the research reactor and particle accelerators which would provide radiation sources for experiments. But before the end of the year, plans were completed for a small greenhouse, and Sparrow was continuing his research on *Trillium*.

Sparrow's special interest in *Trillium* was in determining which stage in the process of meiosis was most sensitive to X-rays. Obtaining the plants in a dormant state late in the fall, Sparrow kept them at rather low temperatures to slow down the process of meiosis. From time to time he removed some of the pollen from the anthers to determine what stage of meiosis the microspores had reached. At the desired stage, he exposed the plants to X rays and then put them in cold storage until mieosis was completed and the next cell division had begun. He and his staff then prepared new smears from

the plants and examined them under the microscope. They determined the effect of radiation by counting or "scoring" the number of broken chromosomes. After examining the data from thousands of scorings, Sparrow concluded in the fall of 1948 that irradiation at one meiotic stage produced fifty times more breakage than that obtained with the same dosage at another stage.[34] The Brookhaven scientists needed still more data to be certain of their conclusions, but they were at least beginning to formulate a systematic understanding of the effects of radiation on the reproductive cells of one plant species.

RADIATION AND MAN

The effects of radiation on plant life provided many exciting possibilities for biological research, but its effects on man were of more than academic concern. Under ordinary circumstances humans could not be the subjects of laboratory experiments with radiation. But the bombings of Hiroshima and Nagasaki in August, 1945, had provided an exceptional (and hopefully unique) opportunity to measure radiation effects in a human population.

The first able to respond to the catastrophe were the Japanese physicians and scientists who, despite the chaos and devastation in the crumbling empire, marshalled their forces to estimate the location and force of the detonations, the number of people killed, and the extent and nature of injuries. By the time the first American medical teams arrived with the occupation forces and a special Manhattan District attachment in September, 1945, the Japanese were completing a series of reports on the disaster. An American joint military commission supplemented the Japanese studies in 1946 by examining seven thousand survivors and preparing a comprehensive summary of the acute effects of the bombings.[35] These reports, however, covered only a small sample of the great mass of evidence available, and in many respects it was the least valuable. Physicians were more interested in long-range effects on the blood cells, the physical growth of children, the mechanisms of heredity, and the development of various pathological conditions such as the formation of massive scar tissue. Reliable estimates would take years to formulate; determining hereditary effects would require decades, if not generations, of observations.

Both the military services in 1946 advocated long-term research directed by the National Academy of Sciences, and before the end of the year the services obtained a Presidential order directing the Executive Branch to assist the academy in organizing the project. Early in 1947 the academy established a committee on atomic casualties and asked the Atomic Energy Commission for financial support. All the members of the committee, including Shields Warren, could speak to the need with authority. The Commission responded promptly. An interim allocation of $100,000 in the summer of 1947 supported preliminary surveys by the new committee until the Commission signed a formal contract with the academy in April, 1948.[36]

By this time several survey groups had visited Japan and formulated plans for comprehensive studies involving all the medical sciences. The main research centers were to be in Hiroshima and Nagasaki, with similar but smaller facilities for control studies at Kure and Sasebo. The first projects, directed by Melvin Block, Fred M. Snell, and James V. Neel, concentrated on scar tissue formation, blood damage, and genetic data. The shortage of supplies and laboratory space, the lack of heat and trained personnel made the work almost impossible in the early months of 1948. Despite these obstacles, by spring Snell had completed a blood survey of 950 casualties at Hiroshima and an equal number of control patients at Kure. Even more difficult was Neel's task of collecting pregnancy data for the genetic studies. Extra rations were offered as an incentive for initial registration of mothers, but traditional Japanese reserve made it difficult to obtain subsequent data on birth defects.[37]

The Japanese and then the American team had earned the gratitude of scientists the world over by preserving the priceless data for long-term studies of the Hiroshima and Nagasaki victims, but their work was only a start. Substantial increases in financial support would be required in the years ahead, and the task of finding that support fell primarily on Warren.

MEETING THE DEMAND

By early 1948 both Fisk and Warren were well aware of the new interests and opportunities that were generating a demand for Commission support of basic research. The achievements of McMillan, Seaborg, Livingston, Sparrow, and

Neel were but isolated examples of the activities of hundreds of American scientists. Fisk felt the greatest pressures from high-energy physicists who needed accelerators. The demands on Warren were more diffuse, but they pointed to a substantial expansion of basic research in the biological sciences, both in the national laboratories and the universities.

Whatever his reservations about Commission support of basic research, Fisk recognized the inevitability of Government investment in high-energy accelerators. Without waiting to formulate a definite plan, he obtained a commitment from the Commissioners in October, 1947, to set aside $15 million for this purpose. Berkeley and Brookhaven were already competing for this prize.

For the eleven smaller accelerators being constructed on university campuses, the Office of Naval Research was still pleading for funds. As Fisk had predicted, the Navy had found the $8 million it needed to continue these projects until June, 1948, but there was little chance that the Navy could carry the entire burden for another year. Alan T. Waterman, chief scientist of the Office of Naval Research, had warned the Commission that Navy support for the nuclear sciences in 1949 would have to be cut back to $2.6 million. By this time Fisk was ready to help in a cautious way. In January he had hired Holbrook M. MacNeille, a mathematician who had represented the Office of Naval Research in London during World War II.

Thoroughly familiar with Navy procedures for handling research contracts, MacNeille in a few weeks worked out a joint program both the Navy and the Commission could accept. Fisk agreed to transfer the $4 million the Navy had requested for 1948, with the understanding that the money would be used only for funding new projects but not to replace money the Navy was already contributing to existing projects. Fisk would also require joint approval of the new projects by both agencies, a key factor being the availability of qualified scientists to perform the research. This condition would prevent the Navy from transferring funds away from nuclear research, give the Commission some voice in the use of the funds, and incidentally, increase the total Government support of the nuclear sciences.[38]

Waterman found only minor fault with the proposal and accepted its general terms on February 3, 1948. It would take several months to select from the more than seven hundred Navy projects in over one hundred institutions those suitable for the joint program, but the Commission transferred the first $1 million to the Navy on the strength of the February 3 meeting. The final plan for 1948 came to $3.1 million for physical research and $1.3 million for biomedical studies, the total being slightly more than the original Navy request. The Commission announced the new cooperative effort on April 26, just ten days after Ridenour's letter to Lilienthal.[39]

The joint projects provided an excellent buffer against the growing demands from the scientists for Commission support of basic research. All the projects were in nongovernment institutions and dealt with unclassified projects. At the same time, as part of the Navy program, they did not constitute a clearly independent commitment on the Commission's part to sponsor basic research outside its own laboratories. Another advantage was that the Office of Naval Research took the full burden of negotiating and administering the contracts, a task Fisk's small staff could not have assumed even by the summer of 1948. Fisk and MacNeille could observe the joint program in action, calculate its strengths and weaknesses, and hazard a few research contracts on their own to see what problems would arise.

One of these difficulties was sure to be the narrow range of topics that were clearly unclassified. In response to the General Advisory Committee's appeal for sweeping away all security restrictions on fundamental scientific data, the Commission had cautiously opened a few topics to unclassified investigation. These were limited to radiation instruments, particle accelerators, fluorocarbon and fluorine chemistry, including industrial applications, and medical research and health studies. The fact that the Manhattan District reviewers had recommended all of these subjects for declassification in August, 1946, did not make the Commission's action seem especially aggressive. When Lilienthal asked why additional topics had not been proposed, John E. Gingrich, the director of security and intelligence, could only reply that they were difficult to define. The General Advisory Committee found this answer absurd. The proper approach, in the committee's opinion, was to consider all basic research in essence unclassified, with the few sensitive topics an exception to the rule.[40]

Such a sweeping proposal seemed out of the question in the spring of 1948, particularly in view of Commissioner Strauss's overriding concern about the security of technical information. The best the Commission could do was to declassify additional areas, or as Strauss preferred to call them, "topics," for research. The fourteen topics declassified in August, 1948, essentially removed restrictions on all instrumentation, on mathematics, and on all aspects of research in the physical and biological sciences which did not involve the fission process, weapons, or the properties or characteristics of elements above atomic number 90. This restriction effectively prohibited unclassified work on thorium, uranium, and plutonium. To preclude the possibility that unclassified research might reveal classified information, the research divisions adopted the practice of providing a security clearance for the principal investigator, who could presumably steer his research associates away from classified areas.[41]

QUEST FOR THE MESON

The demands for Government support of research, particularly for high-energy accelerators, gained new impetus as accomplishments at Berkeley and elsewhere in 1946 and 1947 opened the possibility for some spectacular experiments. Among these none promised to be more rewarding than the production of mesons in the laboratory. For this task Lawrence's 184-inch cyclotron was marginal at best. At top performance it could push alpha particles to about 380 mev, which Lawrence's staff believed would be sufficient to assure that one proton in the nucleus would occasionally have the collision energy needed for meson production. If it was physically possible, Lawrence was confident that Duane C. Sewell, James Vale, and the cyclotron group would reach that goal.

The second ingredient of success was the ability to record meson production on photographic plates. This was a specialized art with a history going back to the turn of the century, when Henri A. Becquerel had discovered the effect of radiation on photographic emulsions. Over the years physicists had met new requirements by developing new techniques for producing more sensitive emulsions, exposing the emulsions to radiation, developing the emulsions, and analyzing the events they recorded. By the

1930's, when cosmic-ray experiments were taking on new importance, Cecil F. Powell and his associates at the University of Bristol in England had become the world's leading authorities on photographic emulsions for this kind of research.[42]

Lawrence's laboratory had used photographic techniques extensively at Berkeley and had built up a competent group headed by Eugene Gardner, a young physicist from Utah who had been exposing photographic plates in the 184-inch machine since it began operation. For the all-important meson experiments, Gardner had obtained some of the new emulsions developed by Ilford Limited in England, some especially sensitive material which Powell had used with great success in cosmic-ray studies earlier in 1947. With McMillan's help, Gardner and his group designed the experimental assembly, consisting of a thin target probe and a stack of photographic plates mounted in a block of copper, which would shield them from unwanted particles. The alpha particles accelerated in the cyclotron would strike the target to create negatively charged mesons, which would curve outward from the target under the influence of the cyclotron's magnetic field and hit the plates. Robert Serber checked out the theoretical calculations, and all seemed to be in order.[43]

Despite these special preparations, Gardner's group encountered trouble from the start of the experiments on October 13. Nothing appeared on the plates, even when different target materials and exposure times were used. Gardner checked to see that his group was following exactly all the steps in the sensitive process for developing the Ilford emulsions. Still the developed plates revealed no meson tracks under the microscope. The Berkeley group knew enough about the cyclotron and the theory of meson formation to be confident that the machine was producing mesons. The fault, then, seemed to lie in the emulsions. Perhaps knowing of Gardner's difficulties, Powell suggested sending one of his assistants to Berkeley for a year on a Rockefeller Foundation fellowship.[44]

In February, 1948, a vivacious Latin-American, just twenty-three years old, arrived at the Berkeley laboratory. He was Caesare M. G. Lattes, a Brazilian physicist who had worked with Powell on some of the classic cosmic-ray experiments. Gardner needed only a few days to explain the experiment to Lattes, and the cyclotron runs started again on February 15 with Lattes handling the plates. In ten runs during the first week, the results were still disappointing, but Lattes was confident of success. At last in one run on February 22, Lattes detected two of the characteristic meson tracks. Within a few days, Lattes was finding mesons in numbers. Gardner's group could measure with an eyepiece micrometer the range and density of each track in the emulsion to determine the velocity of the meson. They could determine the mass of the particle by measuring the point and angle at which it struck the photographic stack, the lighter particles moving in tighter orbits under the magnetic field. Some tracks terminated in a characteristic star pattern, which indicated that the meson had disintegrated in collision with a nucleus.[45]

The Berkeley scientists wanted to be certain of the results. Although they had found numerous mesons on February 26, they were not ready to announce their success until March 9, 1948. Each plate showed about 50 meson tracks along its edge. Gardner and Lattes had measured 49 of these to obtain an estimate of mass consistent with the Bristol data. The advantage of the Berkeley experiments, as Lattes explained glowingly, was that they had obtained 27 tracks in ten minutes, while eight members of the Bristol group had worked a year to get 100. The event was a ringing accomplishment for Lawrence and Berkeley. They had for the first time brought cosmic rays into the laboratory, and the exploration of the atomic nucleus seemed only beginning.

COMPETITION FOR POWER

By the time Lawrence announced the laboratory production of mesons, both Berkeley and Brookhaven had completed their proposals for proton accelerators in the billion-electron-volt (bev) range. Lawrence had kept Fisk and the Commissioners well informed of the progress Berkeley was making on the bevatron in the summer and fall of 1947. The Commission seemed more than interested in Lawrence's ideas, but he had no assurance of Commission support. The Brookhaven design, calling for an accelerator substantially smaller than the bevatron, seemed to offer quicker attainment of the bev range. If the Commission should decide to build only one accelerator, it might well choose the less expensive Brookhaven proposal. Lawrence himself could appreciate the wisdom of modest steps in moving to higher energies. Perhaps it would be prudent to build a small machine which could later be expanded to higher energies. Early in 1948 Lawrence asked Brobeck to start designing a 1.8-bev machine which could be enlarged to 3.0 and then to 6.5 bev.[46]

With interest mounting in both laboratories, the Commission turned to the General Advisory Committee to referee the contest. The committee meeting scheduled for February, 1948, in Washington, was an opportune time to discuss the two projects; the two "bevatrons," as they were then called, became a big item on the agenda. From the outset there was a wide diversity of opinion in the committee. The only general consensus was that one synchrotron in the low-bev range would probably be enough, but there was no hope for agreement on which machine should be built or where. Rabi and Seaborg demonstrated their respective loyalties to Brookhaven and Berkeley, and the other members seemed undecided. Enrico Fermi, revealing his usual conservatism on expensive research tools, favored only one machine, but he feared that approval of only one would impair the morale of the unsuccessful laboratory. The committee concluded that two machines should be built for substantially different energies, but in a rare moment of indecision, the committee suggested that the two laboratories decide with Fisk the design energies and locations of the machines.[47]

The subsequent meeting in Berkeley on March 8, 1948, was a curious affair in which each group found it in its interests to defer to the other. Both sides understood the dilemma: whichever group built the smaller machine would probably reach the bev range first, but it would also have to run the risk that it would never overtake the other in the race for bigger machines. It was easier to agree that one machine should be in the 2.5- to 3.0-bev range for plentiful meson production and the second around 6 to 7 bev for production of fundamental particles in pairs. Because the Brookhaven group had already given much study to a machine at the lower energy, Morse was willing to accept the smaller machine, provided Fisk could assure him that the Commission would not limit the laboratories to one machine each. Fisk said he knew of no limitations. Lawrence accepted the larger machine, and both groups agreed they should cooperate in exchanging ideas between the two laboratories and with the British group at Birmingham.[48]

By the time the Commission approved the new arrangement on April 14, 1948, both groups were moving rapidly into design studies. Brobeck, faced with the larger scale-up in size, had decided to build a quarter-scale model which would actually accelerate protons. To direct the work on the model he brought Edward J. Lofgren back to Berkeley from the University of Minnesota in the fall of 1948. Lofgren concentrated on the design of the magnet, particularly the defocusing effect that might occur in the straight sections where there were no magnets to guide the beam. Under the stimulus of Lawrence's enthusiasm, the laboratory completed the building for the quarter-scale model in the fall of 1948. Lofgren succeeded in getting the first beam of protons in the machine on April 30, 1949. This was a remarkable achievement, but refining the operation would take the rest of the year, and by that time Lawrence's interests were moving elsewhere. The bevatron was truly becoming the machine of the future.[49]

The "cosmotron," as the Brookhaven group insisted on calling its accelerator, would follow the established conceptions of Livingston, Green, and Blewett. In contrast to Lawrence's emphasis on flexibility, the Brookhaven group concentrated on precision in design. Lawrence's approach had always been to get a beam and then discover how to improve it. Livingston proposed to determine the kind of beam desired and then tailor the design to produce it. The cross-section of the beam in the cosmotron would be smaller than the dimensions Brobeck was planning for the bevatron. A smaller vacuum chamber would mean lower costs and higher efficiencies, but it placed a heavy burden on Blewett and Green to build the machine with such close tolerances. In the spring of 1948, Blewett undertook an intensive theoretical study of the magnet design, while Green conducted several experiments with small-scale models of the magnet. Before the end of the year they had ordered the steel for the magnet and construction forces had poured the reinforced-concrete foundations for the magnet ring. As the magnet blocks began arriving in 1949, William H. Moore, Jr., and his team began extensive tests of their magnetic properties, using the techniques Green had developed. Green and Joseph A. Kosh were preparing with great care to wind the water-cooled copper bars which would form the magnet windings. By the end of 1949 many of the magnet blocks were ready for installation as soon as the last sections of the roof on the cosmotron building were put in place. The firm predictions of early 1948 that the cosmotron would be operating before the end of 1949 had proved optimistic, but progress had been good nonetheless, and confidence at Brookhaven was growing as the machine took shape on the ring foundation.[50]

ORGANIZING BIOLOGY AND MEDICINE

For Shields Warren, the delay in creating the division of biology and medicine had made it difficult to rebuild the biomedical units at the major Manhattan District installations. Under the wartime security system each unit had concentrated on the industrial hazards at its own site: Clinton and the Metallurgical Laboratories on dangers in reactor operations and the plutonium separation process, Hanford on ecological effects of operating the production reactors, Los Alamos on the special hazards of fabricating fissionable materials, and the University of Rochester on the potential risks in uranium-235 production. With reduced staff and incentive, these biomedical teams had struggled through the uncertainties of 1946 and 1947 and were now looking to Warren and the advisory committee for biology and medicine to give them a distinctive and effective role in the Commission's research program.

Offsetting these handicaps, Warren found certain advantages in his position. Had he been required to operate within the division of research and the General Advisory Committee, he could never have hoped to get more than occasional attention from the general manager and the Commissioners. Now he had direct access to these officials. What his advisory committee may have lacked in prestige and influence by comparison with the General Advisory Committee its members more than made up in technical competence and enthusiasm. Rather than rushing to put biology and medicine on the Commission's organization chart, Warren and the members of the interim advisory committee had laid down the broad outlines of a vigorous research effort in the life sciences. Compared with the problems Fisk faced in the research division, Warren's task was simple and straightforward. There were other advantages too. Unlike the physical sciences, the life sciences could operate completely outside the barriers imposed by classification. With no military applications, the biomedical sciences seemed to lie entirely in the realm of humanitarian uses of atomic energy.[51]

Fortunately for Warren and his colleagues, they were organizing the new division at the very time public interest was mounting for a new assault on one of man's oldest enemies. On the eve of the Fourth International Cancer Research Congress in September, 1947, Dr. Charles B. Huggins, an eminent surgeon at the University of Chicago, had warned on a "Round Table" broadcast that "cancer is as great a scourge to the human race as war." Cancer had advanced in twenty-five years from seventh to second place as a cause of death in the United States. In 1947, when Congress was trimming appropriations for research, it added a specific authorization of $5 million for Commission support of cancer research.[52]

DISTRIBUTION OF RADIOISOTOPES

Radioisotopes were the weapon that gave new hope for ultimate victory over cancer. Scientists had demonstrated the effectiveness of isotopes in cancer therapy before the war, but the development of atomic energy had opened up undreamed-of possibilities in making available virtually limitless, inexpensive sources of radiation. Since the summer of 1946, the Oak Ridge laboratory had been shipping radioisotopes to universities and hospitals in all parts of the nation. Of the almost 2,000 orders filled by the end of 1947, about three-quarters were for small amounts of phosphorus 32 or iodine 131. The phosphorus isotope, which tended to concentrate in tumors, was excellent for locating small but dangerous cancers deep in the human body, particularly in the brain. Iodine 131, which concentrated in the thyroid, had revolutionized the treatment of hyperthyroidism. Most of the other orders were for research in physics, chemistry, and metallurgy, and for industrial and agricultural applications. Isotopes were especially useful as tracers. By substituting the radioisotope carbon 14 for the naturally occurring carbon 12 in many organic substances, scientists could instantly detect with a Geiger counter the presence of the smallest trace of the compound in a chemical solution or a growing plant. Under the enthusiastic direction of Paul C. Aebersold, the isotope production facility had become the Commission's most convincing demonstration of the beneficial uses of atomic energy.[53]

The extraordinary potential of radioisotopes in cancer therapy led Warren and the advisory committee to advocate further strengthening of the isotope program in 1948. In addition to closer ties with the medical profession, the committee recommended free distribution of those isotopes used in cancer therapy and research, a suggestion the Commission quickly adopted. Aebersold undertook the task of obtaining better facilities to replace the temporary buildings used to process and package the radioisotopes at Oak Ridge. He had also arranged for the production of a number of stable isotopes in the electromagnetic plant at Y-12.

After a detailed appraisal of all aspects of isotope distribution in the spring of 1948, Aebersold concluded that the Oak Ridge reactor would be able to produce all the radioisotopes required for several years. Costs were not a serious deterrent to the use of isotopes, and a modest increase in personnel would eliminate administrative delays. The greatest obstacle to the wider use of radioisotopes, Aebersold found, was the shortage of scientists and technicians trained to use the new materials.[54]

FELLOWSHIPS IN THE NUCLEAR SCIENCES

The shortage of scientists with any knowledge of atomic energy was a problem extending beyond the use of isotopes. In the nation's hospitals and universities, few physicians or scientists were aware of the new opportunities for research which the wartime project had revealed, and even fewer knew how to take advantage of them. One of the first recommendations of the Commission's interim medical committee in early 1947 had been establishment of an extensive training program in using atomic energy in the biomedical sciences. In June, the Commission's medical board of review recommended that fellowships be awarded by the National Research Council of the National Academy of Sciences and financed by the Commission. Warren and the new advisory committee carried forward these recommendations in the fall of 1947, and drafted with the division of research a general plan for training fellowships in both the physical and biological sciences.

When Fisk ran into some philosophic reservations, Warren announced his part of the program in January, 1948. With about $1 million for the first year the Commission would provide 180 fellowships, 30 of which would be for postdoctoral research using atomic energy in the basic biomedical sciences, clinical medicine, or surgery. The remaining fellowships would go to graduate students for doctoral dissertations in the biomedical sciences or for training technicians in health physics or industrial safety. The National Research Council would award the fellowships on a basis comparable to that followed in the other sciences.[55]

Although the initial response was disappointing to Alan Gregg and the other members of the advisory committee, the fellowships met an obvious need. They quickly became an effective means not only for training scientists and physicians but also for accomplishing significant research in biology and medicine. To increase the opportunities for fellowship training the Commission also decided in March, 1948, to establish regional facilities at smaller universities throughout the nation. In time the support provided by the Commission helped to establish first-rate research institutions outside the major universities and the national laboratories.

Early in February, Fisk resolved his misgivings and the Commission approved an almost identical plan for the physical sciences. With generous Commission support and good administration by the National Research Council, the fellowship program earned the Commission almost as much good will as isotope distribution in 1948 and early 1949. Then new developments, involving both security and politics, suddenly threatened to destroy all hopes for continuing the effort.[56]

BIOMEDICAL RESEARCH

In addition to the isotopes and fellowship programs, the Commission was supporting other activities which would help in cancer research. Early in 1948 Warren proposed an extensive but sensible plan for utilizing at least some of the $5 million provided by the Congress for fiscal year 1948. By limiting his proposals to those activities in which atomic energy would be particularly useful, he could avoid duplicating the work of the American Cancer Society and the U. S. Public Health Service. He proposed to spend $400,000 to study the radiation hazards from the fission process, $50,000 for free isotopes for cancer research, $1.5 million for independent research contracts, and $75,000 for research on the victims of the atomic bombings in Japan. To this request of about $2 million, the Commission, largely on Strauss's initiative, promptly added an extra $1 million "if it could be effectively expended." In July, 1948, the Commission as quickly approved Warren's proposal to provide $2 million to construct the Argonne Cancer Research Hospital at the University of Chicago. Any project Warren could tie to cancer research seemed likely to find support.[57]

Not all research projects enjoyed the same popular interest. More prosaic but equally important were the long-term efforts in health physics, radiation effects, and ecological research which the Commission supported. Austin M. Brues in the late 1940's led Argonne in a series of important studies of the toxicity of plutonium and the radiation effects of ingested substances as internal emitters. At Hanford, Lauren R. Donaldson of the University of Washington continued the studies started during the war to determine the effects of radiation on Columbia River salmon. Donaldson also led the radiobiology teams on two expeditions in 1948 to measure the effects of the 1946 Bikini tests and the 1948 Eniwetok tests on marine life. In Japan the preliminary work of the field group, now called the Atomic Bomb Casualty Commission, had assured that fundamental data would be available for long-term studies supported by the Atomic Energy Commission. Routine work in health physics and industrial medicine at all Commission installations not only made possible an unprecedented safety record over the years but also helped to tone down some of the almost hysterical public reaction to atomic energy, kindled by its dramatic advent during the war. Slowly the public was coming to realize that, like all afflictions of mankind, the effects of atomic energy could be understood and therefore controlled through scientific knowledge and techniques.[58]

NEW AVENUES FOR BASIC RESEARCH

The steady growth of research activities in both the physical and the biomedical sciences by the summer of 1948 was a tribute to Fisk, Warren, and the few dozen scientists who worked with them in Washington headquarters. So far they had concentrated most of their attention on the national laboratories, as illustrated by the isotope distribution program at Oak Ridge, the decision to build high-energy accelerators at Berkeley and Brookhaven, and the environmental health studies at several Commission installations. In many branches of the sciences—chemistry, physics, metallurgy, biology, genetics, and medicine—the national laboratories were beginning to demonstrate capabilities for conducting basic research on a professional level approaching that of the better private institutions. Special devices such as reactors and the experience acquired in the wartime project gave the national laboratories an obvious advantage in the nuclear sciences; but the variety of facilities, the abundance of research equipment, and the level of financial support in the Commission's installations were all setting new standards far above those accepted in the best universities before the war.

Beyond the Commission's own facilities, Fisk and Warren had taken short but important steps toward supporting basic research in the universities and private institutions. The granting of fellowships and support of the projects originally financed by the Office of Naval Research broadened the base of Commission support in both the physical and the biomedical sciences.

Once these steps had proved effective, the Commission could begin to consider granting research contracts directly to the university scientists, as the General Advisory Committee had been urging since early 1947.

By the summer of 1948 the time seemed ripe for this step. Experience with the Navy contracts and a few trial agreements for specific research projects in the universities had convinced Fisk's and Warren's assistants that they could handle the administrative load. They would be responsible only for technical evaluation of proposals, the details of contract negotiation and administration being the task of the operations offices. At both Chicago and New York the Commission had personnel with extensive experience in drafting contracts which provided both the necessary controls and the flexibility needed in sponsoring basic research. Alfonso Tammaro, the Chicago manager, had administered contracts for the Manhattan District during the war and had served on a special committee, led by John R. Loofbourow, which had made a study of the Commission's relationships with academic contractors in 1947. The burden of the Loofbourow report was that close ties between the field office and the contractor would make it possible to negotiate contracts which avoided bureaucratic restrictions and gave the scientists the greatest possible freedom. The Loofbourow report applied most directly to contracts for operation of the national laboratories, but it established a pattern which would be equally useful in direct contracts with the universities.[59]

Equally influential as Tammaro at Chicago was James T. Ramey, a young attorney who had come to the Commission in 1947 from the Tennessee Valley Authority. With a strong interest in administrative law and management, Ramey had seen in the unique relationships between TVA and other regional agencies the opportunity to develop new contract forms to replace the conventional Government instruments with their pages of fine print and legal technicalities. Ramey's TVA experience was particularly valuable in the Commission's contract work at Chicago. The standard Government contract was no more useful in defining an agreement for basic research at a university than it had been in TVA activities. Furthermore, the prohibition against grants-in-aid in the Atomic Energy Act required the Commission's staff to build into the contract form the kind of flexibility usually achieved by means of a grant. Ramey's assignment in Chicago gave him new opportunities to develop his conception of the "administrative contract," which in everyday terms described a working partnership between the Commission and the contractor.

Wilbur E. Kelley, manager of the Commission's New York office, found the administrative contract form popular with the universities in the Northeast. He wrote Carroll L. Wilson in August, 1948, that the simple, straightforward terms of a Commission proposal for basic research was the factor "which really broke down the traditional M.I.T. skepticism about Government contracts." In negotiating for basic research, Kelley maintained, the Government official had to remember that the value of basic research could not be measured in dollars. "Getting the most for our money in research involves two factors, the creation and maintenance of enthusiasm for the project and the setting of goals which can be followed score-wise through reports." [60]

Abetting this new understanding of the research contract was the functional realignment of the headquarters divisions and the field offices which Wilson announced on August 5, 1948. Under the new system the director of research would no longer serve merely as a staff adviser to the general manager, but would have executive responsibility for administering the research program. The reorganization also called for a separate division of reactor development, a step which would enable the director of research to concentrate his attention on basic research to the exclusion of applied technology.[61]

Having assisted Wilson in planning the reorganization, Fisk resigned as director of research to return to teaching at Harvard. His departure not only deprived Wilson of a trusted adviser but also removed from the Commission's councils a strong conservative voice on matters of research policy. Perhaps in time Fisk would have adjusted to the changing attitudes toward supporting basic research in the universities, but now the Commission could recruit a new director who could make a fresh start under the new charter provided by the reorganization.

As autumn came, hopes for the National Science Foundation bill faded once again when Congress adjourned without acting. President Truman had voiced his support of both the foundation in particular and greater Federal assistance to basic research in general, in a speech before the American Association for the Advancement of Science. Few people, however, beside the President believed that his support would count for much after the November election.

Truman's stunning victory was very much on the minds of Commissioner Pike and Wilson when they called on Robert G. Sproul, president of the University of California in Berkeley, on the day after the election. When the two officials got around to their business, they told Sproul they wanted to invite Kenneth S. Pitzer, a young chemist at Berkeley, to take the position of director of research. Not quite thirty-five, Pitzer had done his graduate work at Berkeley, had served as research director of a small eastern laboratory during the war, and had received several awards for his research accomplishments. Pike and Wilson found him receptive to the idea. After visiting Washington, Pitzer agreed to come for about two years if the university would grant him a leave of absence.[62]

By the time Pitzer arrived in Washington in January, 1949, Warren had already laid much of the groundwork for direct research contracts with the universities. In the interest of efficient operations, he welcomed the new executive authority which the reorganization had provided, and he was willing to accept a proposal in the reorganization plan that a single group handle all the administrative functions at headquarters for both divisions. As interest in this idea dissolved, Warren began to develop procedures for negotiating and administering research contracts with the universities in the biomedical sciences alone. The plan, approved by the general manager in late January, 1949, followed closely the tentative procedures the two divisions had tried in 1948. Headquarters would evaluate proposals from the universities and select those which would provide a balanced research effort with the funds available. After determining the probable duration of the project and the annual level of expenditure, the headquarters division would give the proposal to the appropriate field office for negotiation. The field office would administer the financial and management aspects of the contract; the Washington division would evaluate technical performance and accomplishment.[63]

Warren's achievements and the continuing efforts of Ralph P. Johnson, MacNeille, and others in the division of research gave Pitzer a running start on his first assignment—to establish a system for direct research contracts. He took advantage of a meeting of the General Advisory Committee in Washington early in February, 1949, to discuss the subject. Taking a positive approach, he held that the time was right for negotiating direct contracts. He told the committee that MacNeille was already working on twelve such agreements. The arrangement with the Office of Naval Research could be phased out as the division built up its administrative machinery. Obviously pleased with the new policy, the committee had only one criticism. Pitzer appeared to assume that he should sit back and wait for proposals from the universities; the committee favored an aggressive effort to find projects worthy of Commission support.[64]

Moving rapidly, Pitzer completed a formal proposal in time for consideration by the Commissioners on March 14, 1949, when Warren's own paper was on the agenda. Following closely the procedures in Warren's paper, Pitzer suggested that the Commission support the physical sciences at an annual level of $10 million, the minimum recommended by the General Advisory Committee, and that in time the Commission might increase the amount toward the committee's goal of $30 million annually. Commission support of the Navy program was running at $4 million per year in 1949 and 1950 and presumably would phase out in 1951. Now that the Commission would provide most of the money, Pitzer thought the Commission should assume control of the projects as quickly as possible. In view of the Congress's continuing failure to act on legislation for a national science foundation, the Commission could wait no longer. As for the limitation on the division's authority in Section 2(a)(4)(b) of the Atomic Energy Act, the Commission's legal staff had concluded that Pitzer could legally participate in selecting and evaluating research projects as long as the Commission determined the total allocation for such research.[65]

Commission approval of the two proposals on March 14 marked the beginning of a new partnership between the Government and the universities in the support of basic research. For many scientists in the universities, the decision seemed long overdue. For others in the Commission's headquarters, events of the previous two years had justified a cautious approach. Now the Commission could embark upon direct support of basic research with confidence that its criteria and procedures would withstand the challenge of Congressional or Executive examination.

A NEW SPECIES?

The new interest in direct research contracts did not mean that the Commission was neglecting the national laboratories in 1949. Pitzer made a tour of the laboratories one of his first activities and he returned to Washington impressed by the quality and morale of the scientists in the Commission's installations. In February the Commission approved the construction of facilities for the new Argonne laboratory, totaling more than $63 million. Even this astronomical amount would not provide all the buildings in the original plan in the face of rapidly rising construction costs. To this figure the Commission would soon have to add $19 million for the first step in constructing a permanent laboratory at Oak Ridge.[66]

High as these costs were, the vitality and activity of the laboratories seemed to indicate that the Commission was making a sound investment. Argonne, under Zinn's drive, was a beehive of activity, mostly in reactor development but also in the basic sciences. Oak Ridge was at last emerging from years of uncertainty and doubt. The laboratory still had no director, but Weinberg was becoming an effective spokesman for Oak Ridge interests. In March he declared to the readers of *Science* magazine that the Oak Ridge experiment had been a success. One year under Carbide management had demonstrated that a national laboratory could successfully blend the activities of an industrial research laboratory with those of a regional association of universities. A month later he illustrated both the depth and diversity of research at Oak Ridge, in a briefing before the General Advisory Committee in Washington. The laboratory could boast strong programs in chemical technology, reactor technology, basic research, isotope production, radiation protection, and education. Weinberg hoped that Oak Ridge could lead the South into the age of modern science. Just how Oak Ridge would develop in the future he could not tell.

The concept of the national laboratory was still developing. It might prove to be a new species of scientific institution which would bring new opportunities and strengths to research. The next task would be to devise a long-range plan for each of the national laboratories, particularly in the area of reactor development.[67]

Talk of long-range planning, however, assumed a certain amount of stability, a solid base from which to project trends for the future. As 1949 wore into summer, new forces seemed once again to threaten the systematic development of research policy. International tensions were again taking their toll. A new wave of fear over communist espionage threatened to destroy the Commission's fellowship program, and an economy-minded Congress slashed the Commission's budget requests, particularly in "nonmilitary" areas such as research and development. A hostile attack on the very heart of the Lilienthal stewardship sapped the energies and morale of the Washington leadership. Finally, before the end of the summer, a startling achievement in the Soviet Union would turn most eyes from the peaceful atom toward the atomic shield. Would Weinberg's "new species," would the Commission's new approaches to a new age, have a chance to survive in a world of conflict?

COOPERATION WITH THE BRITISH: UNTANGLING THE ALLIANCE

CHAPTER 9

To most Americans, news of their nation's atomic energy effort had come from Truman's statement of August 6, 1945, that an atomic bomb had been dropped on Japan. Almost overlooked was the President's acknowledgement of British contributions to the weapon. Those few Americans who were aware of the details of the partnership must have watched the events of 1946 uneasily as Baruch sought international control in the United Nations, and as Congress framed the Atomic Energy Act. Somehow a policy had to be devised which would give the Baruch plan every chance to succeed, which would replace the former ties with Britain by a new understanding, and yet which would meet the determination of Congress to preserve American leadership in atomic energy. Reconciling these aspects of foreign policy and atomic energy was not solely the job of the fledgling Commission, but Lilienthal sensed that the issues were explosive.

THE WASHINGTON SCENE

Both houses of Congress met at noon on March 12, 1947. After sixteen minutes of desultory business the House of Representatives stood in recess, and the legislators nearest the front of the chamber moved back, leaving vacant the first rows of seats. Diplomats, reporters, and guests watched from the crowded galleries the unassuming and yet dramatic pageant taking place below. At twelve forty-five by the clock over the Speaker's desk, the sharp sound of the gavel filled the room as Joseph W. Martin, Jr., called the House to order. Briefly the rustle subsided; then from the back of the chamber the doorkeeper announced the President *pro tempore* of the Senate and the Senate itself. Down the aisle they moved, and as the senators settled into the chairs, Arthur H. Vandenberg, their presiding officer, climbed the steps of the platform to take his place to the right of the Speaker. At twelve fifty-seven the doorkeeper announced the Cabinet. Led by Acting Secretary of State Dean G. Acheson and Secretary of the Treasury John W. Snyder, the cabinet members filed into the few remaining places reserved for them. Barely were they seated when, at one o'clock, the doorkeeper announced the President of the United States. Harry S. Truman, a black loose-leaf notebook beneath his arm, strode down the aisle and mounted to the rostrum as all in the chamber rose and applauded. Silence fell as the President opened the notebook, drank half a glass of water, and began.

"Mr. President, Mr. Speaker, Members of the Congress of the United States, the gravity of the situation which confronts the world today necessitates my appearance before a joint session of the Congress." Speaking slowly and forcefully, the flat tone of his voice carrying to the nation and the world the accent of Missouri, Truman described the tragic condition of Greece. Only the United States could rescue the devastated and shattered nation; for Britain, exhausted by long years of conflict, could no longer carry the burden of financial and economic aid. Although spared from the havoc of war, Turkey also needed assistance to defend itself against hostile forces from outside its borders. Here too, Britain could no longer help. Almost casually Truman remarked that the United Nations was not equipped to give assistance of the type required. Asserting that a main goal of American foreign policy was to ensure the peaceful development of nations, Truman drew applause as he declared, "We shall not realize our objectives, however, unless we are willing to help free peoples maintain their free institutions and their national integrity against aggressive movements that seek to impose upon them totalitarian regimes." Twenty-one minutes after he had entered the House, the President left, having requested $400 million to aid the two troubled nations. The day had been gray when he arrived, but the sun had broken through when he departed for the National Airport and a few days of rest in Florida.[1]

Congress had listened intently and grimly to Truman, but with little surprise. Days before the joint session Truman had carefully briefed Tom Connally, Vandenberg, and other Congressional leaders. Secretary of State George C. Marshall, leaving for a meeting of foreign ministers in Moscow, had told reporters on March 4 of the critical importance of a stable Greece. In his speech Truman had not referred to the Soviet Union by name, but identifying the source of danger was hardly necessary. His allusions to Britain had been almost incidental, carrying no suggestion that the United States was coming to the aid of a partner.[2]

Yet the United States and the United Kingdom were still closely linked, even if the bonds forged during the war had loosened with the end of hostilities. Americans might find it difficult to understand how an electorate could exchange a flamboyant Churchill for a colorless Attlee, but at least the transition had been made by peaceful ballot. Across the confused world, where new centers of power had not yet emerged to replace the old, the interests of both states were mutually involved, often with the same ends, seldom with the same means. Differences existed over Palestine, China, and India, but although disagreements between the United States and the United Kingdom were inevitable, a break between the two was unthinkable.

Vandenberg, Connally, and Bourke B. Hickenlooper were members of the Committee on Foreign Relations as well as the Joint Committee on Atomic Energy. Better than most of their Congressional colleagues, they were aware of the ties linking the United States and Britain. But as they heard Truman speak on March 12, they did not know that in 1913 at Quebec, Roosevelt had agreed with Churchill that neither country would use the atomic bomb without the consent of the other. They knew nothing of the abortive efforts to dilute the obligation from "consent" to "consult," which had followed the November, 1945, meeting of Truman, Attlee, and Mackenzie King. Nor did they know that the British were receiving one half of the vital uranium ore from the Belgian Congo, and that the half going to the United States was not enough to keep the American atomic energy plants running at capacity. Nor was the President himself, as he spoke on March 12, completely aware of the agreements with Britain or their implications. Of those in the chamber who listened to Truman, probably Acheson was the best informed of the tangled relations.[3]

Lilienthal recognized the dangers in the situation, for Section 15 of the Atomic Energy Act required the Commission to keep the Joint Committee fully and currently informed. As the time had drawn near for the Commission to assume responsibility for the nation's atomic energy program, Lilienthal had appealed to Secretary of State James F. Byrnes on December 30, 1946. Recalling Section 15 Lilienthal had written, "Our problem in this connection will be obviated when the appropriate Committees of Congress are acquainted by the State Department with the status of these arrangements." There was, however, no result. Lilienthal turned to his friend Acheson, but again to no avail.[4]

There was some excuse for the delay. Byrnes was about to resign when he received Lilienthal's letter, and the approach to Acheson came during circumstances which might well have given the Under Secretary—an astute practitoner of the arts of Congressional relations—reason to pause. Matters involving the atomic bomb were obviously sensitive and required the highest consideration. Marshall, recently recalled from China to succeed Byrnes, had been in office a little more than a week when Lilienthal talked to Acheson. Immediately Marshall faced the Greek and Turkish crises, and prepared for the Moscow meeting. Nothing had been done to inform the Congressional committees as Truman spoke on March 12.

That the nation was entering a new phase of its history with the Truman doctrine was evident. If the fall of France and the attack on Pearl

Harbor had shattered the tradition of American isolation, the Truman doctrine marked the end of the dream that the great powers could work together in the United Nations for a world free from war. Now the policy was one of containing communism. Some—such as Walter Lippmann—did not accept the change without question. Lippmann saw containment as a fallacious and hazardous policy which might well make the United Nations a casualty of the cold war.[5] The danger was real. Suspicion and hostility between the two most powerful nations could hardly be reconciled with the idea of unity upon which the United Nations was founded. The plight of Greece was but one evidence of the incompatibility, and other signs were not lacking. Within the United Nations itself the hopes for international control of atomic energy had lost their promise. Near the end of 1946 an associate of Bernard M. Baruch, United States representative on the United Nations Atomic Energy Commission, surveyed the prospects, chomped on his cigar, and observed, "I am a stockmarket man, and this is a falling market."

THE U. N.: A FALLING MARKET

By the end of 1946, Baruch concluded that his work was nearly finished. He and his staff, many of whom were personal associates of long standing, had spent the summer and fall in a wearying number of meetings with the representatives of other nations to develop the framework for international control of the new and dangerous source of energy. Under the driving pressure of Baruch and his team, the commission finished its first report on the last day of the year. Ten nations had voted their acceptance; two—the Soviet Union and Poland—had abstained.[6] In one sense, approval by the majority of the commission was little more than a token, for next would come consideration in the Security Council where substantive action required unanimity.

The first report did not attempt to present a complete plan for international control of atomic energy, ready for world-wide application, but confined itself to the scientific and technical aspects of control and the safeguards necessary to assure that energy from the atom would be used for peaceful purposes. Cautiously and tentatively the majority concluded ". . . we do not find any basis in the available scientific facts for supposing that effective control is not technologically feasible." An international authority would be needed with wide powers of inspection and management over uranium mines, processing and refining plants, and power reactors; for without such controls the majority could find no guarantee against clandestine diversion of atomic energy to military purposes. So crucial to the safety of the world was the work of the international agency that its operations were to be free from the veto of any government. Exemption from the veto was the contribution of Baruch. Lilienthal doubted its value, but Baruch never wavered. In congratulating Lilienthal on his confirmation Baruch warned, "Don't let anyone weaken you on the position that the United States took—that there must be swift, certain and condign punishment set up for any violator of any treaty." [7]

Baruch resigned on January 4, 1947. With him went his brigade of associates, John M. Hancock, Ferdinand Eberstadt, Herbert Bayard Swope, Fred Searls, Jr., Richard C. Tolman, and Major General Thomas F. Farrell. Beneath the smooth surface of the polished phrases of Baruch's resignation ran countercurrents, for the silver-haired elder statesman who proudly bore the title "adviser to Presidents" had not found his relationships easy with Truman, Byrnes, or Acheson. He saw some organizational obstacles that made it awkward for him to remain on the United Nations commission. The permanent members of the Security Council—France, China, the Soviet Union, the United Kingdom, and the United States—were also members of the atomic energy commission. Alexandre Parodi, Quo Tai-chi, Andrei A. Gromyko, and Sir Alexander Cadogan served upon both the Security Council and the commission, but Baruch did not. Although Baruch was the American representative on the atomic energy body, Warren R. Austin spoke for the United States on the Security Council. Baruch thought the situation could only lead to confusion.[8] He had given his name and prestige to the American plan; now it was up to others to shoulder the burden.

Truman had appointed Austin in June, 1946, as American representative on the Security Council. Each had known the other well in the Senate, where the Vermont Republican had won the respect of the Missouri Democrat during hearings on civil aeronautics legislation. The Senate confirmed Austin on January 13, 1947, as Ambassador to the United Nations and United States representative on the Security Council. Four days later he became American representative on the United Nations Atomic Energy Commission. As 1947 began, Austin in the Security Council faced a Soviet attempt to circumvent the work of the commission. For almost a year the Russians had argued that prohibition of production and use of atomic weapons must precede international control, while the Americans saw effective security only in progressive stages of control leading ultimately to the destruction of the weapons. In October, 1946, Molotov had further blurred the issue by demanding that the Security Council take up general disarmament and arms regulation. The danger was that action in the Security Council on the Molotov resolution could undermine the atomic energy commission by merging disarmament and international control of atomic energy. Austin's mission was to prevent this from happening.[9]

A strong point in the American position, as far as world opinion was concerned, lay in the support which Baruch had coaxed, cajoled, and wheedled from the other nations. The difficulty was to preserve this strength against the Soviet lure of disarmament. On atomic energy matters the State

Department coordinated its guidance to Austin with the War and Navy Departments and the Atomic Energy Commission. The warm friendship between Lilienthal and Acheson must have eased consultation between the Commission and the State Department. Acheson confided his misgivings to Lilienthal on January 16, 1947. The Under Secretary did not like the course of events in New York. He was alarmed by Austin's optimism—a quality which others saw as the result of the Vermonter's success in getting to a first-name basis with Gromyko. Marshall explained the complexities of the situation in the Security Council to Robert P. Patterson and James V. Forrestal on January 29. The Secretary of State saw no hope of avoiding a discussion on disarmament, and any American move to do so would draw fire from the other Council members. The three secretaries agreed on strategy for Austin: He should recommend to the Security Council that a new commission handle arms regulation, that a committee drawn from the council members delineate the jurisdiction between the new organization and the atomic energy commission, and that the council itself take up at its next meeting the report of the United Nations Atomic Energy Commission.[10]

These three points, aimed at skirting the hazards of conflict between international control and arms reduction, Austin introduced to the Security Council on February 4. Gromyko opposed the move, finding no need for a committee to define the work of the two commissions and declaring that Austin's proposal was inconsistent with the instructions of the General Assembly. The arguments of Paul Hasluck, of Australia, illustrated the dangers that the Americans saw from Soviet strategy. Hasluck believed that negotiations on atomic energy were deadlocked, and to waste time in breaking the stalemate would jeopardize chances for disarmament. At his suggestion, the council spent the next three days informally searching for a compromise. Failure of the quest was evidenced in a draft resolution containing two diametrically opposed versions of a single paragraph; one restricted the authority of the new commission, the other did not.[11]

On February 11 the debate in the Security Council began, with Austin arguing that the mandate of the atomic energy commission must be preserved, while Gromyko as vigorously insisted that the activities of the new commission must not be limited. The next evening, after seven grueling hours of almost continuous discussion, the tired and hungry delegates began to vote, paragraph by paragraph, on the resolution. As the roll was called the results were clear. The United States and eight other nations voted to exclude atomic energy from the jurisdiction of the new commission. The Soviet Union and Poland abstained. Austin and Gromyko shook hands. It was a courteous gesture and about the only warmth within the building, for someone had turned off the heating system.[12]

Austin had won a skirmish in a long campaign. Although the Security Council was to discuss the first atomic energy commission report, Gromyko announced on February 11 that he reserved the right to raise again the need for a convention to ban atomic weapons. Austin faced the dilemma of how to keep the council focused on the commission's report rather than wasting time on the issue of prohibiting atomic weapons before agreeing on control. As the State Department saw it, Austin should try to get council approval of the report. Realistically there was little hope of success, yet he was to get what agreement he could and to have the points of difference referred back to the United Nations Atomic Energy Commission.[13]

Gromyko raised the veto issue on February 14. Exempting international control from the veto was contrary to Article 27 of the Charter, requiring unanimity among the five permanent members of the council. He was prepared nonetheless to offer amendments and counterproposals. These he embodied in twelve amendments which he introduced on February 16. Except in undefined instances, the operations of the control organization were to be subject to the veto. That organization would inspect, supervise, and manage all existing plants producing atomic material and assume these powers immediately upon concluding a convention.

Gromyko elaborated his proposals in a major speech to the Security Council on March 5. After a few words in Russian, he continued in English. The majority plan he rejected as an American scheme to perpetuate exclusive control of atomic energy, and again he asserted the need to prohibit atomic weapons. Declaring that the Soviet Union was not against effective inspection, he claimed that the majority plan would lead to intolerable meddling into national domestic affairs: "Only people who have lost their sense of reality can seriously believe in the possibility of creating such arrangements." Gromyko spoke for an hour and eighteen minutes, and as he ended it was plain that he offered no concessions. To their surprise, newspapermen covering the speech found that the Russians had taken the unusual step of making mimeographed copies immediately available. In interviews with delegates, the press discovered that the reaction was pessimistic; if Gromyko were stating a final rather than a bargaining position, hopes for international control were gone. On March 10 the Security Council asked the United Nations commission to continue its work by framing specific proposals on the functions and powers of an international control agency. The working committee, one of the subgroups of the commission, gave itself the task of studying the Soviet proposals.[14]

CONTINUING DEADLOCK

While the Security Council deliberated, Marshall made some organizational changes in the State Department. On March 3, he established an executive committee on the regulation of armaments, with representatives of the State, War, and Navy Departments and the Atomic Energy Commission to make policy recommendations on international control and armament regulation. To serve as Austin's deputy on the United Nations Atomic Energy Commission, Marshall selected Frederick H. Osborn, a New York corporation executive who had directed the Army's wartime program on education and information. Dean Rusk, a quiet young Georgian, was named Director of the Office of Special Political Affairs, which had been established in 1944 to handle American participation in the United Nations. Broader in scope was Marshall's creation in May, 1917, of the policy planning staff to provide a philosophy and a perspective to American foreign policy so as to avoid piecemeal responses to critical situations. Marshall turned to George F. Kennan, recently returned from Moscow and currently at the National War College, to head the group. Understandably Lilienthal was interested in the changes. Kennan he found stimulating and intelligent; Acheson, bearing the responsibilities as Acting Secretary during Marshall's absence in Moscow, was exhilarated over the new leadership.[15]

Very early Osborn discovered two conflicting views. He had little more than accepted the position as Austin's deputy when he received an urgent call from Oppenheimer, requesting an interview. During the weekend at Osborn's country home the two men talked. Oppenheimer revealed that from his observation of Soviet conduct he had concluded that the Soviets would not lift the veil of secrecy that shrouded their territory. Obviously, the Baruch plan could not work and give security to all if one nation closed itself off from others. To continue negotiations in the United Nations would, in Oppenheimer's view, give the Soviets chances to stall, to seek compromises that would dilute the strength of the Baruch plan without yielding their own position, and to win propaganda victories. For all of these reasons Oppenheimer urged breaking off negotiations.

The second fact Osborn learned from canvassing the other delegates on the United Nations Atomic Energy Commission. They were resentful of the steam-roller tactics Baruch had employed. They felt they had been given no chance to assist in drafting the plan, and no opportunity to try their hand in negotiating with the Russians. To them breaking off was premature or worse. Osborn assessed the opposing views. The dangers that Oppenheimer saw were real, but so were the hazards from losing the support of the other nations on the commission. Weighing the alternatives, Osborn decided that to continue negotiations was best; with caution and shrewdness the risks could be limited.[16]

Except for Austin, whose hardy optimism remained unshaken, American reaction to the March 10 Security Council resolution was far from enthusiastic. Osborn discovered that Oppenheimer and Bacher believed it would be impossible to describe the functions and powers of an international control agency without getting into classified subjects. Forrestal feared that a slight conciliatory move by the Soviets could lead public opinion away from the real issue. Lilienthal warned the American delegates against the fallacy of trying to distinguish between peaceful and military uses of atomic energy, an argument he felt certain would be used by those attempting to compromise national and international interests. Only when Osborn cautioned that breaking off negotiations would mean the loss of British, French, and Canadian support did he and Austin win reluctant acquiescence to continuation of the conversations in the United Nations. Eventually instructions for Austin and Osborn emerged: They were to make the record clear that Soviet intransigence prevented agreement on international control. If the working committee of the United Nations commission turned to drafting treaty clauses on the operations of an international agency, the American delegates were to try to steer the effort into unclassified areas.[17]

Austin's optimism stemmed from the stubbornness of a sincere man convinced of the necessity of the United Nations. The world scene itself was no source of hope. Marshall returned from the Moscow conference on April 26, his outlook somber on chances of working with the Russians and his mind searching for means to build stability in Europe. On April 29 Marshall asked Kennan to provide in two weeks recommendations from the policy planning staff. At that moment the staff existed largely on paper, but by May 23 Kennan had drawn together a memorandum concluding that the crises in western Europe resulted from spiritual and economic exhaustion rather than communism, and that the proper focus of American effort should be to restore the confidence and economic vigor of Europe. Although aid to Europe was foreshadowed by Acheson in a speech on May 8 at Cleveland, Mississippi, not until June 5 at Harvard did Marshall propose the course of action which was to quicken Europe. The Marshall plan and the Truman doctrine were two of the most important diplomatic moves the United States took in the immediate postwar period, and in neither did the United Nations have a real role.

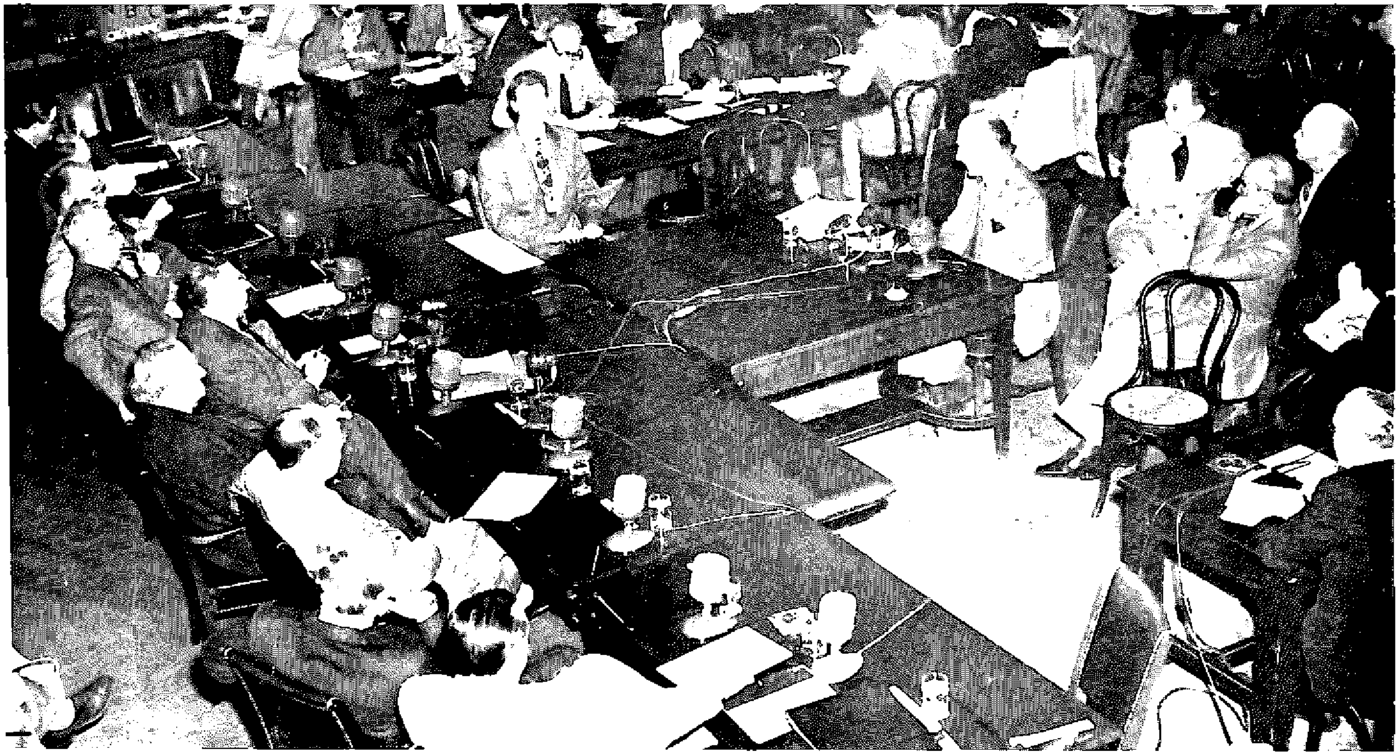
Inevitably the tensions between East and West were reflected in the United Nations Atomic Energy Commission, where working groups struggled doggedly to describe the functions of the proposed control agency. Osborn was convinced that the Soviet delegates were puppets, every move controlled by strings tightly grasped in Moscow. In early June he watched with interest as Gromyko, in a rare humor of geniality and cheerfulness, called for a full meeting of the commission. Briefly there was hope as the Soviet delegate on June 11 presented eight proposals. In essence they called for an international control commission which would assume authority simultaneously over all atomic installations, from mining operations to the production of fissionable material and the generation of atomic energy. Each nation could carry on its own atomic energy program, although the control agency would have access to the national installations, subject, however, to the veto. Organizational details would be determined after concluding a convention banning atomic weapons. Committee 2 of the United Nations commission considered the Soviet proposals for three days in August, 1947, and found them wanting. R. L. Harry of Australia thought the points vague and added, "A year ago these same proposals might have been regarded as useful and hopeful." Only Ignacy Zlatowski of Poland found the Soviet offering a good basis for further discussion.[18]

FORMING A NEW POLICY

The goal of the commission was to submit its second report to the Security Council in September. Lilienthal asked Acheson on June 28 what the American course should be if there were no agreement. Acheson was weary. On July 1 he was returning to private law practice and in the meantime was preparing Robert A. Lovett to take over the position of Under Secretary of State. Acheson described a somber scene to Lilienthal: Czechoslovakia tottering,

France weak, and Britain impoverished. In the United Nations commission the British and French had never favored the American plan enthusiastically, and Acheson saw their support evaporating if there were no agreement in September. In what must have been one of his last acts before he left office, Acheson turned the question of the American position on international control of atomic energy over to Kennan and the policy planning staff. His own advice was to draw closely together Britain, Canada, the United States, and perhaps a few other nations which possessed uranium ore.[19]

Osborn discussed plans for the United Nations commission with his advisers on July 31. As he observed, whatever his advisers decided would probably become the policy of the United States. Osborn's idea was to continue elaborating the majority plan, working out administrative details of the control agency and the necessary steps to maintain the strategic balance during the transitional stages. James B. Conant was attracted to the proposal. Already he had concluded that industrial development of atomic energy would lead to a proliferation of installations requiring control. In his view, foreswearing industrial uses and leaving the uranium unmined offered the best hopes for international security. Osborn's proposal, Conant thought, afforded the chance to provide for the explicit destruction of nuclear fuel and nuclear plants. Tolman and Farrell were lukewarm, while Chester I. Barnard was skeptical. Firmly Leslie R. Groves opposed, arguing the impossibility of writing anything on strategic balance or transitional stages that would be acceptable to the United States and the Soviet Union. Listening to the contending views, Oppenheimer leaned toward Groves's reasoning, but a few days' reflection changed his mind. Conant's plan he disliked, but Osborn's proposal he thought dangerously unreal. Oppenheimer advocated that the United States record its willingness to resume discussions anywhere on the prevention of atomic war, and declare "in the present state of hostility between major powers, the future detailed elaboration of proposals seemed wrong to us in principle." [20]



WIDE WORLD

"INCREDIBLE MISMANAGEMENT" HEARINGS BEGIN, MAY 26, 1949 / Chairman Lilienthal is seated at the small center table. From left to right behind Lilienthal are Commissioners Gordon E. Dean, Lewis L. Strauss, and Sumner T. Pike. The members of the Joint Committee on Atomic Energy are at the long table; from top to bottom: Representatives Henry M. Jackson, Melvin Price, Chet Holifield, and Carl T. Durham, and Senators Brien McMahon, Tom Connally, Bourke B. Hickenlooper, Arthur H. Vandenberg, and William F. Knowland.

UNITED PRESS INTERNATIONAL

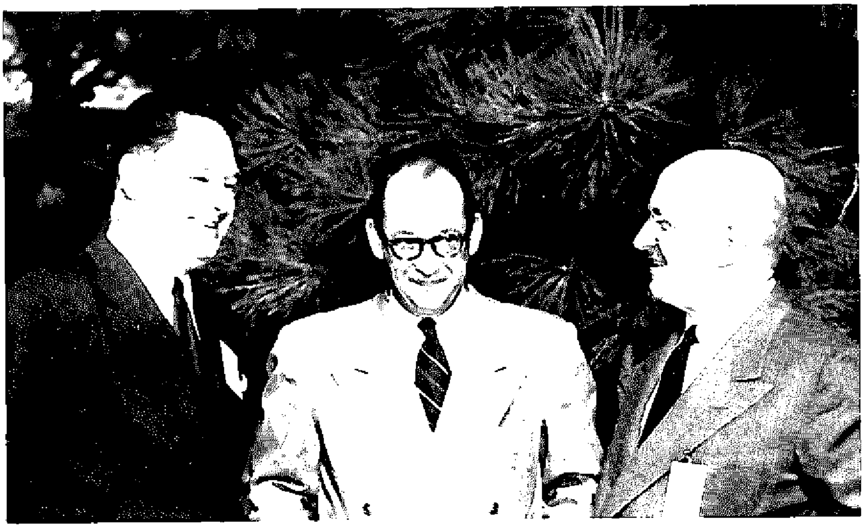
MILITARY VIEWS ON HYDROGEN BOMB DEVELOPMENT / Senator McMahon (center) chats with General Omar N. Bradley, chairman of the Joint Chiefs of Staff, and Robert LeBaron, chairman of the Military Liaison Committee, on January 20, 1950, as an executive session of the Joint Committee is about to begin.

UNITED PRESS INTERNATIONAL

LILIENTHAL WAVES FAREWELL, FEBRUARY 15, 1950 / Employees and the first Commission chairman say goodbye on the steps of the headquarters building on Constitution Avenue.

WIDE WORLD

THE COMMISSIONERS AND SENATOR McMAHON BEFORE A JOINT COMMITTEE SESSION, NOVEMBER 30, 1950 / Left to right: Thomas E. Murray, Henry D. Smyth, Senator McMahon, T. Keith Glennan, Gordon E. Dean, and Sumner T. Pike.



CHAIRMAN DEAN WITH A NEW COMMISSIONER AND GENERAL MANAGER / T. Keith Glennan (left), Gordon E. Dean (center), and Marion W. Boyer in Washington, November, 1950.

THE HEADQUARTERS STAFF AND FIELD PERSONNEL AT OAK RIDGE, MARCH, 1950 / Seated, left to right: Leonard E. Johnston, James C. Stewart, Wilbur E. Kelley, Richard W. Cook, Carroll L. Tyler, Carroll L. Wilson, Carleton Shugg, Frederick C. Schlemmer, and Alfonso Tammaro. Standing, left to right: J. Bion Phillipson, Samuel R. Sapirie, David Saxe, Walter F. Colby, Frank C. Watters, M. L. Black, Raymond Greenhalgh, Lindsley H. Noble, Walker E. Campbell, Fletcher C. Waller, Kenneth S. Pitzer, Francis J. McCarthy, Edward Diamond, Lawrence R. Hafstad, Henry B. Fry, Morse Salisbury, David B. Langmuir, Jesse C. Johnson, John A. Derry, James McCormack, Lawrence P. Gise, Thomas O. Jones, Charles F. Schank, John E. Greenhalgh, and James E. Travis.

By August 21, 1947, Kennan had completed his study of American policy. The analysis dismissed the fourteen months of talks in the United Nations as fruitless. The United States could not agree to destroy its atomic bombs without the guarantee of security, while the Russians would accept only the immediate destruction of the weapons, leaving security for later negotiation. Yet it was wrong to consider both positions as equally balanced, for time favored the Soviets. As sponsor of the majority plan, the Americans were committed, while the Russians were free to obstruct and delay, to confuse and obscure, as they gained time to develop their own atomic weapons.

From these narrow confines Kennan and his consultants sought to free American policy. They advised that the United States not break off negotiations in the United Nations commission; rather, a board of consultants should be gathered secretly to see if new technical data made it possible to modify the majority plan. If negotiations in the commission should near breakdown, a prominent American should travel to Moscow, talk to Stalin and the Politburo, and make sure that they understood the causes of the rupture. No longer should the main pursuit of American policy on atomic energy be through the United Nations. International control had lost none of its urgency, but grim reality was forcing a return to close relations with Britain and Canada. This shift in policy should be announced, perhaps when the United Nations sent its report to the Security Council. The best spokesman might be the President of the United States. These staff views Lovett accepted as a guide for planning.[21]

While Washington officials studied the advice of the policy planning staff, the several subgroups of the United Nations commission continued their efforts to describe the responsibilities of a future international control agency. From the subgroups flowed a stream of papers for each government to accept, reject, or modify.

Discussion of the reports by the Atomic Energy Commission and the State, War, and Navy Departments revealed that others in the United States Government were uneasy over the barren results achieved at the United Nations. Marshall met on September 8, 1947, with Secretary of War Kenneth C. Royall, Under Secretary of the Navy for Air John L. Sullivan, and Bacher from the Commission. Royall raised the basic issue: Why should the United States approve the documents, since the Russians obviously would not? Why not frankly admit negotiations were hopeless?

Sullivan agreed. He did not see how the Senate could possibly ratify a treaty on international control based on the work of the United Nations commission. Rusk and Edmund A. Gullion, a young foreign service officer handling atomic energy matters, replied that the reports under discussion reflected the American position. To repudiate them would only compound difficulties in achieving agreement and leave stranded those nations which had supported the United States. Royall and Sullivan accepted the reasoning.

Perhaps their concern was mollified when Gullion remarked that the policy planning staff was reviewing the American position.[22]

On September 11, Marshall, Forrestal, and Royall considered the recommendations with Kennan. No one took exception to negotiating with the British and Canadians. As Marshall pointed out, the raw materials situation called for action. Forrestal wanted clarification of the understandings with the British on the use of the atomic bomb. Royall saw no reason to continue what he called the Baruch policy. A different theme had captured Forrestal's interest: Suppose the Russians suddenly accepted the majority plan; what then would be the position of the United States? Marshall's reply was matter-of-fact; the negotiations that must follow would reveal clearly the Russian attitude.[23]

That same day General Andrew G. L. McNaughton of Canada, chairman of the United Nations Atomic Energy Commission, transmitted the

second report to the Security Council. The United States and nine other member nations approved. The Soviet Union voted against approval while Poland abstained. One part of the report dealt with the authority of the international control agency over research and development, the production of nuclear material, and atomic energy installations ranging from mines to fabrication plants. The other described the deliberations on the Soviet amendments to the first report and on the proposals of June 11, 1947. Inevitably much of the work had gone into the dreary but necessary effort to define precisely such terms as "control," "establish," and "administer." Although there was no real progress in narrowing the gap between the minority and majority positions, the way was open for further discussion.[24]

There was little optimism as the General Assembly met on September 16, 1947, at New York. "The truth is," declared Oswaldo Aranha of Brazil, as he accepted the presidency of the General Assembly, "that the United Nations have been able to do very little since the last session." Marshall addressed the Assembly the next day. The list of failures was long: no treaty for Germany, Austria, or Japan; no order in Greece; no agreement on Palestine; no unification of Korea. And to the roll Marshall added the United Nations Atomic Energy Commission: "if the minority persists in refusing to join the majority, the Atomic Energy Commission may soon be faced with the conclusion that it is unable to complete the task assigned to it."[25] The efforts in the United Nations were to continue, even after the third report of May 17, 1948, which stated bluntly that the commission had reached an impasse.

The stage for negotiations among the Americans, British, and Canadians had been set in September, 1947. All three nations were represented on the Combined Policy Committee, established by Roosevelt and Churchill to coordinate atomic energy plans. It was natural to use the committee to discuss the highly sensitive subject of atomic energy and the relations of the three powers. The last meeting of the committee had been on February 3, 1947. Since then Lilienthal and his colleagues had been confirmed and the National

Military Establishment, with Forrestal as Secretary of Defense, had come into existence. In recognition of these changes, Truman on September 22, 1947, named the Secretary of State, the Secretary of Defense, and the Chairman of the Atomic Energy Commission as the American members of the Combined Policy Committee. The means for negotiating with the British and Canadians had been brought up to date. There was much to talk over.[26]

NEED FOR ACTION

As 1947 began, Roger Makins, British envoy extraordinary and minister plenipotentiary, was about to return to London. As deputy chairman of the Combined Development Trust, the American-British-Canadian organization responsible for uranium ore procurement, Makins was well aware of the complications irritating the relations between his country and the United States on atomic energy. On January 29, he called on the Commissioners, ostensibly to ask permission for his successor, Gordon Munro, to visit from time to time. After the customary pleasantries, conversation turned to restrictions on cooperation with the British imposed by the Atomic Energy Act. One Commissioner after another told Makins that the agreements on raw materials had to be revealed soon to the Joint Committee on Atomic Energy, if not during the confirmation hearings, then as soon after as possible. Strauss read parts of the Act to Makins, emphasizing that disclosure of the arrangements was a positive injunction upon the Commission.

The five Commissioners were unanimous in their position: However the British viewed the implications of the wartime cooperation, continuation of that partnership was forbidden by the Act. They advised Makins that in their opinion, the best course would be to consider the wartime arrangements ended and to negotiate new agreements for procuring and allocating raw materials. Yet, as Lilienthal summed up, these suggestions were merely "conversation." Only the Foreign Office and the State Department could negotiate.[27]

Under Secretary Dean Acheson was the official for Makins to see. Acheson was ill at home, but Makins, pressed by the approaching date of his departure, called nevertheless. London, he explained to Acheson, believed that the Americans were willing to cooperate on raw materials, where they had much to gain, but not on information exchange, which would benefit the British. Although not indispensable, the data would enable the British to save time, money, and effort in overcoming technical difficulties already solved by the Americans. Conceding the barriers raised by the Act, Makins wanted to explore two paths around the legal obstacles, emphasizing that both suggestions were his own and had not been approved by London. The first was to give Britain that information developed during the partnership before the Act was signed. The second was to merge data on the atomic bomb with the exchange of defense information already taking place. To a query by Acheson, Makins replied that production of nuclear material and the fabrication of nuclear components of the bomb would be included under the enlarged defense information exchange.

Acheson refused to consider either course. However, he had overtures of his own to make. What did Makins think of erasing the wartime agreements requiring mutual consent before using the atomic bomb? The British diplomat saw no objection to recision as part of a larger settlement. Makins rose to leave. Clearly he had the elements of understanding to carry to London. For his part Acheson summarized the meeting for Lilienthal and Marshall; to both he wrote, "Some action is urgently needed." [28]

Although the exploratory talks at Acheson's home revealed the possibility of agreement, there was much to be done before negotiations could begin. Marshall turned to Forrestal and Patterson for the military views on atomic energy facilities located in Britain. The Joint Chiefs of Staff, assuming that Britain would be an ally in a future war, thought atomic energy plants in the British Isles nonetheless would be detrimental to American security. They would be closer to a potential enemy and their operation would require stocks of uranium ore in Britain. For military purposes, it would be better if all the ore could be converted into fissionable material and made available to the United States and its allies for use in an emergency. Stocks of ore accumulating in Britain for use in future plants the Joint Chiefs believed inconsistent with this position.[29]

Although it was obviously necessary that the Joint Committee realize the need for a new understanding with the British and Canadians, as yet they had not heard of the old. The first step in their education came on May 5, 1947, when, at an executive session with the Commission, Carroll L. Wilson with a map and pointer described the nation's atomic energy facilities. The information was highly sensitive, and Lilienthal was concerned that only a drape-covered swinging saloon door separated the intently listening group from the public corridor. Inevitably the topic of raw materials supply came up. The facts jarred the Joint Committee. Pike warned that American and Canadian ore was not sufficient to operate the production plants; ore from the Belgian Congo was vital. Even more alarming was the disclosure that half of the Belgian Congo ore was going to Britain. Senator Connally was astonished to discover that the British knew how to make the bomb. Quickly Lilienthal seized the opportunity. The Joint Committee, he urged, should learn from the State Department full details of the arrangements with the British.[30]

Acheson appeared before the Joint Committee on May 12. He reviewed the wartime cooperation which led to the atomic bomb and he described the advantages that the mutual efforts of the three nations offered in obtaining raw materials. For the first time representatives of Congress learned that Roosevelt and Churchill had agreed that neither nation would use the atomic bomb without the consent of the other. Hickenlooper and Vandenberg were shocked and outraged. Only a week had passed since they had learned of the ore arrangement; now they discovered that Britain held a veto over the most powerful weapon in the American arsenal. In the days that followed the two senators searched for a way out of the entanglement. Both urged Truman, Marshall, and Forrestal to act, suggesting that in return for financial assistance Britain give up her share of the Congo ore. Hickenlooper wrote to Marshall in August, "the present agreement, in view of all the circumstances, is intolerable." [31]

PREPARING A POSITION

As eager as the two senators were for swift action, it was not possible to move quickly. Aid to Greece and Turkey was still awaiting Congressional vote, the Marshall plan was in the early stages of framing, and negotiations were in progress in the United Nations Atomic Energy Commission. In the fall of 1947 the pace of events quickened. Marshall met with Royall and Forrestal on September 11 to consider the American policy on atomic energy. To Forrestal the main issue was whether the United States was bound by the Churchill-Roosevelt agreement on the bomb. Gullion skillfully broadened the question to include cooperation in atomic energy with Britain and Canada. In this context, Marshall explained the real problem. Granting that more uranium was essential to the American atomic energy program, should economic aid be used to bargain for uranium ore? Kennan set forth the State Department position: Aid to Europe must stand on its own merits. If aid were exchanged for ore, and if the barter became known, the outcry might destroy economic aid and ruin the chance for an agreement on uranium. The group agreed that the two matters should be kept separate.[32] One step forward had been taken; the Hickenlooper-Vandenberg idea had been considered and discarded.

For the Secretaries of State, War, and Navy, the issues were those of high policy, dealing with agreements made in secret by heads of state during time of war. For the Commission it was a cold matter of uranium ore. On September 18 and 25, the Commissioners talked over the ore estimates gathered by the staff. Neatly typed figures expressed American requirements from 1948 through 1952 against the total supply available from the free world. Although the preliminary totals were reassuring, they deceived no one at the table. Included in the total supply were stocks already in Britain and those which under present arrangements Britain would receive in the future. The total supply also contained estimates of available production from South Africa, although no agreement for the material had been negotiated and no technical process to separate uranium from the tailings of gold mines had been perfected. Subtract these amounts from the total and the results stood clear and grim. Without the stocks in Britain, without that Congo production allocated to Britain, the American production plants could operate only at a fraction of full capacity. Lilienthal signed a letter to Marshall on October 1, 1947, requesting the American members of the Combined Policy Committee to plan negotiations with the British and Canadians.[33]

In preparation for the meeting the policy planning staff drew up a list of objectives which Marshall, Forrestal, and Lilienthal studied before they met on November 5. The proposals called for conversations with the British and Canadians with the aim of abrogating the wartime agreements on the bomb, continuing the Combined Policy Committee and the Combined Development Trust, and allocating a greater share of raw materials to the United States. However, increasing the share of future production of raw material was not enough: The British and Canadians were to be asked to give up their accumulated stocks in excess of their current industrial projects. Such action by Britain and Canada would enable the United States to strengthen its atomic energy effort to the benefit of the mutual security of the three nations. In exchange, the Americans would offer to assist the others in developing atomic energy for industrial purposes. This offering was somewhat tentative since it appeared to contravene the McMahon Act, which prohibited giving information on industrial development of atomic energy to foreign nations. To meet this point the State Department was willing to ask Congress to change the law.[34]

Marshall began the discussion on November 5 by stating the importance of clearing away the misunderstandings and the antagonisms that had developed with the British, for which, he remarked, the Americans bore some responsibility. Unless the two nations were on common ground, he thought it possible that Belgium might succumb to pressure to sell the Congo ore elsewhere. Listening to the others give their opinions, Lilienthal found himself somewhat at odds. None knew better than he that British ore was essential. But based on his own recent and hard-won legislative experience, he believed seeking Congressional authority involved delay, uncertainty, and risk, with perhaps opening again to hazard the fate of the Commission itself and civilian control of atomic energy. Furthermore, he thought the proposals offered too much.

Others saw the issue differently. Forrestal's reasoning was complex. The United States did not want to see atomic plants in Britain. In his mind, giving information in exchange for raw material would not only ease the American uranium supply, but would keep the British from constructing their own facilities. The possibility that the British wanted the information to build the complex that Forrestal wished to deny them went unchallenged. Gullion found unresponsive the military contention that atomic installations in Britain were vulnerable, for an atomic energy program was a concomitant of a great power. Vannevar Bush pointed out that information exchange worked both ways; the American scientists needed to know what their British and

Canadian colleagues were doing. While all this might be true, Lilienthal wanted to treat information exchange and raw material requirements as separate problems. The meeting ended with the decision that the Commission should try drafting a more acceptable paper of objectives and strategy.[35]

Several factors troubled Lilienthal. Unlike Forrestal and Marshall, he was not the executive head of a department but only one of five Commissioners, and as Chairman possessed no special prerogative. He believed that Strauss found the idea of working with the British deeply disturbing. Nor were the legal grounds for cooperation clear. Section 10 required the Commission to control the dissemination of Restricted Data so as to assure the common defense and security. The statutory definition of Restricted Data covered atomic weapons and fissionable materials, and their use in the production of power. The section contained two opposing principles to guide the Commission. The first prohibited the exchange of information on the industrial uses of atomic energy until Congress declared that effective international safeguards existed. The second encouraged dissemination of scientific and technical data to promote the progress of science. The wording of Section 10 revealed an uneasy attempt to reconcile the flow of information required by science with the demands of national security. Of particular importance was the statement that the Commission should control the dissemination of Restricted Data in such a manner as to "assure the common defense and security."[36]

At the November 5 meeting Lilienthal and Herbert S. Marks, the Commission's general counsel, suggested that "common defense and security" offered the legal key. Marks argued that if it could be shown that exchanging information with the British advanced American security, then the grounds for cooperation were established under the law. That common defense would benefit, he added, was a determination which only the Department of Defense could make. Joseph A. Volpe, Jr., worked nights to draft a position acceptable to the State Department and the Commission.

As Volpe sought to enlarge the areas of agreement, a three-day classification conference with the British and Canadians began in Washington on November 14, 1947. Planned since summer, the gathering was intended to establish a common declassification policy among the three nations, each of which, to differing degrees, had helped to develop the atomic bomb. Without a common policy one nation might release information that another might think still classified. Wilson and James B. Fisk had helped plan the meeting for another purpose. Discreet sounding, without breaching secrecy, might reveal the areas in which the other two nations wanted information. The results were heartening. It appeared that the major subjects of interest were health and safety.

Wilson attended none of the sessions, but he did stop in at an after-work cocktail party. There he greeted Dean C. J. Mackenzie, president of the National Research Council of Canada, leader of his country's group, and John D. Cockcroft, director of the Atomic Energy Research Establishment at Harwell and head of the British delegation. There was another member of the British party—a principal senior scientific officer at Harwell—whom Wilson had not met before. German-born, slender, wearing round spectacles, the stranger was introduced to Wilson. His name was Klaus Fuchs.[37]

The American members of the Combined Policy Committee considered Volpe's paper on November 24. In Marshall's absence, Lovett took the chair. He urged quick action; otherwise, Congress might move, and stir uranium, information exchange, and foreign aid into a hopeless mixture. With his best efforts, Volpe had not been successful in finding common ground. The Commission still felt constrained to treat information and raw materials as separate issues, a position which Gullion remarked would leave scant room for the State Department to maneuver. The compromise left unmentioned the unresolved points. The raw materials position was unaltered; the areas and amount of information exchange were to be explored during the negotiations.[38] Perhaps part of the reason for wasting no further effort to remove the differences was the belief that the British and Canadian information requirements would not be hard to meet.

With an agreed position it was now possible to turn to the Joint Committee. It was high time, for there were signs of restlessness. Senator William F. Knowland lunched with Forrestal on September 26, 1947. The Republican senator had heard that the President was thinking of announcing in October an agreement with Britain and Canada which would cover all matters of atomic energy. If this were true and if the Joint Committee were ignored, Knowland foresaw a violent debate which might well affect the relations between the Congress and the Executive.

Hickenlooper and Vandenburg saw Forrestal and Lovett at the Pentagon on November 16. The two senators listened to Lovett explain the status of the American negotiating position. While Hickenlooper had little to say, Vandenberg was still playing with the idea of tying together economic aid and raw materials. Faced with the need of getting Congressional support for interim assistance to Europe, Vandenberg wanted to be able to say that in return for economic aid the United States would receive certain strategic materials. For the moment Lovett fended off the Michigan Republican, but at the close of the meeting the senator warned that he would raise the matter if the British were stubborn.[39]

Lovett had intended to discuss the negotiations with both Congressional committees on foreign relations. Up to that time only the Joint Committee members had gained access to Restricted Data, although members of that body also served on the foreign relations committees. For example, Vandenberg and Connally were, respectively, chairman and ranking minority member of the powerful Committee on Foreign Relations.

The process of informing the Joint Committee began somewhat uncertainly. Because the committee's procedures for handling classified material were not settled, Hickenlooper decided that for the moment only he and Vandenberg would hear the plans. On November 26, Lovett and Kennan joined Forrestal, Bush, and three Commissioners to meet with the two senators at Blair House. The mansion, located across Pennsylvania Avenue from the Old State Department and near the White House, was often used for small meetings as well as a residence for visiting dignitaries. Lilienthal and Wilson presented the raw materials situation. Lovett stressed the strength of the British hand. Not only had they a part of the ore receipts since mid-1946, but their influence was strong in Belgium, which controlled the present source of ore, and in South Africa, which promised to be the main supply of the future. Nonetheless the Americans would strive to abrogate the wartime agreements, to acquire British ore stocks, to get a much greater share of Congo production, to restrict the storage of raw material in Britain to a minimum, and to obtain British and Canadian support for ore negotiations with South Africa. In return the United States would give some information. Hickenlooper was dubious. The proposals smacked of an alliance and he warned of the provisions of the Act. Vandenberg bluntly stated that he would accept no arrangement which required the United States to consult another nation on using the bomb. He did not see how the United States could give Britain financial help if the British did not recognize that the American proposals would benefit the security of all. The meeting ran on until eight o'clock in the evening.[40]

Lilienthal was elated. The calm agreement on the proposed position surprised him. His fears had proved shadows without substance. The Department of State, the military establishment, and now two Republican leaders had accepted cooperation with the British and Canadians. Only within the Commission itself was there doubt. Nor did the meeting with the full Joint Committee on December 5, 1947, cause Lilienthal to lose his optimism. So long as national security would benefit, the committee found no reason why negotiations could not touch upon information exchange.[41]

NEGOTIATIONS

The meeting was the last step in forming the American position. On December 10 the full Combined Policy Committee assembled for the first time since the previous February. The burden of presenting the American position fell upon Lovett, with Forrestal and Lilienthal ready to add their support. Lord Inverchapel, a career diplomat with years of service in Moscow and Peking, led the British group. Hume Wrong, an able diplomat whose background included more than one Washington assignment, headed a small Canadian delegation.

Lovett began by explaining that lack of progress in the United Nations called for resuming discussions among the three nations. Indeed, added urgency stemmed from Congressional interest in foreign aid; unless the three nations adjusted their relations they might be faced with Congressional intervention. Lovett suggested establishing two subgroups, one on information, the other on raw materials. To the information group Lovett named Fisk and Bush who, with the British and Canadians, would explore areas where information could be exchanged within the limits of the Act. Wilson, as American representative on the Combined Development Trust, was the obvious choice for Lovett to name to the raw materials group. Lovett emphasized the importance of raw materials to the United States; as a guideline he suggested utilizing all raw material in excess of current projects to increase the security of all.

Sir Gordon Munro of the British group asked about wartime agreements on the bomb. With this question, all three issues—raw materials, information exchange, and now wartime agreements—were in the open. Lovett replied that bomb agreements should be swept away rather than continue to exist as a source of misunderstanding and controversy. The British and Canadians heard Lovett without surprise. They had been informed earlier of the trend of American thoughts. Roger Makins, John Cockcroft, and David E. H. Peirson, assistant secretary in the headquarters division of the Ministry of Supply, were expected to arrive from Britain the following day. From this group of technical advisers Inverchapel said he would draw his committee members. Wrong named Mackenzie and George Ignatieff, of the Department of External Affairs, for the Canadian representatives on the information committee, and for the raw materials committee, George C. Bateman, a mining expert, and Thomas A. Stone of the diplomatic corps.[42]

Fisk and Bush met with Cockcroft and F. Neville Woodward of the United Kingdom, Mackenzie and Ignatieff of Canada; by December 12 the subgroup on information exchange had completed its work. The subgroup listed nine areas within which cooperation was possible. Among them were the topics in the proposed declassification guide; others were health and safety, research uses of radioisotopes and stable isotopes, fundamental and extranuclear properties of all the elements, fundamental properties of reactor materials, extraction chemistry, the design of natural uranium power reactors, and research experience with specified low-power reactors. Each area was briefly described. Fundamental reactor materials, for example, dealt with solid-state physics and basic metallurgy, and also included moderators, fuel elements, structural material, and liquid-metal and other coolants, as well as other items.[43] Since the list of areas for cooperation was technical, the effort for information exchange became known as the technical cooperation program.

Raw materials offered more difficulties. Wilson and Volpe, with Bateman and Stone of Canada and Peirson and Arthur Storke of Britain, initialed on December 12, 1947, their agreement on estimated raw materials production. These estimates they matched against American and British requirements, acknowledging that Canadian needs would be small. The Americans submitted a high and a low set of requirements; the difference between the two lay in the varying operating levels of the gaseous-diffusion plants at Oak Ridge and the number of reactors operating at Hanford. For their part the British offered a single estimate, based mainly on a reactor program. No account, they pointed out to Wilson and Volpe, had been made for a planned gaseous-diffusion plant.

Putting together the combined requirements made a grim story. Available ore production for the period 1948 through 1952 could not support an American program operating even at the low level, as well as the British program. But if, in addition to the annual ore production, the accumulated stocks in Britain and the United States were considered, the picture changed somewhat. Operation of the two programs at the high level could continue until demand outstripped supply, by which time either technical improvement or new discoveries might restore the balance. Operation of the two programs on a low level could be carried on, provided that the British did not greatly increase their atomic energy effort. But for both cases the stocks in Britain were crucial to the Americans. In the immediate future the British, just beginning their program, would have more ore than they needed. In contrast the Americans were ore-poor. Neither their low nor their high requirements could be met unless the British agreed to accept less than half of the Congo production and to make available to the United States the supplies in Britain.[44]

The full committee took up the reports of the subgroups on December 15. It spent little time on the nine areas of information exchange. Lovett and Lilienthal stressed the interpretation that the list was only a beginning, that new areas would be added as necessary. Differences appeared over raw materials. Lord Inverchapel took an optimistic view, expressing the opinion that the estimates were unduly conservative. This might be true, Lovett admitted, but the fact remained that the subgroup found requirements greater than supply. Forrestal brought to bear his analysis of the world situation. The prospect was somber, and he concluded somewhat dogmatically that policy must not outstrip power, nor power outstrip fact. Canada, Britain, and the United States he saw as linked together in common cause. To deal with raw materials, Lovett called for a new group to attempt to reconcile uranium availability with demand. Kennan and Wilson were selected for the United States, Munro and Makins for Britain, and Wrong and Stone for Canada. Another subcommittee with Gullion and Volpe, Peirson and Donald D. Maclean of Britain, and Ignatieff and Stone of Canada, assumed the task of drafting the principles of future cooperation. The Combined Policy Committee agreed that the documents would be entered in the minutes, to avoid the need of United Nations registration.[45]

The raw materials group met the next morning to begin working out an allocation of uranium which would satisfy all. Wilson and Kennan proposed an allocation for 1948 and 1949 under which the United States would receive all the estimated ore production, plus a considerable fraction of the British stockpile. The request was based upon the principle of matching requirements to supply. Under the American plan both nations at the end of 1949 would be in a similar position; the reserves would meet the expected requirements of each for about the same period of time. Makins and Munro, however, had authority to allocate only 1948 production, along with some ore in the Congo earmarked for Britain. The only principle that Wilson and Kennan could discern in the British proposal was that all stocks in the United

Kingdom should remain there. They saw no effort to reconcile supply and demand on an equitable basis.

The group met once more in the afternoon of December 16, and again for two sessions the following day. Accepting the fact that Makins and Munro were limited in their authority, the Americans presented a series of cases covering 1948. Underlying each illustration was the principle that both nations should have reserves lasting over equal periods of time. The Americans were seeking ore for the lower of the two cases of operation, and felt that the British should accept and support the effort on the grounds of mutual security. As the arguments grew increasingly complicated, John K. Gustafson and Cockcroft were brought into the meeting to explore some of the intricacies of timing of shipments and amounts of uranium in various parts of the production pipeline. So complicated had the discussions become that Makins and Munro refused to trust to cables to explain the American proposal. They saw no alternative but to return to London.[46]

As the Americans waited for word from Britain, Kennan was optimistic. The talks had been frank and pleasant. But if the two British diplomats could not persuade London on raw materials, Kennan foresaw Congressional intervention and appalling complications. During the interim, Lovett had Gullion brief Hickenlooper. Unexpectedly Gullion met Wilson at lunch and both saw the Joint Committee chairman. Hickenlooper listened to Gullion's account of the negotiations and to Wilson's explanation of raw materials allocation. The senator would have preferred an arrangement in which Britain kept no uranium, since he would not rule out the possibility that it might be bartered or surrendered during a crisis. Yet he agreed that this danger was small. In the main, Hickenlooper was contented. The British too, must have had some reasons for satisfaction. Lilienthal and Bush presented the nine areas of agreement as but a beginning. Lovett had spoken of cooperation as a continuing effort, and Forrestal had described the three nations as partners.[47]

There were other uncertainties beyond British acceptance of raw materials allocation. Gullion was well aware that Forrestal desired to see no atomic energy installations in Britain, that Hickenlooper and Vandenberg were determined to rid the United States of the Roosevelt-Churchill agreement and to obtain the needed ore, and that Strauss was disturbed over the prospect of cooperating with the British. The question came up as to what to call the agreement. Gullion suggested *modus vivendi.* His British and Canadian colleagues demurred, for the term was most often used to describe the relations between adversaries driven by circumstances to get along together. To himself Gullion thought *modus vivendi* accurate.

THE MODUS VIVENDI

London accepted the raw materials allocation and removed the last obstacle to agreement. For 1948 and 1949 all Congo production was to go to the United States. If this amount were not sufficient, the deficit could come from the British stockpile of unprocessed and unallocated uranium ore. There were certain precautions. The American requirements were to be no more than the lower operating level postulated on December 15, 1947, and there were provisions for review and readjustment. Canadian requirements were to be met by the Americans, but in the form of uranium metal for their reactor work rather than ore.[48]

January 7, 1948, was a day full of meetings. The first began at ten-thirty in the morning when Lovett and Gullion, with John A. Derry from the Commission staff, met with Vandenberg and Hickenlooper at the State Department. Lovett showed the senators the three main documents: the *modus vivendi* and the agreements on ore allocations and information exchange. Vandenberg was relieved and congratulated Lovett. The *modus vivendi* erased the Roosevelt-Churchill agreement the senator disliked. Hickenlooper too was pleased, and was confident that the Joint Committee would be satisfied.[49]

The Commissioners themselves had not formally approved the three documents, steps which were necessary before Lilienthal, representing the Commission on the Combined Policy Committee, could join Lovett and Forrestal in meeting the British and Canadians. A few minutes after noon, the Commissioners took up the allocation of raw materials and quickly gave their approval. Information exchange and the *modus vivendi* were not so fortunate. Strauss was worried by the security implications. Information on health and safety, for example, was essential to the development of countermeasures against radiological warfare. Pike admitted the security aspects, but believed the possible benefits to peacetime medical research and to the protection of workers more important. Waymack offered the common-sense observation that the partnership with Britain must have some content. What Strauss was seeking was a method of control so that by approving the areas the Commission would not be signing a blank check. To meet his objections the Commission entered into the minutes its understanding of technical cooperation. The nine areas were general fields in which information exchange might prove beneficial. Implementation of any topic within the field would require the approval of the Combined Policy Committee. On this committee the Commission was of course represented. Volpe and Lilienthal also pointed out an additional safeguard. The Commission representative on the implementing subgroup would be instructed to bring before the Commissioners any proposed action. After more than two hours of discussion the three documents were approved. Lilienthal was to explain the Commission's interpretation to the Combined Policy Committee. It had been an arduous session: not enough copies of the papers for everyone at the meeting, not enough time for lunch, and no opportunity, said Strauss, for the Commission to work out its position at leisure.[50]

The meeting of the Combined Policy Committee which began late in the afternoon at the Blair House was anticlimactic. Lilienthal observed with amusement the scurry to find a green cloth, customary for such diplomatic occasions, to cover the table. Lovett, Inverchapel, and Wrong approved the three documents. To implement the areas of technical cooperation Lord Inverchapel proposed a standing subgroup of scientific advisers. Lilienthal took the opportunity to raise the point that had disturbed the Commission. Information exchange, he pointed out, would have to be carried out within the legal restrictions of the three countries; consequently it would not be possible to vest the American representatives on the subgroup with discretionary authority. Makins saw nothing unusual in the observation, for each representative, he observed, would be guided by the laws of his own nation. Inverchapel's proposal for a subgroup was accepted.[51]

The *modus vivendi*, with the agreements on ore allocation and information exchange, appeared to mark the end of confusion between the United States, United Kingdom, and Canada on atomic energy. Some of the ambiguities of the American position were the legacy of the secret diplomacy of the war, some of the ambivalence was the result of the desire for international control through the United Nations, and some of the indecision stemmed from fears of Congressional sensitivity. Whatever their source, the doubts seemed uprooted and the seeds of a bargain, planted almost a year earlier when Makins talked with Acheson, appeared to have grown naturally into fruition.[52]

COOPERATION WITH THE BRITISH: ANXIETY AND TENSION

CHAPTER 10

For at least one thing Lilienthal could be grateful during the first weeks of 1948: the *modus vivendi* had removed some of the uncertainties that had clouded British-American relations in atomic energy since 1945. The evidence of better understanding appeared on January 29, 1948, when Carroll L. Wilson called to order the first meeting of the Combined Development Agency —the new name for the Combined Development Trust. No longer was it necessary to give major attention to technical problems in estimating quarterly balances of ore reserves. Sir Gordon Munro was content to limit the discussion to financial arrangements. Since most of the ore was now to go to the United States, he could easily demonstrate the inequity of dividing the costs equally between the two countries, and the issue was settled quickly.[1]

Interpreting the *modus vivendi* would be more cumbersome, but James B. Fisk thought the two nations could begin at once to exchange technical information in a few of the prescribed areas. After checking with Vannevar Bush, who represented the military services on the Combined Policy Committee, Fisk proposed to the Commission on February 19 that the first areas be extraction chemistry, power reactor design, health and safety, and research experience on low-power heavy-water reactors. None of the topics involved sensitive subjects, and Wilson's plans for administering the exchange seemed sound. Armed with the Commission sanction, Fisk met with F. Neville Woodward of the British scientific mission on February 21. To start the technical exchange, the two agreed that Walter H. Zinn from Argonne, George L. Weil from the Commission's reactor branch, and Charles W. J. Wende, a General Electric engineer at Hanford, would visit British installations during the spring. Woodward, in turn, proposed that Compton A. Rennie, a Harwell theoretical physicist, visit Brookhaven.[2]

Within a few weeks the Commission had launched what promised to be a prudent but useful exchange of technical information under the agreement. It was a good start, but would it be possible to avoid difficulties if the British proposed exchange in more sensitive areas? The *modus vivendi* was a fragile and untried craft; whether it could survive on the turbulent seas of international politics in 1948 was a real question.

NEWS FROM BRITAIN

Technical cooperation was less than a month old when Edmund A. Gullion, the executive secretary of the Combined Policy Committee, received a visit on March 19 from Donald D. Maclean of the British Embassy. Since Gullion often dealt with Maclean on official matters, the call was not particularly surprising. Nor was Maclean's message astonishing. For about a year and a half, he explained, his government had been at work developing atomic weapons. Secrecy, however, was hampering the effort and the government was planning a casual announcement of the program. The purpose of Maclean's call was to alert the Americans. The Canadians too were being notified.[3]

Maclean was not the only messenger who brought the Americans news of the impending announcement. Admiral Sir Henry Moore, the military adviser to the British members of the Combined Policy Committee, breakfasted with James V. Forrestal on March 31, 1948. The Admiral had been charged by Lord Portal, the leader of the British atomic energy effort, to tell Forrestal that press rumors were forcing the government to announce a rearmament plan which included atomic weapons. To Forrestal the news of the rearmament effort might have been welcome. Only a few weeks earlier he had heard from General Lucius D. Clay that hostilities with the Soviets could come suddenly. After his breakfast with Moore, Forrestal learned that the Russians were about to impose restrictions on the movement of materials and personnel across the boundaries of the Western zone of Berlin. It was the beginning of the blockade.[4]

The promised announcement came on May 12, when Albert V. Alexander, Minister of Defence, rose to answer a parliamentary question on armaments. In a statement which he declined to elaborate, Alexander declared simply that research and development on all types of modern weapons, including atomic, were receiving the highest priority.[5]

If the British intended to announce their program to the world in a low key, they succeeded. No ripple of interest had stirred the American press when, on May 28, Zinn, Weil, and Wende arrived in London. Zinn was enjoying himself. For one thing he had won the toss of a coin for the hotel room with heat; for another he was looking forward to seeing friends whom he had met during the war. On the evening of May 30, the three Americans arrived at Harwell, in the Thames valley some 14 miles from Oxford. For the next few days Zinn, Weil, and Wende were busy in conferences and inspections of the research facilities at Harwell and the production headquarters at Risley. Zinn found Harwell most interesting. Four large hangars, once used by the Royal Air Force in the Battle of Britain, provided the main shop space and housed the two reactors: GLEEP for Graphite Low Energy Experimental Pile and BEPO—beautifully constructed, thought Zinn—for British Experimental Pile Operation.

With quickening interest Zinn listened to the British describe the technical characteristics of their planned reactors. It was clear to him that the design stressed plutonium production more than electric power generation. But if the British were interested in plutonium, why did they not use the proved Hanford reactor design instead of developing a new gas-cooled reactor? In explaining the technical reasons John D. Cockcroft admitted that the British were indeed interested in plutonium. To Cockcroft, who had taken part in the *modus vivendi* negotiations, the point may have been hardly newsworthy. But to Zinn the acknowledgement was startling.[6]

CHALLENGE TO COOPERATION

Strauss was astonished as he read the report of Zinn, Weil, and Wende. It was not the British intent that was alarming; the Commission had known that since Maclean's visit. It was the unwelcome possibility of accomplishment, for the three American visitors rated the capabilities of their hosts highly. Strauss had reluctantly approved the information aspects of the *modus vivendi*. Now he was convinced that he would have to reopen the question.

The opportunity came on June 30, when the Commissioners weighed the merits of fundamental properties of reactor materials as a topic for technical cooperation. Before his fellow Commissioners, Wilson, and other members of the staff, Strauss constructed his case. Three categories of information he saw as essential to the production of atomic weapons. These were fundamental nuclear principles, technological developments in equipment and production processes, and weapon design. The Smyth report, he thought, had gone far to declassify the first and the present proposal seriously breached the second. Strauss contended that the basis for technical cooperation was an equality of value in the information exchanged. What had the British to offer for information which, he asserted, would enable them to manufacture plutonium for weapons? For evidence of the British intention to produce plutonium Strauss pointed to the Zinn-Weil-Wende report.

Waymack admitted that Strauss had raised a point of substance. Bacher observed that the Canadians as well as the British needed the information on fundamental properties. All at the table recognized the point. The Canadians had no weapon program but would be able to provide the Americans with nuclear data from the Chalk River reactor. To Lilienthal there were really two questions. One was whether information on fundamental properties of reactor materials was properly a part of the technical cooperation program. The second and more basic issue was whether the British interest in plutonium changed the basis of technical cooperation. The Commission could defer action on the present proposal, and in the meantime ask the Department of State and the National Military Establishment for their advice.[7]

The Strauss analysis Lilienthal and Wilson explained on July 6, 1948, to Robert A. Lovett from State and Donald F. Carpenter, chairman of the Military Liaison Committee and Forrestal's representative on atomic energy matters. Lovett found no reason to think that the principles underlying cooperation had shifted. He recalled that during the *modus vivendi* negotiations the Americans had assumed that the British would engage in weapon work. Moreover the British had told the Americans of their program on March 19. The British were keeping their part of the all-important raw materials allocation and, from what Lovett had heard, their information provided through technical cooperation was judged valuable. Once Carpenter was assured that the British program made no difference in the division of raw material, he agreed with Lovett. Both admitted that weapons stockpiled in Britain were more vulnerable than those stored in the Western Hemisphere, but there was little that the United States could do about the situation. So far from accepting the Strauss contention, Lovett and Carpenter thought that a British proposal to expand the areas of information exchange should receive serious consideration.[8]

Strauss explained his arguments to Forrestal over breakfast on July 8. The Commissioner had no objection to the British possessing atomic bombs, but he was opposed to their manufacturing plutonium and fabricating atomic weapons. To Forrestal the matter was not so simple. Some consideration, he thought, should be given to the fact that it was in the American interest to restore and bolster British confidence. That this was a valuable goal Strauss agreed, but paramount was the danger to the United States that might come from leakage of information from Britain or from a surprise invasion which would capture British weapons and facilities.[9]

Later that day Lilienthal reported to the Commission the results of the July 6 meeting with Lovett and Carpenter. Strauss declared his surprise. Lovett and Carpenter were tacitly sanctioning the British weapons program, a position which Strauss could not reconcile with the practice of doling out information to the British piece by piece. He could not believe that George C. Marshall, Forrestal, and Truman realized the implications of the Zinn-Weil-Wende report. Lilienthal turned to the subject of approving information exchange on fundamental properties of reactor materials, which had been in abeyance since June 30. However the Commission decided, Lilienthal thought the Joint Committee should be informed, perhaps by a general report on technical cooperation which would include a summary of the British program.

Lilienthal, Pike, and Waymack approved the subject of fundamental properties of reactor materials for information exchange. Strauss dissented.[10]

The unity among the Commissioners that Lilienthal prized was broken again and once more Strauss stood apart. The debate continued in the days that followed. Lilienthal was disturbed by Strauss's intense emotion. Through memorandums and notes Strauss urged that Truman be consulted. Lilienthal and his other colleagues held that there was no evidence to show that the basis for technical cooperation had changed and that some of the alarm originated in a misunderstanding of technical matters. Reactors produce plutonium. Consequently control of plutonium manufacture was never, as Strauss so strongly asserted, in American hands. Besides, the British had gained sufficient knowledge during the war to mount an atomic weapon program independent of the Americans. Awareness of Strauss's attitude was not confined to the Commission. Lilienthal discovered that Lovett was worried lest the British learn of the division within the Commission and suspect that a policy change was in the offing.[11]

For some time the members of the Combined Policy Committee agreed on the wisdom of acknowledging publicly that Britain, Canada, and the United States had resumed limited cooperation in atomic energy. Selection of an opportunity and means to make the announcement proved surprisingly difficult. Eventually the committee chose the New York Golden Jubilee as the occasion and a major speech by Lilienthal as the device. Interrupting his vacation at Martha's Vineyard, Lilienthal flew down to New York on August 21, where he spent a crowded afternoon looking at the latest revisions of his speech and talking with Pike, Bacher, and Joseph A. Volpe, Jr., about the latest events in technical cooperation. At the Waldorf Astoria that evening, Lilienthal spoke of the wartime cooperation of the Americans, British, and Canadians and of the failure of the United Nations to control the atom. The three governments, Lilienthal said, "are continuing to utilize, in an expanded way, the cooperative principle in certain limited areas." There followed a torchlight parade down Lexington Avenue. Lilienthal enjoyed it all immensely. On the other hand, he had heard from Pike that technical cooperation was in deep trouble.[12]

BREAKDOWN

The proximate cause of the crisis in technical cooperation stretched back to the spring of 1948. Between sessions of the General Advisory Committee meeting of April 23–25, Fisk mentioned to Cyril S. Smith, a committee member who was a distinguished metallurgist, that among the topics considered for information exchange was the metallurgy of plutonium. Smith listened with professional and personal interest. Plutonium underwent more phase transformations than any other metal and Smith, who had helped develop processes for preparing plutonium for weapon use, was thoroughly familiar with its fascinating characteristics. Furthermore, the British-born metallurgist was planning a trip to Europe with his wife and family. He offered to stop at Harwell and discuss plutonium. Although the major use of plutonium was in weapons, the element also offered promise as a reactor fuel. Neither Smith nor Fisk included weapon use in defining the "basic metallurgy of plutonium." Smith sailed for Southampton as Fisk began the procedures authorizing the discussions.

On June 9 all of the Commissioners except Strauss listened to Fisk propose exchanging information on the fundamental properties of reactor materials, one of the areas listed under the *modus vivendi.* The paper Fisk presented included in the area the fundamental chemical and physical properties of reactor and reactor auxiliary materials, such as natural and enriched uranium fuels, or fuels of other fissionable material. There was no mention of plutonium, although the element was defined as a fissionable material in Section 5(a)(1) of the Atomic Energy Act. One remark caught Lilienthal's attention. Fisk had just stated that he was assuming that the proposal now before the Commission was acceptable to the Department of Defense, since Bush of the Research and Development Board had helped define the areas of technical cooperation.

This assurance was not enough for Lilienthal. Perhaps his thoughts ran back to the meetings of late 1947 when he and Herbert S. Marks had explained to Marshall and Forrestal that cooperation with the British and Canadians might legally be possible under the phrase "common defense and security" of Section 10 of the Act, provided that the military establishment—in particular, Bush—attest to the advantages which would accrue to the United States. At any event, Lilienthal asked Fisk to get Bush's views. On June 15 came the reply. Shorn of the wool of government phrasing, it informed Fisk that the Commission should handle nonmilitary sections of technical cooperation while the armed services would take care of the military areas. The answer was hardly satisfactory to the Commissioners, who saw technical cooperation as an effort in which both agencies worked closely together.[13]

The Commissioners were still withholding their approval of fundamental properties of reactor materials when Frederick T. Hobbs, the Commission staff member who handled routine matters in technical cooperation, received a letter from Alexander K. Longair of the British Scientific Mission. Longair requested, on June 22, authorization for Smith to talk to Harwell scientists on a number of topics. Hobbs studied the list. Noting that basic metallurgy of plutonium was among the items, he took a red pencil from his desk and checked the topic for Fisk's attention.

Buttressed with Bush's reply that military concurrence was not needed, the proposal returned two more times to the Commissioners, on June 30, when Wilson and Fisk were absent, and on July 8, when the two men were present. Both meetings were tense, for Strauss was calling for Presidential review of the technical cooperation program. At the latter meeting, with Strauss in dissent, the Commissioners approved initiating information exchange on fundamental properties of reactor materials. At Lilienthal's request, the staff was to draw up a report on the decision and on the British production program for the Joint Committee. Fisk left the meeting with his paper approved, but neither he nor Wilson could have had any illusions about Strauss's position. Fisk, after consulting with Wilson, authorized Smith on July 26 to discuss the "basic metallurgy of plutonium." [14]

The Commission on July 30 sent Carpenter of the Military Liaison Committee a copy of the report to Hickenlooper. Carpenter scanned the report closely, for another factor was intruding. His recent conversation with Admiral Sir Henry Moore revealed that the British wanted to expand information exchange. Among the new areas would be atomic weapons. Carpenter summarized the conversation for Lilienthal, Lovett, and Fisk on August 3. The following day he received a request from Hickenlooper to call.[15]

The Joint Committee chairman had several things on his mind, among them the custody of weapons and the proposed Commission reorganization. He also wanted to talk about a report he was soon to receive from the Commission. Carpenter heard him without surprise, for with the close contacts between the Commission and the Joint Committee, Hickenlooper understandably could be aware of the report. More interesting was the senator's reaction. In ruminating on the direction of the British program, Hickenlooper was inclining toward the position that plutonium production was contrary to the spirit of the *modus vivendi.* Carpenter presented the opposing view. He was convinced that the British had intended to manufacture plutonium. This was nothing less than the Russians were doing.[16] Hickenlooper remained unpersuaded.

Carpenter sent his comments to the Commission on August 9, 1948. He thought too much importance had been placed on the Zinn-Weil-Wende report, but he was still troubled. In the memorandums passing between Strauss and the other Commissioners, Carpenter saw the differences of interpretation on technical cooperation. He had studied the documents on the *modus vivendi;* he had investigated the background of the negotiations; he had learned that the documents had been available to the Commissioners, and that at least Hickenlooper and Vandenberg had seen the papers. He also knew that Lovett had briefed the President. To Carpenter the record was clear. The British had not concealed their intent to produce plutonium, and none of the Americans privy to the negotiations had challenged that right. But if he had overlooked anything, he wanted to be corrected.[17] The report went to Hickenlooper the same day.

The Commission offices were unusually quiet. To escape the heat and humidity of August, Lilienthal, Waymack, and Wilson were on vacation. Bacher was at Brookhaven and Fisk was on a trip which would take him to Berkeley and Los Alamos. Only two Commissioners were in Washington: Pike as Acting Chairman, and Strauss.

Hickenlooper read the report with increasing apprehension. The extent of technical cooperation was greater than he had realized. On the morning of August 11, he telephoned Strauss, asking for more details. Strauss gathered up a list of the original areas of agreement, a background memorandum to the American members of the Combined Policy Committee, and a summary of Commission actions on several of the areas. He sent the material to Hickenlooper, who received it the morning of August 12.

While Hickenlooper was reading the papers with dismay, Strauss was filled with consternation. Admiral John E. Gingrich, the Commission's director of security and intelligence, had brought him a copy of the Fisk letter authorizing Smith's discussions with the British. For the first time a Commissioner saw the authorization containing the words "basic metallurgy of plutonium." Strauss reacted vigorously. He called Hickenlooper and hurried to Pike's office. Pike examined the letter. Strauss contended that even though the letter was dated July 26, 1948, there was still a chance that Smith might not have been to Harwell. Vehemently Strauss urged Pike to call Smith. Scenting trouble, Pike wanted further advice and telephoned Bacher at Brookhaven. After Bacher agreed that the authorization was injudicious, Pike began his efforts to reach Smith, first by transatlantic telephone, then by cablegrams. The time was now about eleven-thirty.

About a half hour earlier Hickenlooper and Vandenberg had walked into James V. Forrestal's office at the Pentagon. Hickenlooper promptly charged that technical cooperation had expanded beyond recognition. Bush retorted that there had been no expansion, but only a more clear definition of the topics within the areas. Hickenlooper turned to the British program. He had understood that the British were developing industrial power; now he learned their major goal was to produce plutonium. That, he declared, could only mean the production of atomic bombs. Carpenter and Bush repeated the oft-used arguments that the direction of the British program was not news. Hickenlooper shifted to the exchange of information on the basic metallurgy of plutonium. He had learned of the Fisk letter only that morning. Here Bush and Carpenter admitted an error.

Technical cooperation had advantages, but the question was how to regulate it. Carpenter said that he had already instituted procedures so that the Military Liaison Committee would know of all future contacts on information exchange. Vandenberg, the parent of the liaison committee, maintained it had a clear legal responsibility to control the procedures. Was it necessary, he asked bitterly, to double-check the Commission in all these matters? Forrestal still favored continuing the effort. His reasons were the same as they had been during the November 5, 1947, meeting of the American members of the

Combined Policy Committee: The United States needed ore and did not want to see a large-scale atomic energy complex in Britain; if these aims could be achieved and if the Americans could obtain useful information, then technical cooperation should continue. As he and the others saw it, perhaps the way out of the dilemma lay in persuading the British to make their bombs in Canada.

That afternoon at three o'clock Carpenter telephoned Pike to convey his objection to Smith's authorization. Pike replied that he was aware of the matter but so far had not been able to reach Smith. The Acting Chairman could give no assurance that Smith had not yet talked to the British. An hour later Strauss met with Forrestal and Carpenter.[18] It had been a busy day.

Smith was enjoying himself. He had been in no hurry to visit Harwell; indeed he had been back in the United States to attend a metallurgy conference. On his return to England he had rented a car and with his wife and family was touring Scotland and the lovely lake district of England. Pike's messages were raining upon the home of Smith's sister at Four Oaks, a suburb of Birmingham. On August 13, Smith returned from his tour and received a telephone call from Pike. To Pike's huge relief Smith had not yet been to Harwell. That visit did not take place until September 2. Not until much later did Smith learn of the embroilment which was to become known as the "Cyril Smith incident," but the effects in Washington were devastating. Strauss and Pike could never reconcile their accounts of the events.[19] The Joint Committee saw technical cooperation in the worst possible light. The program itself was almost in shambles.

THE BRITISH PRESS FORWARD

On August 16, Carpenter tried to explain to Woodward, the director of the British scientific mission, why technical cooperation could not include weapon information. Woodward was shocked. In view of the information his government had furnished, he could not conceive how the Americans could have failed to understand the British intention. Carpenter admitted that the Joint Committee was the obstacle, but Congressional apprehensions might be lessened if the British manufactured their weapons in Canada. Woodward retorted that much of British military opinion held Canada as vulnerable as Britain.[20]

Carpenter was surprised when the British in early September proposed exchanging information on atomic weapons. The background of the request Woodward explained to Carpenter on September 16. Woodward had sent the American views to London. Attlee had directed Sir Henry Moore to approach Forrestal, who had given the Admiral no intimation that the matter was improper or the timing bad. Carpenter thought otherwise and warned Woodward not to press for a quick reply. Carpenter went further, asserting that there were those who thought American security depended upon keeping weapon information secret and that data given to Britain might reach Moscow. Vigorously Woodward rejected the imputation. More than once, he declared, the Americans had been invited to Britain to review security precautions and the invitation, as yet unaccepted, still stood. As for Carpenter's suggestion not to press for an early reply, Woodward pointed out the urgent need for a response.[21]

Forrestal had, as a matter of fact, suggested to Moore that the British not press for an answer before the approaching Presidential election. The Secretary of Defense, aware of Congressional sensitivity on the subject of security and atomic bombs, was bearing heavy burdens. Around Berlin the Russians were drawing the blockade more tightly. Marshall and Lovett on September 7, 1948, could offer the President and the Security Council only a gloomy report on negotiations at Moscow. From his office at Columbia University, Dwight D. Eisenhower read the portents and concluded that the Russians in their confidence might push too far. Forrestal's thoughts turned increasingly toward the atomic bomb. The most secure bases from which to deliver the weapon lay in Britain. If the British would let the Americans provide the needed facilities for a small number of British airbases, then in an emergency hours might be saved. He recognized, however, that Britain might well ask in exchange for more atomic energy information.[22]

The views of the Joint Chiefs of Staff on expanding information exchange, Carpenter found, had remained essentially unaltered since early 1947, when Marshall had asked for their opinion on cooperation with Britain. Carpenter had sounded the Joint Chiefs on the recent British request. On September 29, 1948, they replied that on military grounds they could not justify expanding information exchange beyond the areas of the *modus vivendi,* and they saw cooperation on atomic weapons as a return to the partnership of the war. If the United States should offer such a close association, then Britain should agree to have neither stockpiles of raw or fissionable materials, nor plants to produce fissionable materials or weapons, within the home islands.[23]

As the Joint Chiefs deliberated, the British waited. On the last day of September, Sir Oliver Franks, the British ambassador, and Sir Gordon Munro, the British minister, called on Lovett at the State Department. Lovett openly related the obstacles. He described Hickenlooper's reaction to the "Cyril Smith incident." He explained the adverse feeling in military circles to an atomic weapons program in Britain. Along with Carpenter and Forrestal, Lovett counseled patience.[24]

Lovett might well have had another reason for suggesting caution. The day that Franks and Munro called, Truman was castigating big business, the National Association of Manufacturers, and the Republican Party before a crowd in Louisville, Kentucky. He had begun his campaign for reelection. Polls and predictions favored the Republicans, and it was logical to assume that a new administration might have a different policy.

That reason for caution Truman removed on November 2, 1948. Not only did the Republicans fail to gain the Presidency, but they lost control of Congress as well. On the Joint Committee, McMahon replaced Hickenlooper as chairman. The auspices for cooperation must have looked somewhat better to Franks as he called on Lovett on November 16. The Under Secretary still saw a number of obstacles: Congress would need some months to organize; the Commission and the military were still divided over custody; and within the Commission itself were problems and uncertainties. Franks perforce agreed; perhaps it would be best to wait.[25]

FORMULATING A NEW POLICY

How much events of the summer had weakened the *modus vivendi,* Ralph P. Johnson, Fisk's deputy in the division of research, realized when he took over administration of technical cooperation. Faced with a prospective meeting of the Combined Policy Committee subgroup of scientific advisers, Johnson sought Commission guidance on October 15, 1948. Lilienthal recognized the need for clarification. He was troubled by the fact that Bush, the chief scientific representative of the armed services, was no longer the military representative on the subgroup. If Bush no longer attended the meetings, then, in Lilienthal's opinion, the inference was that the sessions were not significant to the military. Yet the legal basis for technical cooperation was that exchange of information would benefit the defense and security of the United States. Since this was not a matter for the Commission to judge, Lilienthal proposed a review of atomic energy relations with Britain.

Strauss heartily agreed. He pointed out that for some time he had advocated such an examination with a Presidential determination. Pike was less certain of the need to reopen the matter, for cooperation through easing the raw materials situation obviously benefited national security. Bacher's reasoning coincided with Lilienthal's views: it would be wise to see if military thinking had shifted. Johnson was to wait until the Commission had the advice of State and Defense.[26] Given the events of the summer, probably no other conclusion was possible. The matter was too important, and the Commission too vulnerable, to leave the issue suspended.

During November, staff members of the Commission, State, and Defense worked out the mechanism for analyzing the nation's atomic energy policy. Volpe reported the results to the Commission on December 9. The plan was for a general study of atomic energy policy by the American side of the Combined Policy Committee, with the advice and assistance of a panel of leading public figures. The Commissioners disliked the idea. Strauss thought an advisory group would need too much time to grasp the complexities of the problem. Moreover, he saw policy development as the province of the State Department. Although Lilienthal was doubtful about a panel, he was not willing to leave policy formulation to the State Department alone. Neither were Bacher and Waymack; they saw the Commission and the Defense Department as having roles and responsibilities that neither agency could abdicate or delegate.[27]

Some way had to be found to bring order out of the chaos of divergent views. William Webster, who had replaced Carpenter as chairman of the Military Liaison Committee, saw the need to reach agreement among the Department of Defense, the Department of State, and the Commission. Carefully he prepared a position, and then suggested a meeting at Princeton where free from interruption the representatives from all three agencies could talk over the problem. On January 4, 1949, he telephoned Wilson. The plan was for a group consisting of George F. Kennan, James B. Conant, and a few others to meet with Oppenheimer. Wilson and Volpe were to attend for the Commission. The numbers grew somewhat as R. Gordon Arneson and George Butler from State, and General Lauris Norstad and General Kenneth D. Nichols from the Department of Defense were added.[28]

With Oppenheimer as host the group spent most of January 24 and 25 at Princeton studying background material and weighing alternatives. The premise was that Russian possession of the atomic bomb would be detrimental to the interests of the United States. American military thought had been conditioned to the monopoly of the weapon, but that was a temporary advantage. American aid to the British would neither impede nor hasten the Russian achievement, although the assistance could speed British progress. As for raw materials, the production from the Congo, South Africa, Canada, and the United States would probably support the present American and British efforts, but with little to spare for the next few years, providing that the Redox process were successful in reclaiming uranium as well as plutonium from production reactors. American objections to a British program narrowed to three: British facilities were more vulnerable and their output consequently more easily lost; their plants would at first undoubtedly be less efficient in converting scarce uranium ore to fissionable material; and finally, their effort to duplicate American facilities would waste British technical and economic resources. Constructing the hypotheses was enough for one day, and the group adjourned to Oppenheimer's for dinner.

Discussion the next day revealed that no one favored continuing the *modus vivendi* or trying to block the British. Rather, the consensus was that the projects of the three nations should be closely coordinated to make the most effective use of resources, raw materials, and manpower. Fundamental to such tight integration would be a full and complete exchange of information on all aspects of atomic energy, including weapons, and acceptance of the principle that all atomic facilities be located in accordance with strategic considerations. Insofar as practicable, the public should be aware of the cooperation and Congress should by some action give its sanction. Probably the arrangements should be related to, but not part of, the treaty linking together the North Atlantic nations.

Wilson and Volpe thought the conversations had gone with remarkable smoothness. Kennan, Arneson, and Butler had had little to say, and Nichols, Norstad, and Webster had been surprisingly accommodating. The reason for the harmony, the Commission representatives suspected, lay in the principle of strategic location of atomic plants. Through its judgment on strategic considerations, the Department of Defense would be able to exercise its influence. To Arneson, the degree of unanimity was unexpected and heartening. The discussion had been free and straightforward, and he thought the views of the group even though unofficial would have a great influence on forming policy.[29]

The Commissioners began their discussion of the proposed atomic energy policy on February 3. With great deliberation, almost as a professor lecturing to college freshmen, Lilienthal explained that the Constitution of the United States to a large degree placed responsibility for foreign policy on the President. Although the Secretary of State was the President's chief adviser on foreign relations, the Commission as well as other governmental agencies had a role. But once the President adopted a policy, the Commission and each individual Commissioner were bound by it. His presentation had been an unusual performance; but Lilienthal made it clear that, although the Commissioners might differ among themselves, he expected them to accept a decision with loyalty. Bacher suggested replacing the *modus vivendi* by a permanent policy. Lilienthal was not convinced, believing that the *modus vivendi* was broad enough to include cooperation in atomic weapons, yet in the interest of Commission harmony he would yield.

Strauss argued that technical cooperation should not be expanded while the policy was under discussion. Recent proposals for information exchange, he thought, entered the weapon category. Bacher and Pike pointed to past failure to draw a distinction between weapon and nonweapon information. Lilienthal proposed continuing technical cooperation during the interim, but exchanging no information in any area which any Commissioner thought improper. It would, he admitted, be necessary to inform all parties. Strauss, expressing his appreciation, refused the offer, adding that he preferred not to see a precedent established for an individual Commissioner to exercise a veto. There was no unity on the long-term policy. To Lilienthal's proposal that the Commission recommend to the Secretary of State a program of full cooperation with Britain and Canada, Strauss contended that no weapon data should be revealed until the role of each country had been established and Britain had agreed not to stockpile atomic weapons or materials.

This was the fundamental difference. Strauss wanted to impose qualifications as conditions which Britain must meet before reaching an agreement. Lilienthal saw these matters as important, but subordinate issues to be worked out after concluding an over-all arrangement. One further time Lilienthal tried for unanimity, but he failed. Under his new proposal, the Secretary of State would devise the procedures for interim cooperation, and for weaving long-term cooperation into the over-all foreign policy. Lilienthal agreed to take to the meeting of the American members the views of Strauss as well as those of the majority.[30]

The chairman of the American side of the Combined Policy Committee was no longer Marshall. Shortly after his victory at the polls, Truman asked Dean G. Acheson to call. One November afternoon Acheson dropped in at Blair House, where Truman was living while the White House was being restored. Little more than greetings had passed between the two men when Truman asked Acheson to become Secretary of State. The offer was completely unexpected and as Acheson hesitated, Truman went on to explain that Marshall was in the hospital. Because of ill health Marshall could not continue to serve, although Truman hoped for sentimental reasons that the military statesman could continue until January 21, 1949, which would complete two years in office and coincide with the beginning of a new administration.[31] On that date, Acheson began his duties as Secretary of State, and between the urbane Easterner and the spirited Midwest President, there grew a feeling of respect and friendship.

At Acheson's recommendation, Truman gave to a special committee of the National Security Council the task of casting the State Department and Princeton proposals into a form for his consideration. The composition of the special committee was the same as that making up the American members of the Combined Policy Committee: the Secretary of State, the Secretary of Defense, and the Chairman of the Atomic Energy Commission. Each member selected a small staff from his agency to serve on the special committee.

By March 2, Acheson, Forrestal, and Pike, as acting chairman in Lilienthal's absence, accepted the proposals worked out by the special committee staff. To the fullest extent practicable, large-scale atomic energy plants and weapon fabrication facilities were to be located in the United States and Canada. Nuclear components of atomic weapons were to be stockpiled in Britain only to the extent required by common war plans, with the United States taking the main responsibility for manufacturing atomic weapons required for joint defense. Because of American predominance in fissionable material production, Canadian and British atomic energy efforts should require no more than 10 per cent of the raw material available for the next five years. If the President approved the proposals, the next step Acheson saw would be conversations between Truman and leading Congressional figures. If chances of Congressional support appeared promising, informal discussions with the British and Canadians would follow, to sound out whether the proposed arrangements were suitable to them. Eisenhower, one of those present at the meeting by invitation, volunteered to testify before Congress. He thought the arrangements would go far to restore trust and confidence among the three nations. Pike raised the question of continuing technical cooperation during the interim period. Any attempt at restriction, cautioned Acheson, could prejudice the policy being proposed to the President.[32]

In the afternoon Pike and Volpe reported Acheson's warning against restricting technical cooperation and Eisenhower's declaration of the need for trust and confidence. Bacher listened approvingly and remarked that the proposed policy seemed good. Strauss's reaction was cooler, but he found the policy at least an improvement. To his comment that it was too bad that the special committee had not heard his views, Wilson replied that they had been considered by the staff of the special committee.[33]

The policy paper sent to Truman on March 2 was the work of State, Defense, and the Commission, and as such represented a consensus for the President to follow. One of those who agreed was ending his career. Forrestal, wearied and exhausted from the burdens of office and stripped of the force needed for decisions, submitted his resignation to Truman on March 2. Boldly and vigorously Louis A. Johnson strode into the vacancy. His qualifications were good. He had served overseas as an infantry captain in World War I, as National Commander of the American Legion in the 1930's, as Assistant Secretary of War prior to World War II, and as the President's personal representative to India during the dark days after Pearl Harbor. Moreover, he was high in the councils of the Democratic Party.

MEETING AT BLAIR HOUSE

Truman read the report. That much Lilienthal discovered from casual remarks of the President at a meeting on April 14, 1949, with the Commissioners, Johnson, and Webster. A few days later Lilienthal learned that Truman had given his approval and wanted to know the best method of getting Congressional support.[34]

Congressional sanction was essential, but the timing was difficult. Congress was already heavily committed on foreign affairs, for Truman had sent the North Atlantic Treaty Organization pact to the Senate on April 12, and the Committee on Foreign Relations had begun planning for hearings. During the spring Acheson was in Paris attending a four-power conference on a German peace treaty. Possibly another factor was the long drawn-out sessions of the Joint Committee in which Hickenlooper hunted for evidence of "incredible mismanagement."

The British were also anxious for the Americans to settle on a policy. A few days after Truman received the March 2 policy paper, representatives from the British Embassy called on Arneson to find out if meetings with the

Canadians and Americans could begin soon. Later the British approached Kennan. They hoped that cooperation among the three states could be settled soon, for they could not hold off much longer decisions which would shape their own atomic energy program. On the other hand, the Hickenlooper investigation made them aware of the power of Congressional opinion and of the importance of Joint Committee support for any suitable agreement.[35]

Not until June did Acheson and Johnson meet with Truman to decide that the search for Congressional support should start with McMahon of the Joint Committee. Arneson met with McMahon and the executive staff director, William L. Borden, on June 30 to lay the groundwork for the Senate to meet with Acheson, Johnson, and Lilienthal. McMahon heard Arneson summarize the points of the new policy and remarked that offhand he favored persuading the British to stop all production of fissionable material in Britain. The goal should be that all production should take place in North

America. However, these were only casual views, and Arneson noted that McMahon listened to Borden's appraisal of the policy of partnership as "realistic."

On July 6 McMahon came to the State Department. Acheson outlined the tangled situation. More was involved than information exchange, for the raw material agreement was scheduled for renegotiation at the end of 1949. Also, conditions had changed since the *modus vivendi.* Not only were other nations embarking upon atomic energy programs and raising questions needing policy decisions, but Russia might have atomic weapons in 1950 or 1951. In any event Britain remained the most valued ally of the United States. Acheson rejected the old Congressional idea of using economic aid as a club to extort favorable terms in atomic energy. From this background Acheson presented the President's proposal. Johnson had nothing to add and Pike stressed the urgency of the raw materials situation.

McMahon did not like the prospect. He could see only a rough reception in the Joint Committee, and was troubled by legal and constitutional implications. Acheson tried to reassure McMahon by pointing out that much would depend upon the kind of understanding that would be acceptable to the British and Canadians. If there should be constitutional difficulties, perhaps they could be solved by an executive agreement sanctioned by the Joint Committee or by a joint resolution of Congress. Volpe pointed out that the Joint Committee had found no legal obstacles to accepting the *modus vivendi,* and the present proposals were based upon the same reasoning. McMahon replied impatiently that the mood of the Joint Committee now was far different. Hickenlooper, for example, might use the negotiations to strengthen his attack on the Commission. Yet McMahon unhappily recognized that his committee could not avoid its responsibilities. He was still turning over contingencies in his mind when Acheson skillfully dropped the suggestion that the President meet with selected Congressional leaders. Eagerly

McMahon accepted the idea, and added others to the names Acheson suggested.[36]

Truman held a press conference at four o'clock on July 14, and after reading an announcement that John Steelman would coordinate an effort to reduce unemployment, opened the session to questions. These ranged widely, covering topics from New York politics to an impending steel strike. One inquiry must have caught Truman by surprise: What comments did the President care to make on his invitation to members of the Joint Committee to meet with him at the Blair House at five o'clock? Truman replied there was no conference scheduled for that hour but he had invited some people to the Blair House that evening. He had, however, no further comments.[37]

Early that evening reporters gathered outside Blair House and waited in a heavy rain as cars began to draw up. W. Sterling Cole, Representative from New York and a Republican member of the Joint Committee, was the first to arrive. Somewhat later came Connally, then Acheson. Eisenhower arrived just before Lilienthal and Volpe. To the reporters Louis Johnson offered the same response that others had given, "No comment." In rapid succession followed Vandenberg, Rayburn, Carl T. Durham, Democratic representative from North Carolina and vice chairman of the Joint Committee, McMahon, and Millard E. Tydings. No sooner had Tydings hurried up the steps than the big black limousine carrying Vice President Barkley pulled up to the curb. Hickenlooper was among the last. Two of those who came to Blair House the newsmen could not identify. The one carrying a dispatch case was Arneson; the other, in a green raincoat, was Webster.[38]

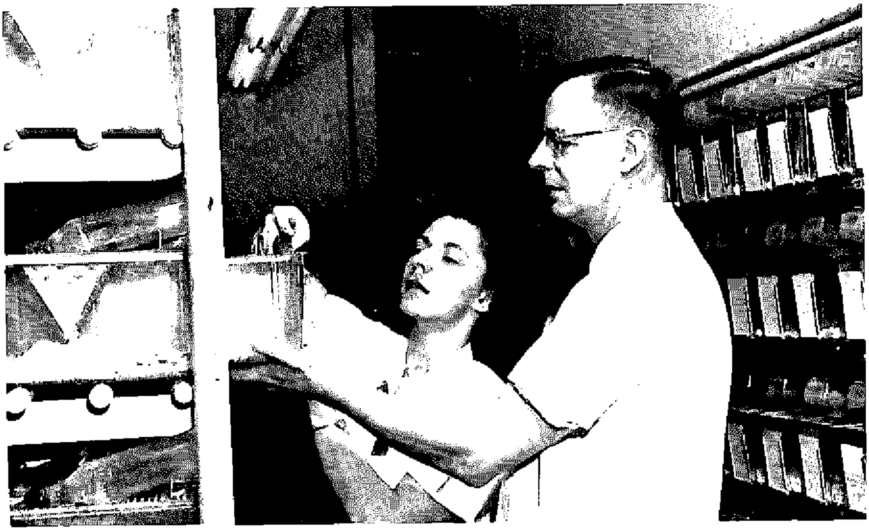
It was a small room for such a gathering, Lilienthal thought as he cast his reportorial eye around the group and caught such incongruities as Vandenberg sprawled upon a sofa beneath a portrait of Franklin Roosevelt. Truman, looking somewhat tired, opened the meeting by reading from his notes. Arneson glanced at his watch: it was eight-fifteen. He listened intently. The preceding day at Acheson's request, Arneson had prepared a single typewritten page of remarks for Truman. The young State Department official noticed that the President had accepted the ideas, but recast them into his own words. Truman covered the same points: the common history of Britain, Canada, and the United States in developing the atomic bomb, and the need to review the raw materials agreement. Once the Congressional leaders understood, Truman concluded, they would recognize that there was no alternative to the policy they were about to hear.

From this introduction, Acheson took over, and with much the same approach he had used with McMahon, summarized the situation. He turned to Lilienthal, who stated that to meet the weapon goals set by the Joint Chiefs of Staff, the Commission facilities would have to operate at 100-per-cent capacity. Johnson and Eisenhower took up the case from the military point of view. Once again Johnson had little to say, other than acknowledging agreement with Acheson's analysis. Eisenhower elaborated on the need for close relations with the British, a subject on which, he pointed out dryly, he had some reason to be expert. So closely mixed were the military fortunes of the two countries that he saw no sense in cooperating in all save atomic energy. With the testimony of Lilienthal and Johnson to support him, Acheson read of the aims of the policy.

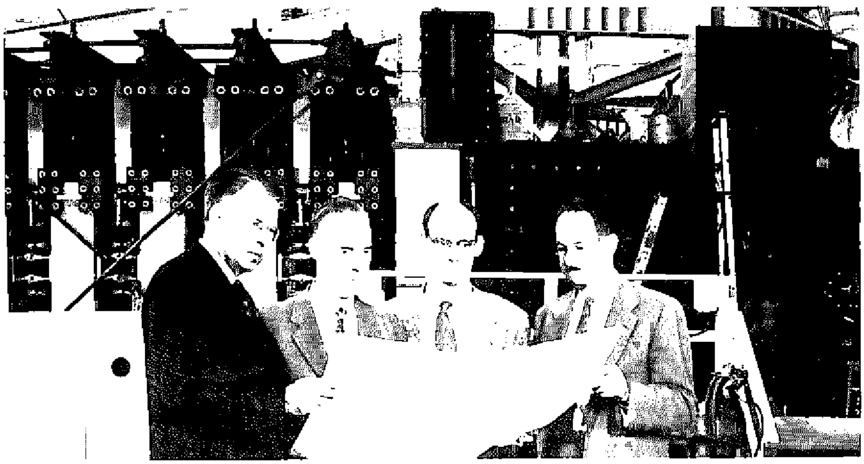
With the case of the Executive Branch set forth, attention turned to the reaction of the Legislative Branch, particularly Vandenberg. The Michigan senator was not pleased. He thought the proposals Acheson had just read amounted to bailing out the British yet again. Certainly he was not, he explained, able to decide such a matter at once. Lilienthal, Acheson, Eisenhower, and Webster joined forces to try to reassure Vandenberg that the proposals did not mean giving up the secret of the bomb; that in fact there was no secret about the bomb; that indeed from their work during the war the British knew how to make an atomic bomb. The senator was stubbornly unconvinced. Was it not possible, he asked, to work out some arrangement whereby only the United States made the weapons and earmarked a certain number for British use? Completely unrealistic, was Acheson's verdict. Vandenberg turned to Hickenlooper. The Iowa Republican observed that the decision to talk with the British and Canadians seemed pretty well decided. For himself, he thought the proposals were contrary to the Act. Nor did Hickenlooper think the raw materials situation was as serious as was claimed. Lilienthal interrupted to declare that if the equal allocation of the Congo raw material were restored, weapon production would slow down within three months and large numbers of men at Hanford and Oak Ridge would be laid off. Eisenhower looked at Hickenlooper and asked, "And who would take the responsibility for explaining *that* to the American people?"

The meeting ended inconclusively with general agreement that the sooner the matter came before the Joint Committee, the better. McMahon accepted the argument that it would be premature to decide the type of Congressional action required before the conversations with the British and Canadians revealed the terms of an agreement. Personally, however, he doubted the President's proposal was legal under the Act. As the meeting was about to break up, Truman warned of the need for secrecy. Arneson looked at his watch: it was ten-thirty.

Outside the reporters waited. Tydings, who was suffering from a heavy cold, had left early. To the barrage of questions he replied that if the newsmen knew the subject of the conference they would not, for the good of the country, print the story. When the others at Blair House came out they took their cue from Barkley: the grim-faced Vice President was asked what had been discussed. "Not a damn thing," he replied. Eisenhower observed to the press that "It's a hot evening and rainy." Last to leave were Acheson and Johnson. The two secretaries talked for a few moments in the doorway with Truman. As Acheson went down the steps he could not have been encouraged

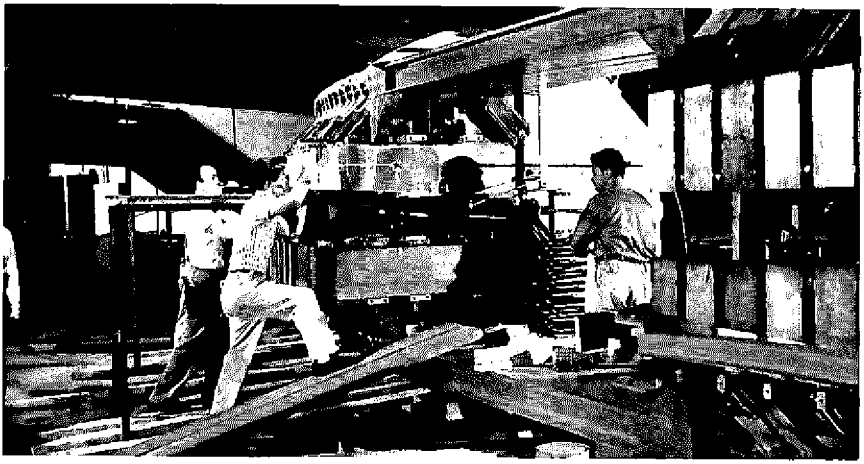


RADIATION GENETICS AT OAK RIDGE / William L. Russell and Liane B. Russell examine a mouse from one of the thousands of cages at the Oak Ridge National Laboratory. The bottles on top of the cages supply water for the mice.



LAWRENCE RADIATION LABORATORY

BUILDERS OF THE BEVATRON / Standing in front of the giant accelerator at Berkeley are the scientists principally responsible for designing and building it. Left to right: Ernest O. Lawrence, William M. Brobeck, Edward J. Lofgren, and Edwin M. McMillan.

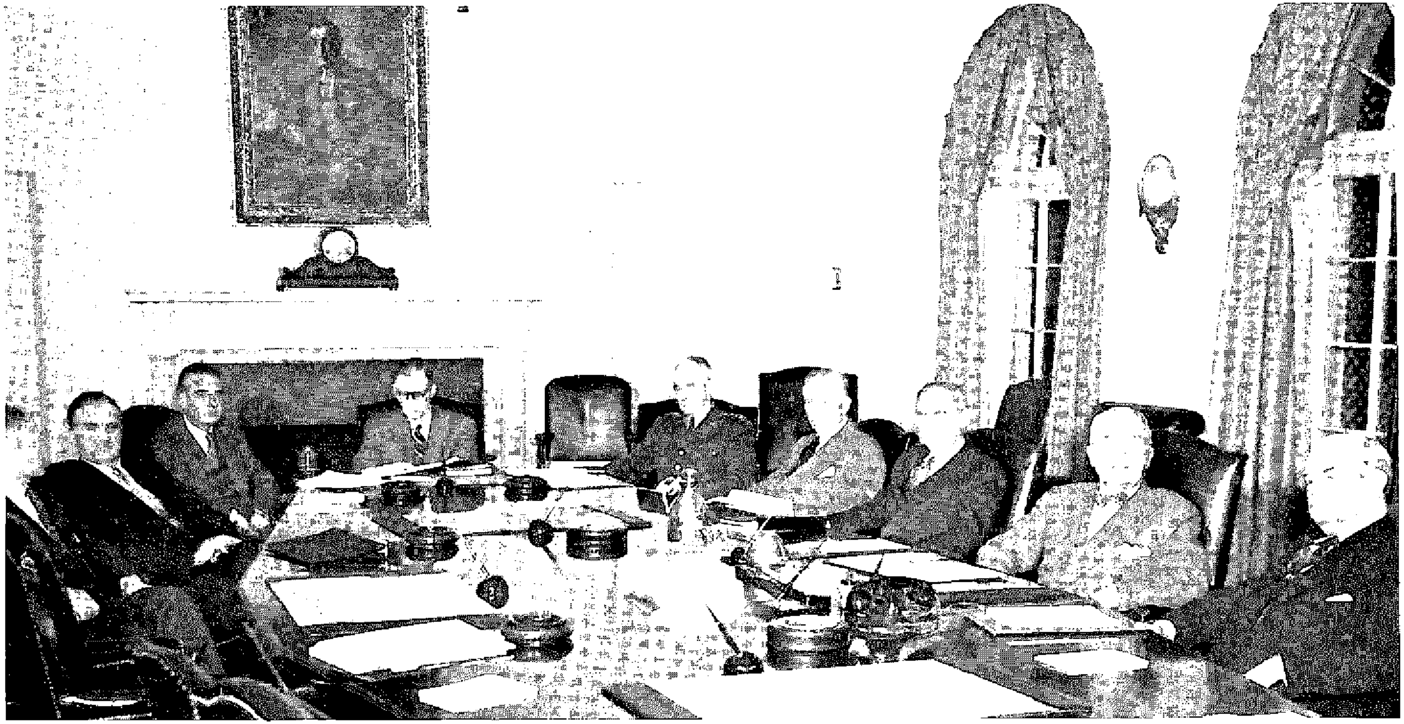


BROOKHAVEN NATIONAL LABORATORY

ASSEMBLING THE BROOKHAVEN COSMOTRON, 1950 / Workmen are installing a bundle of water-cooled, wound copper bars which form part of the magnet coil. The photograph shows the return winding on the outside of the magnet at the end of a quadrant.

BROOKHAVEN NATIONAL LABORATORY

CELEBRATING A MILESTONE IN CONSTRUCTION OF THE COSMOTRON / Members of the cosmotron team enjoying a moment of relaxation after succeeding for the first time in guiding a proton beam through one quadrant of the magnet in December, 1950. G. Kenneth Green stands in the center of the group. From left to right around the circle: Abraham Wise, George B. Collins, Charles H. Keenan, Gerald F. Tape, M. Stanley Livingston, Martin Plotkin, Lyle Smith (mostly hidden), Joseph Logue, and Irving L. Polk.



U. S. ARMY

THE NATIONAL SECURITY COUNCIL, JANUARY, 1951 / Left to right: Executive Secretary James S. Lay; W. Stuart Symington, chairman of the National Security Resources Board; W. Averell Harriman, Special Assistant to the President; Lt. Gen. Walter Bedell Smith, Director of Central Intelligence; General Omar N. Bradley, Chairman of the Joint Chiefs of Staff; Secretary of Defense George C. Marshall; Secretary of State Dean G. Acheson; President Truman; and Secretary of the Treasury John W. Snyder.

LOS ALAMOS SCIENTIFIC LABORATORY

FOUR LOS ALAMOS SCIENTISTS: Edward Teller (*top left*); Stanislaw M. Ulam (*top right*); Marshall G. Holloway (*bottom left*); Darol K. Froman (*bottom right*).

by the results of the meeting: Hickenlooper was opposed, Vandenberg was very doubtful, and McMahon was uncertain. The quest for Congressional support would not be easy.[39]

QUEST FOR CONGRESSIONAL SUPPORT

If Acheson had forebodings, they could only have been increased by a telephone conversation with McMahon on July 18. McMahon said Vandenberg was still upset over the Blair House meeting and had repeated his argument that after all the United States had done for Britain, the British should now do something for the Americans. Two members of the Joint Committee were thinking of resigning on the grounds that they could not accept the proposed policy. McMahon also said he had seen a resolution which would call upon him to declare to the Secretary of State that no negotiations should take place without the Joint Committee's having full information. The next day McMahon met with his committee to sketch the substance of the Blair House proposals. It was a rough session, some committee members taking the Vandenberg position, others wondering about the legality of the proposals, while the remainder were willing to see negotiations take place. It was clear that the Secretary of State could not expect an easy reception.[40]

The full Joint Committee gathered to hear the proposals on July 20. Acheson, with the support of Lilienthal and Johnson, was to present the case. Along with Lilienthal were four Commissioners, including Gordon E. Dean and Henry D. Smyth, who had replaced Bacher and Waymack. After the Joint Committee voted not to have a transcript, Acheson began. His strategy was the same as he had used earlier: describe the background, offer the testimony of Lilienthal and Johnson for justification, and finally read the aims of the proposed policy. He ran into heavy weather. Lilienthal had done little more than portray the need for raw materials when Millikin, Hickenlooper, and Knowland laid down a barrage of questions. Knowland, holding his temper with difficulty, demanded to know whether the Commission believed the proposals could be carried into effect without Congressional approval. Lilienthal replied that the Commission would be guided by the decision of the Executive Branch. But what if the Joint Committee disagreed? Then, Lilienthal answered, new legislation would probably be needed.

For a moment Acheson recovered control and returned to his basic strategy. Johnson was to testify, but he swiftly passed the issue to Eisenhower, who began to speak in favor of a policy which the Joint Committee had not yet heard. Badgered by questions from Vandenberg and others, Eisenhower found himself in difficult straits, particularly when the Michigan senator asked whether British manufacture of atomic weapons did not duplicate the efforts of the United States. The question was important, for prevention of such waste was one of the objectives of the North Atlantic Treaty Organization for which Vandenberg was fighting. As Eisenhower groped for words to voice his thoughts, Acheson stepped in. His attempts to return to the planned procedures of exposition failed. Partial testimony had raised so many issues that a steady drumfire of questions prevented him from reading the prepared negotiating position. Finally he suggested another meeting. Johnson, sensing the angry temper of the session, quickly concurred, and soothingly added that the Department of Defense would review its position.

Johnson had calmed the committee, but had upset Lilienthal, Wilson, and Volpe. To them Johnson had not saved the policy for presentation another day. Rather, he had suggested that it was possible to chip away at the President's policy. Not all the difficulties were in the Department of Defense. When Hickenlooper asked if the entire Commission unanimously favored the

President's policy, Strauss had replied that while he had been a minority of one in the past, with two new members on the Commission that position might change.[41] From the chaos of the meeting there was little reason for optimism for cooperation with Britain and Canada.

Lilienthal and Acheson planned the strategy on July 25 for the next meeting with the Joint Committee. Acheson reported that the President wanted a fair measure of Congressional approval. That same day Johnson advised Truman not to press the constitutional issue of Presidential power, but as a practical matter to concede that whatever arrangements were negotiated would be referred to Congress.

The meeting with the Joint Committee on July 27 Lilienthal found anticlimactic. Acheson told the Joint Committee that the President did not intend to press the issue of executive and legislative supremacy, since the support of both was necessary. The plan was to begin talks with the British and Canadians with the Joint Committee kept informed. McMahon summarized the results of the meeting in a press release, and on the following day Truman read a background statement at his news conference. Why were all the men who left the Blair House on July 14 so gloomy? he was asked. "It's a gloomy subject," answered the President.[42]

PREPARING FOR NEGOTIATIONS

Cooperation with the British was hardly an academic question. Zinn at Argonne refused to talk to any British visitor on classified subjects until the status of cooperation was clarified. Within the Commission itself there was debate on the legal issues. Volpe argued that the common defense and security clause of Section 10(a) authorized technical cooperation. In his mind, the fact that the Joint Committee had followed the conversations leading to the *modus vivendi* confirmed his interpretation. Dean did not agree. Perhaps it could be postulated that giving certain data to Britain would benefit American defense and security. But if this information had industrial significance, its transmission contravened Section 10(a)(1), which forbade such action until Congress by joint resolution found that adequate international safeguards existed. To Dean the prohibition governed the policy statement. Dean did not question that the Commission was committed to the *modus vivendi,* but he was convinced that legal ambiguity must be removed.[43]

Lilienthal believed that the spirit of the negotiations with the British and Canadians was important. On August 16, 1949, he lunched with James E. Webb, who had replaced Lovett as Under Secretary of State and who was to conduct the talks. Lilienthal warned that narrow haggling was no way to achieve a broad and comprehensive agreement. Webb's response was not reassuring. While Webb agreed with Lilienthal, Johnson was charging that the *modus vivendi* was illegal, that the majority of the Commission supported Strauss, and that the Commission was inefficient. Uneasy at the news, Lilienthal the next day repeated his ideas to Clark M. Clifford and Sydney W. Souers, executive secretary of the National Security Council. Then, exhausted from the strain of the Hickenlooper hearings, he departed for the quiet of Martha's Vineyard.[44]

Across these doubts and hesitations came a new and startling event. In early September monitoring aircraft picked up airborne radioactive debris from a nuclear detonation. As Webb met with the American members of the Combined Policy Committee on September 13, 1949, to discuss the forthcoming negotiations, analyses were indicating with ever-greater certainty that the Soviet Union had successfully detonated a nuclear device. Pike expressed the Commission's hope that the British could be persuaded to manufacture and store atomic weapons only in the Western Hemisphere. Bush and Norstad believed the British would insist on a token weapon production effort. The question of psychological preparation for the negotiations was important but seemed to have no real answer. Norstad reported that his British contacts felt the American attitude on atomic energy prevented full military cooperation. Kennan added that failure to reach agreement could wreck the pattern of good will. To him the greatest stumbling-blocks were Congress and certain parties within the administration. Bush, well aware of the implications of the airborne debris, was confident that Congress would accept a reasonable partnership.[45]

NEGOTIATIONS—FIRST PHASE

Negotiations began in a full Combined Policy Committee meeting on September 20. Webb presented the American objectives and pointed out that a new long-range agreement would require Congressional sanction. Not unexpectedly Sir Oliver Franks described British experience with technical cooperation as slow, cumbersome, and incomplete. Wrong saw room for improvement, although Canadian scientists had received considerable benefit. Both agreed to Webb's proposal that the talks be carried on by a subgroup on strategic and military considerations, another on raw materials supply and requirements, and a third on information exchange. Their findings the full committee would consider within a week.[46]

Within the less formal subcommittee meetings the differences were more sharply expressed. Sir John Cockcroft for the British described the annoyances and frustrations of dealing with the narrowing technical cooperation program. The Canadians too were critical. Bacher, now a Commission consultant, quickly turned the tables: Were the delegates saying that technical cooperation was not worth the effort? Cockcroft answered that the exchange of information had certainly been helpful, but the trend toward contraction bothered him. His government needed answers to two questions. Exchange of information in some areas had never taken place, despite the fact that they had been approved. What were the chances that these areas could become active soon? What could the Americans do to quicken the administrative procedures? At a later meeting Bacher promised administrative improvements, but he and his colleagues and advisers in the Departments of Defense and State could not change the existing areas without the permission of Congress. The time was not ripe for this step.[47]

Thus far the subcommittee meetings had dealt with the failures of the past. On September 24, Cockcroft presented the British plan. In brief, the British wanted a complete, well-rounded atomic energy program. They wanted full cooperation with no bars to information exchange. Some facilities such as a weapon proving ground might be used in common. Dean C. J. Mackenzie of Canada wanted full cooperation except in weapons, an area in which his country had no interest.[48]

Lilienthal learned on September 29 from Webb and Kennan that the talks were going badly. Neither of the State Department officials thought that the Joint Committee would accept the British plan. Webb reported that Truman thought he could conclude an agreement which furthered defense and security; if the Act prevented him, then it was unconstitutional. Practically, Kennan saw no alternative to telling the British that their terms were unacceptable. Lilienthal saw the threatened impasse as the consequence of narrow bargaining. More important, he thought Kennan and Webb were too quick to foreclose the possibility of Joint Committee acceptance. After all, the British had stood by the raw materials agreement. Then too, the Russian detonation had destroyed the rationale for a policy which accepted secrecy as the means to preserve American defense.[49]

The Combined Policy Committee on September 30 did little more than accept the reports of its subcommittees on raw materials estimates and on information exchange procedures, and adjourned until each government could assess its position.[50]

INTERLUDE

During the interim Acheson summarized the negotiations for the Joint Committee. Although the problem of raw materials had not been settled, Acheson saw no great obstacles. On the long-term arrangements there were two courses: isolation or increased collaboration. With the Russian achievement it was obvious to him the second alternative was better. He sketched in the background of the basis for cooperation, the exchange of information and personnel, and acceptance of comparable standards of security. He did not minimize potential difficulties. All proposals for cooperation among the three nations were based on preventing waste and inefficiency. The British wanted a complete and well-rounded atomic energy program and might not accept the principle of the most efficient use of resources, under which they might have to give up part of their effort. Further discussions, he concluded, were clearly in order. Acheson's presentation had been strong, able, and skillful. Knowland, not an easy man to please, praised the Secretary of State. Hickenlooper too, was satisfied.[51] The spirit was much different from that of the stormy session of July 20, partly because committee sensitivities had been placated, partly because of the grim impact of the Soviet detonation.

Truman, too, was pleased at the attitude of the Joint Committee. He was convinced that he had the authority to reach an agreement with the United Kingdom and Canada on atomic energy without the approval of Congress. When he had expressed this position at a cabinet luncheon, Attorney General J. Howard McGrath and Vice President Barkley had suggested that such a course would be unwise. Some clarifying legislation might be helpful, but given the composition and spirit of Congress, neither of the cabinet members saw much chance of getting favorable action. Although Truman had accepted reluctantly the need for consultation, he did not intend to let Congress prevent him from reaching an agreement he believed necessary. As he remarked to Webb on October 1, he favored a partnership with Britain and Canada and if necessary he would go to the country if the matter became a partisan issue. The atmosphere of the October 13 hearing must have given Truman the feeling that he and Congress could probably act together.[52]

Acheson told the Joint Committee that the British were about to invite a small group of Americans to visit the United Kingdom. For two weeks Nichols, Arneson, and Weil were in Britain and on November 21, 1949, drew up their report. Two production reactors and their associated chemical processing facilities were so far along that stopping work on them would be unwise. Such, however, was not the case for the third reactor. Very little progress had been made on a gaseous-diffusion plant, but Nichols, Weil, and Arneson suspected that for political reasons the British would be reluctant to cancel the project. For the forthcoming negotiations the three men recommended that the Americans press the British to stop work on the third reactor, limit the gaseous-diffusion work to a pilot plant, and cancel certain other facilities. A high opinion of British abilities came from Glenn T. Seaborg. At Wilson's request, Seaborg had agreed to visit Britain during a trip to Europe. His main interest, of course, was chemistry, and he saw several aspects of the British work that might interest the Americans.[53]

The Americans planned their strategy on November 22 for the next round of talks. Limiting the British production facilities was accepted. Nuclear components for British weapons were to be made in the United States. Only a limited number of weapons were to be stored in the United Kingdom, and these were for use only in accordance with common war plans. Particularly urgent was the need to come to an agreement on raw materials to replace the arrangement expiring at the end of 1949—now a little more than a month away.[54]

NEGOTIATIONS AGAIN

The first of the new round of meetings began on November 28. Adrian S. Fisher, now legal counselor at the State Department, presented the major topics, raw materials and long-range agreements. The British raised several questions. Roger Makins wanted to know whether the raw materials agreement was tied to the long-term arrangement. In his view the American principle that the most efficient use should govern the distribution of raw material among the three nations was too theoretical. Franks called for candor. The British were willing to integrate their atomic energy effort with that of the United States, but they wanted facilities to take advantage of future civilian uses. This, declared Franks, meant that Britain needed a small but complete program. A specific British proposal, added Makins, would be ready by the afternoon. At the end of the session Franks raised the crucial question: Would the Americans have to go to Congress for new legislation? The nature of the agreement would determine that answer, replied Fisher.[55]

That afternoon the Americans studied the British proposal. It was as Franks had foreshadowed. Assuming complete cooperation among the three nations in military aspects, the British would still want in the United Kingdom personnel and facilities engaged in manufacturing atomic weapons. A certain number of weapons, ready for use, were to be in British hands. Fisher, Wilson, and others gathered in Arneson's office at three o'clock. They saw the chances of agreement as slim. The proposal amounted to an alliance on the military aspects of atomic energy and left untreated other facets such as cooperation in the production of fissionable material. Fisher was pessimistic. If this were the firm proposal, there was little hope and the working groups might as well return the issue to Acheson and Franks. Still, Wilson was to explore the British views.[56]

Wilson began a long day of negotiations at nine o'clock on December 2, 1949. He first met with the Commissioners and reported that agreement on raw materials seemed possible, but the British and Canadians wanted time to study the details. Of more immediate urgency was the long-term agreement. A memorandum of American counterproposals lay on the table before each Commissioner. If the Commission approved, Wilson would use them in his discussions with the British and Canadians at ten o'clock. The counterproposals contained the same underlying principles: The purpose of cooperation was to increase the collective security of the three nations within the shortest possible time. Such cooperation would entail complete information exchange and the integration of British and Canadian scientists in all parts of the American program. In return, the British were to be asked to limit their program to two reactors, chemical processing facilities, and a research effort at Harwell. Plutonium from the British reactors was to be exchanged for American weapons. So far there was nothing new, but the next point was obviously an attempt to bridge the gap between the positions of the two nations. The British were to be free to develop and manufacture in the United Kingdom any weapon component they desired, so long as their work did not prejudice the combined effort.[57]

The Commission reaction was cool. Lilienthal was pessimistic. The whole spirit of negotiations seemed to him deplorably narrow. The only proper course, he thought, was for Truman to seek authorization to negotiate on the broad grounds of increasing the national defense and security. Wilson and Volpe saw no reason to give up hope. Both pointed out that the British and Canadians had never heard the detailed American proposal, and that there was no reason to think that the British position was not subject to negotiation. Smyth and Dean doubted whether the contents of the memorandum were in complete harmony with the President's policy. Yet the differences seemed slight and both Commissioners thought the arguments pointing out the vulnerability of a British program were the most persuasive. The memorandum received the lukewarm approval of the Commissioners at nine fifty-five.[58]

Five minutes later Wilson, General James McCormack, and Volpe entered the State Department where they, with Fisher, Arneson, Nichols, and Webster, met with the British and Canadians. In a general meeting, and later in a smaller group, Wilson, McCormack, and Nichols argued that the British proposal to have all the facilities needed to make atomic weapons in the United Kingdom did not take advantage of the increased scientific knowledge or greater production facilities in the United States. William G. Penney of Britain agreed the proposals were logical if the two countries were one, and Omond McK. Solandt of Canada thought the plan was reasonable if war were assumed possible in the next few years. The two great imponderables, Franks observed, were the American Congress and British public opinion. Was a binding agreement really possible? Cockcroft asked. The Americans repeated the earlier response: It depended upon Congress, and Congressional reaction was most likely to accept a combined effort which made the greatest contribution to the atomic weapon stockpile. It was past noon when the session adjourned. Cockcroft and Penney agreed to discuss the American ideas with Franks and meet later in the day in Wilson's office.[59]

A few minutes before five o'clock Cockcroft and Penney entered Wilson's office. There were two major points upon which the two Englishmen wanted clarification. One was the exchange of information and personnel, and here Wilson was able to assure them that there would be no closed areas. The other was the effect of integration upon a British weapon program. Accepting the American plan would mean that Britain would have to postpone its own weapon plans. Although this was conceivable for some time, Cockcroft and Penney warned that eventually Britain would want its own weapon establishment. To Wilson this point did not pose an insurmountable obstacle. He explained that a British weapon complex could be a part of the joint effort. Cockcroft and Penney were about to return to London with the American proposals; how soon did Wilson need an answer? Congress was scheduled to meet on January 3, 1950, the general manager replied, and he hoped to report to the Joint Committee before that date. Cockcroft and Penney thought they could meet the deadline.[60]

The reply and counterproposal arrived from London and, on December 29, 1949, Franks sent the documents to Acheson. Copies were circulated to the American working groups. The British accepted the principle of complete collaboration among the three nations in all aspects of atomic energy, including weapons, research, production of fissionable materials, and the development of military and peaceful applications of atomic energy. They were willing to accept a production complex limited to two production reactors and a low enrichment gaseous-diffusion plant, although they wanted the freedom to vary their program as they desired within the limits of the raw materials allocated to them. They were willing to integrate their weapon program and personnel with those of the other two countries so that the combined efforts of all might result in the maximum number of the most advanced atomic weapons during the critical period of the next three years. They were willing to accept a formula under which they would receive weapons up to a limited number for stockpile within Britain in exchange for plutonium from their reactors. Weapons in excess of the stated number would be held in Canada at the disposal of the United Kingdom.

A few points bothered the Americans. Some thought the period of three years indicated a feeling that after that date the British would be less interested in an integrated effort and more concerned with applying the results of the collaboration to their own weapons. The British, too, reserved the right to continue their own weapon development in any area they chose so long as their effort did not interfere with sending adequate personnel to the United States. And nothing was said about the use of bombs in common war plans.

The Commissioners' opinion was unfavorable. They discussed the British proposals with Wilson and Volpe on January 5, 1950. Lilienthal was displeased for several reasons. He had not liked the operations of the working group and he thought the papers clearly vindicated his warning that major negotiations could not be carried on by working groups. What was needed was Presidential intervention. Strauss pointed out the lack of reference to common war plans, Smyth was worried about the significance of the three-year period, and Dean wondered how cooperation on developing reactors for civilian as well as military uses could be justified to American industry.[61]

On January 18, Fisher and Arneson summed up the status of the negotiations in a memorandum to Johnson. The two State Department officials saw the need for talks among Acheson, Lilienthal, and Johnson to establish a firm administration position. Fisher and Arneson believed the British had come close to the American position on weapon research and other military arrangements. Storage of weapons and the length of time of the agreement were potential points of differences, but appeared negotiable. They saw only two major problems. The first was the British desire to be free to build additional production facilities if these did not affect the allocation of raw materials or require the services of personnel needed in the joint weapon program. Fisher and Arneson suspected that since the United States already had large production plants, British personnel would not be needed for this purpose. More important was the fact that the British had the uranium ore and were in a position to call the tune. The real issue was whether additional production facilities would be built in the United Kingdom or not at all. Since the number of weapons in existence at the outbreak of hostilities was what mattered, the State Department was inclined to think that production facilities in Britain was not a real point of dispute.

As far as civilian applications of atomic energy were concerned, these were in the future. Information exchange was, of course, important and could lead to development of civilian uses. Fisher and Arneson touched the sore point of the past two years of technical cooperation when they wrote: "Information is valuable only if the recipient is in a position to use it and it is not much of an informational exchange which says to the British: 'We will give you information concerning industrial use but you must not construct facilities to assure you an adequate supply of uranium 235 for use in any practicable benefit which might be obtained in the industrial field.' "[62]

For the moment the negotiations were in abeyance, but on raw materials the situation was clear once more: All the ore from the 1950 production of the Congo was, with certain reservations and limitations, earmarked for the United States.[63]

FUCHS AND FAILURE

Wilson arrived at his office on February 2, 1950, at eight-fifty-five. He was caught up almost immediately in the preparations for the morning Commission meeting. Carleton Shugg, McCormack, Lawrence R. Hafstad, Walter J. Williams, and Kenneth S. Pitzer came into the office to discuss the hydrogen bomb program, a major topic on the agenda and on which each might be questioned. For over thirty minutes the group talked, and after they departed Ralph P. Johnson entered on a matter of a Belgian request for information. This too was to be considered by the Commission. Wilson could give the problem only a few minutes and then, gathering up his papers, he hurried from his third-floor office to the Commissioners' conference room on the floor below.

The conference room door to the corridor closed behind him. Outside waited a few staff members who, at the proper time, would be summoned into the meeting for their advice or background information on matters on the agenda. Wilson glanced around him as he settled into his chair at the large triangular table and arranged his papers before him. The five Commissioners were present, and seated near Wilson were Volpe; Roy B. Snapp, the secretary; and Snapp's young assistant, Philip J. Farley. The opening was not very different from those of the 362 previous meetings. The rustle of papers subsided, and at a nod from Lilienthal, discussion began. The first topic dealt with weapon development plans. As the discussion neared conclusion, Wilson glanced at his papers for the next item of business, but before Lilienthal could make the transition, Strauss interrupted. He asked for an immediate executive session for the Commissioners alone. Wilson was astonished, curious, and disturbed. He, Volpe, Snapp, and Farley left. The time was ten-thirty.

Fifteen minutes later Lilienthal and Strauss left the room and Wilson and other members of the staff reentered. Strauss returned soon after the meeting resumed. Under discussion was the exchange of information with the British on the preparation of hafnium-free zirconium, a metal of promise in reactor work. Although the Commission approved the exchange, Strauss remarked that the action was tantamount to declassification. Another subject was the foreign travel of an individual who had admitted earlier to Communist Party membership and who at one time had been part of the Manhattan project. Smyth was inclined to think that the application for a visa should be granted, since a number of years had gone by. Strauss demurred: where there was an element of risk the doubt must be decided in favor of the Government. Near the end of the meeting Lilienthal reentered. He waited until there was a pause and then called for an executive session. Wilson, he said, could remain if he desired. Wilson stayed.

He heard that at the earlier session Strauss had revealed direct information from the Federal Bureau of Investigation, that Klaus Fuchs, a British scientist, had confessed to espionage. The man had been a member of the British team working on weapons at Los Alamos during the war. His capabilities were high and he had risen to a responsible position at Harwell. Nor was that all. Strauss had gone on to point out that British members of the Combined Development Agency had offices in the Commission headquarters; that they possessed passes issued under Wilson's direction enabling them to enter the building at will. At twelve-fifty-five Wilson strode back to his office, furiously angry at his exclusion from an executive session, and at the implication of negligence in granting passes.

As always happened when he was away from his desk, several matters had piled up for his attention. A few scheduled meetings he was able to cancel, but the one with the Military Liaison Committee he could not postpone. Nonetheless, he found time to ask for a check of the Commission minutes. Not too long ago, he remembered, he had called to the Commission's attention an FBI letter which stated that the British were working on a case of atomic espionage. Farley found the reference. The date had been November 2, 1949. Pike, Smyth, and Dean had been present; Lilienthal and Strauss had been absent. In the afternoon, while Wilson was at the liaison committee meeting, Lilienthal was seeing Truman. The chairman and the general manager saw each other again late in the afternoon. Lilienthal, a few days away from private life, suggested that Pike receive the reports which would be coming on Fuchs. The day had been long and hard, and a grim change from the gaiety of the last evening when members of the staff had given Lilienthal a farewell party.

The next morning began in confusion. Lilienthal arrived at the office, having understood that there would be time for the Commission to prepare a public statement which would be released simultaneously with the one by the British. But there had been a misunderstanding and the British had already acted. Hurriedly the Commissioners scanned a draft and, making only a few revisions, gave their approval. Then Wilson brought up the events of yesterday's executive session. Resentfully he spoke of his exclusion. Barring him from a meeting dealing with espionage he called an intolerable reflection upon him. Strauss, unsuccessful in calming the general manager, explained that he had received the information with the request that knowledge of the case be limited to the Commissioners. Wilson went on to the matter of issuing passes to British members of the Combined Development Agency. This action, he declared, had been taken after consultation with Lilienthal as chairman, or Pike as acting chairman. Neither Pike nor Lilienthal recalled having been consulted. Lilienthal, however, observed that the action appeared within the authority of the general manager. Strauss promptly disagreed. In his interpretation Wilson had exceeded his powers and had failed to keep the Commission informed.

Feelings were still taut when the meeting adjourned and the Commissioners and a few members of the staff left for the Capitol and a meeting with the Joint Committee. McMahon called the session to order at ten-thirty. Reading aloud some of the newspaper stories, he remarked, "Apparently we are in a hell of a mess . . ." Lilienthal made no attempt to hide the gravity of the situation. Fuchs had done great damage. Of that there was no doubt. But what must not happen, Lilienthal warned, was an orgy of witch-hunting. A brazened, unreasoning hue-and-cry raised against scientists might be even more devastating to the nation's atomic energy effort. All in all, the Joint Committee took the news well. The members recognized the seriousness of the perfidy but they indulged in no recriminations.[64]

Whatever hopes had existed for a tightly integrated program with the British and Canadians died with the Fuchs revelation. Yet even without Fuchs the chances of close cooperation were problematical. Probably the Cyril Smith incident had increased the Joint Committee's distrust of the Commission on international matters and made more powerful the voice of the military. On the other hand, the Soviet nuclear detonation that shook the sands of Central Asia also shattered many preconceptions, among them the myth of American technical supremacy. The British had demonstrated to Forrestal their steadiness during the siege of Berlin, and their partnership in the face of the Soviet nuclear achievement might have been welcomed. But this course no longer existed as Fuchs stood in the dock at Old Bailey. The Lord Chief Justice might know little about the abstruse principles of nuclear weapons, for these were new to the world's history. But treachery was familiar; its history was far older than the age recalled by the medieval scarlet and ermine of Lord Goddard's robes. Nevertheless, cooperation would continue in one way or another, for as old as treachery was the need for allies in a troubled world.

sion would not be signing a blank check. To meet his objections the Commission entered into the minutes its understanding of technical cooperation. The nine areas were general fields in which information exchange might prove beneficial. Implementation of any topic within the field would require the approval of the Combined Policy Committee. On this committee the Commission was of course represented. Volpe and Lilienthal also pointed out an additional safeguard. The Commission representative on the implementing subgroup would be instructed to bring before the Commissioners any proposed action. After more than two hours of discussion the three documents were approved. Lilienthal was to explain the Commission's interpretation to the Combined Policy Committee. It had been an arduous session: not enough copies of the papers for everyone at the meeting, not enough time for lunch, and no opportunity, said Strauss, for the Commission to work out its position at leisure.[50]

The meeting of the Combined Policy Committee which began late in the afternoon at the Blair House was anticlimactic. Lilienthal observed with amusement the scurry to find a green cloth, customary for such diplomatic occasions, to cover the table. Lovett, Inverchapel, and Wrong approved the three documents. To implement the areas of technical cooperation Lord Inverchapel proposed a standing subgroup of scientific advisers. Lilienthal took the opportunity to raise the point that had disturbed the Commission. Information exchange, he pointed out, would have to be carried out within the legal restrictions of the three countries; consequently it would not be possible to vest the American representatives on the subgroup with discretionary authority. Makins saw nothing unusual in the observation, for each representative, he observed, would be guided by the laws of his own nation. Inverchapel's proposal for a subgroup was accepted.[51]

The *modus vivendi,* with the agreements on ore allocation and information exchange, appeared to mark the end of confusion between the United States, United Kingdom, and Canada on atomic energy. Some of the ambiguities of the American position were the legacy of the secret diplomacy of the war, some of the ambivalence was the result of the desire for international control through the United Nations, and some of the indecision stemmed from fears of Congressional sensitivity. Whatever their source, the doubts seemed uprooted and the seeds of a bargain, planted almost a year earlier when Makins talked with Acheson, appeared to have grown naturally into fruition.[52]

THE ART OF ADMINISTRATION

CHAPTER 11

The Commission was to be something new in American government. This was Lilienthal's aim and the lure that had attracted many of the staff. Decentralized administration was to be the touchstone of future Government practices. That there would be difficulties in winning recognition for the new art of administration was evident. The civilian management of the atom had to show that it could convert the successes of the Manhattan project to a continuing and stable program based on sound financial practices, that it could devise and administer standards to measure the reliability of thousands of people who needed access to Restricted Data, and that it could foster industrial relations which would allow contractors and unions to exercise their rights, so long as vital plant operations never stopped. Congress—including such old and well-established groups as the appropriations committees, as well as the new Joint Committee on Atomic Energy—had to be convinced that decentralization was not a cover for weak and slipshod management. In 1948 the Commission could expect its practices to be scrutinized closely. According to the Act, the preliminary terms of the Commissioners would end, and the President would have to submit his nominations to the Senate. The fact that deliberation over the nominations would come during a Presidential election year was an added hazard. The years of 1948 and 1949 were to be a time of challenge to the Lilienthal Commission.

THE LILIENTHAL-WILSON APPROACH

Thursday, December 4, 1947, was a day Carroll L. Wilson had long anticipated. Despite the continuing crises of administration and inertia in the Commission's program, he had resisted the temptation to postpone this first meeting with the managers of the field offices. To make the best use of the three days available Wilson had scheduled the meeting to begin promptly at nine o'clock in the Commissioners' own conference room on the second floor of the headquarters building. All the managers were there when Wilson arrived—Carroll L. Tyler from Los Alamos, John C. Franklin from Oak Ridge, Wilbur E. Kelley from New York, Alfonso Tammaro from Chicago, and Carleton Shugg from Hanford. All had now been on the job long enough to know at first hand the difficulties they faced. Collectively they could bring to the Commission's business an impressive record of management experience and talent. The task facing them would demand every bit of that and more. The kind of organization Lilienthal and Wilson were building demanded imagination and creativeness.

These qualities could be fostered best under decentralized administration. The five managers gathered in the room had been given broad powers

and reported directly to Wilson. Each manager, within certain wide limits, was free to hire and fire his personnel, and to issue his own directives on how Commission goals should be met. Each manager, depending upon the type of operation he supervised, could negotiate contracts, ranging from $2 million to $5 million per contract, to carry out Washington-approved projects. Perhaps the measure of the managers' independence was the requirement that they need report only those matters involving policy or other operations offices. The authority running directly from Wilson to the managers meant that the Washington office had no line responsibility.

The headquarters staff could be divided into two groups. The program directors—James McCormack of military application, Walter J. Williams of production, James B. Fisk of research, John K. Gustafson of raw materials, and Shields Warren of biology and medicine—watched over projects which were integral parts of the Commission's program. Roger S. Warner's division of engineering, while considered a program division, suffered from having a poorly defined mission. As Wilson's staff, the program directors could deal directly with key field personnel. In the second category were the management offices. Rear Admiral John E. Gingrich of security and intelligence, Donald E. Bostock of organization and personnel, Morse Salisbury of public and technical information, Herbert S. Marks as general counsel, Paul M. Green as controller, and Paul W. Ager as chief budget officer could contact their opposite numbers in the field offices. Like the program directors, the heads of the management offices reported to Wilson. If decentralization were to work, Washington headquarters had to be informal, flexible, and free from the incubus of cumbersome staff.[1]

Much of what Wilson had to say on the second day of the meeting dealt with Washington techniques to achieve coordination. He admitted that communications between headquarters and the field had been poor, but he saw improvement. He thought the managers would soon notice the effect of the program council. Although it had been in existence for only three months, Wilson found that the council was helping the headquarters staff in examining issues cutting across the interests of several divisions and in formulating recommendations for the Commissioners. In fact, no major issue reached Wilson's desk without council consideration. Under David B. Langmuir as executive secretary, the council's operations had become routine; it met at least twice a week with Wilson or, in his absence, with a division director as acting chairman. To provide balance, the acting chairmanship was rotated every two months.[2]

Wilson pointed to the secretariat as another element of growing importance in Washington. After a weak and faltering beginning, the secretariat within the last few months had become an effective force. The credit for this improvement Wilson gave to Roy B. Snapp. The function of the secretariat was to prepare, coordinate, and organize staff papers for Commission action; the format and procedures Snapp had used in the office of the Joint Chiefs of Staff during the war. His task was complex, for he had to be aware of the interests and idiosyncracies of five Commissioners. He had to know the strengths and weaknesses of the divisions and their directors, to be certain that the views of all were obtained and—no mean task—to see that papers and recommendations for the Commissioners were succinct and clear. His familiarity with the atomic energy program had begun in April, 1946, when he became special assistant to Groves; he had served Wilson in the same capacity when the Commission replaced the Manhattan Engineer District. Snapp became acting secretary on October 1, 1947. Quickly the headquarters staff noticed his influence as he moved to organize and codify the paper work. Necessarily some of the instructions were painfully precise, and perhaps reflected Snapp's legal training, but to Wilson the organization which Snapp brought to the secretariat was an enormous help.[3]

The initial reactions to Wilson's remarks were bland and cautious. Nearly all of the managers called for better communication with Washington. They wanted more information and a greater role in formulating decisions. They felt overwhelmed with requests from headquarters for reports. Not until Fisk outlined on the blackboard the Commission's programs and responsibilities did discussion focus upon specifics. The interests of the operations offices overlapped. Tyler was, of course, primarily concerned with weapons, but he had two reactors for research and a community to manage. Shugg watched the activities of General Electric at Hanford. However, the company also administered the Knolls laboratory at Schenectady, which involved Shugg with research and the intermediate-power-breeder reactor project.

Tammaro's responsibilities were even more widespread. Through his Chicago office funneled reports from three university contractors—the new laboratory at Argonne, the laboratory at Ames, Iowa, and the radiation laboratory at Berkeley. The Berkeley-Brookhaven competition for the high-energy synchrotron made Tammaro in this matter a rival of Kelley. The New York manager not only represented the Commission at Brookhaven, but was also responsible for procuring uranium and other urgently needed metals. Franklin at Oak Ridge was surrounded by perplexities. Labor difficulties involving the production plants and the laboratory were troubling. Further, the unhappy situation was complicated by a change of contractor for the laboratory. The transfer was to take place by January 1, 1948. It was now December 5 and little had been done. Franklin declared, "I am going to do something. I can't wait for the resolution of a lot of problems by Washington as to some of the intangibles of this problem." Time pressed hardest upon Franklin, but Shugg, Kelley, Tammaro, and Tyler also had their difficulties.

That same afternoon Lilienthal interpreted his philosophy of contractor relations. Under the provisions of the Act, the Commission could have chosen to operate its installations directly. That course was not chosen, partly because government operation offered less chance to tap the best skills of industry. Admittedly the approach had its dangers. Contractor operation

implied contractor responsibility, but unless the Washington staff and the managers of operations were constantly alert, government monopoly of fissionable material and ownership of facilities, along with the necessarily close association between Commission and contractor personnel, could dilute this responsibility. That must not happen. From family experience Lilienthal drew an analogy: Like a wise parent who hesitates to help a child, the Commission must refrain from trying to solve the contractors' problems. Lilienthal promised that the Commission would back the delegation of authority to its managers. That was the TVA way; after fourteen years Lilienthal was convinced that it worked. He admitted that the Commission form of organization offered grave difficulties. "When I first read this law, I described it to a gentleman who was discussing the situation with me as an 'administrative monstrosity.' " Lilienthal did not say so, but the gentleman to whom he had described the law as a "monstrosity" was the President of the United States.[4]

To Lilienthal and Wilson decentralization was more than a slogan. The philosophy, triumphantly proclaimed by Lilienthal at TVA, offered hope to those alarmed by the growing centripetal force of Government. Students of business administration could point to General Motors and du Pont as successful examples of decentralized authority. To operate under this principle required personnel of the highest caliber—not only in the field, but in Washington. In their search for highly qualified men, in their efforts to free the Commission from the trammels of Civil Service, the Commissioners and Wilson showed they understood this need. If it took people of outstanding competence to work under decentralized authority, it was also true that the best hope of attracting such rare individuals lay in granting them powers unusual in other organizations. To Wilson, with little administrative experience, the philosophy must have been strongly attractive. It fitted his personal predilection; moreover, Lilienthal's reputation was an earnest that the approach worked. A new and powerful instrument of Government charged with developing a new source of energy for peaceful uses and defense was an exhilarating combination. It must have seemed one of those rare times when theory and reality met in benign conjunction.

APPROPRIATIONS—BUSINESS AS USUAL

In the crowded three days of the Washington meeting, Wilson, the Commissioners, the staff, and the field managers tried to cover all the facets of the Commission's program. Joseph A. Volpe, Jr., deputy general counsel, spent his allotted half hour explaining Congressional relations. This was a subject, Lilienthal declared, of tremendous importance to the Commission.

Congressional relations encompassed more than the status of ties with the Joint Committee, for the Commission, like most other agencies, depended upon Congress for appropriations. Because of the importance of financial legislation, and the constitutional primacy of the House of Representatives in fiscal matters, few Congressional committees had more prestige than the House Appropriations Committee. Few congressmen possessed more influence than the chairman, New York Republican John Taber, sixty-eight years old in 1948, and a veteran of twenty-five years in Congress. To handle the large volume of business, Taber appointed subcommittees, one of which—that on independent offices—heard the Commission defend its estimate of financial needs. Subcommittee chairman Richard B. Wigglesworth, Representative from Massachusetts since 1928, was not the man to allow his group to be overshadowed by a new agency, even if it was the custodian of so vital a source of national strength as atomic energy.

In dealing with the Commission, Wigglesworth faced an unusual situation. Most agencies appearing before the appropriations committee had already presented their request to the scrutiny of another committee for authorization. After authorization, a step usually involving lengthy hearings and a detailed examination of budget items, the appropriations committee set to work. From this procedure the McMahon Act had excepted the Commission, allowing it, because of the highly classified nature of atomic energy operations, to present its request for funds directly to the appropriations subcommittee.[5] From Wigglesworth's point of view, his subcommittee was the only means by which the House of Representatives could assure itself that the Commission handled its operations prudently.

Evidence of careful management Wigglesworth sought unsuccessfully in the testimony the Commission presented in 1947. Dissatisfied with the financial data presented by the four-month-old Commission, frankly skeptical of the explanation that the poor information reflected inadequate records kept by the Manhattan District, Wigglesworth claimed he could find no basis to judge the request. He suspected that the amounts of $250 million for cash expenses and $250 million for contract authority were excessive. He recommended a reduction of $75 million from the cash request, pointing out that when Congress convened in January the Commission could return with better information to show the need for the larger amount. Taber approved his lieutenant's action by declaring on the floor of the House, "If they do come back, I hope they come back with some figures that some committee or somebody in Congress can understand and get in shape." The reduction was approved by the Senate Appropriations Committee.[6]

The imputation of carelessness rankled Lilienthal. Prior to the meeting the Commission had conferred with Taber, and at his request the Commission agreed to submit only unclassified data. But it was apparent during the first session that Wigglesworth's committee was dissatisfied with the procedure. The Commission therefore returned with classified information, a course which Wigglesworth found no more helpful than the first. Lilienthal knew that the financial data presented to the committee were poor. The criticism, however, did not explain why this situation existed: that because of secrecy, the magnitude of the effort, and the pace of events, the Manhattan District had been unable to keep the precise financial data of an old-line Government agency. Nor did the committee refer to the Commission's exceptional steps to give the information required. To Lilienthal, the committee actions were unfair and dangerous, and could shake Congressional and public confidence in the Commission.[7]

Under the best of circumstances budget preparation was a time-consuming business. First, Ager and his small budget group prepared the detailed estimates. These could be broken into two main categories: one to cover the Commission's direct expenses, the other to meet already authorized obligations to contractors. After careful study by the Commissioners, Wilson, and the principal staff, the estimates went to the Bureau of the Budget for measurement against the President's budget policy. The Commission's program, spanning the gamut of industrial-type operations from raw materials to complex production and fabrication facilities, also included such esoteric fields as physical and biological research and more mundane affairs like community management. Adding to these ingredients a generous measure of security sometimes produced unexpected results. Williams could testify on the need for millions of dollars for production facilities, and find no committee member interested in challenging his carefully compiled justification. But a comparatively small sum for road construction at any of the three communities could produce hours of wrangling.

Lilienthal thought that the Commission showing in the 1948 appropriations hearing would be better, a confidence he manifested in talking to the President on November 25, 1947. Few people pored over the Government's budget with more zest and enthusiasm than Truman, who prided himself on his mastery of the intricacies of the fiscal system. He had studied the Commission's request which, to cover the period ending June 30, 1949, totaled over a billion dollars. Was the amount enough? Could the Commission use more? Lilienthal replied that the estimates were an honest judgment of the requirements. The next day he assured James E. Webb that the unhappy experience with Wigglesworth would not be repeated, for now the Commission had more experience and better information.[8]

Truman submitted his budget to Congress on January 12, 1948. For the year ending June 30, 1949, he estimated total Government expenditures of $39.7 billion. The Commission's share was $625 million.[9] For the Commission the next step was to appear before Wigglesworth's subcommittee to justify the amount. But this was not all. The earlier reductions and new construction, mainly at Hanford, required more money than had been appropriated to cover the year ending June 30, 1948. The amount needed to make up the deficiency in addition to the $625 million had been in Truman's mind when he asked Lilienthal if a billion dollars were enough. As 1948 began, the Commission faced two sets of appropriations hearings, one on the deficiency, the other on the amount needed for fiscal year 1949.

Lilienthal's chance to demonstrate his confidence in the Commission's fiscal estimates came when the deficiency hearings began on February 28, 1948. He had tried to pave the way. On Senator Hickenlooper's advice, Lilienthal had explained the Commission's goals and difficulties to H. Styles Bridges, chairman of the Senate Appropriations Committee and a useful ally should the House committee cut the request.[10] Moreover, Lilienthal could point to progress in building an accounting system designed to meet the needs of the Commission. To show the completely inadequate financial system which the Commission inherited from the Manhattan District, Lilienthal could offer reports made by five public accounting firms on contracts used during the war. Although varying in details, the reports unanimously concluded that the contracts did not provide sound financial controls.

In Green and Ager, the Commission had officers who understood the need for strengthening the financial procedures. Many of their staff had come from the Office of Price Administration, where they had become familiar with industrial control systems. Lilienthal himself had fought successfully in TVA for freedom from the detailed, item-by-item scrutiny of Government auditors. Little more had been done so far in the Commission than data-gathering and planning, but Lilienthal promised that by July 1, 1948, the Commission would have the elements of an accounting and auditing system that could provide management information for Congress.[11]

The deficiency hearings passed smoothly. Perhaps better fiscal data were the reason; perhaps the presence of the five managers of operations to testify on the program requirements was a help. On the other hand, the deficiency hearings were perhaps not the real test of the Commission's relation with the House Appropriations Committee. That trial would come during the regular appropriations hearings.

In preparation, Wilson and the field managers explained the basis for the financial estimates to the Joint Committee on May 27 and 28. Only on one matter did the committee members raise a strong objection. Wilson had asked for the committee's support for removing the salary limitation imposed on nontechnical and nonscientific personnel in the 1948 budget. He had argued that the discharge of the Commission's heavy responsibilities required exceptional personnel, and that individuals of high caliber were difficult to recruit under a salary limitation of $10,000. Hickenlooper dismissed the topic as one suitable for the appropriations committee to decide. Lilienthal intervened to warn that the Commission was dependent in Congress upon the Joint Committee. "It seems to me that if we can't look to the Joint Committee as having been given the legislative responsibility for this undertaking, then we are in a quite impossible situation. The over-all policy rests under this law, as we understand it, with this Committee." [12]

The hearings began a few days later. The relative calmness of the deficiency hearings had vanished. The technique of having Kelley, Tyler, Franklin, Shugg, and Tammaro testify now proved confusing. Too often the questions from the subcommittee members went into peripheral areas which required mastery of minute detail to answer. Inevitably some of the replies were lame and halting. Furthermore, each manager had under his supervision several segments of the Commission program. Research, for example, was fragmented in the field among the five managers, and divided in headquarters between Fisk for physical research and Warren for biological and medical research.

Some fireworks resulted when Wigglesworth asked Lilienthal and Wilson to arrange their projects into categories of priority. Lilienthal and Wilson refused, asserting that atomic energy was such a new field that it was impossible to list the relative importance of the several projects. Unforeseen developments might make any one of them critical to national security. Furthermore, the Commission had already combed out the nonessentials and the result was a carefully integrated program. Wigglesworth refused to accept the explanation. If the committee recommended a reduction, he was certain that the Commission could discover some relative priority among the projects which must absorb the decrease. The real issue, as Lilienthal saw it, was that in such circumstances the Commission and not the subcommittee would decide where the blow must fall.

Wigglesworth also attacked the organization of the Commission. He expressed astonishment at the vast powers given to the field managers. He speculated, in view of the field managers' activities and Wilson's responsibilities, on the function of the Commissioners. Their role, replied Lilienthal, was to keep aloof from the administrative detail and try to find "answers to some of the questions which are so complex and new in American society." [13]

The rather pompous tone of the reply suggested that Wigglesworth and Lilienthal were speaking for the record. The chairman was describing his management philosophy; the Congressman was asserting his claim that the organization was weak and the administration lax. With a program wrapped in secrecy and security, Lilienthal welcomed the hearings as a forum, even if the preparations were time-consuming.[14] And, without detracting from the importance of the sessions, the exchange of views often appeared more dramatic in cold print than in actuality. The fact that both knew the House committee actions could be appealed to the Senate appropriations committee allowed a certain freedom to declaim and maneuver.

Wigglesworth recommended cutting the request, but with the proviso that the reduction was to be absorbed so as not to affect the Commission's military program. Determined to cut the appropriation, and faced with Lilienthal's and Wilson's refusal to rank their projects in priority, Wigglesworth had no other recourse. The Senate restored the cut and eventually the bill was to pass, appropriating the amounts requested by the Commission but not removing the salary limitation. As far as the House Appropriations Committee was concerned, the Atomic Energy Commission was no different from any other Government agency. John Phillips of California, who had heard Wilson and Lilienthal testify, recited doggerel on the floor of the House on June 9. The Congressman suggested his verses might be called an "Ode to the Appropriations Committee" by the Commission. The concluding lines were:

Our testimony's vague but calm,
Your job's the budget; ours, the bomb;
We walk on clouds (of radiation);
You save the cash; we'll save the nation.[15]

THE SPECIAL RELATIONSHIP

In the House debate on the 1949 appropriations bill, Wigglesworth on June 9, 1948, accused the Commission of lavish expenditure. House members of the Joint Committee quickly entered the discussion. James E. Van Zandt of Pennsylvania and W. Sterling Cole of New York—both Republicans—appeared inclined to accept some of Wigglesworth's description, while Chet Holifield, Democrat from California, took on the role of defender. Holifield remarked that he had attended every session of the Joint Committee at which the Commission had appeared, and in no instance had he heard a charge of general extravagance. In the other wing of the Capitol a similar pattern appeared as Senator Brien McMahon castigated the attempts of the House to limit funds for research, an action he described as an uninformed, unconsidered, reckless exercise of power.[16] The debate in both Houses was languid, for the Commission was but one of five agencies covered in the bill, and the others—among them the Veterans Administration—were far more attractive for Congressional oratory.

Had the attack been serious, Lilienthal could have looked to the Joint

Committee for support with some hope of success. The amount of authority which that committee possessed was unusual among Congressional organizations. Unlike most committees, it was established by statute and had the right to consider all atomic energy matters introduced in either House, and to undertake continuing studies of Commission activities and atomic energy problems. This mandate gave the members a greater sense of cohesiveness than ordinarily prevailed in Congressional committees.[17]

Under Hickenlooper's leadership, the Joint Committee stressed security. By the end of 1947 the committee staff numbered fourteen people working under the immediate direction of two former intelligence officers, Fred Rhodes, Jr., and David S. Teeple. The committee's first report to Congress, issued on January 30, 1948, reflected this preoccupation. Adequacy of plant protection, efficiency of the guard force, and means of visitor and document control were significant, but the committee felt it must watch closely the type of person engaged in the atomic program. "It is the opinion of the committee that the matter of security of personnel is of extreme importance in the over-all problem of the protection of the vital aspects of this program." [18]

Others felt the same way. The House Un-American Activities Committee under J. Parnell Thomas had found headlines in its search for Communists in Hollywood. Rumors that Thomas might again seek to dig into the past of some of the people working in atomic energy alarmed Hickenlooper. To find out how vulnerable the Commission would be to such an attack, he called a special meeting of the Joint Committee on November 28, 1947. What the committee learned was not reassuring. Gingrich explained that investigation of Manhattan project employees who had remained with the Commission had uncovered some doubtful cases. In some instances the decisions to issue clearances were hard to defend; in others the procedures had been so cumbersome that no determination had yet been made. Wilson, however, had something positive to offer. The Commission planned to establish a temporary personnel security review board which would examine some of the doubtful cases and provide advice and precedents which could be used to develop uniform procedures and standards.[19]

The work of the board would not be easy. Somehow personnel security standards had to be devised to allow for the frailties of those who judged and those who, with their future and families, lay in the balance. Formal Commission approval of the five-man board on December 4, 1947, Waymack warned the staff, did not mean that the Commission was abdicating its responsibilities. Much to Lilienthal's delight, he was able to persuade Owen J. Roberts, former associate justice of the Supreme Court, to accept the chairmanship. The group was given considerable freedom to establish its own internal procedures, conduct hearings at its discretion, and initiate what inquiries it deemed necessary; it was also to have access to Commission personnel and records.[20]

The House Un-American Activities Committee justified the Joint Committee's concern on March 1, 1948. In the afternoon the Thomas committee released to the press a report that Edward U. Condon, director of the National Bureau of Standards, appeared to be "one of the weakest links of our atomic security." A physicist, Condon had engaged in weapons work at Los Alamos during the war; later his position had brought him into social contact with officials of communist countries. Furthermore, he had been the target of earlier attention of the House group.[21]

To the Joint Committee the Thomas charges cut close. Not only was the Bureau of Standards described as one of the nation's major defense research institutions, but throughout the report the ties between Condon and atomic energy were proclaimed. Not omitted was the fact that Condon had served as consultant to the Special Committee on Atomic Energy which had drafted the Atomic Energy Act. The implication of the Thomas report was clear. On security and atomic energy the House Un-American Activities Committee had set itself up as a higher authority than the Joint Committee on Atomic Energy. Even more was at stake. The Un-American Activities Committee had asked Secretary of Commerce W. Averell Harriman for the complete text of a normally confidential report on Condon from the FBI. In the name of security and loyalty Thomas and his committee were challenging Truman and the whole Executive Branch.

Hickenlooper reacted cautiously. The day after the committee release, he announced to the press that the Joint Committee had no plans to ask Condon to testify, although that situation might change if the House committee documented its charges. That afternoon Hickenlooper had scheduled a meeting with the Commission to examine the Oak Ridge labor situation. He used the occasion to raise the issue of the Condon case. Wilson explained that the Bureau of Standards was performing certain routine analytical work for the Commission and that Condon as bureau director had a clearance. By no stretch of the imagination, however, could Condon be considered in the center of the atomic energy program. Volpe set forth the administrative complexities of the case. As director of the bureau, Condon had been appointed by the President and confirmed by the Senate; he reported to the Secretary of Commerce. For the time being the Commission was waiting for the outcome of an investigative board appointed by Harriman.

The findings of the Harriman board, whatever they might be, were in the Joint Committee's opinion no answer to the immediate question: Did Thomas have new information on Condon which he was about to exploit? Until this point was established, the Joint Committee had no intention of following Thomas's lead. As Congressman Holifield remarked, "Unless the thing is clarified and the man given an opportunity to protect his name, this Committee should not lend itself to further condemnation." In Senator Edwin C. Johnson's opinion, the Condon case appeared to be a good one to send to the Roberts panel. Wilson accepted the idea, adding that a meeting between the panel and the Joint Committee might prove helpful to all.[22]

Before the panel met with the Joint Committee, Truman took steps to meet the Congressional challenge. On March 13, 1948, he issued an executive order that no one in the Executive Branch, save from his office, was to release personnel records. While this blocked Thomas, it also broke off Joint Committee access to the personnel files of the Commission's employees. The committee heard on April 1 Roberts's report on the panel's goals and methods, but the real interest lay in the executive order. Pike related that the Commission had opposed its inclusion in the directive, "feeling that the relationship between the Committee and the Commission is unusual and unique. . . . We got a bloody nose trying to get this exception." [23]

Truman's refusal to exempt the Joint Committee from his executive order was placing heavy strain on the prized special relationship. On April 8 Lilienthal and Adrian S. Fisher, the Commission's new general counsel, met with Attorney General Tom C. Clark and hammered out the basics of a procedure which would make personnel records, including FBI reports, available to the Joint Committee on terms acceptable to the Department of Justice. That afternoon Lilienthal checked with Clark M. Clifford in the White House to obtain Truman's consent. The timing was fortunate. Shortly before, Hickenlooper had telephoned Truman and had asked for a modification of the directive. The President had refused. Now, however, the Attorney General was with Truman and explained the arrangements reached during the morning. To Lilienthal's relief, Truman accepted the procedures and the special relationship remained intact. As Lilienthal confided to his journal, it had been a close call to a bad row.[24]

REAPPOINTMENT—A QUESTION OF STRATEGY

Toward the middle of March, 1948, Lilienthal was weary and looking toward the time he could exchange the raw humidity of Washington for the warmth of Florida. Others too, were tired. Waymack found the heavy burden of work sapping his health and Bacher wanted to return to physics. To both Lilienthal had pointed out the inferences which would be drawn if two of the five Commissioners resigned during an election year.[25] Moreover, Lilienthal was loath to lose them, although he could sympathize with their desires. With a robust sense of the comic, Waymack had often used humor to ease the tensions of Commission business. Bacher's vacancy would be particularly difficult to fill. By his skill in unraveling tortuous technical and scientific problems he had won the respect and confidence of his colleagues and of officials in other parts of the Government who dealt with the Commission.

Personal interests were not the only source of thoughts about departure. Under the provisions of the Act, the terms of the Commissioners expired on August 1, 1948. From that date was to begin a system of staggered five-year terms, arranged so that each year only one Commissioner need be replaced. To put the system in operation, the terms beginning on August 1 each had to be of different duration, descending in annual decrements from a maximum of five years to a minimum of one year. Bacher and Waymack, if they could not resign on August 1, at least wanted the shorter terms.

Lilienthal with his political instinct knew that reappointment held all the seeds of a struggle as bitter as that waged over confirmation. Even before Waymack and Bacher had talked to him, Lilienthal urged on Clifford the need to plan the strategy of reappointment—if indeed Truman intended to renominate the Commissioners. Lilienthal had no reason to think that Truman would not. The realities of politics made it unlikely that the President would propose to change the membership, an action liable to the interpretation that the Commission was a failure.

The four Commissioners—Bacher was in the West—filed into the President's office on March 19. Truman told them that all had done a fine job and all should be reappointed. In fact it would look bad if they did not continue. Although he would like to send their names to the Senate as soon as possible, the political opposition he faced was so strong that confirmation seemed doubtful. However, he had a plan. He could submit their names after Congress had adjourned, which it was certain to do during the summer so as to leave the fall free for campaigning. Of course, the Commissioners would be serving under interim appointments, but at least the maneuver would carry them past the campaign season. When the new Congress assembled, confirmation hearings could be held.

Lilienthal persuasively presented another course. Submitting the nominations as early as possible would give the Senate a chance to deliberate and would preserve the original nonpolitical spirit of the appointments. Attempts to block confirmation would leave the opposition open to the charge of injecting politics into the nation's atomic energy program. Interim appointments, on the other hand, would only postpone the battle and create uncertainty in the Commission's operations. Truman was noncommittal, but the idea seemed to have had appeal. Recognizing that he might be the storm center, Lilienthal proposed that he take the one-year term. The struggle might not be so difficult if the opposition knew that in a year it could focus on him alone as it had during the 1947 confirmation hearings. Lilienthal was pleased that Truman rather casually brushed the suggestion aside.

A few days later Lilienthal left for his vacation, knowing that all the names of the Commissioners would be submitted for reappointment. Waymack had made it clear to Truman that he and Bacher would serve longer, but neither felt a moral obligation to remain much beyond reconfirmation. When the President would send the names to the Senate Lilienthal did not know. Away from Washington he found his thoughts returning to the idea of a one-year term for himself. Within the Commission he saw signs of a growing competence which, he felt, would enable him to leave at the end of the term without compunction.[26]

Senator Hickenlooper would have disagreed with Lilienthal's optimistic appraisal. Over lunch with Secretary of Defense James V. Forrestal on February 24, 1948, the Joint Committee chairman spoke freely. He distrusted the philosophy in the Lilienthal speeches. Beneath the promises of atomic power for industry, under the appeal for public understanding of the atom, Hickenlooper found intimations of a Lilienthal who felt himself indispensable and who was promoting a philosophy of statism. Except for Strauss, Hickenlooper was not impressed with the practical abilities of the Commissioners; however, he thought Bacher a good scientist.[27]

Hickenlooper faced a political situation growing daily more complex. As a Republican, he had hopes for his party's victory in the coming Presidential election and an end to the long sojourn in the desert of political opposition. Along with others, he watched Thomas E. Dewey, Harold E. Stassen, and Robert A. Taft battle in the primaries for the party's nomination.

He also speculated on the possibilities that his Senate colleague on the Joint Committee, Arthur H. Vandenberg, might emerge as the party choice. On atomic energy matters there was a wide difference between Taft and Vandenberg. Few people knew better than Hickenlooper the damage that the delay in confirmation had done to the nation's atomic energy program. It was obvious to him that if Truman renominated the Lilienthal Commission there was every likelihood that the drama of 1947 would be replayed, but with even more bitterness because of the intense emotion of an election year. However, it was possible to reduce the hazard. If Truman did not renominate Lilienthal, the forces of controversy might never gather.

THE PRESIDENT ACTS

Hickenlooper was astonished to read on the morning of April 19, 1948, that, according to the New York *Herald Tribune*, nominations for the Commission would soon go to the Senate. If the story were accurate, Lilienthal had wanted the one-year term, but had been overruled by the other Commissioners. Shortly after Hickenlooper finished the newspaper account he read a broadtape reporting that the nominations would be sent to the Senate that week. No mention was made of terms.

Hickenlooper acted fast. He called the White House at nine o'clock for an appointment. Two hours later he finally reached Matthew J. Connally, Truman's appointment secretary. Connally replied that because of the crowded calendar Hickenlooper could not see Truman that day. Hickenlooper had no choice but to accept an appointment for the next day. Even that might be too late. In the afternoon an uncompromising Taft left a session of the Republican Policy Committee, remarking to reporters, "There is a growing feeling among Republican senators that no one nominated should be confirmed regardless of the job." [28]

With all the signs of a first-class fight in the offing, Hickenlooper turned to Forrestal. Over the telephone Hickenlooper explained the situation —the surprise that the nominations had been sent up so early, the lack of any notice. What was Truman trying to do? Was he trying to "push us around"? That seemed to be the reaction of some Senators, a group from which Hickenlooper carefully disassociated himself. His own desire was to see the atomic energy program continue with a minimum of friction. A few minutes' conversation with Truman to explain the Senate feeling might be helpful. But in the light of the White House action, was it any use for Hickenlooper to see Truman? Forrestal urged Hickenlooper to keep the appointment, and on this note the conversation ended. As Hickenlooper could have expected with reasonable certainty, Forrestal sent a brief note and a transcript of the telephone conversation to Truman.[29]

Events of the next day could not have encouraged Hickenlooper. At ten-thirty in the morning Charles G. Ross, Truman's press secretary, announced to the reporters the nominations of the Commissioners. Lilienthal was proposed for five years, Pike for four, Strauss for three, Waymack for two, and Bacher for one. An hour later, Eben Ayers, Ross's assistant, told the reporters that the names would not yet go up to the Senate. In another fifteen minutes a stenographer added the name of Senator Hickenlooper to the list of visitors expected that day at the White House. Linking the delay in sending the names to the Senate to the Hickenlooper visit was an easy deduction for the press corps.

That afternoon at three-fifteen Hickenlooper saw Truman. The Joint Committee chairman proposed that Truman lessen the chances of controversy by nominating Lilienthal for the one-year term. Truman was cordial but avoided a commitment. After a quarter hour Hickenlooper left. On his way out he told reporters that he had talked atomic energy matters with the President, and he admitted that he had requested the visit. His car had barely left the White House grounds when Ayers reentered the press room and redistributed the morning's announcement, remarking that the nominations would reach the Senate in about five minutes.

Hickenlooper had just returned to the Senate chamber when the presiding officer announced that nominations for the Commission had been received. The Presidential brusqueness irritated the Senator. Truman later told Forrestal that his conversation with Hickenlooper had been pleasant enough but he saw in it an attempt by a Republican Congress to prevent the President from exercising his functions as chief executive.[30]

BATTLE AVOIDED

Hickenlooper and Lilienthal talked about reappointment on April 21, when Lilienthal went to the Senator's office to report on the *Sandstone* weapon test.

With a quiet sincerity which Lilienthal found impressive, Hickenlooper explained how events of the last few days had left him little room to maneuver. His soundings of senatorial opinion led him to believe that a one-year term for Lilienthal offered the only means for averting a clash. For his part, Lilienthal recognized the dangers of a struggle and the merits of the argument that the chairman of so important an organization as the Commission should offer to resign at the end of an administration. However, he pointed out, Truman had left him no choice.[31]

Taft, now waging a primary campaign in Ohio, left no doubt where he stood. In a radio interview in Cleveland on April 23, the Senator stated bluntly that he and several of his colleagues objected to Lilienthal as chairman. Candidly Taft admitted the influence of an election year: "I'm inclined to think the Senate will look very critically at any nomination for terms that run beyond the present Presidential tenure." How much, however, did Taft speak for himself and how much for the Republican Party? Waymack asked the question. He himself was a registered Republican; Strauss proudly identified himself with the Hoover philosophy; Pike leaned toward the views of Stassen or Wendell L. Wilkie; Bacher, whose career in science had left him little time for politics, had voted Republican; while Lilienthal called himself an independent. Moreover, Waymack observed shrewdly, Dewey, Stassen, and Vandenberg were not excited over reappointment.[32]

Battle lines were not yet completely drawn. Taft intimated to the press that Lilienthal would be acceptable for the one-year term. From Vandenberg, Lilienthal learned that Hickenlooper was working on a compromise in which the terms of all the Commissioners would be extended by one year. Lilienthal was not impressed: the one-year extension he saw as holding no advantage over interim appointments. Neither would give the Commission operations that certainty which would follow from putting into effect the provisions of the law without evasion or postponement. With this analysis Vandenberg disagreed, possibly favoring the compromise because it required positive Congressional action in the fairly near future. Whatever his reasoning, he turned to the subject of Hickenlooper. The Joint Committee chairman, warned Vandenberg, was dubious of the abilities of the Commissioners and was still smarting under Truman's discourtesy. Without going into the merits of these matters, Vandenberg made it clear that if a fight developed, he would support Hickenlooper.[33]

Lilienthal had suggested to Vandenberg that Hickenlooper's doubts about Commission competence could best be answered by consulting with the various advisory committees. Perhaps as a result of the idea, Hickenlooper unfolded his compromise to Karl T. Compton, Vannevar Bush, Oppenheimer, Isidor I. Rabi, and Lee A. DuBridge at an executive session on April 28. They favored the Presidential course, but Hickenlooper warned of the political dangers. His plan, developed further since Lilienthal had seen Vandenberg, called for an extension of the terms of the entire Commission to June 30, 1950. With this two-year extension Hickenlooper thought he could avoid a struggle. Reluctantly the scientists agreed. For the record they drafted letters, and checked them with Truman, who proved understanding. "A week of idiocy," grumbled Oppenheimer.[34]

Truman put his case before the public at his press conference on April 29. Reading slowly from his prepared statement, he declared that a year and a half had passed since the Commissioners had assumed direction of the atomic energy program. He had sent the nominations to the Senate as the law required. There were no political motives behind the timing; all that he was doing was giving the Senate a chance to deliberate. As for the choice of terms, that matter had been decided by the Commissioners themselves.[35]

The reference to the Commissioners choosing their own terms intrigued Hickenlooper, and perhaps gave him hope that the selection of Lilienthal for the five-year term was not unalterable. The day after the press conference he called Waymack. Warily the two Iowans fenced with each other. Finally Waymack admitted that the President's statement was not inaccurate. The terms assigned to Lilienthal and Pike, the Senator remarked, were receiving the most adverse comment. Once criticism began there was no telling where it would stop; perhaps the civilian-military control issue would break open again. Hickenlooper suggested that the two-year extension was really a vote of confidence. When Waymack could not follow this interpretation, Hickenlooper thought that a commendatory statement by the Joint Committee would reassure those who doubted. At any event, he did not see how Truman could veto the extension.[36]

That afternoon the bill was introduced into the House and Senate. In mid-May the Joint Committee reported the bill. The majority argued that the original intent of the McMahon Act was to provide a two-year trial period for the first Commission before putting into effect the system of staggered terms. Because of the delays in confirming the first Commission, the trial period had been seriously abridged. All that the compromise was trying to do was to restore this period. The minority—McMahon, Connally, Lyndon B. Johnson, Carl T. Durham, and Holifield—accused the majority of politics. To buttress their charge, they cited Taft's campaign remarks. For evidence of achievements they pointed to the recently concluded weapon tests.

The extension bill reached the floor of both houses only two days before adjournment. There were no new arguments. The most significant fact was that Vandenberg announced his approval of the Hickenlooper compromise as the best way to avoid controversy. McMahon argued that evasion of debate was a poor reason to confirm the Commissioners. If there were cause why any of the Commissioners should not be reappointed, the possibility of a fight and the near adjournment of Congress were hardly good excuses. In the orotund manner he loved so well, McMahon declaimed, "God in his heaven did not ordain that this Congress should end tonight. That determination comes from the majority leadership." The bill passed the Senate on June 19, the last day of the Congressional session.

Truman was left with two choices: sign the measure, or veto it and name the Commissioners to interim appointments. What Truman would do Lilienthal did not know, although he hoped the President would yield. To Lilienthal's relief, Truman signed the bill on July 3, 1948.[37]

Truman really had no alternative. To veto the bill would have gained him little. As a political device, interim appointments could hurdle over the campaign season, but the Hickenlooper compromise accomplished the same purpose and for a longer period. In the scrambling and maneuvering of an election year, Hickenlooper had neatly removed the fuse from an explosive issue. He had not achieved this result alone; he had been favored by gaining Vandenberg's support. If atomic energy were to become a campaign issue, it was less likely to be charged with the emotional tensions that seemed to cling to Lilienthal. In this instance, averting conflict was victory. The Senator's effort did not mean that he found the Lilienthal Commission any more acceptable. His doubts and reservations remained.

DECENTRALIZING SECURITY

Responsibility for plant protection, missing documents, classification, and personnel security Admiral John E. Gingrich assumed as director of security and intelligence in August, 1947. He found his task one of appalling magnitude. He discovered there were no maps of security boundaries of Commission installations or of the location of facilities to protect against sabotage, fire, and other hazards. He had to develop procedures for security inspections, and to plan with the military the defense of vital plants. Above all, he had to build up an effective staff. A skilled seaman, Gingrich compared his assignment to that of a captain conning a ship on a tight course while the engines were being replaced, the crew changed, and new officers assigned.[38]

His greatest headache was personnel security. Requests for clearances poured into headquarters from the field. Gingrich's division did the necessary processing and sent the cases to the FBI for a background investigation. After a lapse of weeks, the FBI submitted the information it had developed. Gingrich's staff evaluated the data. In most cases, clearance was routine. However, occasionally the investigation turned up character traits or habits which, while not involving security, cast doubt on whether the individual would be a satisfactory employee. In these instances, called "invite" cases, the contractor was invited to view the information and decide whether to hire the person. Another category was the "hold" case, involving security doubts. The term stemmed from the procedures under which the staff held the case for

Gingrich's decision and, if he were uncertain, for Wilson and the Commissioners.

Requests for clearances were coming in faster than they could be handled. Looking over the statistics in November, 1947, Gingrich found he had over 6,000 requests for investigations in the hands of the FBI, and almost 7,000 completed investigations awaiting review by his staff. And more requests were flooding in. Somehow he had to step up the clearance process. One way to keep headquarters from being swamped was to give the field offices authority to analyze the data from the background investigations and to issue clearances where there were no doubts. Uncertain cases could be returned to headquarters. But if such a system were to work, the field offices would need help on recognizing the signs of security risk. Counting on the Roberts board to help, Gingrich and his men formulated criteria. If all went well, Gingrich planned that by July, 1948, they would have sound criteria and procedures. Then would come painstaking instructions so that the field offices could assume their responsibility.

To Wilson this was not fast enough. Looking at the increasing costs of administration as 1948 began, he saw possible savings if decentralization of security could be speeded up. Gingrich hastened his efforts. Instructions went out to the field on March 30. A final conference with the field security officers on April 8 and 9 checked the new system, which went into effect on April 15. The criteria for determining a security risk were far from perfect, but even here Gingrich had made a beginning.[39]

The new system applied only to those seeking jobs. Reinvestigations of personnel from the Manhattan project fell into a different category. These individuals already had access to Restricted Data and some had skills which would be difficult to replace. New procedures issued on April 15 gave the employee the right to appear before an appeal board. The use of a board in such instances was not original. The Army, Navy, and other defense agencies had boards of appeal, although regulations governing them were not standard. Under the Commission's procedures, the field manager was authorized to establish a three-man board to hear a case. Membership was not confined to Commission or contractor employees, but only to persons with a clearance. This provision allowed the selection of board members with the same speciality as the individual in question. By the end of April experience was showing that character and associations were most often the subjects involved at the local hearings.[40]

The members of the Roberts board studied the experiences to which Wilson referred. They examined cases, spent two days in Oak Ridge to gain field perspective, and heard more than once from Gingrich and his staff. The Roberts group recommended on June 7, 1948, withholding a decision on Condon until it was certain that the House Un-American Activities Committee had no new information to exploit. The Commission, assured that Thomas was raking over old coals, agreed that Condon should retain his clearance.

The action was perhaps somewhat more rapid than Roberts thought wise, but he made no strong objection when Lilienthal telephoned him before issuing a public statement.[41]

In late June, 1948, Roberts reviewed draft criteria for determining eligibility for clearances. He found the definition for loyalty satisfactory, but not the definitions covering character and associations. These were important, for character traits such as carelessness or personality difficulties could lead to security risks. As for associations, the terms were surely broad enough to include husband and wife. An applicant denied employment, Roberts was inclined to think, should have no right to appeal. After all, private industry did not tell a person why he was not hired, and there was no reason for the Commission to do differently. Yet Roberts recognized that denial of a job with the Commission did imply a slur on loyalty. As a solution, the board suggested consolidating applications and security forms into one document which would have in bold print a statement that aptitude, training, past experience, and employment history, as well as character, associations, and loyalty would be considered.[42]

The Roberts board, its task nearly completed, had proved helpful, and the earlier moves investing field managers with limited authority to grant clearances were working well. But the administrative burden was still heavy. As the Commission rebuilt old installations and constructed new ones, the need for emergency clearances increased. By June 1, 1948, Gingrich had personally signed more than 1,500 emergency clearances. On July 22, the Commission found even further decentralization necessary. If an individual were essential, if there were insufficient time for a complete FBI investigation, and if preliminary checks revealed no derogatory information, the manager could issue an emergency clearance.[43]

Since January, 1948, the Commission had done much to decentralize administration. Was security weakened? That question worried Gingrich. It also bothered Hickenlooper.[44]

CONSTRUCTING FINANCIAL CONTROLS

Decentralization of security was only one aspect of the Lilienthal-Wilson approach of meeting difficulties by granting authority to the field offices. If these offices were to fulfill their role, Washington headquarters had to have information to make sound policy decisions. Construction of a system of financial controls was a major means of providing the necessary data.

After a long and careful search, Wilson selected Paul M. Green as controller. At the time of his appointment on April 17, 1947, Green was virtually unknown to any of the Commissioners or the staff. However, his name ranked high on the list of candidates proposed by an advisory committee. His credentials were good. From an academic background at the University of Illinois, he had moved into the Office of Price Administration during World War II. Impressive to Wilson was the high praise Green had won from those in industry who had dealt with him.[45] He had been about to return to his university when Wilson offered him the controllership. Green found the offer attractive. As one who saw accounting as a strong instrument for creative management, he had been appalled at the inefficiency and rigidity of traditional Government accounting procedures. He saw the Commission as a new and important agency which by example might serve the cause of reform of accounting and auditing practices in the Government. The new controller studied the financial records and contracts from the Manhattan project. He did not like what he saw.

In the press of war there had been little uniformity of contracts or consistency in defining fees or overhead costs. Moreover, the system of paying contractors was cumbersome. Contractors met from their own funds the cost
of work performed for the Commission, a practice which often led to haggling over minor and vaguely defined items. Reimbursement followed a check of vouchers, once in the field, once in the Commission offices, and once again in the General Accounting Office. Above all, the system did not provide data for efficient management.

The new controller warned that the Commission was vulnerable as long as it did not have a sound policy for reimbursing the contractor. Lilienthal's reaction to Green's ideas seemed disappointingly cool. Uncertain that his message had been understood, Green wrote to Wilson, "I predict that the cost policy will not only be attacked directly but will be used as a point against which to launch attacks that are designed to break the fundamental activities of the Commission." It was time to raise defenses. Impressed, Wilson scheduled another session with the Commissioners. Warned that he had only an hour in a crowded agenda, Green rehearsed carefully. At the meeting he finished his presentation to the minute, and looked up to face a grinning and converted Lilienthal.[46]

Accounting under the Manhattan District had been centered at Oak Ridge, but as soon as he could, Green moved the central office to Washington and increased the responsibilities of the other field offices. Not until October, 1947, was his office sufficiently staffed so that he could turn with some confidence to revising the accounting practices used in the Manhattan project. His first assignment to his staff was to prepare a comprehensive analysis of the obligations and expenditures from July 1, 1946, to November 30, 1947. From these data would come the information needed to give an intelligent review of the Commission's budget and to provide a basis for a sound accounting system.[47]

Green's goal was to establish industrial accounting and auditing procedures in place of the Government practices encrusted with tradition and custom. Each major contractor would be required to maintain a distinct set of accounts on the work performed for the Commission. No longer would the contractor spend his own funds and apply for reimbursement. From financial reports submitted monthly the Commission would advance funds to the contractor. From monthly financial reports the Commission would at last be able to learn the amount invested in the atomic energy program, the cost of operations, and the composition of its assets. Eventually the term "integrated contractor" would come to describe the close bookkeeping relations between the Commission and its contractors.[48]

Lindsay C. Warren, Comptroller General of the United States, approved the Commission system of advancing funds to contractors on June 15, 1948. His action was an important step in providing the basis for financial management. Green himself recognized that certain factors had favored him. The Commission's endeavor to break away from old Government practices, with their emphasis on cash disbursements and obligations, came at a time when the Hoover commission on organization of the Executive Branch was calling for reform. The Joint Committee had listened to Green sympathetically. In this favorable climate Green and his staff had built well.[49]

REORGANIZATION

Wigglesworth was not the only one to question the Commission's organization. Although less outspoken, men with decades of management experience looked with skepticism at the administrative structure Lilienthal and Wilson had created. Robert M. Underhill, business manager of the University of California, began to doubt in September, 1947, whether the Commission and the general manager could effectively delegate contract authority to the field managers. The actual effect of decentralization, he feared, was that headquarters would still have the ultimate responsibility for decisions but would not have the understanding with which to act wisely.

Donald F. Carpenter, vice-president of the Remington Arms Company, shared the same concern. Carpenter's doubts were raised when, as a member of the Commission's industrial advisory group, he visited the field offices and the laboratories. Although the purpose of the group was to see how participation in atomic energy by industry could be increased, the Commission had also asked for comments on its organization. Carpenter was more interested in this aspect of the Commission than he was in its relations with industry. His main criticism was the concentration of authority in the general manager. In Carpenter's view an intolerable number of individuals overburdened Wilson with so many details that he could not give time to serious matters. Perhaps the program council alleviated some of the pressure, but Carpenter doubted it. In his opinion, the most effective way of freeing Wilson was to interpose between the general manager and the staff a layer of administrators with carefully defined authority. Carpenter thought the division directors could fill these key positions. Transferring the program directors from a "staff" to a "line" position and giving them the responsibility to coordinate and supervise the field offices was a major part of his plan. Authorizing the assistant general manager to handle routine administration would also improve management.

Carpenter's recommendations were part of a preliminary report to the Commission in early June. Wilson and the staff concentrated their criticism on Carpenter's ideas. In the margin of one copy Wilson saw six bold question marks, the scrawl "no understanding of the Program Council," and opposite the suggestion that field managers report to a division director, the word "impossible." The spirit of the two-hour session with the Commissioners on the afternoon of June 3, 1948, was consequently somewhat cool.[50]

The General Advisory Committee meeting in Washington the next day thoughtfully studied the proposals. In most instances the committee members had had more experience in the management of atomic energy than had the Commissioners and Wilson. Moreover, with the terms of Rabi, Hood Worthington, and Cyril S. Smith about to expire, the original advisory committee was coming to an end. Under the circumstances it was natural for the members to review their experiences with the Commission. The fact that the Commission was about to reorganize reactor development—an area of great interest to the committee—was another cause for considering the Commission's structure. In his references to reorganization, Wilson had said nothing about rearranging staff and line functions: key points in Carpenter's proposals. Setting up a new division, not in itself a bad idea, did not reach the heart of the matter.

James B. Conant, DuBridge, and Hartley Rowe, at the request of Oppenheimer left the meeting to draw up a statement on the Commission's organization. They labored well, and while they had captured the spirit of the committee, the tone of the comments was undeniably sharp. Eventually the committee decided that in a session with the Commission, Oppenheimer could act as spokesman and pave the way with a few introductory remarks.

At four-thirty on June 5, Oppenheimer and the committee entered Lilienthal's office. All unsuspecting, Lilienthal, Waymack, Bacher, and Strauss waited. Oppenheimer minced no words. He declared that the General Advisory Committee from the beginning had approached its job with high spirits and hopes of contributing to a unique public enterprise. This enthusiasm had grown dim as the Commission failed to attack with imagination the difficulties of security, laboratory administration, and reactor development. Awareness of the Commission's shortcomings was not confined to the committee. Oppenheimer warned that the entire scientific community was losing confidence.

From this introduction, Oppenheimer turned to the statement. Although it was informal, the Commission must make no mistake: The statement accurately reflected the opinion of the entire committee. The burden of the argument was that the Commission was unable to make good use of the advice offered it. For this condition the committee blamed the Commission's organization. The decision to decentralize they branded as wrong and proposed an organization—very similar to the Carpenter plan—calling for five key positions. Four of these would be the directors of research, weapons, reactors, and production. The fifth would be an over-all administrative officer. The committee recommended that the directors assume line responsibility and direct the activities of the field offices. The proposed pattern was similar to the relations existing between McCormack and Tyler in weapons, the one area in which the Commission had achieved any measure of success. Oppenheimer read the final devastating conclusion: "We are afraid we can be of little use to the Commission under the present organization. We despair of progress in the reactor program and see further difficulty even in the areas of weapons and production unless a reorganization takes place." [51]

Lilienthal was dismayed. Of course there had been failures, but the Commission organization was not the cause. Perhaps the committee did not realize that several enterprises operated successfully in this pattern.

Shrewdly, Oppenheimer suspected that Lilienthal's reaction might be defensive. On June 18 Oppenheimer wrote Lilienthal that the criticism was no light and casual matter. The committee members were as unanimous on the shortcomings of the Commission as nine people could ever be on a single subject. If the committee, composed of individuals familiar with the Commission's problems and sympathetic with the Commission's goals, was so discontented, Lilienthal must realize that in industry and in the scientific community, disenchantment was even greater. Nor should Lilienthal discount the views on the grounds that the committee's role was primarily to offer technical advice. Most of the members in the pre-Commission days had administered atomic energy activities and faced similar problems. The committee had hoped the Commission would manage the atomic energy program so as to combine responsibility with candor, guidance with a minimum of control. The committee had hoped to find a willingness on the part of the Commission to correct its errors, to admit them publicly, to give leadership in questions of secrecy and security, and to furnish a unity of purpose and understanding on the various aspects of atomic energy. It was not wrong to hope for these things, Oppenheimer continued, nor was it wrong to continue to hope for them. However, unless the Commission moved to fulfill these expectations it would be hard in the future to argue the need for the Commission. On June 25, Oppenheimer telephoned Lilienthal from the West Coast. Confessing regret for the anguish the committee had caused, Oppenheimer admitted that perhaps it was unfair not to have referred to the difficult environment in which the Commission lived. Although he tried to soothe the hurt feelings, he withdrew nothing from the catalogue of deficiencies.

The Lilienthal-Wilson approach was a failing. That was the verdict of

Carpenter, familiar with large corporations, and of Oppenheimer and the General Advisory Committee. From his vantage point as Secretary of Defense, Forrestal was thinking of more drastic changes: Perhaps Herbert Hoover's commission on organization of the Executive Branch should look into the Commission; perhaps one Commissioner should be a military man.[52]

Within the Commission, discussion of reorganization took on a new sense of urgency. Wilson talked individually with the Commissioners, to explain the proposed reassignment of functions and his progress in recruiting for the new positions. He also met with Carpenter, now chairman of the Military Liaison Committee. With Fisk, Wilson found he had some friendly philosophic differences, and together the two men flew to Maine to discuss organization with Oliver E. Buckley, once of the industrial advisory group, now a member of the General Advisory Committee. At Los Alamos, John H. Manley, executive secretary of the advisory committee, was curious to learn of the outcome of the meeting with Buckley. He had heard what he hoped was an incorrect rumor that Wilson had resigned. On July 29, 1948, Wilson and Lilienthal spent over three hours with Hickenlooper, Rhodes, and Teeple, to explain what the changes would be. Lilienthal believed Hickenlooper understood and approved the reorganization, except for changes in security, which would decentralize some of the authority in that area, and for the salary of the new position of deputy general manager. A few days later Hickenlooper repeated his main concern to Carpenter: Decentralization might weaken security.[53]

On August 5, 1948, Wilson issued a statement for the managers of operations and the principal Washington staff. Although many of the details of the reorganization were not settled, he was able to block out the major changes. Executive responsibility for production was now assigned to Williams; for research, to Fisk, who was about to leave for Harvard; for reactor development, to a new director; and for military application, to McCormack. Under Williams's purview would come all production, from raw materials to fissionable material, which would include Gustafson's division of raw materials and the managers of the New York, Hanford, and Oak Ridge offices. The director of reactor development would have authority over Argonne and Schenectady. Stripped of reactor work, the division of research would focus on the physical sciences and biology and medicine. The director of military application would obviously be responsible for Sandia and Los Alamos. In addition to the four divisions which then possessed line authority, there were five with staff functions—security, personnel, information, finance, and general counsel. Under the new plan, budgeting, accounting, and auditing would all be part of the finance division.[54]

The more complicated structure also reflected the growth of personnel at headquarters. Wilson had hoped that the small size of the headquarters building on Constitution Avenue would keep the Washington staff small.

However, from a total of 361 in August, 1947, the number a year later came to 699, many of whom were housed in a temporary building several blocks from the Washington headquarters on Constitution Avenue.

Wilson chose Shugg for the position of deputy general manager. From the first interview with Shugg to offer him the job of manager of Hanford operations, Wilson had been impressed and nothing in the succeeding months had changed the initial opinion. For his part, Shugg felt that he had always been given backing by Wilson. When Wilson first telephoned the offer, Shugg hesitated. Washington atmosphere might call for tact, diplomacy, and patience—qualities he obviously and somewhat proudly lacked. On the other hand, he felt his staff was now at a stage where he could leave. In David F. Shaw, his second in command, he had a man who could assume the duties at Hanford, although, as Shugg suspected, Washington would think him too young and bring in someone else. Then too, flood waters of the Columbia River had recently swept away his home and he was living in temporary quarters. Adding it all up, Washington did not look too bad.

AN OCCASION FOR COURAGE

Organization was only one subject which the General Advisory Committee criticized at the meeting. Equally caustic were its views on the Commission handling of secrecy and scientific research. Glenn T. Seaborg returned to the chronic problem at the June 6, 1948, session. He saw security as putting a strain on the ties between the Commission and the scientific community. The chorus of agreements Oppenheimer with his usual skill blended into a summary. There were many roots to the trouble: obscure policy, uninformed public opinion, poor provisions of the Act, timid or unimaginative security personnel, and unsound relations with Congress. What was needed, Oppenheimer thought, was a new approach, one which would not get bogged down in routine investigations, but focus upon individuals who could be dangerous. Furthermore, a true security system would hardly bend to Congressional judgment on individual cases. Enrico Fermi declared that security had become a ridiculous fetish. He suspected that a statistical analysis of the employees who had been discharged, denied clearances, or suspended on security grounds would reveal the inadequacy of the present system. Oppenheimer delivered the fundamental criticism. There should exist, he remarked, enough courage to take a reasonable risk in favor of an individual.[55]

The need for courage Lilienthal recognized, and not long after the General Advisory Committee adjourned, he discovered an occasion for boldness. An applicant for a grant in the fellowship program, designed to provide advanced training in the biomedical and physical sciences, had a record of membership in the Communist Party. Lilienthal saw an opportunity to dramatize the issues of personnel security. The Commission itself provided the funds for the fellowships. The National Research Council performed its familiar role in selecting the fellows. They were not employees of the Commission; their areas of research were not secret; they had no access to Restricted Data, and hence were not subject to FBI investigation. True enough, there was the hope that those who received training would be interested in jobs in atomic energy, but the fellowships were intended to increase the numbers of technically proficient personnel in the nation, not simply to train future employees. Lilienthal saw the question broadly: So long as Restricted Data were not involved, should a qualified person be denied Government assistance in education on the basis of political belief?

Lilienthal placed the question before Pike, Bacher, and Waymack on June 17, 1948. They agreed that the Commission should grant the fellowship. Lilienthal knew that the gesture would be dangerous and provocative unless the Commission made clear the reason for its stand. Otherwise the battle would take place in the shadows of innuendoes and half-truths. Perhaps the first move in setting the stage was to have the research council raise officially with the Commission whether clearances for fellows were required. Lilienthal was heartened to see that Wilson, Fisk, and Williams recognized the significance of the issue.

Strauss agreed that the matter was important, but he saw another aspect. Absent from the June 17 meeting, he read the minutes with growing concern. As he understood it, the Government was spending money to educate people who might later be eligible for Commission employment. If this were so, he thought the Commission should determine whether applicants were qualified before committing public funds for their education. Moreover, the number of fellowships was limited. Why should a person receive a grant—if he could not be cleared—and so deprive someone else who was acceptable? Hickenlooper was also disturbed, for without the safeguard of an investigation the Commission might find itself spending Government funds to educate a potential subversive. On July 30, 1948, he asked for an explanation of the Commission's policy.[56]

Even before the Hickenlooper letter arrived, Strauss had asked for a legal study on the applicability of other statutes. On September 17, 1948, the Commissioners received the report. The general counsel found that there was no legal requirement to clear an individual so long as he had no access to Restricted Data. Further, the study contained the opinion of Detlev W. Bronk, chairman of the National Research Council, that imposing a clearance to qualify for a grant to pursue academic study and research could damage the tradition of freedom in American education.[57]

For Lilienthal, however, events presented another forum. The American Association for the Advancement of Science in Washington heard President Truman on September 13 assert the need to press ahead with research. Adequate funds and facilities were of course to be provided, but also necessary was an atmosphere in which scientists could work free from unjustified suspicion and politically motivated attacks. Three days later Lilienthal put the argument to the association even more strongly. He denied that American leadership depended upon a secret formula locked in a safe. The true source of strength was knowledge. Ominously, the Commission was experiencing increasing difficulty in persuading outstanding people to serve in the Government. The reason was their reluctance to expose themselves and their careers to misunderstanding. For its part, the Commission was working out procedures which would safeguard the decent and ferret out the bad. In the final analysis nothing could replace common sense and good judgment. These qualities Lilienthal thought had not been lacking in the nation's history.[58]

On October 11, 1948—seventy-three days after his request—Hickenlooper received a statement of the Commission's policy on clearances for the fellowship program. The letter was long and contained several administrative details on procedures. It also acknowleged that after careful consideration, an applicant whose background contained derogatory information had been assigned to work in a hospital where no possible question of security could arise. On the broad issue, the Commission asserted that if no clearance were required so long as Restricted Data were not involved, the balance between security and scientific freedom was maintained. There, for the moment, the matter rested.[59]

LABOR RELATIONS

Organization, finance, and security were undeniably important, but they did not directly affect the production of fissionable material. Labor disputes, as events at Oak Ridge in 1947 showed, could conceivably cause plant shutdowns.

The settlement without a strike of the dispute between the United Gas, Coke, and Chemical Workers (CIO)—representing the production plant men—and Carbide in December, 1947, had not brought labor peace to Oak Ridge. One of the thorny complications centered around the laboratory where eighteen local unions affiliated with the AFL had a contract which in some respects was superior to that won by the CIO. When Carbide assumed management of the laboratory in early 1948, the company took the position that all of its employees, whether in the production plants or in the laboratory, had to receive similar treatment. For their part, the AFL unions were determined to keep their advantages. The CIO was pressing for the right to oust the AFL so that only one union would represent the Oak Ridge facilities. The situation was not without precedent, but what made matters even more awkward was the fact that, in the final analysis, the Commission was responsible for seeing that vital plant operations were not interrupted.[60]

Senator Hickenlooper, looking at the Oak Ridge situation, wondered whether atomic energy labor relations required special legislation. Cyrus C. Ching, veteran labor negotiator and director of the Federal Mediation and Conciliation Service, who had played a role in settling the 1947 troubles, was leaning toward some form of compulsory arbitration.[61]

The Commission was reluctant to see special legislation or compulsory arbitration. Its long-term goal was to weave the traditional rights of labor into a pattern of an atomic energy industry which, although now consisting of Government-owned, contractor-operated plants, might eventually be owned and operated by private industry. More immediately, the Commission had to avoid a strike which might interrupt plant operations. This overriding consideration deprived labor of its ultimate weapon: the right to strike. The ban had broad ramifications, for conceivably a strike in a distant supplier plant, of which the Commission might be only one customer, could halt production. Still, Lilienthal and Oscar S. Smith, the Commission's director of labor relations, believed that the just claims of the Commission, labor, and contractor could be met if the three could agree upon the limits of the bargaining process. Within these boundaries labor and management could seek their own solution to disputes.[62]

Of the Commissioners, Lilienthal had the most practical grasp of labor matters and an understanding of the labor point of view, qualities which came in part from his TVA experience. His years in the Tennessee valley had won him a good reputation among labor leaders and gave him a confidence he showed in participating directly in labor negotiations. Smith had come to the Commission in November, 1947, after a decade of service with the National Labor Relations Board. As many others recruited for the Commission, Smith had given up an opportunity in private industry because of the lure of a new and powerful Government agency.

Other Commission installations were not free from labor tension. Oak Ridge was the only facility at which unions had been recognized. Whether the ban on union activity could be lifted depended in part upon events at Oak Ridge, and in part upon compliance with the non-communist affidavit provisions of the Taft-Hartley Act. Under the law, union officials were required to file affidavits stating that they were not Communists, communist-influenced, or members of other groups seeking to overthrow the Government. Unless these affidavits were filed, the union had no status under the law, and could claim no protection from the National Labor Relations Board. At Chicago the United Public Workers were seeking recognition from the University of Chicago to represent Argonne National Laboratory, while at Schenectady the United Electrical, Radio, and Machine Workers of America (CIO) had a contract with the General Electric Company. Officials of both unions were alleged to be Communist or communist-influenced and had not filed affidavits.[63] The UEW at Schenectady posed the most serious problem. Since the union had a contract with General Electric that covered several plants, the

UEW was likely to argue that it had the right to represent the labor force in the Commission-owned, General Electric-operated Knolls laboratory.

Taking steps against the UEW was not so simple. Smith was surprised to find that the National Labor Relations Board was helpless. While the Taft-Hartley Act was the law, its provisions on unfair labor practices did not apply to labor contracts in existence at the time of passage. Consequently the UEW officials did not yet need to file affidavits. Indeed, by not filing, the union deprived the board of the right to intervene on the grounds of communist influence. On the other hand, Smith found, among the national officials of the CIO, recognition that the Schenectady union was vulnerable. Furthermore, there were other provisions of the Taft-Hartley Act which could be used, among them the section prohibiting guards from belonging to the same union as the plant working force. Under Commission prodding, General Electric declared to the UEW that as of April 1, 1948, the guards had to be members of a separate union. The action became effective on schedule and with no untoward incident.[64] It was a first step toward making Knolls suitable for union activity.

OAK RIDGE AND TAFT-HARTLEY

At Oak Ridge the labor situation became tense as Carbide assumed management of the laboratory on March 1, 1948. The AFL unions at the laboratory threatened a strike if they did not receive certain wage increases and other benefits. The company, in turn, was anxious to convert the labor contract made by the previous operator—Monsanto—into terms similar to the agreements which Carbide had for the production plants. To Lilienthal, a strike in the laboratory would not be immediately crippling, but a stoppage of any long duration could slow down the atomic energy program. On March 5 Truman, invoking the emergency provisions of the Taft-Hartley Act for the first time, established a board of inquiry and asked for the company and the unions to maintain the *status quo* until March 19. To bring as much of the matter before the public as possible, Hickenlooper held several days of open hearings; not, he assured the Commission, contractor, union, and other witnesses, to propose a solution, but simply to explore the need for new legislation. In light of the tense situation at Oak Ridge, it was inevitable that the testimony of all would have been cautious. Yet there was agreement that the continuity of operation must be safeguarded, and that perhaps the Commission should draw a statement of labor-management bargaining rights. In the union point of view, Lilienthal's philosophy of contractor responsibility coupled with a prohibition of strikes loaded the dice against labor.[65]

The March 19 deadline passed with no settlement. Truman took the next step under the Taft-Hartley Act and called for an eighty-day injunction during which negotiations would take place with the aid of the Government. However, if no agreement were reached by the end of this period, the men could strike. The President, in turn, had to submit a full report to Congress along with his recommendations.

Some preparations were needed against the chance of failure. In January, 1948, the Commission had sent to the Joint Committee a report on labor problems and the need for continuity in the operation of the Commission plants. Building upon this report and upon advice from labor and company officials, Smith and the labor relations staff constructed a plan. They proposed a master agreement defining the areas of responsibility among the Commission, contractors, and unions. Lilienthal did not like the plan because it undermined contractor responsibility. But if new legislation were necessary, the proposal offered a foundation.

In this spirit Lilienthal presented the plan to the Joint Committee in a closed session on May 6. Grimly the committee heard Lilienthal, Wilson, and Franklin describe events at Oak Ridge. Hickenlooper saw no clear answer to the dilemma of continuity of production and the right to strike. Realistically, Holifield observed, "We, as legislative bodies, are too frequently prone to believe we can write out a simple formula in the form of a law to end controversy." [66]

Through May there was stalemate at Oak Ridge. Lilienthal found himself agreeing with Carbide, but sympathizing with the unions. The time to maneuver was drawing to an end. On June 3, the executive council of the AFL pressed Lilienthal closely on what he would do if there were a strike. Almost angrily he replied, ". . . those plants must be operated, and whatever it takes to do it, that's what we must do." That same day he heard the news from Oak Ridge: the Carbide offer had been rejected by a vote of 771 to 26. On the other hand, the executive council, convinced the Commission meant to stand firm, put pressure on the locals at Oak Ridge. The injunction was discharged on June 11, and negotiations continued with no letup for meals or sleep. On June 15 the break came. The unions accepted the terms of a new contract.[67]

There had been no strike, but the margin by which it had been avoided was uncomfortably thin. On June 18 in a special message to Congress, Truman called for a commission. It should study ways to adopt the best of labor relations experience to the new and vital field of atomic energy. It should submit its report as soon as possible.[68]

SCHENECTADY AND TAFT-HARTLEY

The fact that there had been no strike at Oak Ridge showed that it should be possible to recognize union activity at Chicago, Hanford, and Schenectady, providing the communist issue could be resolved. Further steps toward that end followed on June 1, 1948, when the National Labor Relations Board found that journeymen plumbers working on the Commission's Knolls laboratory could be represented by another union than the UEW. From the Commission's point of view, General Electric had not helped matters greatly by signing a new UEW contract, which became effective on June 11. It was, of course, the company's prerogative to contract with a union for its own plants, but covered in the contract were 250 men working on atomic energy projects. The Commission could not tolerate a situation in which union officials of suspected loyalty could exercise discipline over members working in atomic energy. As the Commission saw it, General Electric as contractor had the responsibility for correcting the situation.[69]

To Smith, the major step in solving the Schenectady problem was to make certain that the rank-and-file membership were aware that the issue was the possibility of communist influence and not the presence of unions. Visiting the company offices on June 17, he found General Electric willing to withdraw recognition of the UEW for atomic energy work, providing the Commission gave its cooperation and open support.[70]

By September the company felt that the Commission would have to take the initiative in withdrawing recognition of the UEW as the bargaining representative for Knolls. Harry A. Winne believed that the General Electric-UEW contract prevented the company from acting by itself. Other officials pointed out that the company had no knowledge of its own that the union leaders were under communist influence. Also, withdrawing recognition at Knolls did not strike at the heart of the matter, for the employees could still associate with the suspected officials.[71]

Events now moved swiftly. On September 23 the Commission approved opening Argonne and Hanford to union organization, and agreed that General Electric should be directed to withdraw recognition. Smith turned to the task of preparing the necessary notifications and correspondence for publication. His letters were ready for Lilienthal's signature on September 27, and sent to the University of Chicago, General Electric, and the chairman of the National Labor Relations Board. Two days later they were released to the press.[72]

Hearing from a New York *Times* reporter that Philip Murray of the CIO was about to challenge the Commission, Smith called Murray's office for an appointment on September 30. In the meantime, Albert J. Fitzgerald, general president of the UEW, publicly accused Lilienthal of unjustified action. At two o'clock in the afternoon, Smith talked with Murray and Arthur J. Goldberg, the CIO general counsel. The spirit of the meeting was friendly and frank. Murray was worried that the Commission's action might affect the West Coast shipping strike, where communist influence was also apparent. Neither Murray nor Goldberg showed any sympathy for the particular UEW officials, but both thought the Commission could have used other means. Murray thought he should have been consulted. Nonetheless, Smith left the CIO office, feeling that Murray would not issue a statement to the press.

Smith was wrong. That evening he heard from a reporter the text of an open letter which Murray was releasing to the press. The CIO president charged that the Commission was blacklisting unions affiliated with the CIO without consulting any of the responsible officials. He asserted that the Commission was unilaterally denying unions their rights. Furthermore, the Commission was prejudicing the merits of the union's legal case challenging the constitutionality of the noncommunist affidavit provisions of the Taft-Hartley Act.[73]

The Commission offered to explore the loyalty question, providing that the UEW officials would give complete information on communist ties. Fitzgerald rejected the offer, and on November 1, 1948, the Commission ordered General Electric to withdraw recognition. The next move of the UEW was to file suit against the Commission and General Electric for breach of contract, a move which Smith and Adrian S. Fisher, the general counsel, had foreseen. On April 25, 1949, Judge F. Dickinson Letts of the United States District Court for the District of Columbia dismissed the case, with the finding that the Commission had exercised its authority according to the Atomic Energy Act.[74]

THE DAVIS PANEL

Truman established on September 3 the labor study panel he had promised Congress after the Oak Ridge dispute. Under its leader, William H. Davis, formerly chairman of the National Defense Mediation Board and the War Labor Board, the panel completed its study in April, 1949. The three members had written two reports, one to the Commission and the other to the President. In the Commission's report, the Davis panel pointed out that the responsibility of the Commission was perfectly apparent to all parties to a dispute, and therefore negotiations often tended to maneuver the Commission to one side or another, and to uncover the Commission position. Probably the best way around this stubborn fact was to establish and publish general principles for labor-management relations in atomic energy.

In the report to the President, the Davis panel urged that management and labor accept their special responsibility in atomic energy, that security matters be left to the judgment of the Commission, that so far as possible normal collective bargaining processes be utilized, that all disputes be settled without interrupting plant operations, and that the Commission establish a labor relations panel of three members appointed by the President. The task of drawing up the general principles called for in the report to the Commission took longer. An interim statement was issued on April 29, 1949, but difficulties in getting agreement among the contractors, unions, and Commission staff in headquarters and the field made it impossible to draw up a final statement.[75] The result over the years was a series of modifications elaborating the interim statement.

That there would be labor-management disputes in the future was undeniable. But events at Oak Ridge and Schenectady, and the conclusions of the Davis panel, gave confidence that disagreements could be handled within the framework of collective bargaining, security, and uninterrupted plant operations. Probably it would never be possible to consider atomic energy as a normal industry, but the presence of labor unions was a healthy step in that direction.

348 *DEMOCRATIC VICTORY*

The Presidential campaign of 1948 virtually ignored atomic energy. Only once was this welcome state of affairs threatened. At Phoenix, Arizona, on September 23, Dewey paid tribute to the atom, demonstrably terrible in war, potentially a blessing in peace. Full benefits of atomic energy could not be harvested by the heavy hand of Government monopoly. More participation by industry was needed.

Lilienthal thought Dewey's remarks were unexciting. At various times since he had become chairman, Lilienthal had talked with the New York governor. From his impressions Lilienthal discerned no fundamental cleavages which would make it impossible for him to continue on the Commission if the Republican won. Nonetheless, it was possible to view the Dewey speech as an opening gambit to which Truman should reply. Clark M. Clifford, traveling with the Truman campaign party, called Lilienthal from Oklahoma and found him lukewarm to the idea of bringing atomic energy into the campaign.

McMahon, however, was eager to accept the challenge. To provide ammunition, the senator sent Truman a draft of an article soon to appear in the *Bulletin of the Atomic Scientists*. McMahon proposed to refute Dewey by pointing out that the Government had developed the atomic bomb, that he was ignorant of the role played by industry in atomic energy, and that his speech was injecting atomic energy into politics.[76]

Truman did not reply to Dewey until October 14. Speaking at Milwaukee, the President recalled his efforts to gain international control and the many achievements of his administration in atomic energy. The absence of any plank on atomic energy in the Republican platform Truman interpreted as evidence of an intent to turn over to private industry the source of energy developed by the Government. For the rest of the campaign, Truman made only casual references to atomic energy. Dewey too, kept the peace. Both parties apparently felt that the Taft-Hartley Act, housing, and inflation had more political appeal.[77]

Like many Americans, Lilienthal awoke on November 3, 1948, astonished to find Harry S. Truman elected President of the United States. The Democratic victory would mean a recasting of the Joint Committee. Not until Congress convened in 1949 would Lilienthal know all of the changes. McMahon would replace Hickenlooper as committee chairman. Senator John W. Bricker, Republican from Ohio, would lose his place on the committee to Senator Millard E. Tydings, Democrat from Maryland. On the House side of the committee there would be two changes. Lyndon B. Johnson, Democrat from Texas, as a result of a victorious senatorial campaign, and James T. Patterson, Republican from Connecticut, because of the change in the party balance in Congress, left the Committee. In their places, Speaker Rayburn would appoint two Democrats: Paul J. Kilday of Texas and Henry M. Jackson of Washington.

Lilienthal interpreted the surprising Democratic victory as heartening evidence that his political philosophy was deeply rooted. He and others could enjoy the discomfiture of the professional pollster with his cold calculations and see in the election results a vindication of the citizen exercising his power in the privacy of the voting booth. However, an unexpected victory contains along with triumph some elements of danger. Those who counted upon a Republican president and Republican Congress found themselves again denied, and the cup of victory dashed from their lips. Upon these citizens lay a heavy responsibility. Once more they had to assume the role of the opposition, acting within the framework of the democratic system.

THE ULTIMATE RESPONSIBILITY

Toward the end of 1948, Lilienthal was disturbed by signs of weakness in the Commission's administration. Some of his awareness came from Shugg's abrupt tactics to cut debate and force action. Lilienthal admired Shugg's decisiveness, but uneasily recognized that the Commissioners and their policy-making function might be bypassed.

Theoretically the Commissioners should formulate policy and leave the operations to the general manager. In actuality the line between the two functions was hard to draw, for operational decisions created the environment in which policy was made. The Commissioners' need for information had to be met in some way which did not infringe upon the authority of the general manager. Somehow a balance had to be established between the strategy and the tactics of management. In the final analysis the five men who sat at the conference table and listened to the staff proposals bore the ultimate responsibility for the nation's atomic energy program.[78]

Lilienthal was particularly concerned about the Commissioners' need for information during contract negotiations. Since the Commission depended so heavily on private industry, the contract was a major administrative tool. Obviously no single type of contract was applicable in all circumstances. For certain matters, such as procurement of common materials or simple construction jobs, it was possible to seek competitive bids for a fixed-price contract. More often the unique character of the Commission's operations made such a course impracticable. Open bidding was not always possible because of the urgent need to get a project started or the imperative demands of security. Fixed-price contracts were often unacceptable to business leaders, who found it impossible to calculate costs and profit margin for constructing or operating unique installations of unprecedented complexity and involving unusual hazards. The result was that the Commission was usually forced to use a cost-type contract in which the Commission paid the costs and an additional

amount for the contractor's management skills. Contract negotiations clearly involved the general manager and the Commissioners: Wilson because his staff negotiated and administered the contracts; Lilienthal and his colleagues because the contract set policy and because they would be held responsible for poor contractor performance.[79] Strauss thought precise definition was the way to separate policy and management functions, but others were not so certain. Lilienthal felt that rigid delineation might destroy initiative. To him the answer was better reports, more frequent briefings, and easier access of the staff to the Commissioners.

More than once at the end of 1948, Lilienthal discussed administration with Wilson, Shugg, Fisher, and Green. Unless they found some means to make information available, Lilienthal did not see how the Commissioners could meet their responsibility. If the staff could not find a solution, then the Act ought to be changed. He did not believe that so drastic a solution was the answer. The Commissioners were only trying to keep up with developments; they were not attempting to abridge the staff's authority. At the final session, Shugg agreed to work out some system to meet Lilienthal's demand for early discussion of contracts. But, Shugg remarked, it was contrary to his eighteen years of business experience. Still, he admitted, conditions were different in Government.[80]

Lilienthal was disturbed by another weakness—the failure of the Commission to gain public understanding. He did not attribute the lack of success to Morse Salisbury, the director of public and technical information. Salisbury, with an extensive background in information services in the Government, had joined the Commission in September, 1947. His division as approved by the Commissioners on October 15, 1947, provided information as well as a declassification service. Salisbury had a complete printing establishment at Oak Ridge capable of issuing all reports from the most highly classified to those intended for public release. A small declassification branch monitored the activities with a consulting group of engineers and scientists who provided advice on material submitted to them for declassification. The public information branch was the Commission's routine contact with the press.

The problems which Lilienthal saw were of a different magnitude. At home on the first day of 1949, Lilienthal set down his thoughts on public understanding and the Commission. He remembered that when the Commission assumed its responsibilities, one of the crucial issues was the need to overcome the irrational attitude on secrecy and security, to remove the feeling that atomic energy was surrounded by an impenetrable aura of mystery, and to create confidence in the civilian leadership. The obstacles were formidable —the reservations of the Joint Committee, the sharp scrutiny by the military, and the tenseness of the international situation. That these barriers remained largely unchanged he felt was not the fault of Salisbury, but of the Commission's failure to work out an effective approach.

Lilienthal saw no solution within the framework of the Commission structure. What must be found was a bold, imaginative individual who, reporting directly to the Commission, could devote all of his abilities to this matter. Lilienthal wrote his memorandum with a feeling that time was running out. "If my antennae about public opinion are working at all well (and they have been fairly sensitive in the past) we are approaching a situation—in say 3 to 6 months—in which our initial large credit balance with the public may be gone." [81]

GATHERING CLOUDS

Somewhat grimly, Lilienthal concluded that 1949 would be better, a cheerless optimism based on the somber analysis that things could not get much worse. He could also see evidence of progress. Shugg had begun a vigorous campaign to cut down administrative expenses. In the difficult area of personnel security, the Commission published on January 5, 1949, criteria for clearance eligibility. With this step at least something had been done to bring into the open the factors used in deciding whether to grant a clearance. Furthermore, during a hurried visit to Oak Ridge, Lilienthal was encouraged by the healthy spirit he found in the laboratory, a far cry from the despondency of the year before.[82]

Almost as soon as Lilienthal returned to Washington from Oak Ridge, he was confronted by virulent attacks. On January 11 and 12, 1949, Fulton Lewis, Jr., the radio commentator, stridently accused Lilienthal of poor judgment—or worse—in issuing a clearance to Frank P. Graham, president of the University of North Carolina. As head of the Oak Ridge Institute of Nuclear Studies, Graham required a clearance. During his active career he had, however, joined several organizations, some of which were alleged to be communist-influenced. His membership in these groups, according to Lewis, made Graham a security risk.[83]

Hickenlooper raised another aspect of personnel security on January 12 when he questioned granting fellowships to applicants whose background contained derogatory information. Using public funds to educate a communist was indefensible, the Senator warned, and could lead to justified criticism. In the preceding June, Lilienthal had seen the issue as one which would serve to clarify the security problem, providing that the matter could be debated publicly. A suggestion to Hickenlooper that the subject be considered at a meeting with the Joint Committee drew no immediate response.[84]

The fifth semiannual report to Congress, an unclassified publication required by the Act, Lilienthal saw as a step toward a common-sense view of security. At a press conference on January 28, 1949, he proudly displayed the green-covered 152-page report. It was the first attempt to present an unclassi-

fied, comprehensive account of the Commission's operations. There were flow diagrams of various processes and several illustrations, among them photographs of the gaseous-diffusion plant at Oak Ridge and a production area at Hanford. Lilienthal promised future reports would cover reactors for nuclear power and for airplane propulsion. A third report was in preparation on the effects of nuclear weapons. The press accounts which followed tended to focus on military aspects. A cautious, carefully worded few sentences reporting improvements in weapon development were seized upon as an admission that the Commission had achieved a startling advance.

The Joint Committee viewed the report with some concern. On February 2, 1949, Lilienthal explained his philosophy that in a democracy an agency of the Government must insofar as possible make all of its actions public. Connally rejoined angrily, "Why is it necessary, because you spend public money, to go out and blah, blah all over the country about these bombs?" Senator Tydings declared that a photograph of the model of a proton synchrotron planned for Brookhaven should never have been published. Hostile military experts could reap too much information from the picture. The comment that a 420-foot tower at Brookhaven was the tallest structure on Long Island was another instance in which the Commission was imparting significant military information. It might be well, thought Tydings, for the Commission to clear its future reports with CIA and the military. In rebuttal, Holifield pointed out that the photographs had been published earlier.

McMahon broached a startling idea: Wouldn't it be well to study whether the number of atomic bombs could be released to the public? Carefully he defined his suggestion. Emphatically he was not talking about bomb technology, but only about the size of the stockpile. Others, McMahon pointed out, were suggesting that the information was needed by a democracy. In talking with Lilienthal on February 9, Truman ruled out the size of the stockpile as a matter for debate. Lilienthal probably expected no other reply. More importantly, he learned that Tydings and Connally had complained to Truman about the amount of information on atomic energy being published.[85]

Lilienthal must have been discouraged. The reception of the semiannual report by the Joint Committee had not been what he had hoped. To Rayburn, Speaker of the House, Lilienthal confided that the Joint Committee as a means of keeping Congress informed was a failure. Within the Commission, the wrangling over technical cooperation was destroying the spirit of free and easy camaraderie that Lilienthal cherished. Waymack had resigned on December 21, 1948, and Bacher was soon to follow. Good relations with Truman was a matter upon which Lilienthal prided himself, but he could not learn who would be named to the vacancies. With some misgivings he had heard mention of Gordon E. Dean, a man whom Lilienthal had never met and whose main qualification seemed to be a former law partnership with McMahon. Lilienthal noticed that Wilson too, was worried and weary. At the close of one arduous day, the chairman of the Atomic Energy Commission telephoned the general manager and sang discordantly, "Don't let the bastards wear you down." [86]

HANFORD OVERRUN

Lilienthal escaped to Florida for a vacation on February 17. A few days later Bacher left for a western swing which would take him to Hanford, Berkeley, and Los Alamos. Returning first, Bacher alerted his colleagues to the fact that Hanford was in trouble. As part of the effort to move production operations out of Los Alamos, Hanford had begun to build plutonium fabrication facilities. General Electric and Commission people from Hanford had visited Los Alamos and had come away believing that it would not be too hard to take the laboratory technique and convert it to a production process. But General Electric had encountered one difficulty after another in developing the new process. The toxicity of plutonium required stringent safety precautions, particularly the provision of adequate ventilation and controlled air pressures throughout various parts of the building. Fred C. Schlemmer, who had replaced Shugg as the Commission's Hanford manager on September 15, 1948, uneasily watched the cost estimates mount from nearly $9 million to over $20 million. He had constructed Fontana Dam in the Tennessee Valley, but there he had been in direct command. Hanford he found vastly different. It was baffling and frustrating to have to delay construction as design changed and changed. Bacher did not find it hopeful that Schlemmer seemed to have trouble in prying information out of the company.

Bacher's news was not completely unexpected. Wilson on February 19 had warned the company officials about their excessive rate of spending.

Williams was worried. To the Commissioners' pointed questions on controls over expenditures of Government money he could give no satisfactory answer. He called Schlemmer on March 7 for a detailed report on each Hanford project. Wilson decided that to get the facts he needed a strong team to go to Hanford. He assigned Williams, Green, and Fisher to the task.

By the time Lilienthal returned it was possible to assess some of the causes of the Hanford overrun. From Wilson's and Shugg's account, Lilienthal judged that estimates had been badly bungled but that there was nothing scandalous in the situation. At Hanford, Williams telephoned Shugg on the difficulty of clearing away confusion and getting to the facts. However, there was no doubt that there had been inefficiency and a diffusion of responsibility. Less apparent was where the blame lay. Commission officials both at Hanford and Washington had accepted the faulty estimates. Lilienthal was despondent. The Commission could not compare with the TVA in management, although he recalled that the latter agency began poorly organized. For his own sake, he was grimly determined to keep out of administrative details, no matter what happened.[87]

A MOMENT OF CALM

Lilienthal found no reason for cheer on security matters. Poor handling of Congressional relations in selecting a site for the reactor testing station brought a session with the Joint Committee. At the close of the meeting, which had gone reasonably well, Lilienthal had a few minutes' conversation with Senator Millikin on the Graham case. The Senator had no doubts of Graham's integrity, but because of Graham's associations, he thought the Commission had acted unwisely in overruling Gingrich and the Roberts board and granting a clearance. Millikin feared the action would throw doubts on the Commission's judgment. It would be wiser to deny a clearance to a person—even if no question of his loyalty existed—than to undermine public confidence. At least, remarked Lilienthal, it was a clear-cut issue.[88]

The Military Liaison Committee met alone in executive session with the Joint Committee on March 16, 1949, the first time the two groups had met together for about two years. Most of the session dealt with the relations between the military services and the Commission. Skillfully Major General Kenneth D. Nichols related the arguments for military custody of atomic weapons. In his opinion, the armed services should have responsibility for the design, production, and custody of the weapons. The military would be, after all, the user, and from this vantage point could contribute more to improving the weapon. Probably the main reason for Commission opposition to the transfer stemmed from the feeling that the weapons were not in condition to turn over to the military. Cooperation with General McCormack was ideal, and the military's relations with the Commission were generally good. Nichols, head of the Armed Forces Special Weapons Project, and member of the liaison committee, found that working with the Commission was a slow and time-consuming process. On production of fissionable material the Commission was doing well; on reactor development the pace was exceedingly slow. Again, limiting himself to his own views, Nichols would also like to see the armed services directly represented on the Commission.[89]

The next day Lilienthal had a chance to refute charges of disclosing military information. To the Joint Committee he demonstrated that photograph after photograph in the fifth semiannual report had been published earlier—in some instances, under the Manhattan project. Even so he found the reaction disappointing.[90]

Oppenheimer and the General Advisory Committee presented a different perspective to the Joint Committee on April 6. In calm phrases Oppenheimer spoke of his committee's satisfaction with the Commission's performance. More progress had been made on weapons than the advisory committee would have believed possible. Firmly he defended the release of the photographs. McMahon's support for the need to disseminate unclassified information Oppenheimer skillfully sought by regretting that there was to be no opportunity for public debate on the size of the stockpile. Of course, releasing information raised perplexities; he was not even certain that the military had enough data to draw up sound war plans.[91]

NEW CRISES

No doubt Oppenheimer's support was welcome to Lilienthal but the relief was short-lived. On April 13, the Commissioners heard formally that fissionable material was missing from Argonne. Again unravelling the facts revealed laxity. Argonne employees on February 7 during the course of events discovered that a bottle of some 289 grams of uranium was missing from a storage vault. On February 14 the Commission security officer at Argonne was notified. Believing that the bottle had been misplaced, or perhaps emptied into a metal recovery can with other material, the Chicago office assigned a technician the task of finding the material. The job was not easy, for only precise and careful laboratory analysis could reveal whether the missing uranium had been mixed with the same material of a different enrichment. On March 21, the Chicago office notified Washington and seven days later asked the FBI to investigate. On April 27 the Commission notified McMahon of the disappearance.[92] Seventy-nine days had elasped since the absence of the bottle had been discovered.

Already a new crisis was in the making. On April 25, Senator Clyde Hoey of North Carolina wrote Lilienthal, asking if it were the Commission's policy to grant fellowships to Communists. According to the Senator a professed Communist at the University of North Carolina had been granted an award. Fulton Lewis, Jr., began a new series of attacks on May 12. That same day Senator Hoey called for an investigation, and the Joint Committee held hearings on the nominations of Gordon E. Dean and Henry DeWolf Smyth as Commissioners.[93]

The biographical facts for Dean were simple: born December 28, 1905, in Seattle, Washington; public school education; graduate of the law school at Duke University; an attorney from 1934 through 1940 in the Department of Justice; special executive assistant to Attorney General Homer Cummings and his successor, Robert H. Jackson; a law partnership with Brien McMahon; service in the Navy during the war; assistant to Jackson during the Nuremberg trials; and finally a professorship in law at the University of Southern California and private law practice. There was nothing in the terse summary to indicate a shrewd, pragmatic individual, endowed with a mind capable of drawing its own conclusions and a tenacity in expressing them.

McMahon had intended to hold confirmation hearings on Dean and Smyth together, but family illness prevented Dean from appearing on May 12. Smyth, however, was present. Unlike Dean, Smyth had a national reputation. McMahon quickly drew out the essential data: born May 1, 1898; educated and taught physics at Princeton; consultant to the Manhattan project. To most people, his name was familiar as that of the author of the Smyth report, the earliest unclassified account of the nation's wartime atomic energy program.

After McMahon's brief questioning, Hickenlooper explored with Smyth the subject of security. All went smoothly until Hickenlooper turned to the fellowship issue. The senator could not accept the idea of training a Communist with public funds. Smyth expressed his dislike of that aspect, but even more distasteful to him would be a procedure investigating students, a practice which might penalize young people with inquiring but as yet unsophisticated minds. Again Hickenlooper returned to the main point: Private foundations could, within reason, educate anyone they chose; the Government could not. If students were not employable in the atomic energy program, they should not be given public aid to study atomic energy. The senator and the prospective Commissioner touched on the issue circumspectly and amicably. There was no doubt that Smyth and Dean would be confirmed and there was no uncertainty as to where Hickenlooper stood on the fellowship matter.[94]

Although Smyth had emerged untouched, Lilienthal recognized that the questions on fellowships were a storm warning. He had been too long in Government, exposed to too many crises, not to see the signs of impending danger.[95]

THE STORM BREAKS

At first matters did not go too badly. At the opening hearing of the Joint Committee beginning on Monday, May 16, Lilienthal tried to place the fellowship issue in the context of Government intervention in education, an old and honored standard around which to rally. Applying a loyalty test to students not engaged in classified work, he saw as tantamount to such interference. On Tuesday, Detlev W. Bronk, chairman of the National Research Council, and Allan Gregg, head of the Commission's advisory committee on biology and medicine, testified. Bronk in particular, Lilienthal thought, had made a strong impression. At the end of the long day, Lilienthal was encouraged.[96]

The next morning headlines in the New York *Daily News* screamed, "Atom Bomb Uranium Vanishes." As soon as Lilienthal reached his office he called Shugg for details. In a few minutes the deputy general manager had the information. The copyrighted story, appearing over the name of William Bradford Huie, a free-lance writer, was broadly correct. Under the circumstances the testimony before the Joint Committee that morning by the North Carolina student was anticlimactic. The committee was focusing on an afternoon executive session at which Lilienthal, Wilson, and a few key staff members would explain the Argonne affair.

At four o'clock Wilson began. He said that most of the material had been recovered, but something over four grams and the bottle itself were still missing. Williams explained the accountability procedures and, with Wilson, assured the committee that nothing had been stolen. Relieved by the factual recitation, McMahon remarked that no harm had been done. Quickly Knowland caught him up. The California senator could not understand how anyone in the Commission could be certain of the whereabouts of any material. Representative Cole found the time lag from discovery to action inexcusable.[97]

The missing uranium was additional grist for Senator Joseph C. O'Mahoney's subcommittee on appropriations. The O'Mahoney group was in a strong position, for it could write into legislation stipulations that students receiving Government financial aid must meet certain criteria. The Argonne revelation had already damaged the Commission as Lilienthal, Pike, Strauss, and Wilson settled into their chairs on May 19 to hear O'Mahoney call the meeting to order.

A trying period lay ahead for the Commission witnesses. The brooding presence of Senator Kenneth D. McKellar as a subcommittee member must have brought back bitter memories of the 1947 confirmation hearings. The questions were sharp. Lilienthal's argument that the fellows were selected under contract by the National Research Council was brushed aside as an evasion. His warnings that loyalty oaths and background investigations threatened academic freedom fell flat. Vainly Lilienthal called for perspective, asserting that one communist student could hardly overturn the Government of the United States. O'Mahoney and his subcommittee were immutably entrenched behind the proposition that Government funds must not be used to educate subversives.

For two more days in open session, O'Mahoney delved into the matter of the missing uranium. Lilienthal was clearly on the defensive. He could only admit that far too long a time had passed until the FBI was called; he could only acknowledge that the Commission had been guilty in moving too slowly; he could only agree that the criticism was merited. Of the ultimate results there could be no doubt. O'Mahoney was going to write controls into the legislation.[98] And there was no indication that the storm had played itself out.

INCREDIBLE MISMANAGEMENT

There was no letup. On May 22, 1949, Senator Hickenlooper demanded Lilienthal's resignation. Each day the senator had found new evidence of "incredible mismanagement." Lilienthal was still on the defensive. No longer could he rely on Vandenberg, so often a source of strength in the past. The senator felt that Lilienthal's position on the fellowship issue was weak and his attitude toward security loose. The charge was too broad, yet rang true enough to Vandenberg to make him think that Hickenlooper was performing a useful role. On the other hand, Truman exuded confidence. The attack, he thought, was political; Hickenlooper had an election campaign to fight in 1950.[99]

As comforting as Truman's assurance was, Lilienthal was greatly worried. But the very broadness of Hickenlooper's accusations gave him a chance he quickly seized. At home on May 25, he pounded out on his typewriter a challenge to investigate the Commission's—with his keen sense of language he skillfully selected the word—"stewardship" of weapons, production, research, and security. Lilienthal denied that the country was weak in atomic weapons or atomic material. He asserted, "It can be stated categorically that the record in this respect is a proud one." The facts should not be difficult to find. There were the many reports over the years to the Joint Committee. Moreover, the committee could call before it those competent to judge: scientists, industrialists, and members of the advisory committees. At his office he hurriedly polished phrases, seeking the tone he wanted. His first idea had been to issue the statement as a press release, but McMahon objected on the grounds that the Joint Committee was the proper forum. Lilienthal recast the statement into an open letter. The form did not matter to Lilienthal; what did was that he was taking the offensive.[100]

The issue was joined as the first of a series of hearings began on May

26. Through the long, hot days that followed Hickenlooper sought to establish a pattern of maladministration. His aim was narrowly focused. "This is an inquiry into the administrative direction and policies of Mr. Lilienthal as Chairman of the Commission itself." To make his case he added item to item and instance to instance. In the klieg-lighted, marble-paneled caucus chamber in the Senate office building, Lilienthal, his colleagues, the Commission staff, and witnesses faced Hickenlooper who, from the recesses of an inside breast pocket, drew recipe cards from which he read question after question. He compiled for the record a list of key individuals who were no longer with the Commission. The number of resignations after short terms of service he saw as evidence of dissatisfaction by highly qualified people with Lilienthal's management. He pointed to the alarming number of emergency clearances. Hickenlooper accepted the General Electric explanation of the Hanford overrun; his interest was in the system that permitted the cost to run so long a time unnoticed. Some of the meetings, particularly those dealing with personnel clearances, were held in executive session.

Hickenlooper hoped to prove that the Lilienthal Commission was guilty of lax security standards, and he sought to bring into the open specific cases, with names replaced by letters and with marks of identification omitted. As a device it was a failure. It proved impossible to drain an individual of his identity and transform him into a hypothetical figure illustrative of poor security practices.[101]

There were some flashes of humor. In presenting statistics on the Commission employment turnover, Lilienthal observed that some had left for maternity reasons: "This may be evidence of incredible mismanagement, but not on the part of the Commission." Laughter welcomed the comment, but such occasions were rare.

Despite attempts to work out in advance an agreement upon a line of questioning, there was no certainty as to how each session would develop. Division directors in their offices sat with briefcases packed with charts and records, gathered in hope that they might supply the answer to a Joint Committee question. Not until the cavalcade of cars departed for the Senate office building did the key staff know whether they were to spend the day at their desks or at the witness table. For many, the nights were spent in preparing testimony for the next session. For others, whose positions had not involved them in policy matters, the hearings were a source of bewilderment.

Repercussions in the field were not as great. Walter H. Zinn recognized that probably some people would always believe the loss of uranium was the result of espionage. The education of Congressmen, he told his staff, was a duty that no one should avoid. At Oak Ridge one scientist asked to be relieved of all duties relating to plutonium recovery. The reason was not the health hazard, as serious as that was, but the danger to name and reputation through working in the area.[102]

Interest in the hearings lagged as they continued. The press turned to the sordid revelations of the Judith Coplon case and the mysterious and perplexing net that linked Alger Hiss and Whittaker Chambers. Neither Lilienthal nor Hickenlooper attended every session. Other duties sometimes accounted for sparse attendance. The hearings on the controversial B-36 bomber took some committee members away, and drew from the irascible Connally the pungent comment at the final session on August 25, "Well, this started out like a B-36, but wound up like a single-seater, didn't it." [103]

The committee majority submitted an eighty-seven-page report in vindication of the Lilienthal Commission. As substantial achievements, the majority pointed to the growing stockpile of atomic weapons and to the successful tests of improved weapon designs at Eniwetok in 1948. Far too long a time had elapsed before the Hanford overrun had been discovered, but this could be attributed in part to developing a new partnership between industry and Government. The likelihood of a recurrence would diminish as

the Commission continued to implement its industrial-type cost accounting system. In other areas—production, reactors, and research—the Commission had much of which to be proud. The export of isotopes, the majority concluded, had taken place without objection from the Department of State, the Department of Defense, and the Military Liaison Committee. After hearing Oppenheimer testify on the matter, the majority of the Joint Committee did not believe that the Commission had violated the Atomic Energy Act. The dissent of Strauss was accepted as evidence of a healthy spirit. An analysis of the specific cases about which there were alleged security doubts revealed no cause for condemnation of the Commission's security procedures.

Hickenlooper in a three-page minority report declared otherwise. Based upon secret information and testimony, much of which had been gained over the years of the committee's existence, the minority found that the Commission should have made greater progress in weapons. In certain areas the Commission's actions had been leisurely and characterized by indecision. Security had been loosely administered, and Commission management inadequate.[104]

It was possible to look at the issues separating Lilienthal and Hickenlooper in broad philosophic terms. To the Commission chairman, atomic energy was a power to be brought into the life and understanding of the people as soon as possible. To the Senator, atomic energy was the great bulwark of the nation, and factual information was to be guarded zealously. The closer Lilienthal came to his goal, the more Hickenlooper was disturbed. The minority and majority reports could not conceal the anguish the hearings held. As they were centered upon Lilienthal, so he felt them most deeply. The way in which the proceedings often mired down in petty detail he found revolting; that a man as eminent as Zinn should have to lecture upon the contents of a bottle was distressing and worse, a waste of time and talent. Lilienthal could only feel that his entire career, and all that he stood for, was in pillory. He found no victory, snatched from the jaws of defeat, as had been so exhilarating in the days of TVA. He found no occasion for eloquence, as he had during the confirmation hearings. There was only detail after detail, a seemingly endless erosion of the principles and reputation of years.

In the public view Hickenlooper had lost the verdict. But Lilienthal was exhausted and wounded, the Commission confused and cautious. That spirit which made it possible to speak of a Lilienthal Commission was shattered. In the quiet of Martha's Vineyard, where he sought rest, Lilienthal may have realized that his public career was over.

DECISION OF DESTINY

CHAPTER 12

The United States Senate set a new record for short sessions on Saturday, September 3, 1949, when it succeeded in assembling and adjourning in forty seconds. Like many Washingtonians, the senators were anxious to leave the Capitol for the Labor Day weekend. Much to the satisfaction of F Street merchants, there was a rush of "back-to-school" buying during the day, but by late afternoon most of the central city was deserted. Even the traffic on Pennsylvania Avenue in front of the White House had subsided to an occasional streetcar and a few automobiles. On G Street, just west of the Executive Mansion, the office buildings were empty except for a few guards and an unlucky group of Air Force officers and enlisted men who had drawn duty on the last holiday of the summer. As the slanting rays of the afternoon sun pierced the clouds, the staccato rhythm of a teletype broke the drowsy tedium. No one could yet suspect the report sputtering from the machine would set in motion a chain of events placing on the Commission and the Administration a burden of extraordinary decisions. For the tangle of events of the next five months recorded more than a political struggle; they seemed to involve the very destiny of man.[1]

SHOCK FROM THE EAST

The teletype report alerted the headquarters of the Air Force's Long Range Detection System that a WB-29 weather reconnaissance plane on routine patrol from Japan to Alaska had picked up some measurable radioactivity. A filter paper, exposed for three hours at 18,000 feet over the North Pacific east of the Kamchatka Peninsula, had produced slightly more than the number of radioactive counts per minute necessary to constitute an official "alert." The report required attention but did not justify alarm. In more than a year of operation the Long Range Detection System had registered many such alerts, none of which had proved to be the result of a nuclear detonation, and this one barely qualified under the criteria. In any case, its significance would be unknown until scientists could analyze the samples. By Monday morning, however, there was enough information to spoil the holiday for most of the Long Range Detection staff. A second filter paper from the same aircraft produced a substantially higher count. Additional measurements seemed to indicate that the activity came from fresh fission products in the atmosphere. Were they from bomb debris or from some accidental release? [2]

The first measurements of radioactive decay in the samples were not very revealing. On the chance that a Soviet nuclear test had produced a radioactive air mass, the Air Force dispatched several special flights to filter the air in different portions of the Pacific. Even before these flights were completed, other routine missions reported picking up radioactive samples, one with twenty times the count rate of the original. By Tuesday positive interpretations were coming in from the special flights and from ground stations in the detection system. By three-thirty on Wednesday morning, laboratory analysis revealed the presence of fission isotopes in the first samples. This fact showed nuclear fission to be the source of the radioactivity, perhaps in a test weapon, perhaps in a reactor accident. Which had produced the radioactivity was the all-important question. To find that answer and the exact location of the radioactive air mass, the Air Force dispatched every available plane to the area with instructions to pick up as many samples as possible.

William Webster, deputy for atomic energy to Secretary of Defense Louis A. Johnson, was among those who now thought it conceivable that the Soviet Union had detonated a nuclear test device, if not a weapon. Early Thursday morning he called on Carroll L. Wilson to discuss these preliminary results with the general manager. Webster was concerned that, no matter how many samples the Air Force collected, the final determination of whether or not the Russians had succeeded in developing a nuclear weapon would rest on a highly sophisticated interpretation of these facts. For one thing, the Russians had apparently caught the United States off guard by breaking the American atomic monopoly months earlier than most experts had predicted. Some people might find that fact hard to accept. For another, everyone might not interpret the indirect evidence the same way. To avoid this difficulty, Webster suggested appointing a committee of outstanding scientists to examine the evidence. Wilson agreed that Vannevar Bush would be a natural choice as chairman of the panel. The venerable scientist was again a private citizen, having returned to the Carnegie Institution after almost a decade of Federal service. Bush's views were likely to be acceptable to both the military and the Commission. Wilson agreed to sound out the Commissioners on the idea. After Webster left, Wilson called in Spofford G. English, an experienced radiochemist in the research division, and asked him to examine the technical evidence being gathered by the Long Range Detection System. Then he asked Walter F. Colby, the Commission's new director of intelligence, to gather what information he could through intelligence channels. Wilson thought the Commission should make every effort to satisfy itself that the reports were accurate.[3]

By Friday noon Wilson had made some progress. The three Commissioners present had reacted favorably to the proposal for the Bush panel, and over lunch Wilson discussed the panel's assignment with his former mentor. English reported that he was satisfied with the evidence the Air Force had collected so far. But before the end of the day there was a new crisis. Just before five o'clock, Bush phoned to ask Wilson to call the Air Force at once. Within twenty minutes the military and civilian chiefs of the Long Range Detection System were in Wilson's office. The radioactive air mass had

crossed the North American continent and was headed out over the Atlantic. Would it be possible, the Air Force officials asked, to alert the British to collect samples as the air mass passed over?[4]

This was a sticky matter for Wilson. To alert the British might constitute a technical violation of the Atomic Energy Act, an unhappy prospect so soon after the "Cyril Smith affair" and the criticisms of the technical cooperation program which that incident generated. But to withhold the information even for twenty-four hours might preclude the possibility of obtaining British samples. Perhaps he could justify the action under the technical cooperation program, but there was no time to find out. Wilson picked up the telephone at six o'clock and called Alexander K. Longair, the British representative on technical cooperation in Washington. Longair, who had just reached his home, hurried to the Air Force office on G Street. He understood the situation at once and thought he could get prompt action in London. An Air Force car sped him to the Pentagon, where he spent most of the night in classified teletype conversations with ranking officials in London. He assured himself before going home in the early morning hours that the British would be collecting samples that day.

Few persons outside the Commission and the Air Force yet had any intimation of a possible Soviet test, but those who did had plenty to do. As additional filter samples came in, radiochemical analysis began to give the first indications of the time of the event and the composition of the test device. English, working with the Long Range Detection staff, arranged for independent radiochemical analyses at Commission laboratories. By Wednesday, September 14, most of those in the know were convinced that a Soviet test had occurred. A notable exception was Secretary Johnson, who despite Webster's argument that 95 per cent of the experts accepted the fact, preferred to side with the 5 per cent who doubted the evidence. For the Commission, Johnson's uncertainty expressed itself in an unwillingness for the moment to consider any announcement of the evidence, even within the

Government. At a meeting on Wednesday afternoon Pike made clear the Commission's growing impatience over the lack of any movement toward a decision to announce the Soviet accomplishment. So many people, including the British, had already heard the news that it seemed impossible to avoid a leak of information eventually. Truman himself had known the facts for only a few days, but the Commission had no desire to arouse the displeasure of the Joint Committee by neglecting to keep them "fully and currently informed" about so sensitive a matter. The very significance of the question, however, made it all the more important to verify the facts. Both Webster and Wilson thought the Commission should delay any announcement until more solid evidence was in. Reluctantly Pike, Strauss, and Dean agreed.[5]

The implications of a probable Soviet test undoubtedly colored the Commission's discussion that same afternoon of the draft report to the President on expansion of production facilities. Presidential appointment of the special committee of the National Security Council, consisting of Secretaries Johnson, Dean G. Acheson, and Lilienthal, had assured the Commission a voice in policy decisions concerning nuclear weapons. Staff officers of the three agencies had hammered out a draft report which came to the Commission for discussion. On September 14, Wilson stressed at the outset that the report was mainly the work of the military establishment. The conclusion of the report, namely that the substantial increase in the production of nuclear weapons would be in the interest of national security, came from the Department of Defense alone. Neither the State Department nor the Commission's representatives had seen evidence supporting this position. They had merely examined the foreign policy and the technical aspects of the proposed expansion. Commissioner Dean summed up the Commission's position by suggesting that the report specifically call these limitations to the President's attention. For obvious reasons the draft report could make only one cryptic acknowledgement of the Soviet accomplishment, but events of the previous few days had provided an impressive new argument for the expansion proposal.[6]

On Monday morning, September 19, Robert Oppenheimer, a member of the Bush panel, met Wilson at his office and they joined Pike for the short ride to the Air Force detection headquarters on G Street. There the other panel members, former Commissioner Robert F. Bacher and Admiral William S. Parsons, were assembling with General Hoyt S. Vandenberg and other high-ranking Air Force officers, a dozen scientists from various laboratories, and a British delegation under William G. Penney. Bush began the meeting with a brief introduction, and the British and American officials exchanged information about their national detection systems. Then the panel got down to questioning the scientists who had collected and analyzed the data from the suspected nuclear detonation. Wilson stayed until the lunch break. Although the panel had not yet started drafting its report, he had no doubt that the scientists would conclude that the event had been a Soviet nuclear test. The internal consistency of the reports was evident. The hundreds of samples collected across a broad portion of the northern hemisphere showed good correlation in the composition and age of the fission products, and their wide dispersal led to the conclusion that they had come from a single, large fission reaction. It was still not possible to fix the exact time and location of the detonation, nor to determine conclusively the composition of the device, but there was no reluctance on the part of the panel to accept the conclusion in Oppenheimer's draft that the observed phenomena were "consistent with the view that the origin of the fission products was the explosion of an atomic bomb" on August 29.[7]

INFORMING THE PUBLIC

Shortly after three o'clock on September 19 Pike and Bacher returned to the Commission's headquarters on Constitution Avenue. There was a brief meeting with Strauss, Dean, and Wilson. All agreed that the panel's unanimous finding made it all the more important to make the Soviet achievement public as quickly as possible. The only way to guarantee a decision was to bring Lilienthal back to Washington to see Truman. Within an hour General James McCormack was on his way to the airport to leave by military aircraft for Lilienthal's vacation retreat on Martha's Vineyard. Late that evening when Lilienthal returned to his summer residence, he found McCormack waiting for him. On the plane back to Washington early the next morning Lilienthal had an opportunity to learn from McCormack the succession of events during the previous weeks. The panel report was convincing. If Bacher and Oppenheimer saw no reason to doubt the occurrence of a Soviet test, Lilienthal could accept it as fact. He called his old friend, James E. Webb, now serving as Under Secretary of State. Webb ruled out any immediate announcement of the discovery. After weeks of crisis the announcement of the devaluation of the British pound the day before had left the world's financial centers too near panic to sustain the news the President was withholding. Lilienthal could appreciate this point of view, but he also understood the deep concern of the Commissioners, Bacher, and Oppenheimer. Bacher feared that with three hundred people knowing the facts, a leak would be inevitable. He thought the Government should take the initiative in announcing the facts rather than trying to shore up a leak.[8]

A call to Admiral Sidney W. Souers, executive secretary of the National Security Council, brought an appointment with the President that same afternoon. Truman told Lilienthal he always believed in giving the people the facts, but crises all over the world, the British devaluation, and the threat of strikes made him pause. Although Lilienthal made a plea for a forthright announcement, Truman wanted to wait until the immediate crises had passed. He was not even certain the Russians had the bomb. Lilienthal did his best to convey the convictions he found in the detection panel's report, but Truman was still inclined to delay. He had heard most of Lilienthal's arguments the previous evening in discussions with Secretary Johnson, General Omar N. Bradley, and the Joint Chiefs. He did not intend by an immediate announcement to make things more difficult for the United Nations General Assembly, then meeting in New York.

In a way Lilienthal was disappointed. He thought the President had made a mistake, but he accepted the fact that the decision was the President's responsibility. This was the point he made later in discussing the meeting with the Commissioners, Bacher, and Oppenheimer. Oppenheimer especially found the news upsetting. He deplored the decision as missing an opportunity to get atomic energy out of the miasma of secrecy in which it had been caught. This was another case of trying to keep a secret when there was none. Lilienthal agreed with Oppenheimer, but there was little more he could do. He stopped off for a drink at Pike's apartment and then headed back to Martha's Vineyard by military plane.

Although Lilienthal did not find his conversation with Truman encouraging, Pike detected the possibility of quick action when he called Admiral Souers at the White House the following morning. Souers was certain the President understood the difficult position in which he had placed the Commission, but he intended to take full responsibility for withholding the news from the Joint Committee until the time was right. Secretary of State Acheson, presumably after conversations with British Foreign Minister Ernest Bevin and others at the United Nations, did not think that time had yet arrived, but Souers thought the President would act before the end of the week. Truman had made it clear the decision was now in his hands; the Commission would simply have to wait for him to act.[9]

Perhaps Souers was being less than candid in an effort to protect his chief; for Truman was already beginning preparations for an announcement. After a full-dress review of the evidence with the Joint Chiefs on Wednesday, September 21, he called Senators Brien McMahon and Bourke B. Hickenlooper as chairman and ranking minority member of the Joint Committee, and invited them to the White House the following day. Hickenlooper was out of town, and McMahon came alone. Truman showed him the Bush panel's report and told him he would announce the detection of the Soviet test at the regular Friday meeting of the Cabinet the next day.[10]

Early Friday morning, before the Cabinet meeting, Webster rode to the Capitol with Generals David M. Schlatter and Albert G. Wedemeyer. Oppenheimer, who was in Washington for the regular meeting of the General Advisory Committee, and Commissioner Pike joined them in the hearing room with as many members of the Joint Committee as McMahon had been able to assemble on short notice. There was little time to brief the committee before the Cabinet announcement, but Webster observed ruefully that he could not say much more than that the United States had picked up evidence of a Soviet detonation. As courteously as possible, he fended off questions about the detection system until the telephone calls came from the White House reporting the Presidential announcement. While the President was informing the Cabinet, Charles G. Ross gave the press a written statement. The President's reference to a nuclear explosion rather than a weapon perhaps reflected his reservations about the panel report, but Lilienthal thought the release showed some effects of his plea for a frank report to the nation. To the terse statement the President had considered earlier in the week, Truman had added a paragraph putting the Soviet accomplishment in context. Scientists had known since 1945, he reminded the American people, that the United States monopoly of the weapon was temporary at best and that the basic facts of nuclear fission were available for all nations to exploit. The Russian explosion demonstrated that fact and stressed once again "the necessity for that truly effective enforceable international control of atomic energy which this Government and the large majority of the United Nations support." [11]

If the Joint Committee reflected public opinion, Truman had wisely added the paragraph as a device to avert public anxiety. The committee's first reaction was one of shock and alarm. Why had the United States been caught unawares and how dangerous was the threat of a Soviet attack? There was even vague talk of the possible need for military reprisals. Despite Webster's efforts to put the event in perspective, clouds of anxiety gathered in the hearing room just as storm clouds outside piled up over the capital city. When a clap of thunder startled the legislators in their seats, someone exclaimed, "My God, that must be Number Two!", and laughter swept away the tension of the moment. The meeting adjourned on a reasonable note, but there was no doubt that the news of that morning would influence the politics of atomic energy for many months to come.

Oppenheimer appreciated this fact when he returned to the meeting of the General Advisory Committee at the Commission's headquarters. The committee had discussed the news the previous day and had already recognized the possible impact on the production of weapons and fissionable material. Commissioner Smyth also saw the possibility of more interest in civil defense and public pressure to concentrate on weapons at the expense of fundamental research. To Glenn T. Seaborg, the Russian accomplishment demonstrated the futility of secrecy, which seemed to hamper the exchange of information among American scientists and with the British rather than to impede Russian progress. Although the security of information was still vital, as Oliver E. Buckley reminded his colleagues, Oppenheimer summed up the committee's attitude in the hope that the Russian achievement would result in a more rational security policy in the United States. Beyond this general observation, the committee had not yet had time to consider the implications of the President's announcement. For the moment it was more profitable to evaluate the premises in the proposed report to the President on the expansion of production facilities, to explore ways of increasing plutonium production at Hanford, to spur the development of better weapons, and to examine the need for more production reactors. Oppenheimer scheduled the next meeting for early December, but he and his associates would be on call should the Commission need them sooner.[12]

Elsewhere in Washington the President's announcement had generated a new sense of urgency. Just down the hall on the second floor of the Commission's headquarters building, Dean, after a telephone conversation with McMahon, was dictating a memorandum pointing out the need for some tangible response to the Soviet challenge. At the Pentagon, General McCormack was involved in an all-day session with Edward Teller, John von Neumann, and key members of the Los Alamos staff. The meeting, scheduled early in August to discuss the need for tactical as well as strategic nuclear weapons, seemed more to the point after the White House announcement. After the meeting Teller called Oppenheimer to ask what he could do to meet the Soviet challenge. Oppenheimer's advice, Teller later recalled, was: "Keep your shirt on." That was perhaps good advice for the moment, but it could not long curb Teller's restless imagination.[13]

FIRST REACTIONS

The weekend gave the nation a chance to adjust its thinking to the new facts of world power. By Monday, September 26, it was clear that the Administration had succeeded in its efforts to announce the event without causing public alarm. Most newspapers reported the facts without sensationalism and many chose to quote General Bradley, the chairman of the Joint Chiefs, and General Groves to the effect that the news was not alarming. There was a consensus in the press that the Russians had accomplished their feat about two years earlier than intelligence sources had predicted.[14]

Within the Commission the news had stirred new efforts going beyond the production expansion plans already on the drawing boards. At a special meeting of the program council on Monday morning, each division director outlined the possible implications for his activity. In some respects the session was merely an exercise; but, as Commissioner Dean had wisely suggested on Friday, the public and the Joint Committee would expect the Commission to respond to the new Soviet threat with specific proposals even though, as Dean believed, the Commission was "in an unusual state of readiness." The proposed report to the President would commit the Commission to constructing the waterworks for operation of the new DR replacement reactor recently completed at Hanford and a third addition, K-31, to the gaseous-diffusion plant at Oak Ridge. General McCormack suggested bringing more scientists into weapon development, transferring nonnuclear components of weapons to the military, speeding up the change of contractors at Sandia, and increasing the production of nonnuclear components. Walter J. Williams, the director of production, proposed to speed up the construction of the K-29 diffusion plant, already delayed by a lag in Congressional authorization, some changes in weapon specifications, and greater emphasis on Redox. The need for larger amounts of uranium ore was obvious, and John K. Gustafson, the director of raw materials, planned to meet that requirement by stepping up deliveries from the Belgian Congo and the Colorado Plateau. Lawrence R. Hafstad, the director of reactor development, was already thinking of new reactors to generate large quantities of neutrons for producing plutonium or even tritium for thermonuclear weapons.[15]

Lilienthal, just back from Martha's Vineyard, had his first opportunity on Tuesday morning, September 27, to judge the draft report to the President. He found no difficulty in accepting the proposals for expanding produc-

tion facilities, but the premises of the report bothered him. He had hoped that appointment of the special committee of the National Security Council would permit the Commission and the Department of State to participate in any recommendations to the President on military aspects of the atomic energy program. He thought a full and frank discussion of views within the three agencies would more likely lead to a balanced and forthright analysis of the issues for the President. As it now stood, the draft report did not represent a group judgment but rather was a composite of agency views; it accepted without explanation the statement of military requirements by the Joint Chiefs. Secretary Johnson clearly had no intention of admitting State Department or Commission officials to the inner circles of military planning. He had told Webster that he would not permit the Commission, as the "producer" of nuclear weapons, to participate with the military, as the "consumer," in determining weapon needs for the same reason that he was opposed to having the Department of Defense certify the need for additional Commission facilities.[16]

If Lilienthal now saw little chance of asserting the Commission's influence in military planning, he still hoped that he and his associates could present to the Joint Committee a balanced response to the Russian accomplishment. He told the committee on Wednesday, September 28, that the Commission saw the need for greater speed and higher priorities in producing nuclear weapons; but he maintained such action would mark no departure from the principle upon which the Commission had operated since 1946, namely, that the nuclear superiority of the nation's defenses always came first. He appreciated Congressional interest and support, but he implied in his statement that committee backing on such mundane matters as removing the construction rider recently attached to the Commission's appropriation would do more good than some hasty and dramatic declaration of Congressional intent. Getting down to practicalities, Lilienthal said the Commission would need as much as $30 million to construct the DR waterworks and as much as

$350 million for K-31. Should the President decide to seek immediate appropriations for these projects, Joint Committee support would surely be important. No less vital, Lilienthal said, was removal of the appropriation rider, which forbade the start of construction without accurate estimates of total cost. Williams argued that instead of starting construction when plans were 15 per cent complete, contractors would have to wait until 80 per cent of the drawings were finished. This limitation would cost the Commission at least five months in starting construction of the Redox plant.[17]

The committee's reaction was not very encouraging. Few members seemed convinced that the rider really hampered the Commission. More fundamental was McMahon's inability to agree that the situation demanded nothing more than speeding up the existing program, as Lilienthal contended. McMahon read into the record a letter he had written to Secretary Johnson on July 14. That letter, clearly reflecting the thinking of William L. Borden, the committee's staff director, started from the assumption that strategic bombing with nuclear weapons had become the nation's first line of defense. From this proposition McMahon was prepared to argue that the nation could never have enough atomic bombs. Borden and the committee staff had been cataloguing every conceivable measure for maximizing the nation's nuclear strength. He invited the Commissioners to come back the next morning to discuss the staff report.

That same afternoon the Commissioners had an opportunity to check their stance with the Military Liaison Committee at a regularly scheduled meeting. The service representatives confirmed their support of the draft report to the President as a sound and practical response to the Soviet threat. General Kenneth D. Nichols, chief of the Armed Forces Special Weapons Project, suggested a few measures to speed the conversion of the nuclear stockpile to newer models, but he agreed there would be little advantage in advancing the date of the next weapon test, scheduled for early 1951.[18]

On Thursday morning, September 29, McMahon began the hearing by reading Borden's staff report on increasing military strength. In writing about requirements, Borden did not miss the opportunity to raise again the question of the committee's access to weapon stockpile information. Without that information, McMahon added, the committee would find it difficult to share with the Commission the enormous responsibility of assuring the nation's defense in the atomic age. Even so, Borden found much in the existing situation to cause alarm. Production goals, Borden guessed, were probably not based on the assumption of a Russian detonation in the summer of 1949. He saw no reason to believe that the Russian effort would be limited by a shortage of raw materials or that it would be any smaller than the American program. Since World War II, the United States had devoted no more than one-thirtieth of its military budget to nuclear weapons. Did that seem sufficient? Did existing requirements for nuclear weapons contemplate bombing military as well as industrial targets in the Soviet Union? Borden had other questions, but the facts he had led him inexorably to the conclusion that there should be a substantial increase in the requirements for nuclear weapons and a new, concerted effort to develop the ultimate weapon system—the thermonuclear weapon carried by a nuclear-powered airplane.[19]

Lilienthal had Wilson and all the division directors present so that they could describe the steps already being taken to accelerate production. Although this discussion took several hours, the staff members had to do little more than repeat their presentations to the program council on Monday. The only new topics were the possibility of strengthening Los Alamos and building a thermonuclear weapon. On the first point, Wilson held that Los Alamos was making the best use of the "great men" of nuclear physics through consultantships and summer employment at Los Alamos. Teller had made it a practice to spend the summer with the theoretical division at Los Alamos after he joined the faculty at the University of Chicago. Lilienthal feared that

recruiting men like Eugene P. Wigner, Oppenheimer, Teller, and Leo Szilard for Los Alamos would undermine the morale of the excellent staff already there, by implying that it was not equal to the job. Pike suggested that Oppenheimer's talents would be better used if he were consulted on special problems rather than put to work full time at Los Alamos.

As for the thermonuclear weapon, Wilson described the Commission's plans for testing the principle of fusion. McCormack added that there seemed to be general agreement that development would be a major endeavor over a period of years. Such a weapon might be practical in sizes as large as one million tons of TNT. But no one yet knew how to obtain, even with a fission explosion, the temperatures and pressures necessary to trigger the thermonuclear reaction even if it could be triggered. Furthermore, it hardly seemed possible to carry such a weapon in an airplane; delivery by railroad train or by ship seemed more likely. In any case, thermonuclear weapons would probably require large amounts of the heavy-hydrogen isotope, tritium. Quantity production of that material would require reactors producing far more free neutrons than any facility then built or planned for plutonium production. McCormack suggested the possibility of starting development of such reactors at once, even though the scientists would not be able to answer many of the theoretical questions about the thermonuclear reaction before the 1951 weapon test series.

For the moment Lilienthal was concerned about closer cooperation with the British and better public understanding of civilian defense against attack with nuclear weapons. He acknowledged that the Government had supported some technical studies, but he thought there had been a lack of open consideration of general policy issues. Technical cooperation was now an urgent matter, and he accepted McMahon's invitation to discuss it with the Joint Committee early the following week. Shortly after noon as the Congressmen hurried to the floor, Lilienthal left the Capitol for lunch with Acting Secretary of State Webb, who told him that there was little hope of closing the gap between the British and American positions on the exchange of technical information. The stimulating conversation with Webb and George F. Kennan quickly dispelled his reflections on the morning's frustrations. On the plane that afternoon, returning to Martha's Vineyard, Lilienthal was preoccupied with the issues of international affairs. The grubby problems of production and weapons seemed suddenly far away.[20]

THE QUANTUM JUMP

The other Commissioners could not so easily escape the operating details on which the expanding production of weapons would depend. That same afternoon, Pike, Dean, and Strauss studied John K. Gustafson's plans for negotiations with the South Africans in November, the construction of a natural gas line at Oak Ridge, and the possibility of testing a new weapon model early in 1950. After the staff had left, the Commissioners came back to the matter of an appropriate response to the Soviet threat. Was the planned expansion of production facilities large enough or would some extra effort be necessary? Strauss, recalling earlier discussions, was leaning toward developing the thermonuclear weapon. Dean thought some extra effort was called for, but he had not yet decided what it should be. Pike as yet had come to no conclusions.

The discussion apparently clarified Strauss's views. The next morning he dictated a draft memorandum to his fellow Commissioners. The Commission had long held, he wrote, that the United States had to maintain its lead over the Soviet Union in atomic weapon superiority. Until September 23, the United States had enjoyed an absolute superiority; now it had only a relative advantage which would surely diminish. The nation should if at all possible regain the absolute advantage, and that could be accomplished only by a "quantum jump" in weapon technology such as the thermonuclear weapon promised. He urged the Commission to consult the General Advisory Committee on the subject.[21]

But how could Strauss persuade his associates and the Administration to accept his views? When he showed his draft to Pike and Dean on Friday, September 30, he found them open-minded but not convinced. He had no reason to believe that either Lilienthal or Smyth would accept his proposal. Without the Commission's support there would be little chance of bringing the issue to the President. He did not want to go to the President directly, but he was thinking of approaching Admiral Souers, whom he had come to know in the Navy during World War II. From his own experience Strauss knew how hard it was for a minority of one to carry an issue in the Commission, but in this instance he would have had reason to expect help. Teller and some of the scientists at Los Alamos were interested in the "Super." McMahon and

Borden were looking for ways of adding to the nation's nuclear strength, and their views might influence Dean. Another likely source of support was Ernest O. Lawrence and the scientists at the Berkeley laboratory, who had made it a tradition to meet every challenge in a national emergency. It had been a busy and somewhat confusing week, but the nation's response to the Soviet threat was beginning to emerge, at least in the form of alternatives. If Strauss could make those alternatives clear, he might be able to carry the decision.

When Lilienthal returned from Martha's Vineyard the following week, his thoughts showed how far Strauss was from his goal. Still struggling with philosophical issues rather than operating decisions, Lilienthal chose Wednesday, October 5, to discuss with the Commission the proposed report of the special committee of the National Security Council. He still saw the issue largely in terms of civilian-military control, but he had given up any hope of basing the report on broad considerations of national security or military strategy. With reluctance he was willing to send the report to the President as the best the Commission could do under the circumstances. This concession hardly sounded like the man who six months earlier had championed the Commission's right to participate in all discussions of national policy involving nuclear weapons. Somehow, the weeks of seclusion had failed to restore the energy and taste for a challenge which had always marked Lilienthal's career.

If the report were to go to the President essentially as it stood, the Commission could consider the mechanics for launching the construction of new production plants. The first step was to ask the President for a supplemental appropriation so that the Commission could negotiate contracts. Rather quickly the discussion descended into a morass of details concerning construction schedules, budget estimates, and obligational authority. For Strauss, still hoping that the Commission would find a bold and imaginative response to the Soviet threat, the discussion was a disappointment. There was no occasion to discuss the superweapon, or to present the memorandum he had drafted the previous week. Rather than force the issue, Strauss chose to wait until after the meeting to send Lilienthal a copy.[22]

Strauss found an occasion to unburden his concern that noon over lunch with Admiral Souers. The more he thought about it, the more he believed the Super was vital to the national security. The Commission was not prepared even to discuss the subject. Was the President aware of the possibility of a thermonuclear weapon? Souers did not think so. Strauss went on in a general way to explain the technical difficulties in developing such a weapon. These were formidable, but Strauss guessed they could be overcome. Clearly impressed, Souers urged Strauss to prod the Commission toward a report to the President. Later Souers found that Truman seemed to know nothing about the Super, but showed an immediate interest. Truman wanted Strauss to force the issue up to the White House and to do it quickly.

Just how Strauss was to accomplish his task was not at all evident. On

Thursday and Friday the Commissioners were preoccupied with the appropriation request for the new production plants, especially after they learned that the President did not intend to send Congress a supplemental request in the closing days of the session. Truman had concluded that a last-minute request would not only be bad legislative strategy but would also tend to exaggerate in public eyes the Administration's reaction to the Soviet accomplishment. Carleton Shugg and Wilson pointed out the danger of embarking on a construction program on the strength of informal and confidential assurances of Congressional support. On Friday Lilienthal stayed home to work on a speech while the rest of the Commissioners spent the day debating the issue with officials from the Bureau of the Budget.[23]

If Strauss had no further opportunity that week to advance his proposal, he might have taken comfort in other developments. On Thursday, the day after Strauss sent his memorandum to Lilienthal, Lawrence met Wendell M. Latimer, the dean of chemistry, at the faculty club in Berkeley. Latimer, long dissatisfied with the Commission's efforts in building a nuclear stockpile, was more worried than ever about national security after the Russian accomplishment. He felt certain that the Russians, spurred by the United States lead in producing fission weapons, would try a short cut to superiority by pushing development of a thermonuclear weapon. Lawrence was not easily swayed by new ideas, but he would not let technical difficulties stand in the way once he had decided such an idea was vital to the national interest.

Half-convinced by Latimer's plea, Lawrence headed back up the hill to the Radiation Laboratory, where he dropped in on Luis W. Alvarez, who was still directing the linear accelerator project. Alvarez was surprised to see Lawrence, but he soon understood the reason for the unusual visit. Alvarez agreed that the thermonuclear weapon would be an effective response to the Soviet threat. The obvious first step was to raise the question with the Commission in Washington. It so happened that Lawrence was to be in Washington over the weekend on another matter. He decided to take Alvarez with him to help arouse interest in the proposal. Recalling that Teller had for years been intrigued with the possibilities of the thermonuclear reaction, Alvarez suggested that they go east by way of Los Alamos, and the two scientists left San Francisco by plane that evening.

Teller had been more than interested when Alvarez called on the telephone, and he was eagerly awaiting the two Berkeley scientists when they arrived at Los Alamos on Friday morning, October 7. Only then did Teller realize he had made a tactical error; he had neglected in his excitement to inform Norris E. Bradbury of Alvarez's call. Annoyed that Teller had apparently gone over his head to discuss his pet idea with Lawrence, Bradbury asked John H. Manley, an associate director at Los Alamos and executive secretary of the General Advisory Committee, to sit in on all the discussions.

Alvarez and Lawrence also talked with the Los Alamos scientists who had been studying the thermonuclear reaction since 1947. If Teller had provided inspiration during his summer sojourns on the mesa, J. Carson Mark, leader of the theoretical division, had borne the daily responsibility for pursuing the idea. Working under Mark were several gifted physicists and mathematicians, including G. Foster Evans and Stanislaw M. Ulam, a protégé of John von Neumann, the mathematical genius who was dividing his time between Los Alamos and the Institute for Advanced Studies at Princeton. Late in 1947 Ulam had concluded that the best approach would be to develop some kind of probability theory to describe the interactions of protons, deuterons, tritons, and other heavier nuclei in the thermonuclear process. By the spring of 1948, Ulam and his associates, with von Neumann's help, had established the boundaries of the calculation, which would involve use of the Monte Carlo probability theories and the new electronic computer which von Neumann was developing at Princeton. Other scientists in the theoretical division at Los Alamos were also studying the fundamental physics of these very light particles. During the summer of 1948 Teller, in working on new weapon designs, had begun to think about using one of them to test thermonuclear reactions. That autumn Ulam began a study with Evans and George Gamow to describe such reactions in quantitative terms. By early 1949 with von Neumann's help, Ulam had completed a general description of the computations. Actual work on the computations could not begin until von Neumann had completed his computer at Princeton and a duplicate machine was built at Los Alamos, but Ulam and his group had plenty to do in developing plans for programming the computer once it would be available.[24]

This was the situation Lawrence and Alvarez found at Los Alamos. Mark, Ulam, von Neumann, Teller, and others had made important strides in defining the problems they faced, but they were obviously still a long way from knowing whether man could produce the thermonuclear reaction, and even farther from knowing how to do it. No matter how much they wished to accelerate work on the superweapon, Lawrence and Alvarez must have seen that actual design of the weapon itself would have to await the outcome of Ulam's calculations and the experiment with a thermonuclear system, which Teller was proposing for the weapon test series in 1951. How, then, could the impatient Californians occupy themselves in the meantime? What basis was there for an immediate, all-out effort on the superweapon? Teller provided the answer that evening in the hotel in Albuquerque. A thermonuclear weapon seemed certain to require large quantities of tritium, which in turn would call for plenty of irradiation space in a reactor with a relatively large supply of free neutrons. Lawrence and Alvarez could be of greatest help by convincing the Commission to support immediate construction of a production reactor which would use heavy water instead of graphite as a moderator.

Now the two scientists understood their mission. The long flight east put them in Washington shortly after noon on Saturday, October 8. Within the hour they were in the Commission's headquarters, where they discussed their ideas with General McCormack, Kenneth S. Pitzer, and Paul C. Fine, a physicist who specialized on weapon and production problems. On Sunday a meeting of the radiological warfare panel at the Pentagon gave Lawrence and Alvarez an opportunity to talk with Robert LeBaron, a chemical engineer who had succeeded Webster as Secretary Johnson's deputy for atomic energy and chairman of the Military Liaison Committee. Lawrence in his customary way was explaining his exciting new idea to those who might be able to lend support.

On Monday morning, October 10, Latimer joined Lawrence and Alvarez at the Commission's headquarters for further discussions with the staff. So far, no one they had seen had opposed their proposal with sufficient zeal to dampen their optimism, but they did not yet have any measure of Congressional opinion. That deficiency disappeared when Alvarez called Carl Hinshaw, a California Congressman who had been consulting him on air-safety systems. Hinshaw, a member of the Joint Committee, was pleased to learn that Lawrence was in Washington and promptly invited the two scientists to lunch with McMahon. The outcome was predictable: The legislators and the scientists were more than ever convinced that the superweapon might well save the nation from the Soviet threat.[25]

That Monday morning the Commissioners struggled with the President's refusal to consider a supplemental request for funds. Most of the discussion in the long meeting revolved around the danger of being placed under a special requirement without having the financial means for carrying it out. Late in the morning, however, Pitzer found an opportunity to mention his conversations with Lawrence and Alvarez. Smyth thought Berkeley's enthusiasm and experience in doing big jobs quickly might be useful, but he doubted that the laboratory's knowledge of reactors was sufficient for designing the big production units it was proposing. Pitzer replied that Lawrence intended to draw on Walter H. Zinn's experience with heavy-water reactors at the Argonne laboratory and that of the Canadian group at Chalk River. Both Smyth and Lilienthal hoped Lawrence would defer his proposed trip to Chalk River because the weapon implications of the project were too sensitive for discussions with the Canadians under the technical cooperation program.[26]

Later in the afternoon Lawrence and Alvarez returned for conferences with the Commissioners individually. For both sides the discussions with Lilienthal were most memorable. Alvarez found Lilienthal uninterested and almost repelled by the proposal. Lilienthal later recorded how distasteful he found the two scientists' ardor for weapons which could singly devastate a vast area. But neither the Commissioners nor Pitzer were able to deter Lawrence from his intention of visiting Chalk River. Moving north from

Washington, Lawrence and Alvarez stopped in New York to sound out Isidor I. Rabi, a member of the General Advisory Committee. Rabi welcomed them warmly and seemed pleased that they were taking an interest in the superweapon. When they were unable to obtain space on a plane to Ottawa, Alvarez returned to Berkeley and Lawrence to Washington, where he sought Nichols's aid in initiating in the Joint Chiefs of Staff a requirement for the superweapon.[27]

OPPENHEIMER WEIGHS THE ISSUES

By the time Lawrence returned to Washington, Lilienthal had already called Oppenheimer to arrange a special meeting of the General Advisory Committee. Presumably the committee of eminent scientists would be able to place in proper perspective the proposals generated by the enthusiasm of Teller, Lawrence, and others. Because Enrico Fermi was in Italy, Oppenheimer could not schedule the meeting before the last weekend in October. Even then, Seaborg, the young chemist at Berkeley, would be in Sweden and unable to attend.[28]

Faced with far-reaching policy issues, Oppenheimer began at once to seek expert advice. Von Neumann, who lived in Princeton, was immediately available. Although he had followed the theoretical work at Los Alamos closely, he could give Oppenheimer a detached view of the chances for success. Bradbury and Manley, who arrived in Princeton on the evening of October 20, presented a more cautious (Teller would have said negative) view of the situation. They recognized that the Los Alamos effort had not been geared to an assumption of Russian success as early as 1949 and that the laboratory program required reevaluation in the light of that accomplishment. Reactions at Los Alamos ranged all the way from an all-out effort on the Super to something approaching business as usual. It was not yet clear where the proper balance lay, but at least Manley was convinced that it would be unwise to choose a single course of action.[29]

Oppenheimer was careful not to commit himself during the meeting, but he put down some of his thoughts the next morning in a letter to James B. Conant, who had been his mentor in national policy matters since 1942. The Super, Oppenheimer wrote, was fast becoming a relevant alternative as a response to the Soviet threat. The technical prospects for the Super were not much better than they had been seven years earlier, but "two experienced promoters" like Lawrence and Teller were bound to change the climate of opinion. They had already had some effect on competent scientists, but they had made the greatest impact on members of the Joint Committee and the Joint Chiefs. The Joint Committee, "having tried to find something tangible to chew on ever since September 23rd, has at last found its answer. We must have a super, and we must have it fast." A subcommittee was heading west to investigate the prospects for the Super at Los Alamos and Berkeley. Oppenheimer confided to Conant that he was not concerned about the technical problem because he was not sure "the miserable thing" would work, nor that it could "be gotten to a target except by ox cart." He was worried that "this thing appears to have caught the imagination, both of congressional and of military people, as *the answer* to the problem posed by the Russian advance." He conceded "it would be folly to oppose exploration of this weapon," but he feared the nation's commitment to it "as the way to save the country and the peace." [30]

Oppenheimer had an opportunity to judge the military position for himself at a luncheon that noon with McCormack and LeBaron. There was very little time for all the items LeBaron wanted to discuss, but Oppenheimer probably noted LeBaron's interest in the Super. Later in the afternoon Hans A. Bethe and Teller arrived. Oppenheimer had been looking forward to this meeting because he knew that Teller had been trying to convince Bethe to return to Los Alamos to work on the Super. Bethe's acceptance of the offer would surely boost Teller's hopes of establishing an intensive effort on the Super at Los Alamos. During the meeting Bethe seemed to be leaning toward acceptance, but he was still undecided. Oppenheimer, still skeptical, was reserving judgment. None of the events of the past two days, including the meeting of the Emergency Committee of Atomic Scientists convening in Princeton for the weekend, could have helped to dissolve the reservations he had expressed in his letter to Conant.[31]

How the rest of the General Advisory Committee would react to the Super, Oppenheimer could only guess. He knew that Conant was dead set against any all-out effort that would disrupt weapon development at Los Alamos. Seaborg, who would not be able to attend the meeting, had written Oppenheimer a cautiously worded letter which seemed to come out somewhat reluctantly on the side of the Super. Manley, as executive secretary, would undoubtedly bring something of Bradbury's measured response to the meeting. Perhaps the balance of opinion would rest with Fermi, who would not return to the United States until a few days before the sessions in Washington.[32]

Almost as important would be the reactions of the Commission and its staff. Once back in Berkeley, Alvarez found a heartening response from Washington. Hafstad arrived in Berkeley on Friday, October 14, to discuss a possible site for the heavy-water reactor. The following Monday Hafstad and Zinn called Alvarez from Chicago to report that they were sending some reactor experts to Berkeley. The Commission officials did express some reservations about Lawrence's suggestion that the new reactor could be simply a scaled-up model of the experimental heavy-water reactor at Chalk River, but Lawrence felt confident enough to appoint Alvarez director of the new project. Not until the third week in October did Alvarez detect a note of caution in his telephone conversations with Hafstad and Pitzer. He concluded that Zinn and Alvin M. Weinberg, two leaders in the Commission's reactor development effort, were worried about Lawrence's "quick-and-dirty" approach to the Berkeley reactor design.[33]

Within the Commission itself there seemed to be little inclination to concentrate all additional resources on the Super. Although Senator McMahon on October 17 had requested a special report on the Commission's efforts to develop the Super, the Commissioners were necessarily preoccupied with the expansion program, which the President formally approved on October 19. At the President's insistence and much to McMahon's disappointment, the Commission would have to undertake the project initially with $30 million from current appropriations. Getting work started on the new Hanford and Oak Ridge production plants certainly took precedence over plans for a new type of weapon which would not be available for years, if ever. Even so, the

Commissioners saw a much broader purpose in the meeting of the General Advisory Committee than did Teller or Alvarez.

In the Commission's formal statement of the subject for the special meeting, Acting Chairman Pike wrote Oppenheimer that the Commission was interested in the broad question of "whether the Commission is now doing things which might well be curtailed or stopped, and also what further things we ought to do to serve the paramount objective of the common defense and security." Plans for civilian defense and the expansion of production facilities were the first order of business. As for the superweapon, the Commission wanted to know whether the nation would use such a weapon if it could be built, and what its military worth would be in relation to fission weapons. Aside from the Super, Pike expressed the Commission's keen interest in immediate expansion of heavy-water production and in a reactor which would generate excess neutrons as well as plutonium. The tentative language of the Pike letter would have profoundly discouraged McMahon, Teller, and Alvarez, who saw the specter of a Russian hydrogen bomb hanging by a thread over a defenseless America.[34]

TIME FOR DECISION

During the last week in October, 1949, both Teller and Lawrence were on the move. Teller had been on hand at the Chicago airport on October 24 to greet Fermi when he arrived home from Italy. Tired and benumbed by the trip, Fermi had scarcely reacted to Teller's excited recitation of recent developments in his crusade for the superweapon. Teller hoped to see Fermi again before the General Advisory Committee met, but he would have to leave almost at once for Los Alamos to greet Congressmen Chet Holifield, Melvin Price, and Hinshaw, all members of the Joint Committee who were interested in the pace of weapon activities at the laboratory. Thus Teller could not be present when Alvarez and Lawrence arrived in Chicago to discuss reactor design with Zinn and his Argonne staff; it was more important to introduce the members of the Joint Committee to the crucial need for the Super. Robert Serber, carrying instructions from Lawrence, had gone off to Princeton to present the case for the heavy-water reactor to Oppenheimer.[35]

In Washington Manley was already at work, with the help of the Commission's staff, in collecting pertinent information for the meeting of the General Advisory Committee. The broad policy issues to be discussed required an unusual number of technical papers and staff studies. In addition to Pike's letter to Oppenheimer and McMahon's letter to Lilienthal on the need for increasing the nation's atomic might, Manley selected staff papers on a possible test of a new weapon design in 1950, the Commission's activities in civilian defense, the Commission's 1951 budget, and the recently approved plans to expand production facilities. There were also special reports from the Commission's staff on the superweapon, the expansion program, and reactor development. Manley himself added a paper on the Super, which repeated his earlier conviction that Los Alamos should not place all of its resources on a single effort. Looking over Manley's collection of documents, Wilson saw little possibility that the advisory committee could come to any conclusions even over a long weekend. He suggested to the Commissioners that they convene a panel which could devote several weeks to studying the issues. Dean liked the idea and urged the Commission to include in the panel military and outside experts as well as its own staff. Manley thought it might be appropriate to suggest the panel to the committee, and the Commission agreed that Lilienthal should present the idea.[36]

The complexity of the issues facing the committee had already forced Oppenheimer and Manley to revise the schedule for the meeting. The first session would now take place on Friday, October 28, to provide more time for the informal exchange of ideas. At two o'clock on Friday afternoon Oppenheimer arrived at the Commissioners' conference room overlooking Constitution Avenue. With him was George F. Kennan, counselor of the State Department and adviser to Secretary Acheson. Manley's staff was distributing the folders of background papers as the members arrived—Fermi, Rabi, Buckley, Cyril S. Smith, and Lee A. DuBridge. Only Seaborg, Conant, and Hartley Rowe were absent. For almost an hour Kennan drew on his knowledge of the Soviet Union in answering the committee's questions about the world situation. There was only a momentary break in the discussion when Kennan left and Rowe arrived. The world scene and the place of atomic energy in it was the topic of conversation until four o'clock.[37]

For the remainder of the afternoon the committee heard Bethe and Serber discuss some of the alternatives the Commission faced in weapon development. Bethe, after soul-searching discussions with Teller and Oppenheimer, had decided some days earlier that he would not participate in the project Teller was trying to form. The probable effects of the Super had convinced Bethe that even for the victors the world would not be worth preserving after a war with such weapons. On this occasion, however, he confined his remarks to the technical feasibility of the Super. Serber spoke for Lawrence. Carefully limiting his comments to an appeal for action and to the advantages of a large neutron-producing reactor, Serber disassociated himself from Teller, Alvarez, and the Super. Already convinced that the Super as then conceived would never work, Serber was pleased that he did not have to discuss the subject. Fermi concentrated on the Berkeley reactor proposal, which he challenged on the grounds that Lawrence and his staff lacked sufficient experience with reactors. Serber replied that Lawrence was primarily interested in action and would be happy to have another laboratory undertake the project. It was difficult to tell what effect the discussion had on the committee, but Serber left the room feeling that neither the Super nor the

Berkeley proposal would win the committee's approval.

The meeting in the Commission's headquarters building broke up before the dinner hour, but the discussion probably continued in hotel rooms during the evening. By the time the committee reassembled on Saturday morning, there was general agreement that the Super would be a key factor in evaluating the broad questions the Commission had raised.[38] This point decided, the committee turned to the impressive list of witnesses scheduled for the morning session. Alvarez, unable to stay far from the scene, had stationed himself in the headquarters building, where he could watch the participants come and go from the conference room. The Commissioners arrived at ten with Wilson, Shugg, and the division directors. Lilienthal had a typed statement which he intended to use in presenting the idea of a panel to study the complex issues confronting the Commission. The division directors were available to answer questions about the background material. Alvarez was impressed when the Joint Chiefs of Staff arrived at eleven with LeBaron, Generals John E. Hull and Lauris Norstad, and Admiral Parsons. Beyond the obvious fact that the military implications were discussed, the only incident anyone recorded of the meeting was General Bradley's statement that the principal advantage of the Super would be psychological.[39]

At noon, after the military contingent had left, the committee members and the Commission participants went off to lunch in small groups, Lilienthal with Strauss and Oppenheimer with Alvarez and Serber. In a small restaurant near the headquarters building, Oppenheimer explained his reservations about developing the thermonuclear weapon. Such an effort, he said, would likely cause the Soviet Union to do the same, with possibly disastrous results for mankind. When Alvarez saw that Serber agreed with Oppenheimer, he realized that the proposal to build a heavy-water reactor on the shores of San Francisco Bay within sight of the Berkeley laboratory was dead. Profoundly disappointed, he returned to Berkeley without waiting for the end of the meeting.[40]

The General Advisory Committee had scarcely begun its deliberations. On Saturday afternoon there was a long session with the Commissioners and their intelligence staff. On Saturday evening the positions of individual members began to emerge. Early Sunday morning Oppenheimer presided as the members orally formulated the general outlines of their report to the Commission. Then Lilienthal and the other Commissioners arrived for two hours of discussion. There would be a general report from the committee, plus supplementary statements from two groups of members. The committee agreed to let the Commission make any use of the report and statements it wished. The committee would not discuss the results in public until the Commission approved, and individual members would refrain from commenting personally for one week.[41]

After lunch on Sunday, Oppenheimer and Manley set to work on the committee's report. They could check drafts with the other members, who were reviewing sections of the report and the supplementary statements. By
three o'clock the three documents were complete. The first section of the report, compressed into less than two typewritten pages, spoke to the questions raised in the Commission's formal request for advice. The committee was not satisfied with the existing production of fissionable material. The Commission should put high priority on studies of costs, yields, and time required for building additional facilities. Cost should be estimated but it should not be a factor in determining whether or not to build new plants. The committee gave equally high priority to developing atomic weapons for tactical purposes and building a reactor generating a large amount of free neutrons. The reactor could not only produce tritium, as Lawrence had suggested, but also such vital materials as plutonium, uranium 233, and polonium. The Commission should ask the Argonne laboratory, the Commission's reactor center, to expedite the design of the new reactor.[42]

The second part of the report, devoted to superweapons, received almost the same amount of space. After long consideration, the committee had decided that it could not endorse high-priority development of the superweapon, mostly for technical reasons. A successful Super would likely require large amounts of tritium, and thus great reactor capacity. The fundamental theoretical studies of the thermonuclear reaction were not yet complete, and even if they proved promising, they would have to be substantiated by carefully instrumented tests. Only then could the Commission begin to consider the formidable engineering problems involved. Predicting the outcome of such an effort was impossible, but the committee believed that "an imaginative and concerted attack on the problem has a better than even chance of producing the weapon within five years."

If the weapon *could* be built, the next question was whether it *should* be. Here the committee found of paramount importance the fact that a superweapon could be of unlimited size. Once the reaction was initiated, it could be sustained, theoretically, simply by adding more heavy hydrogen.

Load limitations in military aircraft would probably hold airborne Supers to not more than one hundred times the power of existing fission weapons, but delivery by ship or submarine would remove this limit. Clearly the use of such a weapon could not be restricted to military targets and would make possible extension of "the policy of exterminating civilian populations." Each member of the committee, the report stated, put stress on a slightly different combination of considerations, but there was general unanimity in the hope that development of superweapons could be avoided. All were agreed that it would be wrong at that moment to commit the nation to an all-out effort in this direction.

Just how the Government should proceed to forswear the development of the Super was not resolved, as the appended statements indicated. The first, which Conant, Rowe, Smith, DuBridge, Buckley, and Oppenheimer signed, proposed a complete and unconditional renunciation. So tremendous would

be the power of the Super that its blast and radioactive effects would make it "a weapon of genocide." The existence of such a weapon would be an intolerable threat to the future of the human race. Development of the Super would not deter the Soviet Union from doing the same, and even if the Russians used such a weapon, the United States would have a sufficient stockpile of fission weapons for an adequate reprisal.

The second appended statement presented the views of Rabi and Fermi. Likewise starting from the extraordinary power of the Super, the two physicists concluded that the weapon entered the range of "very great natural catastrophies" and could not be justified "on any ethical ground which gives a human being a certain individuality and dignity even if he happens to be a resident of an enemy country." Its unlimited destructive power made the Super "necessarily an evil thing considered in any light." Fermi and Rabi thought the United States should invite the nations of the world to join in a pledge renouncing the Super. In their opinion, a pledge would be acceptable even if not guaranteed by an effective international control system, and like the rest of the committee they believed the nation's stockpile of atomic weapons would provide adequate means for military retaliation. What the course should be if other nations would not make such a pledge, Fermi and Rabi did not specify. Presumably they would then reluctantly favor development of the Super.

The only other opinion was that of Seaborg, who had sent his thoughts to Oppenheimer in a letter two weeks earlier, before his departure for Sweden. Offering more questions than answers, Seaborg summarized his position by saying that "I would have to hear some good arguments before I could take on sufficient courage to recommend not going toward such a program." Whether Oppenheimer discussed Seaborg's letter with the committee was never clarified.[43]

After the committee formally adjourned, Oppenheimer and Manley cleaned up the drafts for the typist. It had been a long, grueling weekend, one charged with emotion and not lacking implications for the future. Oppenheimer had enough experience in Government to know that the opinions of scientists were not always heeded, but at least the committee had expressed itself forcefully and directly.

By four o'clock the drafts were in good enough form to leave the finishing touches to Manley. Oppenheimer left with Serber for a meeting of educators at the Statler Hotel. Late in the afternoon he was back at Commission headquarters for a brief conference with Joseph A. Volpe, Jr., the general counsel, and with Herbert S. Marks, now in private law practice in Washington. Before leaving to catch the evening train back to Princeton, Oppenheimer stopped in to see Lilienthal. The committee, Oppenheimer thought, had done a good job, but he was worried about the Commissioners and particularly about Lilienthal. As often in the past, Oppenheimer could not be sure the Commissioners would be able to carry forward the committee's ideas or even, for that matter, fully understand the issues. Certainly Lilienthal knew what was at stake, but Oppenheimer was no longer sure that Lilienthal had the necessary energy and resiliency to carry a tough decision through the Commission.[44]

ALTERNATIVES TO THE SUPER

Lilienthal himself found the weekend's development encouraging. He thought the General Advisory Committee's report might help to prevent a precipitous reaction to the Soviet threat. He could not forget the feeling that a substantial minority of the committee might have favored the Teller-Alvarez proposal on Saturday. Despite what Lilienthal considered the "bloodthirsty" attitude of some scientists, the committee had found its way to a unanimous recommendation against the superweapon. On Monday morning, October 31, he called Conant to congratulate him on the outcome. Without Conant's unswerving opposition to the proposal, he thought the committee's report might well have favored it.

The report had pleased Lilienthal; but, as he told Secretary Acheson on Tuesday morning, the idea of forswearing the Super did not by itself seem a convincing response to the enormous pressure which had built up for the weapon. Lilienthal was searching for some way to tie the renunciation of the Super to a broad statement of national policy, such as only Acheson or Truman could proclaim. He hoped the Commission would have time to formulate such a policy, something broader than the committee's recommendation, which he and Acheson could take to the President. The difficulty was that there was at least a 50–50 chance of developing the Super, and the Joint Committee was determined to have it. On Monday afternoon the Commission had discussed the committee's report with McMahon. The Senator's reaction discouraged Lilienthal. McMahon, in Lilienthal's words, saw war with Russia as inevitable. The Super was the only sure defense against such an enemy. McMahon was writing to Truman asking for a chance to be heard should the President be inclined to accept the committee's recommendation. Acheson could see that the Commission might have trouble holding off the Joint Committee while it explored policy issues.[45]

Manley, sensing the danger of indecision within the Commission, heard Oppenheimer confirm his fears in a telephone conversation on Monday morning, October 31. Oppenheimer's description of his talk with Lilienthal convinced Manley that he should stay in Washington for a few days to see that the committee's report was not lost in the confusion of other matters. He found that Pike shared some of his impressions of Lilienthal's fatigue. Pike saw a striking contrast to the courageous leadership Lilienthal had exhibited at the confirmation hearings in 1947, and some of the headquarters staff were nervous that Lilienthal would see that others had noticed the change in his demeanor. If Lilienthal could not act, Manley hoped that someone else would. Frustrated at finding in headquarters the feeling that the committee report was too sensitive for staff discussions, he turned to Volpe and Frances Henderson of Lilienthal's staff. Together they saw Wilson about preparing a staff paper that would translate the committee's report into some concrete proposal for Commission action.[46]

Lilienthal had time during the middle of the week to think about these issues away from the pressure of Washington. Shortly after noon on Tuesday, November 1, he left on the Commission's plane for speaking engagements in the Chicago area and a visit to the Argonne laboratory. On the plane flying back to Washington on Thursday morning he began putting his thoughts on paper. He was pretty much convinced that the Commission should advise Truman against proceeding with the Super. But, recalling his discussion with Acheson, he was looking for something more than a negative recommendation. Tentatively he thought of a new high-priority effort toward producing fission weapons, with special stress on developing tactical weapons, which would reduce the possibility of indiscriminate bombing of civilian populations. The President, Lilienthal speculated, might announce the nation's intention to refrain from developing the Super, and at the same time propose a "Plan for World Survival," which would control weapons of mass annihilation.[47]

The Commission met as soon as Lilienthal reached his office on Thursday afternoon. Following Lilienthal's statement proposing flat renunciation of the superweapon, the other Commissioners presented their views. Smyth said that after examining the military, psychological, and international factors he had concluded that the military value of Supers for the United States would be doubtful even if the Russians did develop them. He also agreed with Lilienthal that the issue provided an excellent opportunity to reopen discussions of international control, and he argued that these discussions would have greater chance of success if the United States announced in advance that it did not intend to develop the Super. Although Smyth admitted that the chances of success were small, he wanted to reserve the right to reverse a decision against the Super within six months or a year.[48]

Lilienthal was surprised to discover that Dean had now taken a firm position against the advisory committee's report. Dean opposed the idea of "renounce and announce." It would have a bad effect on the American people and Western Europe and would not impress the Kremlin. He thought it also unwise to renounce the weapon without announcing the decision, mainly because the secret could not be kept; the United States would then lose the opportunity for international negotiations. Dean suggested instead that the President through regular secret diplomatic channels inform the Kremlin that the United States did not want to develop the Super if there were any hope of international control and the elimination of weapons of mass destruction. If this approach failed, the President could then make the decision solely on the military and psychological value of the weapon. Pike had not yet made up his mind on the subject.[49]

Strauss began by asking whether the chances of successful development of the Super were good enough to warrant the diversion of the necessary talent, material, and funds from other projects. If the odds were good, Strauss said he would then want to know how much tritium would be required and what the explosive yield of the Super might be. There was wide difference of opinion on both these points, and even after they had been settled the military services would have to determine the value of the weapon. In fact, Strauss noted, the Commission did not even know whether the military wanted the superweapon. As for the effect on Western Europe of any of the courses of action proposed, Strauss thought only the State Department was competent to judge. On the purely technical and economic questions which were within the Commission's competence, Strauss said he failed to see the consistency in a position which advocated developing more efficient and more powerful fission weapons but rejected the Super.[50]

The broad range of opinions led Lilienthal to suggest that the Commissioners not seek any one position on which they could all agree but rather offer the President conclusions reflecting disagreements in principle or emphasis. Strauss, following his earlier reasoning, doubted that the Commission should submit any report to the President without first consulting State and Defense. Wilson was more concerned with technical matters; he thought the staff should investigate the possible consequences of using the Super. For example, was it possible that explosion of superweapons would dangerously increase the amount of radioactive carbon 14 in the atmosphere? Could the existing plants produce enough tritium to make a superweapon practicable? Answering these questions would not delay a policy decision, but Strauss's suggestion surely would. The only consensus of the meeting was that the staff should draft a statement which might later be sent to the President or to the Secretaries of Defense and State.

By this time, new pressures were beginning to mount. Teller had impressed the delegation from the Joint Committee with his descriptions of the Super during the visit to Los Alamos in late October. On Wednesday, November 2, he had arrived in Washington to see McMahon, despite a suggestion from Manley that the meeting would only confuse the situation. Several weeks earlier Teller had arranged to see McMahon about Los Alamos activities. Although Fermi had refused to break his pledge of silence concerning the General Advisory Committee's report after his return to Chicago, Teller had gathered that the report had not been favorable. McMahon confirmed his suspicions. The report, McMahon said, made him sick. In a few days he expected to leave Washington for a swing through the Commission's

western facilities, including Los Alamos, to check the facts for himself.[51]

Lilienthal used Friday morning, November 4, to explore the possibilities of advancing the proposal he had sketched out on the plane the day before. Oppenheimer called early Friday morning to tell him that he had an appointment with Acheson that afternoon. That seemed a good opportunity to suggest the peace plan. The similarities to the struggle in which the three men had been engaged in early 1946 were too obvious for them to miss. Perhaps this was one last chance to save the world from a senseless drift into mass suicide. At least Webb was reassuring. He told Lilienthal that Acheson had raised the question of the Super with the President as a problem with the broadest domestic and international ramifications. Webb agreed with Lilienthal that the Commission should not try to clear its report to the President with State and Defense; Kennan was already examining the issue from the international perspective.[52]

A RECOMMENDATION TO THE PRESIDENT

The Commissioners were no closer to agreement on Friday afternoon than they had been on Thursday. Now that Dean had joined Strauss in a firm position against Lilienthal and the General Advisory Committee's report, there was little possibility of agreeing on a single recommendation to the President. But could Oppenheimer use the great power and prestige of the advisory committee to break the deadlock? It would not be the first time the committee had unceremoniously reversed a Commission decision. Such thoughts might have been in Lilienthal's mind when, at an appropriate time in the discussion, he mentioned that Oppenheimer had asked him whether, under the circumstances, the Commission would object if the committee took the question of the Super directly to the President. The suggestion presumably reflected Oppenheimer's concern about Commission initiative and all but forced the Commission's hand. If the Commission did not act, it surely could not keep the advisory committee from going to the President. The obvious recourse was for the Commissioners to meet with Oppenheimer and the committee in an effort to reach a position all the Commissioners could accept. The meeting ended with a decision that the Commission would ask as many of the members of the committee as possible to meet in Washington on Monday, November 7. Unfortunately Strauss was leaving for Los Angeles that same day, but all the other Commissioners would be present.[53]

At ten-thirty on Monday morning the Commission met to frame its questions for the afternoon session with the General Advisory Committee. Lilienthal had to leave the discussion shortly before noon for an appointment with the President. This was a day he had long anticipated. He was submitting his resignation as the Commission's chairman after nineteen years of Government service. That thought filled his mind as he entered Truman's office and a feeling of remorse swept over him. Truman understood his reasons for wanting to leave, but he hoped Lilienthal would stay until he found a suitable successor. Truman said he wanted someone who would let neither the Joint Committee nor the military run away with the project. The President also made a solemn reference to the decision on the superweapon. Lilienthal said the Commission was trying to get up a paper on the subject before McMahon and the scientists tried to "blitz" the White House for a quick decision.[54]

On such short notice only Oppenheimer, Conant, Rabi, Fermi, Smith, and Manley were able to attend the meeting with the Commission that afternoon. Somehow the opening discussion was labored and artificial, and Lilienthal probably welcomed an interruption by Bernard Baruch, who dropped in to say "hello." Lilienthal's second start was not much better. To Manley's disappointment, he seemed full of questions rather than answers. How urgent, Lilienthal asked, was a decision on the Super? What advantages did the committee see in a public announcement of the nation's intentions? Would a decision not to proceed with the Super be irrevocable? How sound were the technical estimates of the time scale and chances for developing the Super in the Soviet Union and the United States? There were awkward pauses in the discussion, and Smyth, who had been away on business during the committee's meeting in late October, found the discussion no clearer than the committee's report. Dean was equally disenchanted, but for another reason. As the discussion continued, he got the distinct impression that the purpose of the meeting was not to explore the issues, but to persuade him to accept the committee's recommendations. His annoyance growing as the meeting wore on, Dean did his best to disguise his feelings. Perhaps Lilienthal sensed the tension in the room; perhaps, as Manley concluded, he had lost all stomach for a fight. Despite Conant's call for the Commission to seize upon the occasion to reassert the principle of civilian control, Lilienthal was careful not to push the discussion to any conclusions. Oppenheimer and Manley had failed to spur the Commission to action, but Manley took some comfort in the fact that the committee had at least had an opportunity to present its views in person. The meeting broke up after six o'clock on an amicable note, and Lilienthal took the trouble to thank Oppenheimer and Conant for their efforts before going home.[55]

By the time the Commission met on Wednesday morning, November 9, to consider the draft report to the President, both Strauss and Pike were in California. Dean had reported to Strauss by telephone the events of Monday, and Strauss was elated to learn that Dean was swinging away from the position of Lilienthal and the advisory committee. Although Pike and Smyth seemed opposed to an all-out effort on the Super, they did not necessarily agree with the General Advisory Committee's report or any other fixed position. It seemed doubtful that the Commission could ever reach a firm position on which all members could agree. In any case, Lilienthal had no thought of trying to delay the report to the President until the Commissioners had defined and resolved their differences.[56]

The reason for haste was clear on the first page of the draft report. A group from the Joint Committee had recently visited Berkeley and Los Alamos. "They," the draft read, "came away with enthusiasm for an immediate program, at highest priority. Several scientists have become missionaries for the project." McMahon had announced that he planned to call a special executive meeting of the full committee within a few weeks. The Commissioners were convinced that public discussion of the Super "probably very soon, is inescapable, is necessary, and is desirable." As background for the Commission's opinion, the report presented eleven technical considerations, including the fact that the Super could probably be developed, but not in less than three years. It would have unlimited power and the primary explosive would be relatively inexpensive and plentiful. The general principles of the reaction were well known, and the Russians were equally capable of developing such a weapon. General considerations included the facts that the Super would be a weapon of mass destruction, and that beating the Russians in the race for the weapon would require an all-out effort which would disrupt existing projects and could not be kept secret.[57]

From these considerations, the report stated, Lilienthal, Pike, and Smyth recommended against development of the Super at that time. They thought the President should make this decision public, with Smyth adding the suggestion that the President use the announcement to propose renewed negotiations for international control of atomic energy. Dean and Strauss, the report read, recommended an approach to the Soviet Union by secret diplomatic channels to explore the possibility of international control. If that approach failed, the President, with the Defense Department's approval, could announce his decision to proceed with the Super.

To the report the Commission attached the views of the individual

Commissioners. Lilienthal chose to take the broad view that development of the Super, which he saw as a weapon of mass destruction without any apparent peaceful applications, would convince the world that the United States had resigned itself to war. In this sense, development of the Super would not be in the interests of national strength and security. Dean and Smyth added their comments, which contained only minor changes from what they had said on November 3. The two absent Commissioners would be free to send the President their individual views later. To these attachments the Commission added a historical summary of scientific interest in the thermonuclear reaction since 1939 and the General Advisory Committee's report of October 30.

Late on the afternoon of November 9, Lilienthal took the Commission's report to the White House. Unexpectedly Matthew J. Connally, the President's appointment secretary, waved him into Truman's office. The President was in a good mood, having just learned that Herbert H. Lehman had won the New York seat in the Senate from John Foster Dulles. Truman had a few moments to talk about the report and Lilienthal's successor. When he left, Lilienthal was convinced the report had struck the right note. If he had stopped the onrush to seek national security in weapons of mass destruction, his three years of turmoil as the Commission's chairman would be worth the price.[58]

THE CASE FOR THE SUPER

The report to the President by no means settled the fate of the Super. If anything it strengthened the determination of those who believed its development was vital to the national security.

In the solitude of a hotel room in Beverly Hills, California, Strauss was trying to draft his own views on the question in a letter to the President. Initially disheartened by his failure to win his colleagues' support for a "quantum jump" in nuclear armaments, he found new hope in reports from Washington that the Commission had not given rubber-stamp approval to the recommendations of the General Advisory Committee. The opportunity for the Commissioners to submit individual opinions opened a way to offset the awesome weight of the advisory committee's views. Even more encouraging was a surprise visit from McMahon, who stopped in Los Angeles to discuss with Strauss his plans for bringing the question of the Super before the Joint Committee and the President. McMahon had described his reaction to the General Advisory Committee's report and his letter to Truman on November 1. His meeting with Teller on November 2 had strengthened his determination to speed work on all types of nuclear weapons. He was about to begin a tour of the Commission's major facilities in the West, including Los Alamos and

Hanford. Sharing the same concerns about the urgency of the Super, the two men came away from their meeting with renewed conviction. It was just possible that the future of the nation might hang on their ability to rally support for a truly convincing response to the Soviet threat.[59]

Ironically, McMahon's principal host at Los Alamos would be Manley, one of the most eloquent opponents of the Super. While in Chicago on his way home, Manley had received a telephone call from Wilson requesting him to show the General Advisory Committee's report to some of the leaders at Los Alamos and Berkeley in preparation for McMahon's visits. Manley, however, was scheduled to serve as acting director of the Los Alamos laboratory during Bradbury's absence the following week. The assignment would prevent Manley from going to Berkeley and would place upon him the responsibility for briefing McMahon and Borden on November 15.[60]

After two weeks' absence Manley was anxious about the situation at Los Alamos. Arriving too late on Friday, November 11, to accomplish anything, he waited until Saturday morning to arrange a meeting with Bradbury and Carroll L. Tyler, the Commission's local manager. The three men spent all afternoon discussing the General Advisory Committee's recommendations and the Commission's report to the President. On Sunday morning Manley invited both Mark and Teller to read the report. At first Teller made no comment and only after some prodding admitted his extreme disappointment that the distinguished scientists on the committee had not suggested a more imaginative response to the Soviet challenge. In similar discussions during the next three days Manley found enough diversity of opinion to suggest the possibility of winning support for the committee's position if enough people understood the context of its opinion. Whether Manley could provide that understanding was a question. Stanislaw Ulam probably reflected the attitude of many scientists at Los Alamos in a letter to his friend, John von Neumann. Referring to the General Advisory Committee's report, Ulam wrote of the "weird and unnatural things going on in Washington." In the long run, he thought the report would merely mean a loss of time and did not represent a final decision against the Super. He claimed the results of the Washington meeting had been completely predictable, but he suggested that some of the opposition to the Super might have been a reaction against Teller's insistent advocacy of the new weapon.[61]

Manley's supreme test as advocate for the General Advisory Committee came on Tuesday, November 15, when McMahon and Borden arrived for their briefing. In the first few minutes Manley saw that he would have trouble focusing the discussion on technical as opposed to policy issues. As Manley recorded the conversation, McMahon denounced the committee's recommendations as a suicidal response to a challenge by an immoral and implacable enemy. He accepted Manley's observation that this opinion amounted to a "war-now" philosophy; the only alternative McMahon could suggest was to announce as an ultimatum that the United States would proceed to develop the Super until the Russians "behaved." For much of the morning, Manley kept the conversation on technical developments in the laboratory, but the tone shifted again at noon, when Robert LeBaron, chairman of the Military Liaison Committee, and General Schlatter joined the group for lunch. Manley's spirits sank as McMahon and LeBaron found themselves in general agreement on the potential value of the Super. As the group walked back to the laboratory after lunch, Manley began to understand the depth of the convictions on which McMahon and LeBaron based their opinions. In a frightening and dangerous age, the Super might well offer the nation a measure of security no other weapon system could provide.[62]

The technical discussions during the afternoon session centered on new weapon designs. Teller gave a balanced appraisal of the Super. He stressed that all the studies to date had been theoretical and that no one could be sure whether a thermonuclear reaction could be propagated. He described plans for initial experiments during the 1951 weapon test series; and he cautioned that, even if successful, the experiments would not prove that a weapon was possible. In the end, however, Teller could not conceal his personal commitment to the Super. Despite the unknowns, he believed the chances for success better than 50 per cent. To Manley and others at Los Alamos, the statement was another example of the way Teller's enthusiasm for the Super ran counter to his judgments as a scientist.[63]

That evening Manley had some encouraging words to report to Oppenheimer by telephone, but he could not disguise his concern about the course McMahon was pursuing. However superficial his reasoning might seem to Manley, McMahon appeared to be driven by convictions strong enough to carry him over any obstacles. That afternoon he was off to Hanford for a tour of the plant, more discussions, and a press conference. The following weekend in Los Angeles he began revising Borden's draft of a letter for the President. "The profundity of the atomic crisis which has now overtaken us," the final version read, "cannot in my judgment, be exaggerated. The specific decision that you must make regarding the super bomb is one of the gravest ever to confront an American president." These were the opening sentences in a five-thousand-word letter refuting the arguments of the General Advisory Committee.[64]

McMahon admitted the horror of the superweapon, but he suggested that the same horror might save the nation from enemy attack. He challenged the argument that the military value of the Super was dubious, by suggesting that even if there were only a few targets for superweapons, their availability would release for other use a large number of fission weapons. The Super, McMahon contended, would produce more damage for less cost than fission weapons and might well prove decisive against isolated tactical targets as well as large centers of population. Furthermore, McMahon could see "no moral dividing line . . . between a big explosion which causes heavy damage and many smaller explosions causing equal or still greater damage." In the face of Russia's great manpower, the United States had no choice but to rely on strategic air power, which with the Super would guarantee victory over any enemy. "If we let Russia get the super first," McMahon concluded, "catastrophe becomes all but certain—whereas, if we get it first, there exists a chance of saving ourselves." He urged the President to take the entire question to the people of the United States and the world. The people had a right to know what great danger threatened them, and perhaps public opinion could force the Kremlin to accept a sane control plan.

AN ISSUE FOR THE ADMINISTRATION

Even before McMahon had finished his letter, the Super had come close to

being a public issue. Three days earlier, on November 18, Alfred Friendly had reported in a feature article in the Washington *Post* a fact that official Washington had apparently missed. Friendly claimed that Senator Edwin C. Johnson had mentioned the Super on a television program in the course of castigating the scientists for security leaks. Broadcast on a local New York station on November 1, the Johnson statement had escaped newspaper comment until Friendly obtained a transcript. Apparently alarmed that the Super might become a subject of public debate, Truman summoned McMahon and Attorney General J. Howard McGrath to the White House on November 26 and told them he wanted the security leaks plugged. After reading McMahon's letter, Truman may have had more reason to be concerned about McMahon's ability to keep the debate out of the press than about Johnson's statement, but the Colorado senator bore the brunt of the press criticism.[65]

If Truman's quick action prevented the debate over the Super from becoming a public issue, key members of his Administration were already embroiled in the subject. On November 18, Truman told Lilienthal that he was again calling on the special committee of the National Security Council, consisting of Secretary Johnson, Acheson, and Lilienthal, to evaluate the Super in terms of political and military as well as technical factors. In one sense, Truman's decision could not have displeased Lilienthal since it offered a way to delay a decision on the superweapon, but it did indicate that the President was not ready to accept any recommendation against the Super without more study. Now it would be necessary once again to appoint a working group from the staff and begin the long process of developing a position with State and Defense.[66]

In the closing days of November, there was a chance to tie up some loose ends. For the Commission that meant announcing Lilienthal's resignation and, in very general terms, the plans for major plant additions at Oak Ridge and Hanford. Lilienthal also completed the Commission's record on the

Super by forwarding to the President the individual views of Strauss and Pike.[67]

Both statements were largely a summary of earlier opinions, but Strauss now was willing to advocate the Super explicitly. In his opinion, it would be unwise to renounce unilaterally any weapon which an enemy could reasonably be expected to possess. He urged the President to direct the Commission "to proceed with the development of the thermonuclear bomb, at the highest priority," subject only to the judgment of the Departments of Defense and State. To his letter, Strauss appended a memorandum setting forth the reasoning behind his recommendation.[68]

General Bradley had already clarified the position of the Joint Chiefs, in a letter to Secretary Johnson. After studying the implications of developing the Super, the chiefs had concluded that Soviet possession of the weapon "without possession by the United States would be intolerable." It was imperative to determine the feasibility of the thermonuclear explosion both for defense planning and for formulating international policy. If the Super were feasible, it seemed evident to the Joint Chiefs that the weapon might act as a deterrent to war and would provide an offensive weapon "of the greatest known power possibilities." The cost of the weapon seemed within the capabilities of both the United States and the Soviet Union. The Super also promised, in the chiefs' opinion, a more efficient use of uranium ore in larger weapons. The considerations decisively outweighed the possible social, psychological, and moral objections to the Super.[69]

On November 30, Smyth described the first meeting of the working group of State, Defense, and Commission representatives. Once again Secretary Johnson's representative, this time LeBaron, was asking the Commission for data without any preliminary discussion of the broad issues the special committee presumably was evaluating. Lilienthal hoped to avoid the procedure of the previous summer, when communication in the working group had been almost entirely in one direction, from State and the Commission to Defense. Late that afternoon he went to the State Department to urge Acheson and Webb to arrange a meeting of the special committee itself to clarify the ground rules for the report. Acheson readily agreed that the report should not just state the conclusions of the special committee but should also lay before the President the facts and premises bearing on those conclusions.[70]

A QUESTION OF MILITARY VALUE

The General Advisory Committee at its regularly scheduled meeting in Washington that weekend confirmed Lilienthal's conviction that the special report should be more than an exercise leading to a predetermined conclusion. On

Saturday afternoon, December 3, Oppenheimer told the Commissioners that the committee had carefully reexamined its decision on the superweapon and that no member wished to change his views in the October 30 report. To give some indication of the range of factors considered during the meeting, the committee sent the Commission four papers expressing the individual views of three members and the executive secretary. In a succinct, one-page letter, Rowe had argued that the public would consider the Super an absolute weapon and hence would be lulled into a false sense of security by its existence. He held that the dubious value of the Super as a retaliatory weapon would not outweigh the danger of diverting valuable resources from fission-weapon development, helping the Russians to develop such a weapon, and undermining the nation's moral values.

Fermi and Manley both directed their attention to the possible military value of the Super. Manley concluded that its advantages over fission weapons were not sufficient to justify its development. Fermi's letter was less argumentative than Manley's memorandum, but it approached the same conclusion. The Super, in Fermi's opinion, would have a peculiar advantage in destroying heavy structures over a large area; but the number of suitable targets was limited, and the tactical value of the weapon needed further investigation.

The fourth attachment to the committee's report was a long letter from Buckley. He held to his opinion that the Commission should not immediately undertake an "all-out" effort to develop the Super. This conclusion he supported with arguments similar to Rowe's. Buckley did not think, however, that the United States should publicly forswear the investigation of thermonuclear reactions. He favored a thorough and detailed study of the design, methods of delivery, and possible effects of the Super. Careful research by the best scientists and mathematicians available would provide a sound base for policy decisions "without accepting the severe penalties of an hysterical all-out development and production of a weapon of which we know little." The following week DuBridge added his views in a strong letter challenging the military, psychological, and diplomatic value of the Super.[71]

In succeeding weeks the question of military value became the principal concern of the Commission members of the working group. Paul Fine, from the Commission's division of military application, analyzed this question in a lengthy study paper. Fine began by describing the characteristics of the thermonuclear reaction in terms of the materials and conditions required. He summarized the probable effects of the weapon in terms of blast and radioactivity. He appraised the technical problems, including the ignition of the light elements, the production of tritium, and ordnance engineering. Fine was most helpful in his estimates of costs of an all-out effort on the Super. Such an enterprise would surely slow up the development of lighter and smaller fission weapons. It would take at least three years and would require the recall to Los Alamos of some of the talented scientists who had worked there during World War II.[72]

An important consideration, in Fine's opinion, was the tritium requirement. He thought existing facilities could probably produce enough tritium for a test of the thermonuclear principle in 1951. No one could yet guess how much tritium might eventually be needed for full-scale production of superweapons, but Fine estimated that even to produce test quantities of tritium by 1952 might require new reactors costing $150 million and consume large quantities of uranium which might otherwise be used in fission weapons. Likewise, existing heavy-water plants at Trail, British Columbia, and the Wabash Ordnance Works in Indiana would meet test requirements, but if the Commission decided to build heavy-water-moderated reactors to produce tritium, it would have to build a new heavy-water plant costing at least $4 million. Fine concluded that, unless the superweapons were very large, the damage area resulting from their explosion would scarcely exceed that of the fission weapons which could have been produced with the same materials and facilities. And were there, he asked, enough targets for weapons of that size?

This was the sort of question that preoccupied Manley, whom Lilienthal had asked to serve as a member of the working group. Manley was suspicious of the military leaders, who he claimed had seen no need for a superweapon before September 23. The Defense members of the working group were still saying that they did not know what the military value of the Super would be, but Manley thought Fine's detailed analysis made that position untenable. He predicted that the military would continue to avoid precise estimates of military worth; it was the Commission's job to force LeBaron and his associates to realistic evaluation. Both Manley and Smyth noted that the military continued to have complete access to the Commission's technical information but gave the Commission almost no information on military estimates. In the absence of a military study, Manley embarked himself on an analysis of military worth. The study, running to twenty-three pages, included technical considerations such as time scale, ordnance engineering, readiness, military use, and the costs of tests, as well as the political and psychological factors which the General Advisory Committee had considered.

By the middle of December Manley was getting discouraged. He thought the Defense representatives were still using evasive tactics; the State representatives had shown no inclination to take any part in the study. In an almost querulous note to Lilienthal, who was attending a meeting of laboratory directors in Chicago, Manley began raising fundamental questions. What was the special committee to decide? Was it to determine whether the United States should develop the Super, or was it whether the nation should build such weapons if they could be developed? A subsidiary question was whether, having decided to do the first, the nation could avoid doing the second.[73]

Manley's note snapped Lilienthal's thoughts back to the Super. With his departure from the Commission resting on completion of the special report, Lilienthal had personal as well as official reasons for wanting to finish the job. A quick check showed that the Defense representatives expected to have some sort of study paper completed soon. Kennan relieved Lilienthal's mind by telling him in confidence that State had been studying the issue and had a draft on the subject. He hoped he could discuss it with Acheson and have it ready for the special committee the following week. Even so, Lilienthal saw little chance of completing the report by December 31. He told Truman on December 21 that he would stay on until February 15 in order to finish the job. This, Lilienthal thought to himself, would give him plenty of time and take some pressure off the President, who was faced with the resignations of Souers, Clark M. Clifford, and probably Strauss within the next several months.[74]

Now Lilienthal could focus on the meeting of the special committee, which Acheson had helped to arrange. On Thursday morning, December 22, Lilienthal and Smyth joined Secretary Johnson, General Bradley, and LeBaron in Acheson's office. Lilienthal admired the way Acheson skillfully steered the discussion toward a broad consideration of policy issues. This approach did not bother Johnson, who seemed completely relaxed. Lilienthal began by remarking how much the situation reminded him of the issues facing the State Department board of consultants almost four years earlier. The fundamental issue was international control, not development of the Super. Johnson disagreed by making the observation that only if the Soviet Union accepted international control could the Defense Department consider foregoing the Super. Bradley assured Lilienthal that proceeding with the Super would not foreclose a move toward peace; in fact, the general suggested, the deterrent effect of the Super might in itself be a move in that direction. When Johnson and LeBaron insisted that the decision was simply a technical matter with no necessary relevance to the broader questions, Lilienthal could not restrain himself. The whole purpose and course of mankind was tied to this decision. To leave out what Johnson called "the philosophy" was to beg the question entirely.[75]

The discussion came to no conclusion, a development which in a way pleased Lilienthal because it meant the question was not yet closed. He had no reason, however, to be hopeful. Smyth had shown him the Defense Department's first draft of a working paper. Rather than provide a detailed analysis of the issues, the paper did little more than repeat the broad conclusions which the Joint Chiefs had expressed just a month earlier. During that month the military had chosen not to elaborate on the general proposition which Karl T. Compton had stated in a letter to the President on November 9, in which he held that in the absence of international agreement the nation had no choice but to proceed with the Super. And there was nothing to suggest the possibility of international agreement in the foreseeable future.[76]

Perhaps sensing that Bradley might be less dogmatic on the subject than his civilian associates, Acheson and then Lilienthal attempted to arouse in Bradley some consideration of the larger issues. Acheson told Lilienthal on December 29 that he had made some progress in a long discussion with Bradley. The next morning Lilienthal and Smyth found him in a reflective mood, but his conclusions were hardly encouraging. Bradley could see the inconsistency in supporting a policy which advocated the elimination of atomic weapons through international control at the same time the military was relying on these weapons as the only means of defense in Western Europe. There seemed, however, no other military solution at the moment. Perhaps, Lilienthal suggested, the United States should withdraw its proposal for international control and admit the nation was in a nuclear arms race with the Soviet Union. That suggestion was hardly more realistic than the first. Certainly there were no easy answers, and the first week in January left little time to think about them. Not until he reached the balmy shores of Captiva Island in Florida did Lilienthal have an opportunity to reflect again on the role of the Super in the lives of men and nations.[77]

NEW INITIATIVES

As 1950 opened, Lilienthal had all but retired from the scene. For all routine Commission business Pike was serving as acting chairman. Months of unremitting controversy had stunted the flexibility of Lilienthal's thinking, the openness to discussion, and the patience with differing opinions so necessary in formulating policy. Lilienthal's insistence upon seeing development of the Super largely as a moral issue had destroyed the very climate for decision-making he had set out to create in 1947. By opposing the Super on other than technical grounds, some of the Commissioners and members of the advisory committee had sacrificed their immunities as technical advisers in the policy debate and were now subject to political attack.

At that very moment, and not by accident, another group stepped into the breach. Since the October adjournment, the members of Congress had been able to get away from Washington and gain new perspectives. Members of the Joint Committee on Atomic Energy had been able to visit Commission installations, talk with military leaders, and take the pulse of the nation. As they returned to Washington in the first week of January, 1950, McMahon and his associates were psychologically prepared to face the awesome issue of the superweapon in a way Lilienthal could never hope to do again. Dean must have sensed this when Borden called him on January 10 to describe an executive session of the Joint Committee the previous day. McMahon had reviewed for his returning colleagues the course of events in the nine closing weeks of the old year. He read aloud the report of the General Advisory

Committee, including the views of individual members. With many interruptions, this process took several hours, but it helped to orient the members in the complex of issues surrounding the Super. Then McMahon read his letter of November 21 to the President, which drew warm approval from Senator Knowland and most of the other members. The discussion drifted toward the conclusion that the committee should submit to the President a recommendation on the subject, but probably only after hearings with Defense representatives, the Commission, and members of the General Advisory Committee. Whatever was done would have to be done quickly. Despite Truman's warning, scraps of information about the Super were already beginning to appear in the press with the inevitable distortions and inaccuracies. To alert the Administration to the committee's intentions, McMahon sent copies of his November 21 letter to Lilienthal and Secretary Johnson.[78]

Johnson was quick to respond to indications of Joint Committee interest in the Super. He asked LeBaron on January 11 to convey to McMahon the essence of the paper which the Joint Chiefs were just completing on the issue. LeBaron suggested that he and Bradley brief the committee on the substance of the paper without providing a copy. Johnson agreed, but stressed the importance of getting the Joint Chiefs' views to the committee. Since the President had warned McMahon about the importance of security, it would be safe to talk.[79]

The Joint Chiefs' study, which Bradley sent to Johnson on January 13, was primarily a critique of the General Advisory Committee report of December 3. The chiefs saw no need for a "crash" program to build the Super, but they urged immediate determination of its technical feasibility, studies of delivery vehicles and ordnance, and some planning for production. The Super, in the chiefs' opinion, would serve as a deterrent against Soviet aggression and to that extent would strengthen the defenses of the nation. Production of the Super would place additional burdens on material and manpower resources, but would be within the nation's capability without dislocating the existing defense effort. The Joint Chiefs opposed forswearing or renouncing the Super. The American people and the people of the free world expected the United States to develop the most effective weapons against communist aggression. As for moral issues, the chiefs voiced the responsibility of the United States to assert its moral and physical leadership. It was folly to argue in war that one weapon was more moral than another.[80]

In his regular Sunday evening broadcast on January 15, Drew Pearson reported that the question of whether to develop the Super had engrossed the Capital. With less accuracy he described the dispute between Lilienthal and Strauss over the subject, the firm position of Secretary Johnson, and the mixed feelings of Acheson. More comprehensive than the Pearson broadcast was James Reston's page-one article in the New York *Times* two days later. Reston saw the issue not as the simple question of whether to develop the Super, but rather as whether the United States should make one last attempt at international control before proceeding. In general outlines, at least, Reston had a reasonably accurate picture of the situation. Facts he had not yet snared were Dean's growing disagreement with the General Advisory Committee's position as evidenced in his sharp criticism of DuBridge's individual views on the subject, and the new initiative which the Defense Department and the Joint Chiefs had taken on the issue. But the Reston article made the Super headline news. In the glare of the public spotlight the Administration could not long postpone a decision. Fearing a sudden change in the situation, Lilienthal's staff sent him an urgent telegram to return to Washington.[81]

Dean, through his frequent telephone conversations with Borden, had some idea of the Joint Committee's activities. Bradley and LeBaron were scheduled to appear on Friday, January 20. Borden did not yet know whether the Commissioners would be called to testify, but he was arranging to have Hafstad appear to discuss reactor development. Speaking before a subcommittee on January 18, Hafstad began with a general summary of the Commission's reactor program with special attention, perhaps at Borden's suggestion, to aircraft nuclear propulsion as a solution to the difficulty of delivering a superweapon. More immediately relevant were Hafstad's comments on tritium production. He told the Congressmen that since Lawrence and Alvarez had first presented their proposal in October, the Commission's staff had been studying the best way to produce the hydrogen isotope. One way was to modify a Hanford reactor by replacing the natural uranium slugs with fuel slugs of uranium 235 and target slugs of lithium, in which the tritium would be formed. A second possibility was to build a heavy-water-moderated reactor along the lines of the Canadian installation at Chalk River. A third approach was to build a modified version of the materials testing reactor. Staff studies had indicated that the first had advantages for producing test quantities of tritium; the last for production quantities. To check these conclusions, the Commission had asked several contractors to study the three approaches to a neutron-producing reactor. The committee's frequent references to possible costs of tritium production and talk about a "crash" effort suggested an assumption on the Hill that development of the Super was already an accepted fact.[82]

Explicit discussion of the policy issues came in the full committee's session with Bradley and LeBaron on January 20. Bradley began with an extensive summary of the Joint Chiefs' written report, with stress on the inevitability of scientific development, the implacability of the Soviet Union, and the absurdity of calling the Super an immoral or unconventional weapon. Millard E. Tydings, also a ranking Democrat on the Senate Arms Services Committee, concentrated the discussion on the production of tritium for a test of the thermonuclear principle as well as for quantity production of the Super. McMahon, Holifield, and other members who had visited Los Alamos during the recess could assure the committee that the Super was at least theoretically feasible. Teller had dispelled any doubt on that point. McMahon expressed his conviction that the United States' nuclear superiority was the only thing keeping Russia from sweeping across Western Europe; to permit the Soviet Union to get the Super first was inviting national disaster. From this premise the committee had little difficulty moving to the conclusion that the United States should begin to build additional production plants for the Super even while the feasibility tests were under way. The only sensible plan was to throw a tight net of security around the project and push ahead with the Super as quickly as possible.[83]

Still to be reckoned with, however, were the strong reservations of some scientists as expressed in the report of the General Advisory Committee. McMahon volunteered the opinion that Oppenheimer and his associates had gone far beyond their area of competence in opposing the Super on moral and political grounds and for that transgression they would suffer in the judgment of history. But both Congressmen Hinshaw and Henry M. Jackson, who had recently been in Los Alamos, remarked that the scientists' reservations sprang from deep convictions. Even Teller had expressed concern over proceeding with the Super without considering how or when the new weapon might be used. One way to avoid the moral issue, as Teller had suggested, was to announce the decision to proceed with the Super as an ultimatum to the Russians; if they did not move in the direction of international control, the United States would have clear moral justification for proceeding. Knowland feared the Russians would buy valuable time by keeping negotiations going interminably. McMahon dismissed the moral twinges as simply an emotional reaction to a difficult question. The nation would have to face the reality that "total power in the hands of total evil will equal destruction."

McMahon recognized the committee was so close to agreement that it could have sent the President a recommendation that very day. He also perceived that such an action following a hearing at which only representatives of the military were present could have profound repercussions. Even to admit officially that the committee had discussed the Super might be dangerous. He proposed to tell the press only that the committee had discussed matters of national defense. By holding rigidly to this position, McMahon succeeded in avoiding a major press reaction. Except for some speculations in a Washington tabloid, the major newspapers gave the meeting only a few inches on inside pages.[84]

Lilienthal had no way of knowing what had happened in the Joint Committee hearing room that Friday morning, but before the day was over he had a good idea of General Bradley's position. That afternoon, after the hearing, he received a copy of the Joint Chiefs' comments on the General Advisory Committee's report from James S. Lay, who was preparing to replace Souers as executive secretary of the National Security Council. Lilienthal immediately called Smyth with the idea that the Joint Chiefs' reply should be sent to Oppenheimer and the committee. After consulting Dean, who opposed the idea, Smyth suggested that Lilienthal talk with Lay. Then Lilienthal called Oppenheimer in Pasadena to inform him that the paper existed and that he was seeking permission to distribute it. By the time Lilienthal reached Lay late on Saturday afternoon, it seemed too late to bother the President. On Monday noon, January 23, Lay called back to report that Truman considered the report "confidential advice to the President." Lay guessed that Lilienthal could appropriately show the report to his fellow Commissioners but should distribute it no further. Now, as McMahon had suggested on Friday, the General Advisory Committee was effectively removed from further consideration of the Super.[85]

THE TIDE OF OPINION

As the week wore on, it became ever clearer that the tide of opinion was moving in favor of the Super. The Defense Department and the Joint Committee were now fully committed to the Super, and Acheson and the State Department were leaning in that direction. A special working group under the direction of R. Gordon Arneson had at last completed a study paper for Acheson. Carefully balancing the opinions of the Commission and the Joint Chiefs, Acheson found general agreement that the Commission could undertake a concerted but deliberate effort to determine the feasibility of the Super within three years without seriously handicapping existing weapon activities. If the Super proved feasible, it would be hard to stop further work while the extremely complex issues related to production and stockpiling of the new weapon were debated. But Arneson could find little reason to believe that the Soviet Union would not press ahead with the Super, and he admitted that sole possession of that weapon by the Soviet Union "would cause severe damage not only to our military posture but to our foreign policy position." Neither did the State Department believe that an appeal to the Soviet Union was likely to produce an acceptable plan for international control of atomic weapons. Arneson concluded that the President should direct the Commission to determine feasibility of the Super at a rate and scale to be set by the Commission and the Department of Defense, with concurrent work in Defense on ordnance and carrier development. The President would defer any decision on producing superweapons beyond the number required to test feasibility, until State and Defense had completed a full-scale study of national policy. Arneson also recommended that the President announce that the United States intended to continue to explore feasibility of the thermonuclear weapon.[86]

On Thursday afternoon, January 26, Lilienthal stopped by Acheson's office to discuss Arneson's paper. The Secretary had his office windows open and seemed to be enjoying the unseasonably warm weather, as if the hostile attacks upon him for refusing to denounce his former associate, Alger Hiss, bothered him not at all. Acheson appeared to agree with Arneson's conclusions but on somewhat more pragmatic grounds. There was now, Acheson thought, so much pressure built up for a decision that any delay would hardly provide the atmosphere for the deliberate evaluation of policy issues that Lilienthal advocated. Lilienthal still had reservations; the Presidential directive would confirm a wrong policy and lend credence to the myth that weapons of mass destruction provided national security. He reminded Acheson that if the Commission had supported the Super in November, there would have been no consideration at all of the fundamental issues. There was no question, Acheson admitted, that in a democracy strategic bombing would be no more effective as an instrument of national policy than would preventive war. But the continuing Soviet threat and the collapse of the Nationalist government in China made it hard to counter the demand for bigger weapons.[87]

Lilienthal, with only a few days left to serve as chairman, was already looking at such issues with the perspective of an outsider. Having all but lost his campaign for a full-scale debate on the Super, he did not look forward to the hearing before the Joint Committee on Friday morning, January 27. Under the circumstances there was little for him to say. He made a few innocuous remarks about the background of the situation and turned the session over to Smyth, who, with support on details from Paul Fine, reviewed the technical considerations involved in developing the Super.[88]

Then without warning the direction of the discussion changed. Congressman Charles H. Elston asked Smyth whether the Commission had taken any official position on the Super. Since Lilienthal had already left for a meeting with the President, Smyth turned to Pike as the senior Commissioner present. Cautiously Pike skirted the edges of the question. Pike said the Commissioners had sent some tentative views to the President, but they had done this with the full realization that they did not yet have all the facts on which to base a decision, particularly the views of State and Defense. Smyth and Dean agreed the Commission had been unanimous in the opinion that the decision rested with the President, but Dean made it a point to say that on other questions there was wide divergence of opinion. Dean went on to summarize his individual position and Strauss read most of his letter to the President.

For a few minutes Smyth was able to steer the discussion in other directions, but Elston was not to be denied. Two Commissioners, he observed, disagreed with the General Advisory Committee's report. What did the others think? Feeling the growing pressure of Elston's prodding, Smyth tiptoed into his answer. He found so many factors involved in the decision that he had opposed going ahead with the Super "at that time," namely in November,

1949. He had not thought any agreement with the Russians was possible, but he had seen the need for a careful study of the issues. Now, three months later, he thought his position had been correct. The Commission now had a much better understanding of the question, and work on the Super at Los Alamos had not been seriously delayed. Pike said that his indecision had caused him to agree with Smyth. Then Senator Knowland asked the final question: How had Lilienthal voted? Pike's answer put on the record the fact that three of the Commissioners had opposed all-out development of the Super in November, 1949. Beyond this point, neither Smyth nor Pike was willing to commit himself. What their views on the question now were, they could not say; the decision was now in the hands of the President.

The Joint Committee had carried the day. The Commissioners were no longer prepared to defend the position of the General Advisory Committee. All that remained was for the Joint Committee to decide what course it would follow. McMahon and Holifield led the majority who believed the committee had a responsibility to report its views to the President; Hickenlooper and Millikin thought a recommendation would be gratuitous without a request from the President. McMahon, however, was unwilling to surrender the initiative. The committee would meet on Monday morning, January 30, to draft its recommendation to Truman.

While McMahon was consolidating his victory on the Hill, Lilienthal was discussing with Truman the desirability of appointing Pike as acting chairman after his own departure on February 15. Eventually the discussion turned to the Super. Lilienthal told the President he was still trying to complete the report by the special committee, although a meeting for that afternoon had been canceled. Truman hoped he would have the report soon. Baruch had just announced his support of the Super, and now everyone, including the Joint Committee, would be demanding action. That afternoon at his weekly press conference Truman told the reporters that he would have nothing to say on the subject until he had made a decision. With that statement the President formally acknowledged that the issue existed.[89]

As Truman predicted, the day's events touched off a wave of newspaper stories about the Super. H. Styles Bridges, a member of the Senate Armed Services Committee, told reporters after the President's press conference that responsible military leaders had convinced him that development of the Super was necessary for national self-preservation. Carl Vinson, chairman of the parallel committee in the House, took a similar view. Most newsworthy of all was Harold C. Urey's outspoken speech in New York that evening in support of what Lilienthal now called the "E. O. Lawrence-Strauss line." As an acknowledged leader of American science, Urey made clear that not all his colleagues agreed with the General Advisory Committee. The question which had been debated within the Administration since October 5 was now a public issue.[90]

PRESIDENTIAL DECISION

Thoughtful deliberation in the blinding glare of public opinion was now out of the question. Furthermore, the months of debate and the course of events had all but settled the issue. Formally, there remained the task of drafting a recommendation for the President's decision. Actually, the only function left for the special committee was to prepare a record to support the only decision possible under the circumstances.

This tacit understanding among the participants explained the perfunctory tone of the special committee's meeting on the second floor of the Old State Department Building on Tuesday morning, January 31. Lilienthal came with Smyth; Secretary Johnson with Under Secretary Stephen Early,

LeBaron, and General James H. Burns; Acheson with Arneson and Adrian Fisher; and Souers with his replacement, James Lay. Acheson moved into the question with few preliminaries. He proposed to start the discussion by presenting Arneson's study paper, but to save time he would read only the conclusions. This done, he distributed a draft statement for the President to release with the decision. The short first paragraph alluded to the need in a democracy to inform the people of important decisions. The second embodied the key recommendation in Arneson's draft, directing the Commission to continue with the development of all forms of atomic weapons, including the hydrogen bomb. The third and longest paragraph warned the nation against relying on any single weapon and reasserted the nation's dedication to freedom and peace.[91]

Secretary Johnson suggested two changes. The first was to delete from Arneson's recommendations the clause committing the President to deferring any decision on producing the Super until feasibility of the weapon had been determined. The second was to substitute for the public statement a much shorter version which announced the decision, in the absence of agreement on international control, to proceed with the Super under a cloak of "top secrecy." [92]

Acheson was not disposed to argue. He accepted the deletion in the Arneson draft and turned to rewriting the public statement. Early favored playing down the statement as much as possible by making it a press handout rather than a personal announcement by the President. Johnson agreed and in the same vein suggested deletion of the long third paragraph in the State draft. Lilienthal suggested two changes to make clear that the nation would continue to examine all factors affecting peace and security and also that work on the Super would be a continuation of that already started. These small concessions Acheson and Johnson were ready to accept.

The task was done, but Lilienthal requested the minority's privilege of a final statement. He began by mentioning his efforts to have the Commission function "in the spirit and the letter of a law providing for civilian control of atomic weapon development." At no time since 1947 had the Commission received information supporting the weapon requirements which the military establishment had recommended to the President. Except in the abstract, this had not been a serious issue until the spring of 1949. At that time the President had directed the special committee to examine the assumptions underlying the proposal for expanding the Commission's production facilities. The move to examine the military assumptions had not succeeded. Lilienthal was now willing to forget that issue, but he thought the question of the Super presented a clear case for examining the underlying assumptions "if there was to be any substance to the principle of civilian control of atomic weapons by the Commission." He admitted that in recent weeks the special committee had begun to examine the military assumptions, but he still thought it important to make "a real inquiry into the basic question: what is the best way to further our common defense and security?"

Lilienthal now thought the moral issues and the question of international control were relevant but not central. In fact, he said, the central question was not even whether or not the United States should build the Super but rather whether the special committee and the President should not first examine the fundamental weakness which Lilienthal saw in the nation's position: the complete reliance on weapons of mass destruction as an instrument of foreign policy. To proceed forthwith was to miss perhaps the last opportunity to reexamine and realign policy so that American security might be based upon something better than a headlong rush into war with weapons of mass destruction.

Acheson found little in the statement to disagree with, but it seemed to offer no appealing alternatives. The pressure for decision from Congress was so great that deferral was not feasible. Johnson agreed that they had to protect the President.

The discussion then turned back to the recommendation of a study of national objectives in peace and war and the effect of those objectives on strategic plans in a world of fission and superweapons. Acheson said that the draft omitted the Chairman of the Atomic Energy Commission from the group which would make the study. One reason for the omission was the obvious difficulty of working with a five-man Commission. Acheson also questioned whether it was appropriate for the Commission to participate on the level of a Department head. A third problem was the Commission's statutory obligation to keep the Joint Committee "fully and currently informed." Lilienthal thought the first two points were valid and he would not deny the validity of the third. Smyth agreed that it might be difficult to invoke Executive privilege if the Joint Committee had to be informed.

At this point Secretary Johnson recommended that the special committee go at once to the White House and get a decision. He already had an appointment with the President at twelve-thirty, and the group could use that. With all the heat Congress was putting on the issue, every hour counted.

Truman received the three members of the special committee with Souers and Lay at about twelve-thirty-five. Acheson handed the President the recommendation and said that Lilienthal had some comments on it. Knowing full well what Lilienthal had on his mind, Truman said he thought the United States should never use these weapons, but the Russians' behavior left no choice but to make them. Lilienthal summarized the statement he had just made to the committee: No matter how carefully worded or casually issued, the statement would confirm the present belief that atomic weapons were the nation's first line of defense. Truman interrupted to say that a quiet examination of the issues would have been possible if Senator Johnson had not made his unfortunate statement. Now there was so much excitement over the issue that he had no choice but to go ahead.[93]

It was not yet twelve-forty-five when the group left the President's office. After lunch with an old friend, Lilienthal called McMahon, who had scheduled a meeting of the Joint Committee that afternoon to finish its recommendation. McMahon had hoped to complete it the day before, but the discussion in executive session had dragged on too long. Now the committee's action would be only academic. There was, however, still the question of the Commission's response to the President's directive, and McMahon wanted to use the hearing to discuss that subject with the Commissioners. Lilienthal asked to be excused on the grounds that he would be leaving the Commission in two weeks and would have no part in the matter.[94]

By this time the White House had announced the decision. Lilienthal called Lay to work out some details on the President's directive to the Commission. Next he called Smyth to tell him about the arrangements for the afternoon hearing. Shortly before three, he dropped in on the General Advisory Committee, which was holding one of its regular meetings in Washington. Kenneth S. Pitzer, who was explaining the Commission's fellowship program, left with the staff. Lilienthal told the members what had happened. The decision itself was hard enough to take; even harder was their duty to remain silent in the face of public discussion. Some of the members thought they should resign, but Lilienthal urged them not to leave so quickly that their resignations would be considered a protest.

Soon the Commissioners returned from the Hill, and there was a short meeting to discuss the hearing. The session had gone well. Smyth had been able to soften some of the demands for a "crash" effort at Los Alamos by reminding the Joint Committee of the danger involved in sacrificing development of improved fission weapons until the scientists knew whether the Super would work. He had held that the program Los Alamos had proposed for 1950 was about the most the laboratory could do under the circumstances. McCormack had already sent Bradbury a telegram directing him to proceed at once with the plan without waiting for formal approval, which would probably come in a few days.[95]

END OF AN ERA

In the long months of argument, cajolery, and self-examination it had seemed to Lilienthal that the agony of indecision would never end. Now suddenly the wheels of time were turning once again. Strauss, now satisfied that development of the Super was safely under way, had announced that afternoon his decision to resign. The next evening the staff gave a farewell party which easily tapped the deep pool of sentimentality in Lilienthal's personality. The remaining days of routine swept by almost unnoticed. February 15 was a warm springlike day. The buds were already bursting on the trees as Lilienthal turned in his badge for the last time in the front lobby of the Commission's headquarters building, stepped into the sunshine to greet the employees assembled on the steps and waving from the windows, and set off into the world a free man.[96]

Certainly Lilienthal took with him something of the spirit and style which the nation had come to associate with the new agency. He had brought to the fledgling Commission in 1946 many of the strengths often attributed to youth: an unconquerable idealism, a relish for challenge, a driving energy, and a deep personal commitment. Some observers close to the scene thought they also detected in Lilienthal some of the common failings of youth: an impatience with detail, a fascination with glittering generalities, and a strong emotional reaction to events. A full appraisal of Lilienthal, however, had to go beyond personal traits. Taking command of a decaying wartime enterprise in 1946, he had built it into an effective, modern institution of government, which in many ways was setting new trends for the Federal service. Equally important, he had given Americans some sense of the promise of atomic energy, something to displace the grim specter of Hiroshima. Had an international agreement on atomic energy control been possible, Lilienthal might have realized his dreams for the peaceful atom. His tragedy, epitomized in the Hickenlooper investigation, was that of a man forced by circumstances to assume a task his spirit would not let him accept. Without him, the Commission would perhaps take on some of the sturdy qualities of middle age. It might seem more predictable, more practical, more business-like but would it be as imaginative and as stimulating?

TWILIGHT ZONE, FEBRUARY-JUNE, 1950

CHAPTER 13

President Truman's announcement of the decision to accelerate the development of a thermonuclear weapon had been brief. As he later acknowledged to a reporter, he did not intend to elaborate on the issue. For the moment the nation's spokesman on the hydrogen bomb was Brien McMahon. In a ringing Senate speech on February 2 McMahon assured his audience that the President had made the right choice. The new weapon in theory possessed unlimited power. But if the United States were the first to build the bomb, the nation could protect the free world from aggression while its leaders attempted through the United Nations to save mankind from the scourge of nuclear war.[1]

Certain realities McMahon did not touch. The hydrogen bomb was not, as he suggested, a piece of hardware nearly ready for production. The bomb was an idea, tentative and glimmering—its theory based on bold thought reaching to the stars, and its slender stock of data largely unconfirmed by laboratory experiment. Despite McMahon's confidence, there was no assurance that Los Alamos could produce a thermonuclear weapon.

The impact of these events on the Commission's research and development activities was difficult to measure. On March 11, 1950, Congressmen Melvin Price and Carl Hinshaw, representing the Joint Committee, questioned Walter H. Zinn and his staff in the ugly, gray Quonset huts at Argonne National Laboratory. "Supposing," Hinshaw asked Zinn, "today at twelve o'clock noon the President announced a state of national emergency, with some very important events in mind," what changes would Zinn make in his reactor program at Argonne? Zinn did not hesitate for a moment. He would cancel everything except the development of a new production reactor and the submarine propulsion plant.[2]

The President, however, had declared no such emergency. In a full crisis the nation would have no choice but to forego long-range plans and focus on immediate needs. The nation was in a difficult twilight zone between peace and war. The Soviet detonation had spurred the nation one step closer to war; but in the first half of 1950 the Commission would have to keep its balance, ready to move either toward more terrible weapons of destruction or toward the human benefits the atom promised. Greater effort on thermonuclear research, raw materials procurement, and larger and more efficient production reactors was clearly in order. At the same time it would be prudent to maintain the vitality of the national laboratories, the university research teams, and the industrial groups which were developing the nonmilitary uses of atomic energy.

INTERPRETING THE DECREE

As McMahon was speaking in the Senate on February 2, 1950, the Commissioners were discussing the Presidential directive with the Military Liaison Committee. Now that Lilienthal had all but formally left office, the burden of carrying the Commission's position fell on Sumner Pike as acting chairman. Uneasy in his new role, Pike merely stated the substance of the directive. The Commission was to determine the technical feasibility of the thermonuclear weapon; the Commission and the Department of Defense were to fix the scale and rate of effort.

Robert LeBaron, chairman of the Military Liaison Committee, insisted that the Department of Defense had to have a decisive role in interpreting the directive. He believed the Commission and the military together had to draw up a plan for developing and testing a thermonuclear weapon. Only then would the specific tasks of each agency fall into place. Nor, in his view, should the two agencies restrict their efforts to developing a weapon. The Commission should not limit the production of tritium to the amounts needed for tests. If the tests proved a hydrogen bomb feasible, there should be sufficient tritium on hand to fabricate the weapon at once. If the Department of Defense were to fulfill its responsibilities, LeBaron believed that his committee had to understand all phases of the undertaking. The committee could best visit Los Alamos and talk directly to the laboratory personnel. Perhaps, suggested LeBaron, the Commissioners could join the committee.

A constant theme in LeBaron's remarks was the need for urgency. Troubled by this insistent note, James McCormack asked if the committee thought the Commission could move faster. Although LeBaron disclaimed this opinion, he admitted he had heard criticism that the tritium program lacked energy and that the planning was unrealistic. Stung by this comment, the Commissioners demanded to know who was suggesting they could not meet their commitment to the President. LeBaron replied that several scientists, among them Ernest O. Lawrence at Berkeley, had expressed doubts.

Pike began his presentation by asking whether the military had actually established a requirement for a thermonuclear weapon. Not yet, replied LeBaron, because the Pentagon was waiting for an analysis of the cost in money, men, and materials, and the effect on the production of fissionable material. Walter J. Williams set forth the Commission's need for facts in order to set production schedules; McCormack pointed out the necessity to give Los Alamos guidance; and Henry D. Smyth declared the importance of defining production amounts and rates, and establishing military requirements. Bluntly Carroll L. Wilson asked if the Commission's program and approaches were satisfactory. LeBaron replied he could not answer until the roles of the Commission and the Department of Defense were defined. Close cooperation was necessary, but as Pike observed, it had to work both ways.[3]

As Wilson returned to his office after the meeting a new concern filled his thoughts. That morning he and the Commissioners had learned of the treason of Klaus Fuchs. While at Los Alamos during the war, Fuchs had discussed American speculations about a thermonuclear weapon. It was too early to say what the ramifications of the betrayal would be. At the moment it was simply another factor in a complex situation. McCormack's arrival reminded Wilson that he should inform Norris E. Bradbury of the impending visit by LeBaron's group. A glance showed the time was 6:25 P.M. Since Los Alamos was two hours behind Washington, probably Bradbury was still in his office. McCormack placed the telephone call. Necessarily the conversation was guarded; but Bradbury, generally aware of the circumstances and skilled at handling visiting dignitaries, understood enough.[4]

The next morning Wilson still thought the meeting with the liaison committee had been useless. Williams, the tough and shrewd director of production, agreed the session had been barren. Yet there was another chance to explain the Commission's position to the committee. The day before, McCormack had had to plan the Los Alamos visit with the military committee. As it happened, LeBaron was absent when McCormack arrived at the Pentagon, and he took advantage of the situation to speak to those present as one military officer to another. He explained that Los Alamos was ready to begin development work and the Commission was planning to give the laboratory the needed tritium. Establishing production schedules for thermonuclear materials, however, was difficult in the absence of military requirements. As for manpower, the Commission had begun to recruit scientists.

The committee members added little to their position of the previous day. They reasserted that the Commission should plan to produce tritium, interfering as little as possible with the plutonium effort, and on a scale that would leave some of the thermonuclear material after a test. Probably the Commission would find it necessary to build more production facilities and in the committee's view, du Pont should construct and operate them. In a casual mood, the group adjourned with the understanding that the Los Alamos trip would take place sometime during the week of February 20.[5]

McMahon and the Joint Committee were also anxious to learn the details of the Commission's plans. On February 10, armed with Truman's permission, Pike opened the hearing by reading the January directive. He made it clear that the Commission was planning a production program which would go beyond the needs for testing. Strictly speaking, the Commission was stretching its assignment a little, but Pike thought the approach made sense. The main features he described as research and development, production of thermonuclear materials, and certain ordnance and delivery problems which were matters for the military. Pike admitted that the relations between the Commission and the Department of Defense were not clear, but the visit of the liaison committee to Los Alamos should be helpful. McCormack explained that the Commission program was vigorous but "somewhat short of flat out if you consider flat out to mean devil take the hindmost," and he had no doubts about Los Alamos enthusiasm. He and Pike agreed, however, that the thermonuclear effort would hit certain projects hard. Probably the intermediate-power-breeder reactor at Schenectady was the most vulnerable, for the skills of the General Electric scientists would be needed in the thermonuclear effort.

The committee members did not welcome the prospect of cutbacks. Chet Holifield warned against pursuing a thermonuclear weapon with a single-minded zeal which would exclude delivery problems and neglect promising refinements in fission weapons. In Carl T. Durham's opinion, the submarine reactor had a military use and should not be touched. The hearing had been good; the questions were of high caliber and revealed an awareness that the quest for the hydrogen bomb would require sacrifices.[6]

As an acute and perceptive observer of the political currents that swirled around the thermonuclear program, McCormack knew how important it was for Los Alamos to make a good impression on the liaison committee. He warned Carroll L. Tyler that the laboratory had to be ready to discuss accelerated schedules and had to remember that LeBaron's committee spoke for the Department of Defense in determining the scale and rate of effort. McCormack saw the visit as a superb opportunity for Los Alamos to make certain its needs and problems were understood. To prepare the committee for the visit, Wilson sent LeBaron an account of the steps the Commission was taking to see that Los Alamos would have thermonuclear materials for a test sometime in 1952. That requirement would have an impact on the production directive signed by Truman in October, 1949, and some amendment might be required. Although the Commission was studying several ways of manufacturing stockpile quantities of thermonuclear materials, it was too early to discuss the need for new facilities. Wilson stressed the importance of guidance from the Department of Defense; he hoped the Los Alamos visit would be useful.[7]

LOS ALAMOS SELLS A PROGRAM

There was crispness in the air at Los Alamos as Bradbury welcomed the Military Liaison Committee into his office. Because of the pressure of budget hearings, Smyth was the only Commissioner present as the two-day meeting began on February 23. After a few brief remarks, Smyth turned the meeting over to Bradbury. With a sure hand the Los Alamos director sketched the laboratory plans. Los Alamos would place its maximum effort on the thermonuclear weapon, but would continue developing some fission weapons which were too promising and too near completion to be dropped. He thought that as a whole, the laboratory personnel were in fair agreement, although there were individual differences on certain points.

From fission weapons, Bradbury turned to the thermonuclear effort. Incisively he stated the problems, the tentative solutions, the probable requirements, and the possible schedules. The crucial question was whether a thermonuclear reaction could be achieved. Success depended upon finding some way to release energy by fusing the heavier isotopes of hydrogen. The most promising isotope was deuterium, which existed in water. Isotope-separation techniques developed during World War II offered to make deuterium available cheaply in almost limitless quantities. However, fusion of deuterium would be theoretically possible only if its temperature could be raised to about 400 million degrees. This temperature was above that reached by an atomic bomb. Somehow the laboratory had to achieve the higher temperature. The best chance seemed to be through a fusion of a mixture of tritium and deuterium. The hydrogen isotopes would react at a lower temperature and would release energies which might initiate fusion of deuterium.

The uncertainties were staggering. Bradbury warned against pursuing the search for a thermonuclear weapon if the laboratory could find no way to reach the stellar temperatures. He thought that those working on the atomic bomb in 1940 were more sure of success than those now embarking on the quest for a thermonuclear weapon. The endeavor would be costly. Concentrating the abilities of Los Alamos upon the thermonuclear weapon might mean sacrifices. Promising areas of research might lie neglected and new ideas pass unrecognized because of the exclusive devotion to a single purpose. For the nation's only atomic weapon laboratory, the thermonuclear effort raised grave risks which Bradbury felt could only be justified if the hydrogen bomb were needed in the near future. He could not say when a thermonuclear weapon could be produced, but he hoped for a test of thermonuclear principles in the spring of 1951. It was difficult to predict the speed of the effort. In the early days, the laboratory had been working under the pressure of war; now it was not. For another thing, some physicists had moral reservations about the effort, and others felt that the main difficulties were engineering rather than scientific, a misconception Bradbury was finding hard to correct without violating security regulations.

Those listening to Bradbury had come to hear facts and not to offer challenges. There was a feeling that the laboratory plans were as sound as possible, under the circumstances, and LeBaron was anxious to find out how his committee could help. Edward Teller described various experiments needed to acquire data. He agreed with Bradbury that Los Alamos could set no timetable and would face recruiting difficulties. Although the laboratory had been successful in getting some bright young scientists, the hesitation of older leaders to commit themselves had deterred others. For about half an hour LeBaron and his group met alone, and then joined the others for lunch. By the end of the day LeBaron announced, with satisfaction, that Los Alamos had "sold a program." [8]

CLARIFYING THE DIRECTIVE

Los Alamos had given LeBaron a feeling of assurance that the laboratory had set a course, but his doubts about the Commission's production plans remained. The production of Supers would probably require large amounts of tritium. Exposing lithium to neutron bombardment was the most practical way to make tritium, a fact which caused the planners at Washington to look to Hanford. Using Hanford reactors to make tritium meant a decrease in plutonium production. Even more unfortunate, the number of neutrons required for tritium was more than that needed to make an equal amount of plutonium. Another important fact for those who plotted production curves was that the half-life of tritium was little more than twelve years, only a small fraction of that of plutonium used in fission weapons. The obvious solution was to call upon Hanford for a limited amount of tritium until new sources of neutrons could be developed.

As Wilson had written LeBaron just prior to the Los Alamos visit, the Commission was looking at four ways to obtain neutrons. Three of the approaches depended on reactors: a modified materials testing reactor, a heavy-water-moderated production reactor, and a modified Hanford-type reactor. The fourth possibility was Lawrence's idea of a linear accelerator. With the dynamic energy characteristic of Berkeley, a laboratory group was already engaged in feasibility design studies.[9]

To LeBaron, the importance of these efforts had been overshadowed by the revelation that Fuchs was a spy. The liaison committee chairman asked Generals Kenneth D. Nichols and Herbert B. Loper for an evaluation of the significance of the disclosure. Their analysis showed that the information Fuchs possessed could significantly increase the Russian capabilities. The possibility that the Russians were much closer to the Americans in the race for the hydrogen bomb than had been believed was the alarming thought that LeBaron carried to Louis A. Johnson, Secretary of Defense. Johnson sent the appraisal to the White House and, on February 24, buttressed by a recommendation from the Joint Chiefs of Staff, he proposed an "all-out program" for the hydrogen bomb. Anything less, Johnson declared, imperiled the security of the nation.[10]

For resolution of such fateful questions, Truman would again call in the special committee of the National Security Council. As the Commission's representative, Smyth gained a better sense of the course he should follow in a meeting with LeBaron's group on March 1, 1950. Some of the Commission's proposals would affect the established production goals. Before changing the goals, the Commission had to inform the liaison committee even if, observed Pike, the committee could not always speak for the department. Promptly LeBaron responded that he knew Secretary Johnson and the Joint Chiefs considered the thermonuclear effort of such importance that they would accept sacrifices in fission weapon production. Perhaps the military services, suggested Admiral Tom B. Hill and Admiral Ralph A. Ofstie, could lighten the burden on Los Alamos by taking on some of the laboratory projects.[11]

Losing no time, Smyth joined LeBaron and R. Gordon Arneson of the State Department in a meeting of the working group that same afternoon. Smyth said the Commission was moving as fast as it could on production and knew of no recent intelligence information to warrant a reexamination of the scope of the thermonuclear effort. The special committee, however, could clear away the ambiguity in the January directive by recommending to Truman that he make explicit the Commission's responsibility to prepare for stockpile production of thermonuclear materials. In the discussion of costs, schedules, and manpower, Smyth declared that no one on the Commission staff or on the liaison committee had yet suggested how to speed up the effort.[12]

From production matters, Smyth suddenly found himself plunged into Los Alamos affairs. Shortly after noon on March 3, Wilson came to him with the unexpected news that Teller was about to appear before the Joint Committee. Neither the Commissioner nor the general manager knew that Teller had dined the previous evening with William L. Borden, executive director of the Joint Committee staff and McMahon's closest adviser. Vividly impressed by a portrayal of the urgent need for scientists at Los Alamos, Borden had asked Teller to talk to the Joint Committee. Smyth was the only Commission representative present as the hearing began. Teller explained that work on the thermonuclear weapon had lagged after the war because so many people, himself included, had left Los Alamos. Somehow those lost years had to be made good. He saw no need to strip the research centers of their talent, but in some way the reluctance of the scientific leaders had to be overcome. Of course there were doubts of success which he himself shared, but on balance Teller believed a thermonuclear weapon was feasible. High-caliber people were essential. He would not rule out resuming cooperation with the British, despite Fuchs. Teller could think of several British scientists whose help he would welcome.[13]

On March 10, Truman accepted the special committee report which more clearly defined his earlier directive to the Commission and the Department of Defense. By his action he instilled greater urgency into the thermonuclear effort, instructed the Commission to prepare for quantity production of thermonuclear materials, and approved a feasibility test of thermonuclear principles. Together the Department of Defense and the Commission were to establish the scale of effort needed to produce thermonuclear materials, particularly tritium, and to estimate the impact of that effort on existing production goals. The report informed Truman that there was no way to hasten the schedule for the essential tests and, perhaps most important, that there was no guarantee of success. Even if the tests were failures, the President could find consolation in the statement that the proposed production facilities could be used for making fissionable materials.[14] Smyth must have been pleased that the thermonuclear effort now had greater clarity.

That same day before the Joint Committee, Smyth came back to the question of scientific manpower. He read an impressive list of those who were joining the effort at Los Alamos: John A. Wheeler of the Palmer Physical Laboratory at Princeton from a sabbatical in Europe; Emil J. Konopinski, from Indiana University; and Marshall K. Rosenbluth from Stanford.

This was interesting, but McMahon had other matters to discuss. So far, he told his colleagues, the Joint Committee had confined its attention to the Commission. What about the Department of Defense? Did Secretary Johnson believe that the nation was spending enough on atomic energy? The members of the committee listened to McMahon propose that Johnson and the Joint Chiefs of Staff present their separate opinions on the adequacy of the resources allotted to atomic energy.[15] From the committee's approval it was clear to Pike and his colleagues that the Joint Committee was claiming a vigorous and dynamic role for itself in the hydrogen bomb effort. It did not intend to see the program suffer because of hesitancy or lack of initiative.

REACTORS FOR DEFENSE

By March, 1950, most of the reactor development groups at the Commission's national laboratories were already working on military projects. At Argonne, seventy scientists and technicians were directly involved in research on the submarine thermal reactor. Many others, including half the metallurgy division, were performing research related to the Navy project. Design of the materials testing reactor, which would contribute directly to the naval and aircraft propulsion projects, still took most of the time of twenty members of the Argonne staff. Almost as many were investigating the possibilities of modifying the design of the materials testing reactor for use as a plutonium producer. Purely nonmilitary projects, such as the experimental breeder reactor and a new research reactor for Argonne, commanded only a few scientists.[16]

The submarine reactor, without question, was the center of the laboratory's effort in the first months of 1950. The naval reactor branch, under Harold Etherington's direction, had spent most of the preceding six months preparing a reference design for the submarine propulsion plant. The report, completed on March 1, 1950, established the general specifications which Argonne and the Westinghouse Electric Corporation would follow in designing and developing components for the Mark I reactor, a land-based prototype to be built at the Idaho test station, and Mark II, the first plant to be installed in a submarine. Months of study had confirmed the tentative decision that the reactors would use pressurized water as both moderator and coolant. Extremely sensitive and flexible controls would be necessary for submarine operation, and special provisions would be needed to override the poisoning effect of the fission product, xenon 135, in the period immediately following a reactor shutdown. Extensive exposure of fuel element samples in the Hanford and Oak Ridge reactors had also confirmed the selection of zirconium as a cladding material. Oak Ridge had been successful in devising a process for separating zirconium from hafnium, a strong neutron absorber, but the production of large quantities of acceptably pure zirconium was still uncertain, despite the efforts of the Foote Mineral Company to perfect the process.[17]

So far almost all of the burden for design had fallen on Etherington's group at Argonne. Westinghouse had a few engineers in training at the laboratory, but the company could do little more than some experimental work on zirconium and some small pump development in the old hangars at Bettis Field near Pittsburgh, until permanent buildings were completed in the summer of 1950. Etherington's relations with Westinghouse were good, and Zinn and Captain Hyman G. Rickover had come to an understanding about the responsibilities each would have. Rickover unmistakably represented the Navy and the Commission, but Zinn, who could be as strong-willed as Rickover, had insisted on giving orders for all work at Argonne, including that on naval reactors. Rickover as always impatiently demanded progress. For the difficult task of coordinating and scheduling the activities of the three organizations, he had established a policy board consisting of Zinn, Charles H. Weaver of Westinghouse, and himself.

Etherington, a good administrator as well as a good engineer, gave the Navy project at Argonne a clear sense of direction. Westinghouse was beginning to add its support, and Rickover had already clashed with Leonard E. Johnston and his staff at the new Idaho operations office over plans for building the Mark I plant. Development so far had been technically sound, and there seemed every reason to believe that the combined Commission-

Navy-Westinghouse task force could build a useful submarine propulsion system. The big question was time. To have a nuclear submarine at sea by January 1, 1955, as the Navy had requested, would mean having Mark I in operation by May 1, 1952. On that time schedule, Mark I would have to be similar enough to Mark II so that no major development would be required to build Mark II. At the same time, Mark I would also have to include experimental features essential in determining the final design of Mark II. Another complication was that Etherington would have to freeze the design of Mark I before Argonne could obtain results from a critical assembly of the reactor core, then under construction at the laboratory.[18]

The materials testing reactor at Idaho would neither produce plutonium for weapons nor propel a naval vessel, but it would be able to speed the development of reactors of either type. Under the agreement Zinn had made with Alvin M. Weinberg of the Oak Ridge National Laboratory, John R. Huffman and his staff at Argonne were developing the basic design for all of the plant outside the reactor tank. By March, 1950, they had provided the Blaw-Knox Construction Company with 90 per cent of the data the company would need for detailed engineering design of the reactor and service buildings, the plugs for the experimental ports in the reactor, the coffins for transporting radioactive materials, the storage basin for irradiated fuel elements, and the retention basin for cooling water from the reactor.[19]

Coordination with Oak Ridge was still the responsibility of Stuart McLain and the steering committee. Now that McLain had moved to Argonne and would soon go to Idaho, Marvin M. Mann was directing the work at Oak Ridge. Developing the fundamental design of the reactor involved more than forty men in a variety of activities, including estimates of radioactivity induced in reactor materials and cooling water, fabricating and testing fuel elements and control systems, and preparing final drawings for Blaw-Knox. This work centered around the mock-up of the reactor core which the group had built at Oak Ridge. Most of the tests of hydraulic and control systems had been completed in 1949, and in January, 1950, Mann had started the experiments which would bring the mock-up just to the point of criticality. The critical experiments inspired new confidence in the design at Oak Ridge.[20]

Second only to the testing reactor in the Oak Ridge priority list was the work on aircraft propulsion. Scarcely two years earlier Weinberg and his staff had considered the project technically unsound; but as Weinberg explained to Hinshaw and the reactor subcommittee at Oak Ridge on May 5, 1950, the laboratory had changed its mind about aircraft propulsion. The Lexington report in the fall of 1948 had indeed sounded a pessimistic note in suggesting that it would take fifteen years of vigorous development and more than $1 billion to put the first nuclear-powered aircraft aloft. Estimates of the potential value of the propulsion system in long-range bombers, however, seemed to justify spending $200 million on research and development over the next three to five years. Impressed by this recommendation, the Commission in December, 1948, had decided to finance its own feasibility studies at something approaching $3 million annually for two or three years. At the same time, the Commission asked the National Military Establishment to determine whether the very much larger expenditure in materials, money, and talent would be justified in comparison with other military requirements. Lawrence R. Hafstad set up a joint effort which included the Air Force's NEPA project at Oak Ridge and the Lewis Flight Propulsion Laboratory of the National Advisory Committee on Aeronautics.[21]

The selection of Oak Ridge for the Commission portion of the aircraft project was inevitable after the collapse of centralization. Weinberg was looking for ways to bring reactor development back into the laboratory, and the proximity of NEPA in the K-25 area at Oak Ridge offered obvious advantages. Chronic organizational and personnel problems had continued to plague the Fairchild Engine and Airplane Corporation, the principal NEPA contractor, but the technical competence of the NEPA group was gradually improving under the leadership of Miles C. Leverett, who had been a key man in reactor development in the Clinton Laboratories.

Technical progress by the spring of 1950 had led Weinberg from skepticism to real enthusiasm about an aircraft reactor. Working with NEPA, the laboratory had decided to use lighter shielding materials and to provide greater distance between the flight crew and the reactor. Separate shielding around both the reactor and the crew would make possible a great reduction in the dead weight of shielding, which would be a prime disadvantage in a nuclear-powered airplane. A variety of experiments sponsored by the Commission, Air Force, and NACA had helped to find materials that would resist both high temperatures and intense radiation. NEPA continued some of the earlier studies of air-cooled reactors, but their obvious disadvantage at very high altitudes convinced Weinberg that the greatest promise lay in reactors using liquid metals as the heat-transfer medium. Weinberg hoped that a technical advisory board visiting the laboratory during the summer of 1950 would be able to settle the question of reactor type so that the laboratory could begin the design of a small aircraft reactor experiment before the end of the year.

OAK RIDGE: A NEW KIND OF LABORATORY

Progress on the materials testing reactor and the aircraft project were only two sources of the general optimism which prevailed at the Oak Ridge laboratory in the spring of 1950. Two years under Carbide had convinced Weinberg and his associates that an industrial contractor could operate a research laboratory. Relations with Union Carbide had been good and those with the Commission's staff at Oak Ridge even cordial. In January, Clarence E. Larson, a competent and personable engineer, had replaced C. Nelson Rucker as laboratory director. Since 1948 Larson had been director of the Y-12 plant, which housed the biology division and other portions of the Oak Ridge laboratory. He could work well with Weinberg, who became director of research for the entire laboratory. Aside from the retirement plan and the accounting system, the Carbide operation was effective and to the point. "As matters have turned out," Weinberg admitted in the spring of 1950, "Carbide has been an unsuspected source of strength in relations between the laboratory and the commission." [22]

The best hope for the laboratory's future was its new role as a center for reactor development. In Weinberg's opinion, reactor engineering was more properly done in an industrial than in an academic institution. He thought Oak Ridge was carrying the main burden for the materials testing reactor and had raised aircraft nuclear propulsion from an almost-certain death. Weinberg saw great promise for the homogeneous reactor experiment, which a small group intended to build at Oak Ridge during the coming year. It would be an *experiment* in every sense of that word, and not a complete engineering entity. A small reactor, it would generate only a few hundred kilowatts of heat and enough electricity to power a few light bulbs. But it would test the practicality of achieving a chain reaction in a water solution of uranyl sulfate circulated through a pressure vessel with the shape and size of a critical mass. Weinberg admitted that research on the homogeneous reactor had strayed from the original goal of developing a power breeder, but he felt certain that successful operation would represent a real advance in reactor technology. The best feature of the homogeneous reactor, in Weinberg's opinion, was its small size and relatively low cost. He thought the Commission might step up the pace of reactor development by authorizing a large number of small experiments of this type. A more aggressive, experimental approach might provide better reactors for both peace and war.[23]

THE FUTURE OF KNOLLS

For Harry A. Winne and the General Electric staff at the Knolls Atomic Power Laboratory, it was not so easy to adjust to the shifting uncertainties of early 1950. Although the Knolls laboratory could claim some part in naval reactor technology, General Electric was heavily committed to the intermediate-power-breeder reactor. Looking forward hopefully to the day of economic nuclear power, the company was reluctant to abandon the dream of a single plant which would both generate electric power and replenish its own fuel supply by the breeding process. The trouble was that by the summer of 1949 the dream no longer fitted reality. In order to keep alive any hope for breeding, Kenneth H. Kingdon and his laboratory staff had been forced to move toward higher neutron energies in designing the power breeder. At the upper limits of the intermediate range, the reactor would not be a good power producer.

Already worried about the growing divergence of the breeder and power capabilities of the reactor, Hafstad with the support of Carleton Shugg had decided to give General Electric no more encouragement than was absolutely necessary. In August, 1949, they had agreed to authorize $3 million for site studies at West Milton, New York, where the company planned to build the power breeder. But they refused to sanction actual construction until General Electric had completed a feasibility study of the reactor, which would contain detailed estimates of costs. When the report arrived just before the deadline on February 14, 1950, both Shugg and

Hafstad were disappointed. The report contained surprisingly few engineering details and the cost estimates were staggering—more than $36 million, plus a contingency of 15 per cent. Shugg saw no alternative to a full-dress meeting with the company's leaders in Washington. To assure Carroll Wilson's presence, Winne would not agree to schedule the meeting before March 17.[24]

The delay also gave General Electric time to muster support for the power breeder. As a result of several years of correspondence with Lilienthal, Philip D. Sporn, president of the American Gas & Electric Company in New York, had convinced the Commission to establish a small advisory committee of power utility executives to investigate the possibilities of developing a nuclear power industry. Winne invited Sporn and his committee to Schenectady on March 11 to discuss the power breeder. The following day Congressmen Price and Hinshaw arrived on the second leg of their tour of the Commission's reactor laboratories. The meeting was as congenial as that on the previous day. C. Guy Suits, Kingdon, and Winne all acknowledged the company's commitment to the production effort at Hanford, but they concentrated their attention on the power breeder.

Because Zinn had neglected to say much about his own breeder reactor in describing Argonne's work on military projects, the Congressmen shared for the first time at Schenectady a full understanding of the heady dreams of an infinite supply of fissionable material and electric power. The need to increase neutron energies for breeding did hurt the reactor's power capabilities, but Suits and Kingdon pointed to the superior qualities of liquid metal over water as a heat-transfer medium. Toward the end of the discussion Kingdon broached the subject of naval reactors. Hinshaw was surprised to learn that the Knolls laboratory had such a project. It was not yet, Kingdon admitted, clearly separate from the power breeder, but he claimed that development and construction of the West Milton unit would make possible a sodium-cooled submarine reactor without any need for a land-based prototype. Because of its flexibility for experimental work, the power breeder alone might enable General Electric to build the first nuclear-powered submarine in history.[25]

Developments in Washington would certainly have cooled the enthusiasm at the conferences in Schenectady. Just two days earlier the President had approved the special committee's recommendation that the Commission prepare for quantity production of thermonuclear materials. Wilson's preoccupation with such matters was evident when he, Shugg, and Hafstad met with the General Electric group on March 17. The President's thermonuclear decision and the new requirements had placed heavy burdens on Los Alamos for weapon development, on Oak Ridge for uranium 235, and on Hanford for both reactors and the Redox process. The shortage of technical manpower left Knolls as the only source of additional help for Hanford.

Wilson found General Electric's study of the power breeder too sketchy to justify the start of construction. In fact, new uranium discoveries had made ore procurement a matter of economics rather than availability; breeder reactors had lost some of their earlier importance. Hafstad outlined the Commission's decision: The power breeder would be postponed indefinitely; Knolls would concentrate most of its efforts on Hanford problems; and the reactor at West Milton would be designed as a prototype for a submarine plant.[26]

But could the Commission make such a drastic decision stick? Shugg took no chances. The following week he sent Hafstad and Rickover to discuss the decision with McMahon. As Shugg expected, Rickover was extremely effective in making the point that the reorientation at Knolls would greatly strengthen the submarine effort there. Hafstad could also point to George L. Weil's pessimistic appraisal of the power-breeder idea and to Sporn's private opinion that the reactor had been overdesigned. To members of the General Advisory Committee, Hafstad stressed the deficiencies in the power-breeder design and the high cost estimates. Only after the advisory committee had endorsed the Commission's decision did Oppenheimer learn, much to his dissatisfaction, of the weight the Commission had given to military priorities in justifying cancellation of the power breeder.

On April 3, Rickover adroitly turned the Joint Committee's interest from the power breeder to the new submarine intermediate reactor. Sessions with Sporn's committee and Navy officials later in the week removed the last fears of opposition. Armed with Commission assurances of support for the submarine project, Rickover set off for Schenectady to nail down the new arrangement. On April 6, Winne agreed to transfer about half the Knolls staff to Hanford jobs; the other half would work on the submarine reactor. For Knolls the twilight had ended; military requirements had at least for a time completely obscured any glimpse of the peaceful atom.[27]

PRODUCTION: REACTORS AND AN ALTERNATIVE

Even before the President had clarified his directive on the thermonuclear effort, Wilson had begun to explore ways of providing the additional quantities of fissionable material or tritium which a larger arsenal of fission or thermonuclear weapons would probably require. On February 15, 1950, he established in the staff an *ad hoc* committee to consider which type of reactor would most efficiently produce tritium, given the uncertainties and the urgent schedule. By focusing upon reactors, the group did not mean to prejudice the Berkeley accelerator; the exclusion resulted from the lack of comparable data. To Weil of the division of reactor development fell the task of pulling together the information.

As Weil gathered data for his report, Wilson set about organizing his Washington staff to assure firm management of the thermonuclear effort and prompt mobilization of the nation's reactor experts. After talking with Shugg, Wilson decided that the two of them would take personal responsibility for the effort and would call upon the senior staff for advice. On March 21, after Weil completed his paper, Wilson asked Hafstad to invite Zinn, Weinberg, Suits, Eugene P. Wigner, and Chauncey Starr to serve as a review body. To strengthen the analysis, Wilson telephoned Oppenheimer to see if the reactor group of the General Advisory Committee would add its views. Oppenheimer promised to place Weil's paper high on the agenda for the committee's meeting in late March.[28]

As Wilson was making these arrangements, he began a series of gatherings in his office to study Weil's paper. Occasionally during the two days of discussions, Pike, Smyth, and Dean dropped in, but it was Wilson and his key staff who explored the possibilities. The goal was to obtain within two or three years the facilities to produce a large quantity of neutrons. Weil had tabulated the advantages and disadvantages of four reactor designs: a modified Hanford reactor by General Electric; a modification of the materials testing reactor by Oak Ridge and Argonne; a light-water-moderated reactor fueled with slightly enriched uranium, a comparatively new reactor approach by the H. K. Ferguson Company; and the heavy-water-moderated, light-water-cooled reactor based on the Canadian NRX at Chalk River, but with modifications proposed by North American Aviation, Incorporated.

One by one the possibilities for the reactor design narrowed. Hanford types were not completely excluded, but the group thought that building more units at that site would unduly concentrate production reactors. The better course would be to depend upon Hanford for the production of the essential thermonuclear materials until more efficient reactors at a new site came into operation. Certainly the light-water-moderated reactor was interesting, but the time for development seemed too great. The modified materials testing reactor had a long history of design study and component development, but outweighing these advantages was a lack of flexibility. It would not be as good as the other alternatives for producing plutonium. The sessions ended on March 22, with the staff leaning toward the North American proposal.[29]

The sessions with the laboratory leaders beginning on March 30 focused attention on another possibility. Zinn had come to the meeting prepared to talk about a modified materials testing reactor, which Hafstad had asked him to study. Now he discovered that the Commission was primarily interested in a reactor which would be a good producer of plutonium in the event that the thermonuclear effort failed and the need for tritium lessened. For that purpose the modified materials testing reactor would have little value. Zinn also maintained that the North American design would not be the best solution. Without any opportunity to prepare a written proposal, Zinn persuasively argued for a reactor fueled with natural uranium but using heavy water for both moderator and coolant. The suggestion was a natural one for Zinn. Like a proposal he had submitted to Hafstad in October, 1949, the design would be an enlarged version of the CP-5 research reactor which Zinn planned to build at Argonne.[30]

Zinn did not stay in Washington for the meeting of the General Advisory Committee, but he could be confident that his proposal would receive attention. After considering the various possibilities, the committee agreed that the natural-uranium, heavy-water reactors were the most promising approach. The committee advised the Commission to ask du Pont to consider the heavy-water design for production reactors with the expectation that the company would undertake the design, construction, and operation of the new production units.[31]

A subject of great interest to the General Advisory Committee was an alternative to reactors, Lawrence's idea of building a huge linear accelerator which would generate a flood of neutrons for producing plutonium or tritium. The advantage of the accelerator was that it would not consume uranium 235, on which the fission process in production reactors depended. So convinced was Lawrence of the vital importance of the project that he was willing to delay completion of the bevatron and transfer the skills of his Berkeley group to the production accelerator. On February 8, 1950, the Commission had approved Lawrence's proposal to construct a linear accelerator to produce proton currents on the order of 50 milliamperes at an energy of 25 million electron volts (mev). The Mark I, as the accelerator was called, would make several radioisotopes of interest to the Commission.

Somewhat in parallel, design was proceeding on a much larger accelerator. At a total cost of about $65 million, Lawrence believed he could build a 350-mev accelerator. Its size would be immense. The Mark II was to be housed in a tank 60 feet in diameter and 350 feet long, and would require about 150,000 kilowatts of electricity. The technical challenges were severe. No vacuum had ever been achieved in so large a vessel, nor such voltage gradients held between drift tubes. Lawrence was again pushing at the frontiers of technology, but this time for isotope production, not for research. Whether the supply of uranium would ever become so short as to make necessary a production accelerator was a question debated in Washington.[32]

RAW MATERIALS

The raw materials situation was still tight, although improving. Most deliveries still came from the Belgian Congo, with the United States and Canada ranking far below. Jesse C. Johnson's division of raw materials had mounted a vigorous prospecting and drilling campaign in the American West; but even if new sources were found, it was possible that all available uranium would be consumed within a few years by the expanding production of fissionable and thermonuclear materials.

Foreign sources of uranium ore were equally uncertain in early 1950. At some time the Shinkolobwe mine in the Belgian Congo would become exhausted, and in all likelihood the main source of uranium would become South Africa, where the mineral was found in association with gold ore. Separating the uranium, however, involved severe technical difficulties on which several university research groups had been working for years. Even more perplexing were the political obstacles. After long and complicated negotiations, the Combined Development Agency in March, 1950, stood ready to draw up a contract with the South Africans. At this point Secretary of Defense Johnson acted abruptly. Deeply disturbed by Fuchs's treachery, Johnson saw in the event a warning that the United States must rely upon itself as far as possible. Therefore, he proposed on March 13, 1950, that the United States deal directly with South Africa instead of negotiating through the Combined Development Agency in which the British and Canadians were also members.

Wilson promptly took Johnson's proposal to Joseph A. Volpe, Jr., the Commission's general counsel, and Jesse Johnson, director of raw materials. The three men believed that the proposal would disrupt the negotiations with the South Africans and threaten American ties with the British and Canadians. The Commissioners agreed and recommended continuing the conversations with the South Africans while the American members of the Combined Policy Committee assessed Secretary Johnson's proposal. From Arneson, Wilson learned that Secretary Dean G. Acheson disliked the Johnson idea. When Pike met with Johnson and Acheson on April 25, Johnson accepted the softer position that negotiations through the development agency should continue during a review of relations with Britain and Canada. It was a bureaucratic solution to a troublesome suggestion. Negotiations with the South Africans were difficult enough in their own right, and not until

November, 1950, could the Combined Development Agency conclude an agreement.[33]

THE RETURN OF DU PONT

The Johnson proposal was merely an awkward interruption to the consideration of production reactors. Williams was pressing for decisions. As he pointed out to the Commissioners on April 28, if heavy-water reactors were the choice, construction of heavy-water plants should begin soon so that their product would be available on time. All in all Williams believed that the Commission would require a new production site, a new operations office, and another major contractor. Smyth saw the matter in a larger context. The Commission would soon have to reply to the President on the rate and scale of the thermonuclear effort. Once the magnitude of the program was fixed, the Commission could make implementing decisions. To Smyth, the best way to get Presidential approval was for the Commission to draw up a proposal in which the Department of Defense would concur. Robert F. Bacher, now a Commission consultant, stressed with Smyth the need for a flexible program. If the thermonuclear gamble failed, the new installations should be useful in producing fissionable material. From this perspective, Bacher found the heavy-water reactors attractive. They promised good neutron economy for thermonuclear or fissionable material, and the safety aspects seemed sound. Back in his office, Shugg planned with Volpe the course to follow. Hafstad, McCormack, Volpe, and Weil should draft a paper for the Department of Defense and the President. During the next few days others were called in to help, and Wilson himself dictated a few paragraphs. On May 5, the Commission sent its proposal to the Military Liaison Committee.[34]

Shugg had been keeping du Pont aware of the general course of events through R. Monte Evans, a company engineer whose experience in reactor work went back to early Hanford days. Now that the Commission's plans were taking final shape, Wilson and Shugg on May 12 caught the noon train from Union Station for the du Pont headquarters in Wilmington, Delaware. In Crawford H. Greenewalt, the company president, Wilson and Shugg faced a shrewd negotiator. Du Pont would consider the project if the company were given full responsibility for the new reactor facilities, including design, construction, and at least initial operation. The company would make no commitment until its engineers had reviewed the Commission plans, evaluated the several approaches to heavy-water production, and estimated the chances of completing the project on schedule. Moreover, du Pont would need to know the details of heavy-water production, since difficulties in this area might affect the reactor operating data. Following the policy that du Pont had established in the Manhattan days, Greenewalt insisted upon a letter from

President Truman confirming the importance of the project for national security. Having stated these terms, Greenewalt accepted some basic studies for his engineers to analyze.

Wilson reported to the Commissioners that du Pont would accept the assignment if its conditions were met. Since Greenewalt was about to leave for Europe, Wilson urged quick action. The Commission discussion revealed an uncomfortable feeling of wariness. Smyth understood the du Pont concern over the selection of the heavy-water production process, but on the other hand he did not want to see the Commission abdicate its responsibility to du Pont. Dean wondered what other companies the staff had considered. Union Carbide, Monsanto, Dow Chemical, and American Cyanamid, replied Wilson, but they could not match the du Pont experience in design and construction of production reactors and chemical processing facilities.[35]

HEAVY WATER: PROCESSES AND REACTOR

The Commission had already come to some conclusion on heavy-water production processes. During the Manhattan project, Groves had chosen the water-distillation and the catalytic exchange processes for the small amount of heavy water needed. The drawback to these processes was the high unit cost of the product. Two other processes—dual-temperature and hydrogen-distillation—had been considered briefly, but scaling them up from the laboratory bench to the production plant revealed severe engineering difficulties. These obstacles seemed less formidable as industrial techniques improved after the war, and the Commission had asked Hydrocarbon Research, Inc., to design a plant based on the hydrogen-distillation process. On March 1, 1950, the Commission approved the construction of a pilot plant. In this process, hydrogen gas would be cooled to liquid temperatures and the deuterium separated from the gas by fractional distillation. There were disadvantages: hydrogen gas could be hazardous and the low temperature required by the process could make plant operation difficult.

As promising as the hydrogen-distillation method appeared, Williams's production division was anxious to get Commission approval for another heavy-water plant based on the dual-temperature approach. Edward J. Bloch, deputy director of production, told the Commissioners on May 11, 1950, that estimated requirements for heavy water were increasing. Furthermore, the wisdom of relying on a single method was doubtful. Bloch favored constructing another pilot plant for the dual-temperature process. Early work on the method had been done under Harold C. Urey at Columbia and by Jerome S. Spevack. In the dual-temperature process, deuterium was concentrated first in water and then in hydrogen sulfide gas as water was passed through the gas in alternately hot and cold mixing towers. The process required several towers and was dangerous. Because the hydrogen sulfide gas was toxic, men assigned to the plant would have to wear gas masks and work in pairs.

At first the Commission had rejected the dual-temperature approach because of the long construction time required and high costs. Using some of the existing facilities at the Wabash River Ordnance Works near Dana, Indiana, would reduce the cost of the pilot plant. If all went well with the pilot plant, more equipment could be installed at the Wabash site so that production could be increased to tonnage amounts. Commission approval of the Wabash project eased but did not meet the supply situation for the future. Wilson was worried. As he studied the production plans with the staff, he concluded that the availability of heavy water might be the pacing item. He reported to the Commissioners on May 18 that constructing and operating heavy-water facilities for the tritium production effort might well be part of the du Pont assignment.[36]

While the Commission in Washington deliberated over heavy-water processes, Zinn at Argonne had his reactor men working intensively on a heavy-water-moderated and -cooled production reactor. Zinn and his staff believed their design had certain advantages over the North American proposal, which they thought overestimated production rates and overlooked some difficulties in heat transfer. The only obvious drawback they saw in the Argonne design was that the quantity of enriched uranium required was greater than the hurried estimate Zinn had given Shugg on March 31. The positive factors Zinn saw were impressive: The Argonne design should compare favorably to the Hanford reactors on fuel economy, and conversion of heat by cooling towers rather than by large bodies of water promised greater latitude in choosing a site.[37]

Shugg strongly inclined toward the Argonne plan, but Weil was less certain. Confronted by drawings, data, and analyses from Argonne and North American Aviation, he called a meeting of reactor leaders for May 24. After Weil's introductory remarks, Wigner warned that other reactor types should not be overlooked. Although the point was sound, others at the meeting resisted broadening the scope of the session beyond a comparison of the two designs. Tex Fahrner presented the North American design and Zinn described the Argonne approach. For three days the group argued over reactor physics and the definition of terms and constants.

The main differences between the two designs lay in the use of heavy water. The North American group planned to use heavy water only as a moderator, while the Argonne team proposed it as both a moderator and coolant. Zinn challenged the North American idea of forming the reactor core by placing four aluminum tanks side by side to hold the heavy water and the fuel elements. In his view the design called for too much welding, often the source of corrosion problems. Wigner doubted whether the tanks could be made leakproof. He was not satisfied with Fahrner's assurances that aircraft manufacturers in the Los Angeles area were confident of their ability to meet the specifications, because they had had no experience with welds which would be subjected to irradiation. Others at the meeting questioned whether the North American design contained sufficient flexibility to make uranium 233 from thorium or plutonium from depleted uranium.

Zinn fared reasonably well; the main criticism came over the means for heat removal in case of emergency shutdown. After three days, there was agreement that North American and Argonne should begin experimental investigation of pumps and heat exchanger equipment, and undertake further studies of corrosion.[38] By the end of May, the Commission had made its decisions on the technical aspects of reactors for the expansion program.

DECISIONS ON EXPANSION

How large the expansion program would be was the subject of the report which Truman requested on March 10, 1950. McCormack and General Alvin R. Luedecke, executive secretary of the Military Liaison Committee, coordinated the Commission and Defense parts of the report and on May 25, 1950, Pike and Secretary Johnson submitted it to Truman. Cast in the form of a letter, the report dealt mainly with tritium production. Hanford should be able to provide the amount needed by Los Alamos and a test of thermonuclear principles in the spring of 1951. Although this goal was acceptable for the interim, long-range production required more reactors which, to make most efficient use of fissionable material, should take advantage of improved technology. Therefore, the President was requested to approve two heavy-water reactors, along with a recommendation that du Pont design, construct, and operate the new facility. After advising Truman of the effect of the thermonuclear effort on fissionable material production and weapon stockpile, the two leaders assured the President that the Joint Chiefs of Staff had measured and accepted the cost.[39]

Without waiting to study the proposals, Truman authorized negotiations with du Pont. By the time he approved the program on June 8, the Commission and the company had agreed on the broad terms of a contract. On June 12, Pike formally requested du Pont to take the assignment. He asked the company to accept responsibility for the site survey, design, construction, and operation of a new reactor installation and to review the technical analyses of the reactors and the processes for making heavy water. Aware of the pitfalls of community management, the Commission hoped that du Pont could find a location which would not require a Government town. Truman met the du Pont stipulation by writing Greenewalt on July 25 that the project was of the highest urgency and vital to national security. The

Commission and du Pont were to reach agreement on a letter contract on October 17, 1950, but contract negotiations were to drag on for years.

The only remaining loose end in June was the Commission's own organization. Wilson had no question of the ability of Williams and his production division, but further coordination was needed among the Washington staff. On June 23, 1950, Wilson gave Shugg authority to act as general manager on matters involving the new program.[40]

From his office on Capitol Hill, McMahon impatiently watched the Commission's steps. He had asked Secretary Johnson and the Joint Chiefs of Staff to assure him that the atomic energy program offered the nation adequate security. On May 5, 1950, Johnson had replied that he and the Joint Chiefs could make no categorical answer; in developing the thermonuclear weapon there were too many imponderables to know whether the United States would be successful, and there was no way of finding out what the Russians were doing. The response galvanized McMahon to action. He declared that he could not, in clear conscience, accept so vague an answer on an issue of such magnitude.

Gravely concerned for the nation's security, McMahon turned to Pike for a detailed explanation of the methods the Commission and the Department of Defense used in setting military requirements for atomic energy projects. McMahon's restlessness and anxiety were clearly evident during hearings on June 22, 1950, with General Electric officials. McMahon began reading a highly classified report written by Borden. Citing the President's recent approval of two heavy-water reactors, Borden saw no reason why the Commission could not also build additional reactors at Hanford. He had studied intelligence estimates and found that 1952 and 1953 were most often cited as years of greatest danger to the United States. Yet the President's program would add nothing to the nation's strength during this crucial period. Hanford-type reactors would be able to produce material more quickly. Failure to build them as well as heavy-water reactors was subjecting the United States to grave peril. It was obvious to those listening that McMahon was deeply impressed by Borden's reasoning and they must have expected his announcement that he was going to seek the views of the nation's military leaders.[41]

Truman's approval of the scale and rate of effort to produce thermonuclear material had, at least for a time, defined the program. Implementation required engineering judgment, for there was no doubt that heavy-water reactors could be built. Zinn had a small heavy-water research reactor at Argonne and the Canadians had a larger one at Chalk River. There was also no doubt that heavy water could be produced. Instead, the question was which process or combination of processes would provide the quantities needed on a tight schedule. The unknown was whether a thermonuclear weapon was possible. Neither Truman at the White House, McMahon in his Senate office, Johnson at the Pentagon, nor the Commissioners and Wilson around their huge triangular conference table could answer that question. All they could do was wait for results from Los Alamos.

NATIONAL SECURITY: THE LONG VIEW

Through the winter and spring of 1950, the Commission properly focused its attention on the immediate challenge of military requirements. On the verge of a national emergency, if not on the doorstep of war, first priorities had to go to producing fissionable materials and weapons and to speeding research on a thermonuclear weapon. But short of war, the Commission could not neglect the continuing vitality of long-range research and development. The achievements of the Commission's laboratories today would provide the technology for tomorrow.

Whatever the Commission accomplished in research and development, either for military applications or basic science, success would depend in large part on the performance of the national laboratories. During the first three years the function and nature of the laboratories had been anything but clear. In a sense they were not "national" at all, but regional, and even that term did not apply to all of them. Argonne, under Zinn's strong leadership, was largely a reactor development center with little time or inclination for the basic research interests of scientists in the participating universities. After the Commission's reorganization in the summer of 1948, no one understood exactly how the laboratories were related to Washington. Each laboratory encompassed a broad spectrum of scientific disciplines, yet each was responsible to only one of the Washington divisions. This new tie to Washington also confused the relationship of each laboratory to its neighboring operations office.

By the fall of 1949 Carroll Wilson had sensed enough concern about the role of the laboratories to take some direct action. He asked David B. Langmuir, executive secretary of the program council and himself a scientist, to organize a research committee consisting of Wilson, Hafstad, Kenneth S. Pitzer, and Shields Warren. The committee's first concern was the function of the laboratories. At Argonne the heavy stress on reactor development had sapped the strength of the research divisions, and the board of governors representing the participating universities had never become an effective link in the chain of authority from Hafstad to Zinn. The research committee suggested that the laboratory, like Brookhaven, have a small nucleus of permanent staff in the basic sciences to maintain the fundamental structure of a research laboratory. Applied work, mainly in reactor development, would be organized in projects outside the permanent structure.

At Oak Ridge the research committee saw the principal problems as the diffusion of effort and unrestricted growth, largely reflecting Weinberg's exuberant personality. Oak Ridge needed a long-range central mission. Perhaps, the committee thought, aircraft nuclear propulsion, the homogeneous reactor experiment, or a chemical separation process more advanced than Redox would serve that purpose. At Brookhaven there was an uneasiness about the tenuous ties to the Commission's activities. Just the opposite of Argonne, Brookhaven seemed heavily oriented toward basic research. The research committee was troubled by delays in completing the reactor and other facilities and the very high level of overhead and indirect expenses.[42]

Commissioner Henry D. Smyth summed up much of his discussions with the research committee in a speech at Oak Ridge in October, 1949. Smyth told his audience that a mixture of "pure" and "bread and butter" research was one of the strengths of the national laboratories. The increasing costs of research required Government laboratories to supplement the effort previously carried alone by universities and private institutions. The national laboratories also made it possible to maintain secrecy when needed and to provide expensive equipment like reactors and accelerators. The varied background of the Commission's laboratories precluded the possibility of any single pattern of organization. Nor could there be any single pattern for controlling them. The arguments over control in 1949 were to Smyth the sign of a healthy organization. Smyth defended some of the features of decentralization, but he admitted that Washington was tightening its controls over the laboratories. What had to be clarified was the interlocking authority of the laboratory directors, the managers of the operations offices, and the Washington division directors.[43]

Many of the difficulties the Commission was experiencing in directing the work of the laboratories stemmed not from deficiencies in organization but from snarled administrative practice. The laboratories, Smyth had acknowledged in his speech, had to "be alert to fight red tape, even red tape imposed on them by the Commission in Washington." A meeting with the laboratory directors in December, 1949, concentrated on administration and management, and the research committee undertook to prepare a survey of "the mechanisms of administering the laboratories." [44]

The management report was the work of Howard C. Brown, Jr., on the staff of Fletcher C. Waller, now the director of organization and personnel. Brown concluded that the "laboratory problem," the term commonly used in Washington, was not so intractable as many had assumed. Most of the early difficulties he attributed to growing pains in the new administrative structure created by the 1948 reorganization and by the transition from an obligation to a cost-type budget. The staff had worked out most of the kinks in budget procedure. Management troubles, Brown thought, would be resolved by better use of cost controls, better schedules for preparing budgets, and more communication with administrators in both the laboratories and the operations offices. The new policy statements which the Commission adopted in June, 1950, to define the roles of Argonne, Oak Ridge, and Brookhaven reflected many of the ideas which Brown had collected in his management report. After years of uncertainty the character of the national laboratories was beginning to emerge.[45]

INDEPENDENT RESEARCH: A STEPCHILD?

The growing preoccupation with military security in late 1949 and early 1950 had implications beyond the national laboratories in the broader reaches of the scientific community. On the one hand, as Oppenheimer and the General Advisory Committee had recognized, the growing demands of national defense threatened the free spirit of inquiry on which scientific progress depended. On the other hand, scientific discoveries were themselves directly responsible for some of the conditions which made a greater defense effort necessary. Oppenheimer told a Washington banquet audience in March, 1950, that science had profoundly altered the conditions of man's life, both materially and spiritually. Science had for the first time given man "the means for abating hunger for everyone on earth," but he admitted that its greatest impact had been on warfare.[46]

Samuel K. Allison, who had spent World War II at the Metallurgical and Los Alamos laboratories, was more emphatic while addressing the American Physical Society. War itself, he said, was responsible for the emergence of modern physics as a decisive force in American life. The physicists' new importance, in Allison's opinion, was a peril to science. Because physics was now relevant to military security, secrecy was necessary, and secrecy was a grave threat to scientific inquiry. As a good example of the peril to science, Allison cited the legal requirement for security clearances for Commission fellowships. Another danger was that military demands might lure too many scientists from basic research to work "on a kind of applied gadgetry unworthy of the inheritors of Newton and Planck." He urged his colleagues to speak out for more support of the basic sciences by the Federal Government, either through the joint Commission-Navy accelerator program or a national science foundation.[47]

Allison could not hope to stem the rising tide of concern about military security, but he could suggest that basic research was still possible in any situation short of a full emergency. Zinn had assured the Congressmen at Argonne that greater effort on military reactors would not require the end of all basic research. In fact, the year 1950 brought several reasons for encouragement among independent scientists. In May, the Congress at long last approved the establishment of the National Science Foundation. As Lee A. DuBridge told the readers of the *Bulletin of the Atomic Scientists,* the Act was an excellent piece of legislation. The security provisions were unobjectionable and the powers granted the foundation would forward the cause of science without undue restrictions. "At last," he concluded, "we have an agency which will free basic science from the danger of becoming a step-child of military technology." [48]

The Commission itself was continuing to support basic science in several ways. By 1950, the divisions of research and biology and medicine had negotiated more than 125 contracts totaling $5.6 million for basic research in the universities and private institutions. The Commission's part in the joint effort with the Office of Naval Research was almost $6 million, covering about a hundred contracts in fiscal year 1950. In the spring of that year, Pitzer had also responded favorably to a request from North Carolina State College for authorization to build a research reactor and for a loan of the fissionable material needed for fuel. By summer the university group, led by Clifford K. Beck, had completed a feasibility study of the reactor. The Commission's attorneys concluded that the reactor would qualify as a research facility under Section 4 of the Atomic Energy Act and would not therefore be subject to the legal requirement that all facilities producing significant amounts of fissionable material be owned by the Commission. In October, 1950, the Commission approved allocation of the fissionable material. Barring unforeseen difficulties, North Carolina State would earn the distinction of being the first university in the United States to have its own research reactor.[49]

PARTNERSHIP WITH INDUSTRY

The increasing attention to defense requirements in the Commission posed as great an obstacle for engineers and technology as it did for scientists and basic research. Lilienthal in his Detroit speech in October, 1947, had spoken in glowing terms of a partnership with industry in developing the peaceful uses of atomic energy, but the results had been disappointing. The industrial advisory group under James W. Parker consisted of too many executives too busy ever to dig deeply into nuclear technology. More than a year later, in December, 1948, the committee had little more to recommend than declassifying and publishing technical information and bringing more American companies into atomic energy work as contractors.[50]

The Parker report and some persistent pleas from Philip Sporn to release technical information useful to the electric power industry momentarily rekindled Lilienthal's concern about industrial participation. In the winter of 1949 Wilson and the staff looked for ways of accomplishing the Parker and Sporn proposals. Following up the Parker idea of releasing more technical data, Morse Salisbury, director of the Commission's public and technical information service, concluded that it would be possible to organize technical information according to specific technologies, such as metallurgy and chemistry, and then to permit small teams of technical experts in each field to select reports that would be useful to industry. If the Commission could declassify these reports, they could be published in trade journals or press releases. Sporn's proposal was more difficult to handle. If the Commission granted representatives of the power industry access to classified information, what would prevent other industries from asking for the same privilege?

By August, 1949, the Commission had resolved enough of the administrative difficulties to permit a trial of both ideas. A temporary advisory committee representing professional societies and the trade press would explore declassification of technical information, and a temporary three-man committee under Sporn's direction, but not formally representing the power industry, would examine classified information on reactors.[51]

The Sporn group, like the Parker committee, had difficulty finding time to digest the vast amount of technical information available behind the security barriers. But the technical information group, under the leadership of Ernest E. Thum of the American Society for Metals, soon produced results. Thum reported early in 1950 that in eight hundred patent abstract files the group had not found any large amount of declassifiable information that would have been of interest to American industry. Stemming from facts rather than superficial generalities, this and subsequent reports established the Thum committee as an effective channel of communication between the Commission and the engineers.[52]

Education was another way of encouraging industrial participation in Commission work. In June, 1949, the American Society of Mechanical Engineers proposed a series of one-week seminars covering classified information for executive engineers, a plan for on-the-job training for working engineers in the Commission's laboratories, and development of a guide which the Commission staff could use in declassifying technical information. The Commission never adopted the first proposal in its original form, and the second encountered the resistance of the Commission's contractors, who were wary of having employees of other companies in their organizations on a temporary basis. But study of these suggestions did lead to more practical ideas, such as the Oak Ridge School for Reactor Technology, which began offering a twelve-month course for scientists and engineers in the spring of 1950. In July, 1950, the Commission announced a new procedure for issuing technical reports, which were indexed in a biweekly summary called *Nuclear Science Abstracts*.[53]

These tentative efforts to educate scientists and engineers helped to break through some of the barriers which security had erected around the Commission's activities. It seemed likely that universities would soon have research reactors and that the use of radioisotopes would become standard practice in American science and industry. But none of these secondary applications of nuclear technology would in themselves create an atomic energy industry. That, in Hafstad's opinion, would come only when there was concrete evidence that the generation of electric power from nuclear energy was economically feasible. Even successful operation of the Commission's several power reactor experiments would not be enough. Hafstad told his friend John G. Grebe, in Washington temporarily as an Army consultant, that it would take commercial operation of nuclear power plants to bring industry into the main stream of nuclear technology. Impressed by Hafstad's remarks, Grebe visited Argonne and Oak Ridge in the spring of 1949. Soon after returning to his regular job at the Dow Chemical Company in August, he began exploring the possibility of building nuclear power plants.

Other industrial leaders were also interested in nuclear power. Charles A. Thomas of the Monsanto Chemical Company had sparked his company's efforts to develop the Daniels reactor as a power demonstration plant at the Clinton Laboratories in 1947. A friend of Lilienthal's since 1946, Thomas knew of the Commission's efforts in 1948 and 1949 to establish ties with industry. He welcomed the formation of the Sporn and Thum committees in the summer of 1949, but he too had set his sights on nothing less than a nuclear power plant. Among the several informal proposals Hafstad received in the fall of 1949 was one from the Kellex Corporation suggesting that the Commission finance a survey of industrial interest in power reactors. Hafstad and George G. Brown, the Commission's director of engineering, considered writing specifications for a power reactor and inviting industry to bid. The idea, however, of bringing industry behind the security barrier still seemed like a daring idea in early 1950, especially in the worsening international situation.[54]

If outside initiative were necessary to bring about public discussion of nuclear power, the opportunity was in the making in the spring of 1950. Within a few weeks after leaving the Commission, Lilienthal began to reflect on the way defense needs had delayed the constructive development of atomic energy. Probably increasing his concern was the news in March that the Commission had canceled the power-breeder project at Schenectady and redirected research at Knolls to submarine propulsion. By May, Lilienthal had completed an article entitled "Free the Atom" for *Collier's* magazine. The article proposed an end to Government monopoly of nonmilitary and commercial aspects of atomic energy. So enthusiastic was the publisher that Lilienthal thought it wise to warn President Truman of the impending "blast."

Lilienthal did not record in his journal any correspondence with Thomas about the article, but he had seldom delved into such subjects during his chairmanship without consulting his former colleague. It may therefore have been more than a coincidence that two days after the *Collier's* article appeared on June 9 with full-page advertisements in some major newspapers, Thomas proposed an industrial study of nuclear power.[55]

Thomas suggested that industry be allowed to design, construct, and operate atomic power plants at its own expense, to produce both useful power and plutonium. Thomas had no doubt drafted his proposal to appeal to

Commission needs more pressing than industrial development. A dual-purpose reactor would give the Commission an additional source of plutonium at the very time it was endeavoring to increase plutonium production for weapon requirements. If Thomas could entice the Commission to accept such an agreement, private industry would have a compelling reason for access to classified technical information. Furthermore, revenues from the sale of plutonium to the Government could be used to offset power costs and thereby make the dual-purpose reactor more attractive to electric power companies. Thomas thought this incentive, plus the promise of long-term amortization, would induce private industry to undertake the huge capital investment required.

Thomas's proposal was sufficiently attractive to command extensive study by the Commission's staff in the summer of 1950. Because Thomas had no precise data on plutonium production costs, the staff first examined the economics of the proposal and determined in a rough way that plutonium revenues might be high enough to provide electric power at a reasonably low cost. More difficult to accept was Thomas's assumption that the necessary design data for the dual-purpose reactor already existed in the Commission's files. The best approach seemed to be to let Monsanto first study the Commission's reactor development projects and then determine whether development and construction of a reactor should proceed.[56]

THE SUPER: A RECEDING GOAL

In the shadow of an international crisis the Commission had done well to maintain its equilibrium. Whatever the demands for nuclear materials and weapons, it was still possible to move ahead on other fronts—on basic research in the universities, on reactor development in the national laboratories, and on industrial studies of nuclear power plants. But the shadow of crisis remained, and as it lengthened in May, 1950, the prospects of devising a thermonuclear weapon took on new importance. Only Los Alamos could gauge the chances for success.

At Los Alamos in early 1950 Edward Teller looked to the future with eagerness and enthusiasm. In two staff lectures he had outlined his ideas of a thermonuclear weapon. The most likely way to attain energy from thermonuclear reactions was to fuse the tritium and deuterium isotopes of hydrogen. Fusion, however, would require exceedingly high temperatures which perhaps could be reached by using the energy released from a fission bomb to ignite the thermonuclear reaction. This approach posed for Teller and his group a very different set of problems from those which Los Alamos had faced nearly a decade earlier in designing the fission bomb. Then it had been a matter of bringing together a supercritical mass of fissionable material—either by implosion for a plutonium weapon, or by firing a uranium projectile into a uranium target for a gun-type weapon. Teller did not consider these techniques practical for a thermonuclear weapon.

It was also uncertain whether a fusion reaction once begun could be maintained. The possibility existed that natural phenomena, as inexorable as the force of gravity, stood in the way as insurmountable barriers. By careful design, the theoretical physicists at Los Alamos hoped in some way to overcome them. The obstacles were but challenges to Teller, who wrote to Luis W. Alvarez that the physicists at Los Alamos were "busy like monkeys." [57]

Los Alamos desperately needed data to predict and describe the behavior of materials at incredibly high temperatures, the method in which energy moved from particle to particle, and the means by which energy was dissipated and lost. The greatest handicap of the physicists in Carson Mark's T, or theoretical, division, was the lack of computers. The most advanced machine available was the electronic numerical integrator and calculator, a title inevitably shortened to ENIAC. The ENIAC was completed in 1946 at the Aberdeen Proving Ground in Maryland, and with its 19,000 or more vacuum tubes and hundreds of thousands of other electrical parts, was useful for rapid and repetitious calculations needed for ordnance tables. But the machine had no ability to store information. The problems coded by Los Alamos were already pressing against the boundaries of computer technology. John von Neumann, mathematician and consultant to the Army and Los Alamos, was in a perfect position to bring computers to bear upon the fusion calculations. He had in mind the MANIAC, a more sophisticated computer to be built in Princeton.

Los Alamos could not wait. With slide rules, desk calculators, and tabular data, Stanislaw M. Ulam and Cornelius J. Everett of the T division explored the mechanism of thermonuclear reactions. By reducing problems to stark simplicity, by pruning them vigorously, by making intuitive assumptions, the two hoped to establish orders of magnitude for some of the answers while the laboratory waited for more complete and precise results from the computer. The work was laborious, but as February, 1950, began, Ulam saw a fifty-fifty chance that the fusion reaction, once begun, would continue.[58]

Idea after idea tumbled from Teller's mind and, with exhilarating zest, he scattered them throughout the division and the laboratory. Bradbury had to devise some sort of administrative framework in which Teller could work without disrupting the rest of the laboratory. The Los Alamos director proposed a committee, consisting of the main division leaders and with Teller as chairman, which would be responsible for the thermonuclear effort at Los Alamos. Through this arrangement Bradbury could keep the laboratory organization intact, and yet bring to bear upon thermonuclear problems the strength of each division.

To Teller, administration was a dreary business which he did not understand. If Los Alamos were to succeed, it would be by heroic measures, not by organizational palliatives. Teller held it imperative that Los Alamos become once again, as it had been under Oppenheimer, a center around which the scientific leaders of the nation would gather to concentrate their talents. For assistance in recruiting these leaders he turned to Borden and the Joint Committee. Teller wrote to Borden that the position of the General Advisory Committee was crucial. "I feel that the attitude of the members of the GAC has been a serious difficulty in our recruiting efforts. . . . A man like Conant or Oppenheimer can do a great deal in an informal manner which will hurt or further our efforts." Borden had no difficulty in enlisting McMahon's assistance, but he was pessimistic over getting Conant or Oppenheimer to take a more positive stand.[59]

By March optimism was fading fast. In the early part of the month Ulam completed his first report on the possibility of igniting a thermonuclear reaction under given circumstances. He acknowledged that the entire calculation surpassed the capacity of any existing computer, a situation which only the MANIAC at Princeton could rectify. Nonetheless, Ulam had estimated the values of multidimensional integrals which expressed that fraction of energy originating in the form of fast particles with sizeable mean free paths and ranges in one zone and transmitting thermal energy to another zone. From these and other assumptions he and Everett performed their hand calculations. The procedures, Ulam had admitted freely, were unorthodox. Gloomily he reported, "The result of the calculations seems to be that the model considered is a fizzle." [60]

The obvious step was to change the model. As Foster and Cerda Evans and John W. Calkin formulated the long and complex problems for the ENIAC, Ulam traveled to Princeton to see von Neumann. He arrived on April 17, the day on which Teller ended his visit with the Princeton mathematician. Late on the afternoon of April 21 the telephone rang in the von Neumann house. It was Enrico Fermi. That evening and the next day the three talked over the implications of Ulam's results. Von Neumann concluded that there was no choice but to increase the amount of tritium in the theoretical design. The direction of the change made the Super less attractive, but von Neumann could see no alternative. Ulam returned to Los Alamos, bringing to Teller the parameters for the new problem.

Teller reacted intensely. Ulam reported to von Neumann, "He was pale with fury yesterday literally—but I think is calmed down to-day." Teller admitted his anxiety to von Neumann, who offered reassurances that the motives behind the changes were constructive. Nor was the shift in the parameters intended to be the basis for a final calculation, but only a way of revealing the magnitude of some of the factors to be considered. On May 18, 1950, von Neumann received disappointing news from Ulam: "The thing gives me the impression of being miles away from going." Von Neumann admitted that prospects for success were not bright, but he wondered if Ulam was not premature in his pessimism. In any event, von Neumann expected to spend part of the summer at Los Alamos.[61]

That summer Hans A. Bethe visited Los Alamos, not to work upon the Super, but to do what he could on fission weapons and to investigate certain phenomena which had received inadequate treatment earlier. He looked over the Ulam-Everett calculations and agreed that prospects for the Super were poor. He had little doubt but that the ENIAC would confirm the hand calculations. Nonetheless, Bethe thought that the test of thermonuclear principles, one of a series of tests planned for the spring of 1951, should go forward.[62] By the end of June, the proposed tests had been given the name *Greenhouse.*

Throughout much of Los Alamos work continued along the accustomed grooves of practiced efficiency. In the T division there was tension. Some felt that the Super would not work, that insurmountable natural barriers blocked the way to success. Perhaps the quest for the Super was squandering talent and material which could be better spent on improving fission weapons. Teller's response to bleak obstacles was an ever more determined and fiery assault, involving a further marshalling of the nation's scientific leadership. Beyond this he could think of no other ways to reach his goal.

The fading hopes for a thermonuclear weapon in the last days of spring in 1950 seemed to blend with the somber outlook in international affairs. For the United States the twilight between peace and war ended abruptly on June 25, 1950, when communist troops in North Korea launched an attack across the 38th parallel. President Truman immediately ordered naval and air units to Korea, and the first American troops met the enemy on Korean soil on July 5. For the moment there was a feeling of unity and a recognition that the President could make no other responses. In the Commission there would no doubt be new demands for nuclear materials and weapons, but would these military requirements further delay the pursuit of peaceful uses of atomic energy? Only firm decisions and a judicious appraisal of resources could answer that question.

CHANGING PATTERNS OF ADMINISTRATION

CHAPTER 14

So much had happened in the twelve months since July, 1949, that it was difficult to believe only a year had passed. The Hickenlooper investigation, the first Soviet detonation, the debate over speeding development of the thermonuclear weapon, the resignations of David E. Lilienthal and Lewis L. Strauss, the demands for more fissionable material and weapons, and the outbreak of war in Korea had all but transformed the world of atomic energy as Lilienthal and Carroll L. Wilson had visualized it in the summer of 1949.

The larger currents of change were clearly of significance in national and international affairs, but they also had profound impact on the Commission as an agency of the Federal Government. Changing requirements and new leadership brought new patterns in most aspects of the Commission's organization and administration. As important as any factor was the emergence of Gordon E. Dean, first as one who brought a fresh approach to administration, and then as heir apparent to Lilienthal as chairman.

The changes taking place, however, were too broad and far-reaching to be attributed to one individual. Some were parts of trends going back to 1947—for example, the interest of Congress in appropriations and in the management of the Commission's communities. Others, such as the Commission's labor and security policies, were already in a state of transition when Dean joined the Commission.

The summer of 1950, marking as it did the effective end of the Lilienthal era and the beginning of the Korean conflict, was a turning point in the Commission's administrative activities. Both labor and security policies soon reflected the growing demands of national defense, and the Dean administrative style was at last to lead to effective cooperation between the Commission and Congress. In the rising tempo of change, new patterns of administration were emerging to replace the tentative solutions of the 1940's.

THE EMERGENCE OF GORDON DEAN

President Truman's decision to appoint Dean to the Commission in May, 1949, had profoundly disappointed Lilienthal. Having never met Dean, he envisaged a brash young politician, perhaps a younger version of Brien McMahon, who had been Dean's law partner and chief sponsor. Lilienthal admitted that Dean might be as intelligent as any of his colleagues and that he might bring a needed new look to the Commission's deliberations. But Lilienthal could not forget the fact that McMahon's sponsorship was the principal reason for Dean's selection. It was in Lilienthal's words "a second —or third—rate appointment to a first-rate responsibility." [1]

The Commission, Lilienthal had explained to Truman, was as important as any body in the country, perhaps even in the world, and it deserved the very best people available. Since 1946 Lilienthal had maintained that there was something special, even unique, about the Commission's responsibilities that set it apart from other agencies of Government. Dean's appointment suggested to Lilienthal that "politics as usual" was replacing nonpartisan statesmanship as the hallmark of the Commission's leadership.

Lilienthal began to temper his disapproval of Dean after meeting him. Dean looked older than Lilienthal had imagined, "thoughtful, judicious, easy. No touch of the politico at all." Others soon discovered that Dean had more than a time-server's interest in the Commission. Dean, who had no technical background, read everything he could find on atomic energy, and he astutely observed the unfolding drama of the Hickenlooper investigation in the summer of 1949. Dean was certainly not the cigar-chewing political dilettante Lilienthal had feared.[2]

Dean's criticisms of the Lilienthal administration had first appeared in several Commission discussions in the summer and fall of 1949. In July Dean had questioned the strict legality of the Commission's procedures for exchanging technical information with the British and Canadians under the *modus vivendi* of 1948. He thought the Commission should discuss the subject with the Joint Committee to determine Congressional intent. He also agreed with Strauss that the Commission should reexamine the sweeping powers of the general manager, including the organizational arrangement that required the general counsel, the controller, and the secretary to report to the Commission through the general manager.[3]

In time Dean's misgivings seemed to settle on the division of responsibility between the Commissioners and the general manager. In August he questioned Carleton Shugg's decision, as deputy general manager, to award a large construction contract without consulting the Commissioners. He complained when the staff prepared an agenda for a meeting of the General Advisory Committee and showed it to the Commissioners only the day before the meeting. In October he objected when Wilson, almost as an afterthought, asked the Commissioners to approve a $42-million construction project at Los Alamos.[4]

This last incident precipitated a general discussion of the Commissioners' role in making policy decisions. At Wilson's invitation Dean set down his views on the matters troubling him. He acknowledged the difficulty in trying to define precisely the division of responsibility between the Commissioners and the general manager, but he maintained that only the Commissioners could make such a decision. To get the ball rolling he ventured to compile his own list of those matters in which the Commissioners should participate directly. In the area of Congressional relations, he urged that the Commissioners take a more active role in preparing the budget, drafting legislation, and presenting the Commission's program to the Joint Committee. He agreed with Strauss that the Commissioners should have direct representation in State Department talks with the British and Canadians and that the Commission should tighten up the administration of security. In all the Commission's relationships with outside organizations, whether the Defense Department, the Military Liaison Committee, the White House, the General Advisory Committee, or the Combined Policy Committee, Dean favored more frequent meetings, more open discussions, better agendas, and more participation by the Commissioners. Internally he advocated direct involvement of the Commissioners in selecting key personnel, awarding major contracts, approving construction projects, reviewing production data, and establishing personnel policy. Dean found only two areas in which he thought Commission review was no longer necessary: the foreign distribution of radioisotopes, and visits under the technical cooperation program.[5]

Dean's concern increased in early November, 1949, when the Commission discussed the General Advisory Committee's recommendations against all-out development of a thermonuclear weapon. Dean thought that Lilienthal was determined to delegate the issue to the staff, while he and Smyth insisted that this was one question the Commissioners themselves would have to tackle. Only after some heated discussion did Dean convince his colleagues that they should prepare their own views for the President.

There was no opportunity to continue the discussion of the Commissioners' responsibilities until Strauss and Pike returned to Washington from speaking engagements, but Lilienthal made plans to set aside most of the week of November 21 for this purpose. The first opportunity came after the regular Commission meeting on November 23. During the meeting Lilienthal had received the news that Truman had accepted his resignation effective December 31. In announcing his decision Lilienthal explained that he wanted to be able to speak his mind fully as a private citizen about Congressional and military restrictions on Commission activities. Dean and Lilienthal were clearly moving in opposite directions.[6]

The discussions actually began the following Monday, November 28. In executive session Dean apparently started off with the topics in his October 26 memorandum. He later recorded that Lilienthal and Pike reminded him that delegation of responsibility was necessary in an organization as large as the Commission. When Dean pursued the question of whether the Commissioners should retain any authority, Lilienthal, according to Dean, could suggest little more than public relations.[7]

The following day most of the talk revolved around the Commission's relations with the advisory committees and other organizations. With most of the division directors present, Lilienthal spoke with some feeling about the difficulties of making decisions when the advisory groups and the Joint Committee were "breathing down our necks." Dean responded at some length about what he saw as the realities of the situation. The Military Liaison Committee, in his opinion, was there to stay; it served a vital function in coordinating Commission activities with military needs. Dean admitted that he himself did not always agree with the General Advisory Committee, as the recent debates on the thermonuclear weapon indicated, but that disagreement did not suggest to him that the Commission should dispense with the judgments of eminent scientists. As for the Joint Committee, Dean believed the Commission should "learn to live with it." It seemed to him perfectly reasonable that some group representing the people of the nation should have an opportunity to get behind the security barrier.

Dean ended with the observation that the Commissioners, in talking about the other groups, were evading the central issue of their own responsibilities. This remark prompted Strauss and Smyth to reiterate some of their earlier suggestions of topics the Commissioners should consider. Lilienthal, growing impatient, "blew open" his feelings on the subject. The Commission's role, in his opinion, was hard to define because the basic organization had been wrong in the first place. He contended that the Commissioners had no function other than passing on the most general policy issues and handling public relations. Those tasks could be performed by a part-time Commission and a full-time single administrator. Lilienthal intended to advocate such a reorganization after he left office. To Dean, Lilienthal's suggestions were completely impractical. The American people would never agree to give so much power to one individual. The balanced views of men with different backgrounds were needed to resolve the life-and-death issues facing the Commission.[8]

Even two days of discussion had not settled the far-reaching questions Dean had raised, and neither Lilienthal nor Dean was in a position to press his colleagues to a decision. Although Lilienthal agreed to stay on as chairman until February 15, 1950, to advise the President on the thermonuclear weapon decision, Pike was in fact serving as acting chairman on most other business. Dean was still a junior member of the team. Until the President could find a new chairman, there would be little chance of defining the role of the Commissioners.

INTERREGNUM

Long before Lilienthal left office, newspaper columnists were speculating about the appointment of a new chairman. Robert Oppenheimer, Paul G. Hoffman, and Chester I. Barnard were the first names suggested. By February there were rumors that the President had offered the position to Charles Luckman, who had just resigned as president of Lever Brothers Company. Strauss himself was mentioned but his own resignation, effective April 15, and Lilienthal's departure on February 15 left the question wide open as the President named Pike to serve as acting chairman.[9]

In the following weeks Washington was full of rumors of Commission appointments. Truman apparently asked Gordon Gray, the retiring Secretary of the Army, to take the chairmanship, but Gray had already accepted the presidency of the University of North Carolina. Strauss suggested Admiral Paul F. Foster as his replacement, and Dean told McMahon that many people around the Commission favored Paul M. Gross, vice-president of Duke University and president of the Oak Ridge Institute of Nuclear Studies. James B. Conant, Arthur H. Compton, and Robert M. Hutchins were momentarily in the news as possibilities for chairman. Dean himself was a leading candidate with strong support from McMahon, Strauss, and Donald Dawson, Truman's assistant on personnel matters. James Reston told Dean on March 17 that with Gray definitely out of the picture Dean was moving up on the President's list. A few days later Reston was even more confident that he was on the right track when he could find no one to knock down his "hunch" that "Senator McMahon's candidate" would get the job. "For Lord's sake," Dean shot back over the telephone, "don't put it that way!"[10]

When Dawson suddenly departed for the vacation White House at Key West on March 20, the press corps was convinced that the announcement would come soon. It did, but it was the appointment only of a Commissioner, not the chairman. The nominee to complete Lilienthal's term was Thomas E. Murray, a New York industrialist. Born in 1891, Murray had received a degree in mechanical engineering from Yale, had been president of an engineering company, and at the time of his appointment was a director of the Chrysler Corporation and other industrial and financial organizations. Holder of more than 200 patents and a prominent Catholic layman, Murray was also interested in labor matters. Truman had selected him in 1946 as the impartial chairman of the United Mine Workers welfare and retirement fund. The Senate section of the Joint Committee acted quickly on Murray's nomination, and the full Senate confirmed Murray on March 31.[11]

As the first weeks of spring slipped by with no word from the White House on further appointments, Dean and his colleagues became more anxious. Under the compromise agreement which Senator Bourke B. Hickenlooper had devised in the summer of 1948, the terms of all the Commissioners would expire on June 30, 1950. It would then be necessary for the President to submit new nominations and to designate the number of years each nominee would serve in order to place the appointments on a five-year rotating schedule. Perhaps to minimize the opportunities for a political sideshow in the confirmation hearings, Truman did not send up the nominations until June 19. Pike got the four-year term, Dean three, Murray two, and Smyth one. As yet there was no nomination for the five-year term.[12]

Three days later McMahon told Dean that he was going to poll the senators on the Joint Committee on three of the nominees. Hickenlooper was "on fire" about Pike, and there was sure to be trouble. But McMahon hoped that he could avoid having any hearings at all. He thought hearings might revive some of the issues which Lilienthal had raised in recent articles about abolishing the Commission form of organization and ending the Government "monopoly" of atomic energy. True to his word, McMahon reported out the nominations of Dean, Murray, and Smyth on June 23. The Senate confirmed them on June 26.[13]

As Pike's term was running out in the last days of June, Smyth was getting angry. McMahon was doing nothing to secure action on the nomination and Dean had gone off on a trip to Berkeley. Finally at noon on June 28, Smyth telephoned McMahon. He had no intention of letting the Pike nomination die without a fight. Unless McMahon held a hearing on the nomination at once, Smyth would call a press conference and give his own views on the subject. That was enough for McMahon. The next afternoon the Senate members of the committee met to hear Smyth deliver a ringing testimonial to Pike's ability and integrity. Dean, just back from Berkeley, and Murray supported Smyth's statement, but none of the senators had any questions to ask. The entire hearing was over in thirty-five minutes.[14]

Whether Smyth had done Pike a favor in demanding the hearing was not entirely clear. William L. Borden called Dean the next day to report that the committee had voted against confirmation. Democrat Edwin C. Johnson had joined his Colorado colleague, Eugene D. Millikin, and the Republicans, Hickenlooper, William F. Knowland, and John W. Bricker, in the opposition. Only McMahon, Tom Connally, Millard E. Tydings, and Richard B. Russell voted for Pike. McMahon had called Truman and told him that there would be no chance to bring the question to the Senate floor before July 5. McMahon assured the President he would be ready to present the facts.

Dean was troubled about the course of events. Now that there was no hope of confirming Pike before his term expired, he could no longer serve as acting chairman. That fact might upset plans for the appropriation hearings. Furthermore, as senior member of the Commission, Dean was now in the embarrassing position of being acting chairman. McMahon told him it was unlikely that the President would try to forestall the opposition to Pike by naming someone else as chairman. Anyway, McMahon guessed, Pike would probably be confirmed.[15]

Whatever the basis for his optimism, McMahon did not find it easy to prepare for Pike's defense on the Senate floor. The senators voting against the nomination in the Joint Committee had been careful to keep the reasons for their opposition off the official record. Not until the following day did Hickenlooper state on a "Meet the Press" broadcast that he opposed Pike for his failure to support Strauss and Dean on the thermonuclear weapon decision. That Pike had taken a positive attitude since the President's decision in January was beyond question, but McMahon told Dean privately that he thought Pike was vulnerable for his indecisive stance during the preceding months. The best McMahon could do was to ask Pike for letters justifying his position on this and other points. Truman in his press conference on July 6 voiced his complete confidence in Pike, scoffed at charges against Pike on the thermonuclear weapon decision, and dismissed the opposition as "Republican party politics."[16]

The Senate debate on July 10, 1950, showed that the President was not far from the truth. Senator Johnson of Colorado was the only Democrat who spoke against the nomination, and his opposition, like Millikin's, was mainly on the grounds that Pike had advocated maximum efforts to procure uranium ore from foreign sources rather than from the Colorado Plateau. For Hickenlooper, however, the nomination represented the broader threat of perpetuating in the Commission the last traces of Lilienthal's influence. Hickenlooper described at some length Pike's role in the Cyril Smith incident in 1948, with all the implications that Pike had been helping the Lilienthal administration to subvert the provisions of the Atomic Energy Act restricting the foreign dissemination of technical data. Knowland added the charge that during seven months as acting chairman Pike had done nothing to find a replacement for Admiral John E. Gingrich as director of security. Millikin revived some of the charges leveled during the Joint Committee investigations of the previous year that the Commission had been lax in controlling security clearances and fellowships. Pike, as a member of the Commission, presumably bore some responsibility for these shortcomings.[17]

One final source of opposition to Pike was the concern that the President might name him chairman. Truman had dismissed this idea with the remark that he could have appointed Pike months earlier if he had intended to do so, but he refused to give the Senate any assurances. McMahon, who already knew that Truman would appoint Dean, did his best to assure his colleagues that Pike would not get the chairmanship. On the final vote, the Senate justified McMahon's optimism by confirming Pike's nomination 55–24. The next day Truman appointed Dean chairman. The interregnum was over.

By the time Dean became chairman he had already suggested the elements of a new administrative style. He could not hope, however, to escape the legacy of the Lilienthal era. He had inherited a living organization with established procedures and assumptions. Whether the question was one of appropriations or policies in the Commission's three communities, he would have to start from patterns of previous years in dealing with Congress and the Joint Committee.

CONGRESS AND THE BALANCE OF POWER

James R. Newman, one of the principal authors of the Atomic Energy Act, called his creation a radical piece of legislation. It established an agency, he said, vested with "sweeping authority" and entrusted with "portentous responsibilities." During the first two years of its existence, the Commission had exercised its extraordinary powers almost in a vacuum. Behind the security barriers the Commission's staff and its contractors lived in a world of their own, a world unknown to most of the nation. The President caught only fleeting glimpses of this world and the Congress was almost totally excluded. The predilection of Congressional appropriation committees and even the Joint Committee for criticizing the Commission's housekeeping and administrative functions demonstrated the inability of the Legislative Branch to exert any effective influence in central policy decisions. The question was whether the exceptional demands of security and the presumably esoteric nature of nuclear technology required such a large displacement in the traditional balance of power in the American system.

Certainly Congress could not hold the Commission solely responsible for whatever imbalance existed. In 1947 Lilienthal had considered irresponsible the Joint Committee's refusal to accept classified information. Congressional hearings, whether before the appropriations committees or the Joint Committee itself, had centered on relatively peripheral administrative matters. There was little evidence that members of Congress wanted to probe the mysteries of the atom or the grim arena of nuclear weapons.

McMahon's appointment as chairman of the Joint Committee in the 81st Congress opened new possibilities for redressing the balance of power. William L. Borden, the committee's new executive director, set out to transform the committee into an effective instrument of policy. McMahon's demand for access to classified information marked the first step in this direction. A second was Borden's proposal in May, 1949, to amend the Act to give the committee power to authorize the Commission's annual appropriation.[18]

Before World War II Congress had customarily incorporated in organic legislation a blanket authorization for all funds to be appropriated under the basic act. Section 19 of the Atomic Energy Act was an example of this practice. Only the appropriations committee had authority to review the Commission's budgets, and those who were familiar with the Commission's activities always found something unreal about the annual appropriation hearings. Almost never coming to grips with the essential aspects of the Commission's budget, the appropriations committees frequently became enmeshed in almost irrelevant administrative questions, as the hearings on community affairs had demonstrated. Almost as often members of the Joint Committee had been forced to intercede in the cause of reason and understanding. The need for a better system was obvious to both sides.

Borden's idea was part of a new trend in legislative procedure. A requirement for specific authorization by a legislative committee would impose on agency budgets some expert review which the appropriations committees could not hope to provide. The device also gave the legislative committees an opportunity and an incentive to push for larger appropriations for the agencies and departments under their jurisdiction.

The Hickenlooper hearings on "incredible mismanagement" had hardly begun when, on July 7, 1949, McMahon and Congressman Carl T. Durham had introduced bills based on Borden's authorization proposal. Carefully both men disassociated their action from the Hickenlooper hearings. Their amendment, they explained, would permit the proper exercise of Congressional authority. No longer would the Commission be able to proceed on new projects costing millions of dollars without specific Congressional approval. Even so, the Commission would still have more discretion and authority than most Executive agencies. In McMahon's view, he and Durham were merely trying to maintain the system of checks and balances essential to democracy. As members of legislative committees usually did, McMahon and Durham had couched their argument in constitutional terms, but their real goal was greater power for the Joint Committee.[19]

It was not surprising that Lilienthal and his associates took a contrary position on the amendment. They argued that atomic energy posed complex, dynamic, and unpredictable problems. Handling these had required the Commission to exercise all the unusual powers granted by the Act. If these powers were transferred from the President and the Commission to Congress, the Commission would lose the flexibility needed to exploit technical advances in weapon development, to take emergency measures in nuclear accidents, and to keep production rates at the maximum possible levels. Furthermore, the Commissioners contended, no other large Government agency had to obtain Congressional authorization for all of its continuing activities; the most required was authorization for major construction projects. Satisfied for the moment, McMahon announced on July 15 that for the time being he would not press the issue.[20]

The appropriation bill which Truman signed on August 24, 1949, however, contained further evidence of Congressional intention to abridge the Commission's power. Senator Joseph C. O'Mahoney's appropriations subcommittee had written into the bill a requirement for FBI investigation of applicants for Commission fellowships. The bill also restricted the Commission's authority to begin new construction projects if the estimated cost were not in the approved budget or exceeded the budgeted amount. Only if the director of the Bureau of the Budget sent a detailed justification for such a project to the appropriation committees of Congress could the Commission proceed with construction. The budget director would have to submit a similar justification whenever the estimated cost of any current project exceeded the budgeted cost by 15 per cent.

O'Mahoney explained to the Senate that the amendment was intended to prevent the Commission from changing its plans without notice to the President or Congress. He did not mean to single out the Commission by these provisions; they could apply equally well to other agencies. The subcommittee, O'Mahoney said, had drafted the proviso with the help of the Joint Committee and the Commission. Acknowledging this fact, McMahon countered that the version before the Senate was a vast improvement over the original proposal. Lilienthal too had accepted the proviso, but with some mental reservations. He feared that the amendment crippled the Commission's flexibility, and he agreed privately with McMahon that the language was too restrictive. In October, 1949, McMahon and Durham succeeded in amending the appropriation act so that it would not apply to technical and production facilities if the Commission certified that they were essential to the national security.[21]

The summer of 1949 had marked the low point of the Commission's relations with Congress. Lilienthal, scarred and enervated by the Hickenlooper inquiry, saw his attempts to satisfy Congressional committees as a harassing and futile experience. After Lilienthal's resignation, Pike fared better in his exchanges with the Joint Committee, but the spirit of accommodation seemed to stem largely from the understanding that he would not be chairman. Now Dean would have a chance to demonstrate his ability to work with the Legislative Branch.

COMMUNITIES: AN AMERICAN ANOMALY

The nation's atomic energy program as the Commission inherited it in 1947 was in many respects an anomaly in American life. Bred in extraordinary scientific developments which few Americans tried to understand, isolated by security barriers, and protected by unprecedented national legislation, the Commission was, as one observer put it, "an island of socialism in the midst of a free enterprise economy."[22]

Of all the aspects of this anomaly, none were more striking than those manifested in the three "atomic cities" of Oak Ridge, Richland, and Los Alamos. Created by the Army during World War II, the three towns were completely owned and operated by the Commission. Everything from cemeteries and sidewalks to homes and grocery stores was Government property. In 1947 Oak Ridge and Los Alamos were still closed communities surrounded by patrolled security barriers. Even relatives of residents could not enter without a pass. Behind the fences the scientists, engineers, technicians, and laborers who manned the production plants and laboratories lived with their families in an isolated world of their own. The Army and then the Commission, through local management contractors, operated the bus systems, collected rents, delivered coal, repaired homes, manned the fire departments, operated the movie theaters, leased stores, and ran the schools. Never threatened by the crass forms of exploitation sometimes imposed on residents of "company towns," the inhabitants of the atomic cities were more nearly the privileged subjects of a beneficent, if not indulgent, ruler.

For the Commission, the communities were an unwelcome legacy. The towns, hastily established on a temporary wartime basis, possessed neither the buildings nor the organization necessary for permanent communities. They were expensive to operate, difficult to administer, and always vulnerable to criticism. As one observer remarked, Congressmen and others who would never have dared to raise questions about scientific aspects of the Commission's work considered themselves experts on local community problems. The quicker the Commission could divest itself of the communities, the better; but as long as the plants and laboratories at the three sites were vital to the national defense, the Commission would find it difficult to escape from its community responsibilities.

Much to his credit, Carroll Wilson recognized the complexities of community management from the start. Early in 1947 he obtained the services of Lyman S. Moore, an authority on municipal government and city manager of Portland, Oregon. Moore began at once to frame some of the questions the Commission would have to answer. Was it desirable to provide the towns with some sort of local democratic government in which the people themselves would determine the scope and quality of public services in terms of related needs and costs? If so, how would a democratic government operate in an environment in which security and defense requirements were paramount? What would be the ties between the communities and county and state governments? To what extent were subsidies needed to attract highly skilled scientific and technical personnel to these isolated areas? To answer these and other questions, Moore suggested that the Commission set up an advisory panel and hire several analysts with expert knowledge of housing, public financing, and municipal government to survey the Commission's communities.[23]

In the chaos of the confirmation hearings and the efforts to organize the Washington staff in 1947 there was little time to apply Moore's recommendations. Virtually all actions on community matters occurred at the local level. The one exception was a general policy statement in which the Commission declared that "residents at field installations shall enjoy those facilities, services, and activities which are properly a part of American community life." There was no commitment to end Government ownership of the communities, but the Commission did encourage the people to join in making community policy to the extent that security and plant operations made possible.[24]

In April, 1948, the Commission hired Moore to make the survey which he had recommended more than a year before. Moore did not have time for an exhaustive study, but with J. Bion Philipson, an expert in home financing policy from the National Housing Agency, he did get some first-hand knowledge of the communities during two-day visits to each site. His report, reinforcing the Commission's policy statement of December, 1947, proposed that the long-range goal be "to achieve democratic control of a visible local government which provides responsible town management and efficient operations at minimum cost consistent with getting the job done." [25]

As first steps toward democracy in community management, Moore pointed to the need for uniform classification of accounts for all town activities, including housing, commercial operations, utilities, and government services. Only through a uniform accounting system and regular reports of costs and revenues could the Commission gather the information to formulate workable procedures. Moore thought it also important for the Commission to state as clearly as possible its fiscal policies for all aspects of town activities and to find ways to separate the landlord function from community management. Moore also expressed the hope that Oak Ridge might become an open community so that private ownership of land would be possible.

Although Wilson and the headquarters staff took little formal action on the Moore report, both Shugg at Hanford and John C. Franklin at Oak Ridge adopted its recommendations as guide lines. At Hanford, Shugg's problems were relatively simple. Richland had never been behind the security barrier; one contractor, General Electric, operated both the community and the production plants; and some community services, such as the school system, were established originally within the local county government. Residents of Richland showed little interest in self-government, largely for economic reasons; but there was real local interest in taking over commercial enterprises in Richland and even in home ownership. For Los Alamos, the Moore report was almost irrelevant. As long as the laboratory was in the middle of the community, there was no possibility of opening the town, and the absolute space limitations on the mesa made the expansion of housing almost impossible. In 1948 it seemed likely that Los Alamos would have to remain under complete Government control for the foreseeable future.[26]

Oak Ridge, as the largest and most diversified of the three towns, posed the greatest challenge in community operations. Fortunately for the people at Oak Ridge, Franklin had the breadth of vision to understand that community relations were one of the most important factors in the success of production operations. To supervise community activities, Franklin had excellent assistance in Fred W. Ford, a former city manager. Together they set out to accomplish the immediate goals set forth in the Moore report. Franklin hired an expert appraiser to put rents on a more equitable basis, established uniform accounting systems separate from the plant systems, and reorganized the community management staff to put all municipal functions under a city manager and real estate operations in a separate office. Completion of the Oak Ridge master plan provided a framework for municipal zoning laws. Franklin also hired consultants to study the feasibility of incorporating Oak Ridge, to estimate tax revenues, and to draft a model charter. Late in 1948 Franklin organized a series of town meetings to discuss the incorporation studies. The Commission authorized the first sale of Government land at Oak Ridge in January, 1949, for church sites. On March 19, complete with ceremonies including Vice President Alben W. Barkley, Lilienthal, and movie star Marie McDonald, the guards took down the barriers to the city. Oak Ridge had taken the first step toward the goal of self-government.[27]

Despite these accomplishments, most of the features of a Government town were still evident at Oak Ridge and Richland. Some of these brought distinct advantages to the residents. The community services provided by the Commission were superior to those furnished in neighboring cities of comparable size. Rents were about 20 per cent lower and there were no property taxes in the Commission's towns. But the residents had no stake in the community and no financial incentive for establishing one. Government ownership and operation bred an insidious type of paternalism that sapped the initiative of the residents. The Commission faced the improbable task of inducing Americans to exercise their rights as free citizens.

Far more worrisome in the short run than public lethargy were the constant irritations inevitably generated by community operations. Franklin complained that, even with a management contractor to serve as a buffer between him and the people, he was continually besieged by irate housewives who complained about leaky faucets or uncollected garbage. In the absence of a free enterprise system, residents could readily demand services they did not pay for and object to rent increases stemming not from impersonal market conditions but from the "arbitrary" decisions of Government officials. Eventually the more outspoken citizens mailed their grievances to the Tennessee Congressional delegation in Washington, thus providing convenient ammunition for Senator Kenneth D. McKellar and other Lilienthal opponents to use against the Commission. Perhaps a typical example was Senator Hickenlooper's prolonged debate with the Commission during the 1949 investigation concerning the cost of garbage can enclosures at homes in Oak Ridge.[28]

The Hickenlooper investigation no doubt reminded Wilson of what he already knew well: that the Commission could never work too hard to free itself of the communities. He told the Commissioners in December, 1949, that he had been able to get community management on a sound administrative basis. Significant steps had been taken at Richland and Oak Ridge toward making the towns "normal" American communities, but he did not believe the Commission had really thought through the question of what "normality" would mean in these communities.

Some of the difficulties were apparent in a comprehensive report which Richard W. Cook, the new manager at Oak Ridge, sent to Washington in January, 1950. To create a permanent community and free enterprise in a true sense would require private ownership of real estate, but the Oak Ridge staff was convinced that sale of commercial properties would not be feasible until the town had been incorporated. To complete the vicious circle, incorporation would not be practical until private enterprise provided a broad enough tax base to meet at least some of the municipal costs. Even if the standards of municipal services at Oak Ridge were substantially reduced and a high municipal tax rate were established, there would still be a gap between revenues and costs, in terms of property evaluation, of almost $38 million. The low population density of the town, which resulted in unusually high costs for streets and utilities, and the demands of the residents for schools superior to those in nearby localities did not make cost reduction a promising solution.[29]

As an interim measure, Cook and the Oak Ridge staff proposed to grant long-term leases on land at Oak Ridge, for both commercial buildings and private homes. There was some hope that existing commercial structures could be sold if the prices were low enough to make it possible for the merchants to meet the high maintenance costs on the temporary buildings. Cook also had plans to place the building of additional homes at Oak Ridge in the hands of private developers. It was still not feasible, however, to sell homes, even to people directly engaged in Commission work, without resale restrictions. The shortage of housing and the continuing demand for homes resulting from the expansion of production facilities at Oak Ridge required ultimate control by the Commission. Another consideration was that Government ownership provided the only basis for typical ordinance controls over health, safety, sanitation, and zoning until the town was incorporated.

Beyond these practical matters there were important policy questions which the Commissioners raised in January, 1950. However desirable self-government and free enterprise were, the Commission could not let these aims interfere with the primary purpose of the communities. As Walter J. Williams suggested, the towns did not exist in their own right but only as they supported the Commission's essential activities. Wilson raised the question of whether incorporated towns could meet the housing needs of Commission and contractor personnel. Dean was concerned about the implicit assumption in the Oak Ridge proposal that the town was to be a permanent community. Both he and Pike saw the difficulty of guaranteeing for ten or twenty years the operation of the production plants necessary to support the population of the town. Changing demands and obsolescence of existing plants could spell doom to a one-industry town. In short, the Commission did not intend to abandon its long-term goals for the communities, but it recognized the practical difficulties of removing the anomaly of Government control in the immediate future.[30]

COMMUNITIES AND CONGRESS

Orderly withdrawal from community operations may have seemed a reasonable goal for the Commission in early 1950, but there was some reason to believe that Congress might force precipitous action. Since the first full-scale appropriation hearings in 1948, the House subcommittee under Albert Thomas of Texas had shown a preoccupation for probing the complexities of community management. Most Congressmen thought they understood the operation of local governments. They could imagine a town of 33,000 people, the population of Oak Ridge, and they could envisage the services a town of that size would probably require. They admitted that the Commission had reduced the costs of community operations substantially over the years, but they still found it incredible that gross costs for operating Oak Ridge in fiscal year 1950 could exceed $12 million. Even harder to accept was the fact that the Roane-Anderson Company, the management contractor for the town, received an annual fee of $180,000 over and above all salaries and expenses. How many city managers, they asked, received such a princely fee for directing the services of a small municipality? [31]

After three years of hearings, Shugg, Williams, and Cook were growing weary of explaining that Roane-Anderson did far more than provide municipal services. The company served as landlord for almost 9,000 private homes and all the commercial buildings in the town and collected about $5 million per year in rents. In addition to providing the usual municipal services, the company maintained all the homes and commercial buildings, operated the steam plant and community warehouses, disposed of surplus Government property, maintained all Government vehicles and equipment, ran the taxi service, kept the grounds, and delivered coal. Subcontractors now performed many of these functions, but Roane-Anderson was still responsible for activities costing more than $14 million per year. In short, the company was far more than a city manager.

Williams had explained several times that the Turner Construction Company had created Roane-Anderson as a subsidiary in 1943 at the Army's request specifically for the purpose of operating Oak Ridge. During the peak of the wartime operation, the company had received a fee of $300,000 per year. The Commission had since negotiated the fee down to $190,000 and then to $180,000. Gross costs were dropping steadily and Roane-Anderson employment had declined from 4,000 workers in July, 1948, to less than 1,400 in January, 1950, despite the growth of community operations required by the expansion of production plants at Oak Ridge. For achieving these economies, Williams maintained, the company deserved a management fee. Shugg insisted that the fee was modest, particularly if the portion paid for real estate services and other nonmunicipal functions were deducted. Of one thing Shugg was certain: The Commission could not reduce the costs of community operations either by running Oak Ridge directly with Government employees or by finding another contractor.

The repetition of these arguments seemed to have little effect on the committee. Congressman Albert Gore of Tennessee still thought both the reimbursable costs and the fee were too large. The same judgment applied to American Industrial Transit, Incorporated, which operated the bus system at Oak Ridge, and to the Zia Company, which provided all the community services at Los Alamos. Only the General Electric Company, which operated the Richland community, escaped criticism and presumably only because the company received an overhead allowance of $200,000 rather than a fee.

When the House hearings ended on February 22, 1950, there was little doubt that this time the committee would do more than complain about Commission performance. Thomas and Gore had made a point of inquiring about the impact of a statutory limitation on fees paid for community management. In a letter to Thomas, Wilson contended that such a limitation would force the Commission to operate the communities directly, at considerable additional cost to the Government. In defense of the $180,000 fee, Wilson showed that only $27,000, or 15 per cent of it, applied to the city management function. Despite these protestations, the committee report to the House on March 28 recommended a proviso that no part of the appropriation could be used for payment of a contractor "where the fee for community management is at a rate in excess of $90,000 per annum or for the operation of a transportation system where the fee is at a rate in excess of $45,000." The involved language was a technical device to circumvent the Congressional prohibition against using appropriation bills to accomplish substantive legislation, but the effect was clear enough. It would cut the community fees in half.[32]

Following the usual practice, the Commission carried its appeal to the Senate Committee on Appropriations and to the Joint Committee. Shugg told the senators the effect of the limitation would be damaging, particularly because the House committee meant the limitation to apply to the entire fee and not just to that portion paid for city management. A further complication was that all the community contracts would run until the end of 1950, but the limitation would take effect in June, thus forcing the Commission to repudiate valid contracts. Senator McMahon told O'Mahoney's committee that disruption of community operations at Oak Ridge and Los Alamos would slow the development of the thermonuclear weapon. Pike stressed the same theme before the Joint Committee on April 18. He assured the committee of the Commission's long-term interest in divesting itself of the communities. To speed up that process, Pike said the Commission was considering the appointment of a disinterested advisory panel to survey the possibility of making the three towns independent, self-governing communities.[33]

The idea of a survey panel took on added importance after May 5, when Congressman Chet Holifield, also a member of the Joint Committee, failed in his attempt to strike the fee limitation from the appropriation bill during House debate. Moore had already recommended several names for membership on the panel, and Pike checked these with McMahon a few days after the House acted. On May 17, the Commission approved the terms of reference for the committee. The panel was to devise a plan by which the

Commission could divest itself of the responsibility for operating the communities and to recommend the policies the Commission would have to adopt to carry out the plan. The panel would also be expected to point out any practical limitations on the Commission's ability to attain the goal and to evaluate the steps already taken.[34]

The House amendment was not the only pressure Congress was bringing to bear on the Commission's community policy. The Senate committee had listened to the Commission's arguments against the amendment, but gave no signs of favorable action in the weeks after the hearing. Then on May 28, in discussing the appropriation bill with O'Mahoney, Shugg learned that the senator was considering an additional amendment which would require the Commission to turn over all responsibility for the towns to the residents by June 30, 1951. Shugg pointed out the disastrous results such an amendment might have, but his statement did not seem to impress O'Mahoney.

The Commission's response to this challenge reflected something of the new style which Dean would bring to relations with Congress. Dean's first reaction was not to fight but to try to explain the situation and in a way that would not embarrass or perturb the legislators. He supported the idea of sending O'Mahoney a strong private letter pointing out the impossibility of acting so quickly on the complex problems involved in community divestiture. Dean could also gain support from McMahon and Borden, who would see in the proposal a threat to weapon production. Most of these discussions, however, were behind the scenes. When the Commissioners met with the Joint Committee on June 6, most of the discussion went to the effects of the House amendment. Dean vaguely referred to "some kind of rider that might attempt in this session to tell us to free ourselves of this town within the course of the fiscal year." Before the meeting ended, Senator Bricker had offered to discuss the community issue with O'Mahoney, and Dean had promised McMahon to establish the community panel and have a report for the Joint Committee by January, 1951.[35]

Within a week the threat of the O'Mahoney amendment had disappeared. On June 13 Wilson discussed the charter for the panel with Herbert Emmerich and Don K. Price, Jr., two experts on municipal government from the Public Administration Clearing House in Chicago. It no longer seemed wise to commit the Commission to divestiture as an immediate goal. Emmerich and Price agreed that the complexities of the situation recommended a cautious approach. Under the revised charter, the panel would seek a plan which would enable each of the three communities to contribute most effectively to the atomic energy program and suggest how, within that context, the Commission might grant greater local autonomy and reduce Government costs. The Commissioners readily accepted this approach and approved the formation of the panel under the chairmanship of Richard G. Scurry, whose law firm had represented the Dallas housing authority and many private real estate interests in that city for more than a decade.[36]

While Scurry was organizing his panel, Congress was at last taking final action on the 1951 appropriations bill. The report of the Senate Appropriations Committee on June 6 showed that the Commission's blandishments had not been in vain. The report not only omitted the O'Mahoney proposal but also deleted the House amendment. The committee, however, did call upon the Commission to discontinue "the present undemocratic method" of operating the communities and suggested that the Commission establish a definite timetable for eliminating the community management and transportation contracts. The final blow came when the Senate-House conference committee restored the House amendment, which became law on September 6, 1950. The Commission now had no choice but to apply the statutory limitation on fees paid to the three contractors. Congress had expressed its determination to end the American anomaly.[37]

LABOR: THE CREATIVE POSSIBILITIES

In April, 1949, a month before Dean joined the Commission, President Truman had formally established the Atomic Energy Labor Relations Panel. Acting on the recommendations of the *ad hoc* group under William H. Davis, the President hoped that the new panel would stabilize labor relations in the Commission's plants and laboratories. Now it was up to Davis as chairman to carry out the principles for negotiation he had recommended to the Chief Executive. During the preceding year Davis and his *ad hoc* group had helped Lilienthal and his colleagues avoid the worst pitfalls in labor relations, but it remained to be seen whether the new panel could maintain the delicate structure of cooperation between the Commission, its contractors, and the unions under the pressures of successive expansions of production facilities.

Davis was fortunate to have the continuing services of Edwin E. Witte and Aaron Horvitz, who had been members of the temporary panel established in the aftermath of the Oak Ridge dispute in 1948. Davis himself, just a few months short of his seventieth birthday, was a man of unusual experience and ability. His discursive, conversational manner often concealed the shrewd and penetrating qualities of his mind. That same mind had led him to the conclusion that studied uncertainty in negotiations was a valuable ingredient in successful labor-management relations. With this approach both Witte and Horvitz agreed.

The new panel was a part-time group, empowered to step into such disputes as it chose to consider after all the usual conciliation methods had failed. Not only were the panel's procedures deliberately flexible, but Davis was always vague about the next steps he would take in any situation. If the parties could not reach a voluntary agreement, the panel could recommend a settlement. During the following thirty days the parties could neither interrupt production nor modify the agreement in effect when the dispute began. The intent of the broadly defined steps was to keep labor and management from using the panel as a means of avoiding the normal bargaining processes. The principle of uncertainty would preserve what Davis called "the creative possibilities of responsible collective bargaining." [38]

If the panel were to work successfully, both management and labor would have to accept the role which Davis had proposed for it in his report to the President. Most important was the provision that there would be no interruption of production or services before, during, or thirty days after the panel assumed jurisdiction. The unions agreed, as did all the Commission's contractors, with two exceptions. Robert G. Sproul, president of the University of California, which operated the Los Alamos and Berkeley laboratories, was sympathetic to the panel's aims, but he doubted whether the university as an agency of the state government could accept any limitations on its authority without violating the state constitution. Oscar S. Smith, the Commission's director of labor relations, was reluctant to press the issue. Labor relations with the university were good, and from conversations with its representatives Smith was sure the university would maintain the *status quo* during a labor dispute.

The second contractor with qualms about the Davis formula was General Electric. The company was willing to accept the panel for Hanford disputes but not for those at the Knolls laboratory. Not only was the laboratory close to the company's huge plant at Schenectady, but the company was also still uneasy about its relationships with the union of the United Electrical Workers, which, in late 1949, was being expelled from the CIO on charges of communist domination. For Knolls, Smith also advised that the Commission move cautiously. He suspected that the company's hesitation would disappear after the panel had demonstrated its effectiveness.[39]

None of the Commission's sites were without labor difficulties, but Oak

Ridge continued to live up to its reputation as a trouble spot. Since the beginning of 1950 jurisdictional disputes had kept Oak Ridge on edge. On May 24, laborers employed by the Maxon Construction Company, contractor for the new gaseous-diffusion plants, walked off the job after a disagreement on wage differentials. Although local and national union leaders and the craft unions repudiated the walkout, the stoppage spread to the laboratory and the town. Richard W. Cook, the Commission's manager at Oak Ridge, considered the need for additional police. As a last resort Cook could have summoned the 82nd Airborne Division of the Third Army, but fortunately this proved unnecessary. The last of the laborers returned to work on May 31, when the Commission assured them that an arbitration panel would issue an award by June 12.[40]

A threat to plant operations at Oak Ridge followed hard upon the construction dispute. Late in May, Cook warned Walter J. Williams, the director of production in Washington, that operators of the K-25 gaseous-diffusion plant had voted to strike on June 8. The issues between the United Gas, Coke, and Chemical Workers (CIO) and Carbide included wages, benefits, and, as later negotiations revealed, better contract terms which AFL employees of the same contractor enjoyed at Oak Ridge National Laboratory. Donald B. Straus, secretary of the Davis panel, hurried to Oak Ridge and found the situation ominous. In Washington, Williams asked Cook to decide what he would do if the strikers put up road blocks. At Oak Ridge, Samuel R. Sapirie, Cook's deputy, met with Carbide officials to draft emergency plans for operating the plant. Carbide intended to use supervisory personnel to run the K-25 plant and shut down some of the ancillary operations. The chief worry was whether the supervisors could get through the picket lines. Again a strike was averted when the union and the company agreed to abide by panel procedures. Philip Murray, president of the CIO, lent his influence to keep negotiations going and the plant operating. By the middle of August, 1950, the parties had reached agreement on all but a few issues, and Davis expected the terms of the settlement to appear in a new contract.[41]

SECURITY—SINE QUA NON

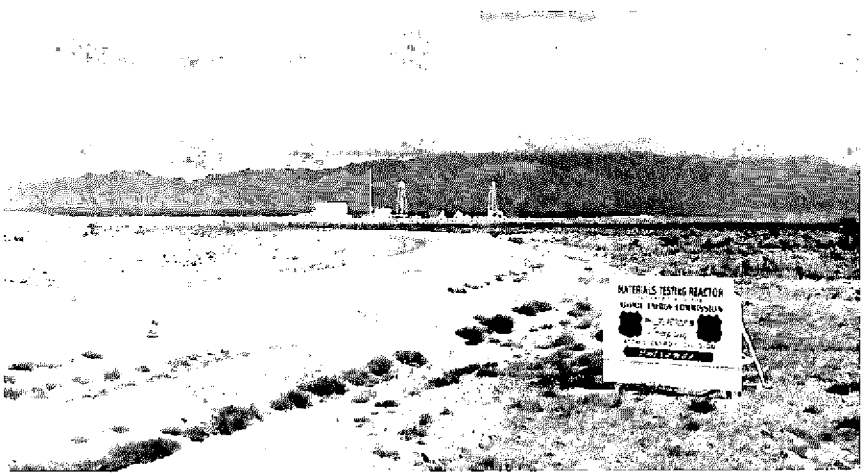
Among all the aspects of administration, none took more of Dean's time than did security. On the day he took office as Commissioner in May, 1949, his colleagues were deeply embroiled in a public dispute over security. Congressional voices were demanding an investigation of the Commission's practice of granting fellowships to scientists without security clearances. The day before, Commissioner Strauss and Admiral Gingrich, who had just resigned as director of security, had expressed to the Joint Committee a lack of confidence in the Commission's security program. Gingrich complained that decentralization of administrative functions to the field offices had left him with little more than a staff function at headquarters; even there, he said, he did not control all the activities that seemed properly to belong to the director of security. Under the Commission's existing organization, he had been responsible to the general manager, not to the Commissioners. In the interests of efficiency, Gingrich suggested, Wilson had relegated security to a subordinate staff function.[42]

Strauss admitted that these views represented a minority opinion in the Commission. Both Lilienthal and Pike accepted Wilson's contention that true security lay more in "positive" achievements than in "negative" policing of personnel and plants. The failure to find a replacement for Gingrich during the spring and early summer of 1949 reflected the stalemate within the Commission. Presumably the two new Commissioners, Dean and Smyth, held the balance of power and would eventually determine whether the Lilienthal or the Strauss view of security would prevail.[43]

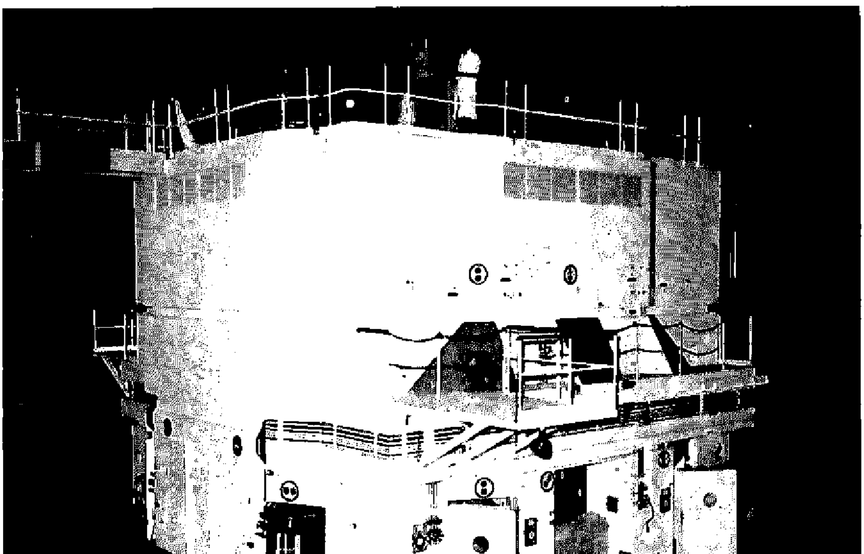
By July, Strauss must have gained some hope that Dean would eventually support his position. Just before Wilson had gone on vacation, Strauss had reopened the question of decentralization of security. Although Dean did not express himself formally on this matter, he took a firm position on Strauss's side that the existing language of the Act did not support the Commission's actions in exchanging technical information with the British and Canadians. Like Strauss, Dean showed an interest in administrative procedures and particularly in the functions of the general manager and the Commissioners. In September, Dean questioned Wilson's practice of making the final decision himself on security clearances for fellowship applicants rather than forwarding them to the Commission when the investigations revealed derogatory information. Perhaps in time Dean would enable Strauss to escape his lonely minority of one on security matters.[44]

Both Dean and Strauss had taken an active part in the search for a director of security during the summer. Finally, on September 12, when the latest of these efforts proved unsuccessful, Pike suggested that the Commission first define the organization and functions of the division before seeking a director. Having recently read a transcript of Gingrich's remarks before the Joint Committee, Pike thought some clarification would be helpful. Three days later Wilson suggested the appointment of an *ad hoc* panel both to study the Commission's security system and to recommend a director. The Commissioners accepted this idea and agreed to suggest members of the panel. One of those Dean recommended was John S. Bugas, a former FBI agent and since 1944 an industrial relations executive with the Ford Motor Company. Strauss also knew Bugas and offered to approach him.[45]

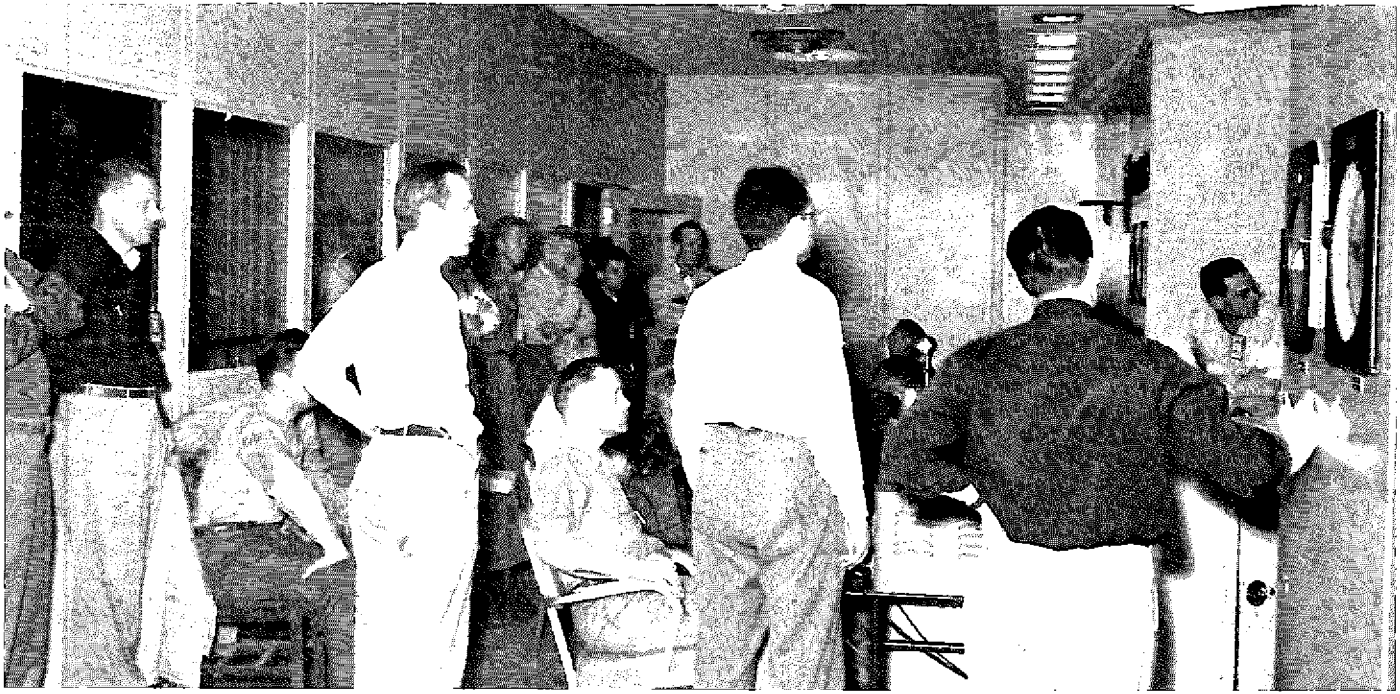
Strauss convinced Bugas to take the chairmanship, but it took several weeks to select the members of the panel: J. Arthur Mullen, a Detroit businessman, D. Luke Hopkins, a Baltimore financial executive, and Paul E. Klopsteg, scientist and engineer. Strauss, already planning to leave the Com-



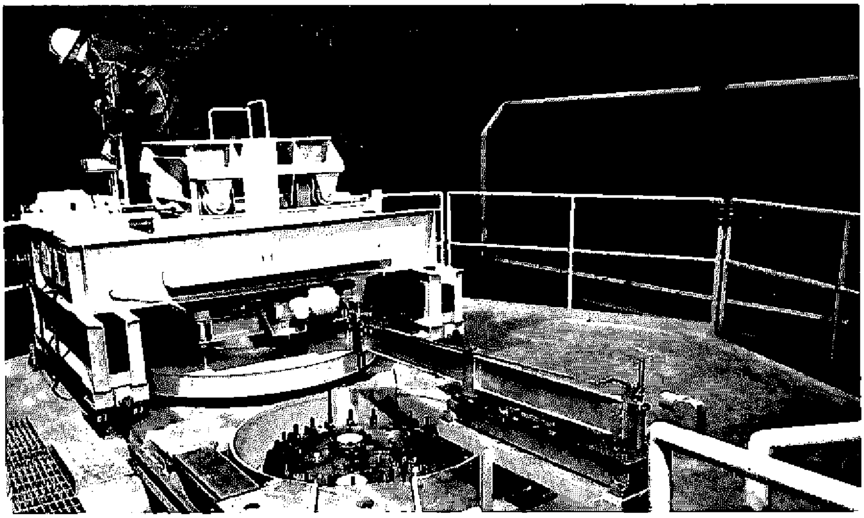
THE MATERIALS TESTING REACTOR FACILITY AT THE TIME OF COMPLETION, 1952 / The huge reactor building and supporting facilities are dwarfed by the vastness of the Idaho desert.



THE MATERIALS TESTING REACTOR, JUNE, 1952 / The reactor as it appeared about two months after criticality—still so new that the floor surrounding the reactor looks strangely vacant of experimental equipment.

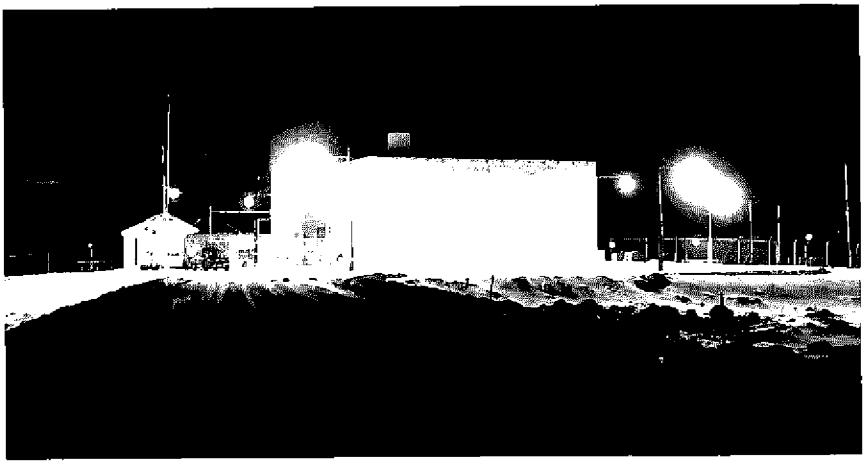


THE MATERIALS TESTING REACTOR REACHES CRITICALITY, MARCH 31, 1952 / The group is watching the reactor instrument board in the control room. Standing from left to right: Richard L. Doan of the Phillips Petroleum Company (with arms folded); J. Bion Phillipson, assistant manager of operations at Idaho for the Commission; Deslonde de Boisblanc, head of the Phillips instrument section; Steven Hanauer (in white shirt), Oak Ridge instrument technician; and Leonard E. Johnston (in dark shirt, near instrument panel), manager of Idaho operations. In the right background close to the instrument panel is Marvin M. Mann, leader of the Oak Ridge design group.

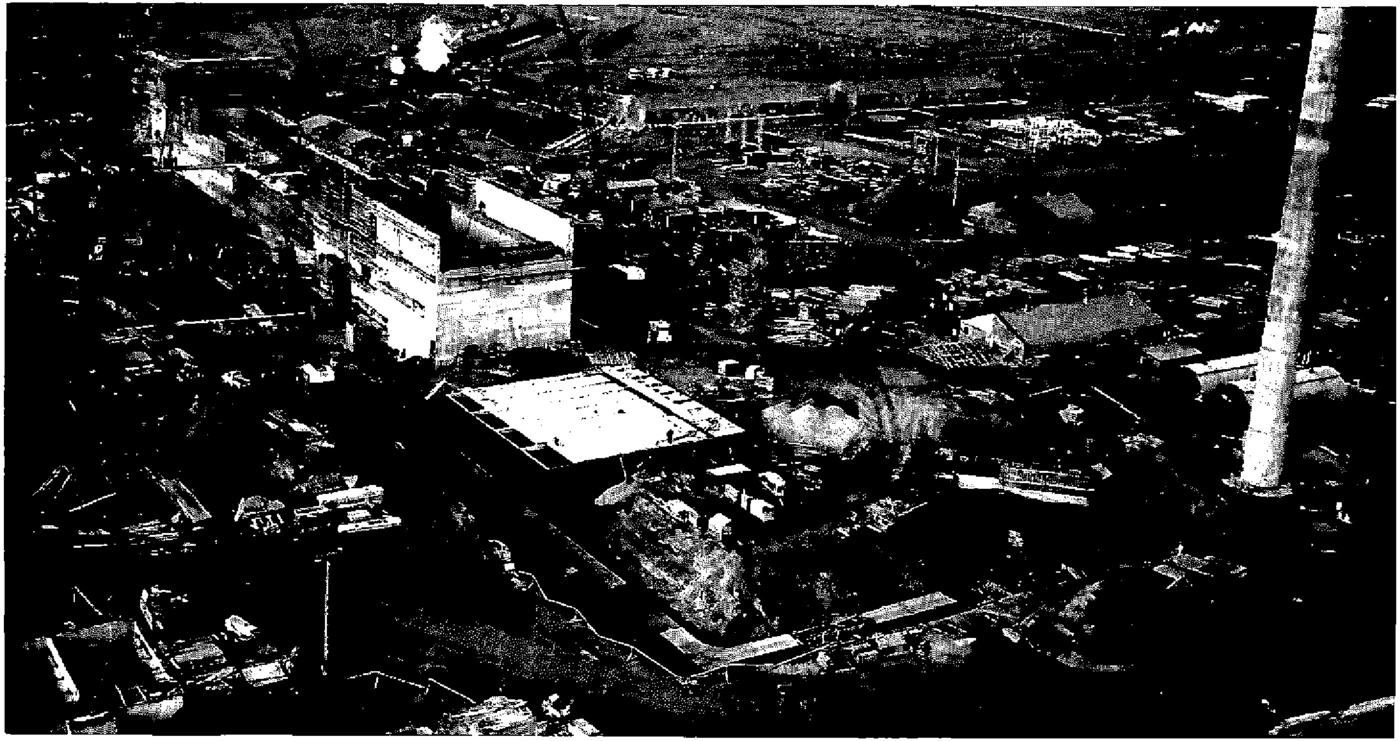


ARGONNE NATIONAL LABORATORY

MECHANISM FOR REMOVING FUEL ELEMENTS FROM THE EXPERIMENTAL BREEDER REACTOR / This photograph, taken just before full power operation in December, 1951, shows the small diameter of the reactor tank in comparison with the large amount of concrete shielding required. During removal the rod had to be shielded and kept in an inert atmosphere at all times.



LIGHT FROM THE ATOM, DECEMBER 27, 1951 / The reactor building illuminated by nuclear power from the Experimental Breeder Reactor.



THE REDOX PLANT TAKES SHAPE AT HANFORD / The long "canyon" of concrete cells would contain chemical equipment for recovering plutonium and uranium from slugs irradiated in the Hanford production reactors. The photograph was taken on December 1, 1950.

mission, made every effort to expedite the work of the panel. He offered the members assistance on administrative details and arranged with the Navy to have Gingrich flown from his new station in Hawaii for a meeting with the panel in San Francisco. Although Bugas and his associates did not begin their work until January, 1950, and had to visit all the Commission's major installations, they completed the report on April 6, nine days before Strauss left the Commission.[46]

From the opening paragraph the report showed that the panel construed its mandate broadly. Security, the panel contended, pervaded all functions of the Commission and was a "*sine qua non* of a successful achievement of the objectives which Congress had in mind in creating the Atomic Energy Act." Because safeguarding information often seemed to conflict with operational efficiency, the director of security had to be in a position to exercise the nicety of judgment required for sensible compromise. In the panel's opinion, the Commission's organization did not give the director this kind of independence. The panel thought the division had been downgraded and had lost prestige, partly because it lacked aggressive leadership and partly because top management failed to understand the importance of security.[47]

The Bugas panel could suggest dozens of administrative remedies, but its principal recommendation was that the Commission establish a new position for an assistant general manager. He would supervise all activities with security implications, including, in the panel's estimation, personnel, public and technical information, intelligence, classification and declassification, export control, and accountability of source and fissionable materials. For matters he deemed of sufficient importance, the assistant general manager should have direct access to the Commissioners.

Strauss was ready to accept the report without change. The division had been without a director for almost a year. To delay until new Commissioners were appointed to replace him and Lilienthal would require the Commission to go back over the same ground. Dean was inclined to agree with Strauss that the Commissioners should act on the report without waiting for a laborious review by the staff, but Pike and Smyth thought the issues were too large and far-reaching for quick decision. Although he would no longer be a member of the Commission when the report came back for final action, Strauss accepted the suggestion of staff review.[48]

Wilson was circumspect in his comments on the report. He tried to be positive despite his strong reservations about the wisdom of some of the recommendations. Many of the suggestions for better administration and coordination he could adopt at once, but the proposals for an assistant general manager aroused misgivings not only in Wilson but also in the staff.

General James McCormack thought there would be advantages in cutting down the number of people reporting to the general manager, but he wondered whether the Bugas proposal would give the impression that security in the sense of secrecy and exclusion was more important than security by achievement. Both McCormack and Williams questioned the wisdom of permitting the assistant general manager to report directly to the Commissioners. The idea of putting the Commission's personnel and information activities under the assistant general manager seemed questionable, particularly if, as Williams predicted, the new official's security functions overshadowed his other responsibilities. Wilson shared most of the panel's suggestions, but he disagreed that the organizational change was the only alternative available.[49]

Wilson's report to the Commissioners on May 19, 1950, revealed that the Bugas panel had sharply spurred the staff to greater efforts in improving administrative procedures. Wilson was speeding completion of a comprehensive manual of security procedures. The manual would include new instructions for transferring and controlling classified documents, making security surveys, controlling visitors to Commission installations, clearing employees,

and fixing standards for physical security. Wilson also accepted Bugas's criticism that action on policy matters took too long. To coordinate action in the general manager's office, Wilson called on Thomas O. Jones, who had helped to set up the Commission's security operations in 1947. The staff itself was planning more frequent conferences for security personnel and considering the use of special panels to hammer out new procedures. To meet some of the complaints that inspections of the field offices were often ineffective and unreasonable, the division was developing a special training course for inspectors, revising inspection procedures, and making sure that the field offices took prompt action on findings. In the area of personnel security, the staff was almost ready to replace the "interim" procedures in use since 1948 for the personnel security review board. The staff was also considering the feasibility of the panel's recommendation for periodic reinvestigation of all Commission and contractor employees.[50]

The more fundamental issue of organization was the principal topic in the Commission's meeting with the panel on May 24. Responding to Wilson's written comments to the Commissioners, Bugas stressed the breadth of the panel's fact-finding efforts and the unanimity of its recommendations. Appointing an assistant general manager was not the only solution the panel had considered, but it had not found any other to recommend. Bugas said his group did not expect the assistant general manager to be an "exalted" director of security or a "super cop." He would be the general manager's assistant in every sense of that term, except for the right to go directly to the Commissioners, a right he would exercise rarely if ever. There were other ways of providing this kind of assistance in the general manager's office, but Bugas thought the prestige and authority of an assistant general manager would be valuable.

Wilson thought the panel had diagnosed the Commission's ailment but had not prescribed the proper remedy. Many of the shortcomings in administration and communications Wilson attributed to the lack of a division director for more than a year. He thought the isolation of the security group from other headquarters divisions stemmed from Gingrich's tendency to treat his job as a temporary assignment. Adopting the panel's suggestion would probably leave the division without a leader for another year. Wilson thought the most pressing requirement was to find a director.[51]

In the absence of a decision by the Commissioners during the final hectic days of the interregnum, Wilson as an operating official had a distinct advantage over Bugas as head of an advisory committee. Wilson and Shugg devoted their energies toward finding a new director of security. The Commissioners found it hard to object to that effort, although Dean warned Wilson that he should check back with the Commission before taking any final action to make sure that he was not prejudicing organizational changes.[52]

The outcome reflected both Wilson's and Dean's efforts. Just a few days before Wilson resigned as general manager in August, 1950, the Commission agreed to appoint John A. Waters as director of security. Waters had just retired as a captain after thirty years' service in the Navy. As one of his friends described him, Waters was a "plugger," a steady worker with experience in security. Wilson's departure also opened the way to appointing an assistant general manager if Dean wished to do so. Although never cast in a formal Commission action, the decision was to recruit three such officials to assist the new general manager. One would cover the activities suggested by the Bugas panel; the second, the assistant general manager for research and development, would watch over research, biology and medicine, and reactor development; the third, the assistant general manager for manufacturing, would supervise raw materials procurement and fissionable materials production.[53]

Wisely the Commission refrained from announcing the new positions until there were men to fill them. As Williams remarked several years later, it was not easy to find qualified men to accept such broad responsibilities at the salaries the Commission could offer. By the end of 1952, the Commission had filled only the position dealing with manufacturing. Security was indeed a *sine qua non* in the Commission's organization, but the main recommendation of the Bugas panel would have to wait for a more propitious time.

THE DEAN ADMINISTRATION

Even before Dean was appointed chairman, he had begun to lay the foundations for his administration. Late in June, 1950, he had asked Roy B. Snapp, the Commission's secretary, to compile a list of those decisions which the Commissioners had deferred until it was again appropriate to consider long-range policy issues. Presumably with the confirmation of the four Commissioners and the naming of the chairman, that time would soon arrive. Snapp had the summary ready on July 12, the day after Dean became chairman; but the Commissioners deferred it until August, when Carroll Wilson expected to return from a well-deserved vacation.[54]

In the meantime, Dean had several new ideas to explore. One was to establish a series of committees consisting of a Commissioner, the general manager or his deputy, and perhaps the appropriate division director to make continuous evaluations of the Commission's most critical responsibilities. Dean thought the committees might well supplant the program council, which seemed to have outlived its usefulness. Dean was also eager to discuss various ways of streamlining the Commission's organization.[55]

Any changes in organization would depend heavily on Wilson's plans. In the closing days of his July vacation Wilson had stopped at Lilienthal's summer home at Martha's Vineyard. Wilson had followed with a growing feeling of disgust the Congressional attacks on Pike. Now Dean's appointment had convinced Wilson that he would have to resign. He simply had no confidence in the new chairman. Wilson had talked with Vannevar Bush, James B. Conant, and Hartley Rowe, and all of them agreed he should resign under the circumstances. Lilienthal added his support, but warned Wilson to act quickly before McMahon or the Joint Committee found some way to force him to resign under political pressure. Lilienthal was still upset by what he regarded as McMahon's attempt to control the agency by arranging Dean's appointment to the Commission in 1949. It was hard for Lilienthal to believe that Truman was happy about making Dean chairman, but he advised Wilson to say "as many nice things about the President as he could" in his letter of resignation so that the President's political foes would not use the letter against him.[56]

Back in Washington on Thursday, August 3, Wilson told Shugg of his intentions. Shugg advised against the resignation and especially against a candid disclosure of the reasons for it. But Wilson believed in being forthright. On Friday afternoon he read to the Commissioners a draft letter to the President. Although Dean could hardly be pleased, he took the news well and thanked Wilson for being frank and open. Pike tried without success to change Wilson's mind, and later in the afternoon Wilson went to the White House for an appointment Dean had arranged through Dawson. Wilson found Truman cordial and even interested that he was resigning over a matter of principle and not because he was tired of Government service.

The public did not learn of Wilson's action until August 8, when the White House released his brief letter and Truman's reply. From Wilson the press got the details. He did not have the degree of confidence in the chairman necessary to do an effective job. Furthermore in the preceding year he had seen a trend toward greater control of management by the Commissioners. In time he feared this would result in "a cumbersome, slow-moving administrative machine." [57]

Wilson's action was understandable enough. Since the summer of 1949 Dean had been suggesting a variety of decisions in which he thought the Commissioners should be directly involved. These he had summed up in his memorandum of October 26. In the spring of 1950 Dean had supported an amendment to the Atomic Energy Act which would limit the general manager's term to three years. In June Dean had again raised the question of action on his October memorandum and, since becoming chairman, he had given reorganization much of his attention.

More surprising than Wilson's resignation was Dean's public reaction to it. Most men in Dean's position would not have been able to resist the temptation to strike back with a personal attack on his detractor, and Dean admitted that he was "sorely tempted." Instead he took the path of conciliation. In a press statement on August 8 and in an informal talk with the Washington staff the following day, Dean stressed Wilson's many contributions. Wilson's departure, Dean said, was entirely his own idea. There had been no clashes between them. In fact, Dean had scarcely seen Wilson since his appointment as chairman.

Turning to a larger perspective, Dean claimed that the agency had been "bedeviled" by controversy ever since he had joined the Commission. At times controversy was good, but Dean thought the Commission had encouraged too much of it by insisting that "we are always right" or by carrying "too many chips on our shoulders." Dean was not suggesting subservience to every pressure, whether it came from Congress, labor unions, universities, or industry. Rather he thought it was "an hour in the life of the Commission when we will have to do some selling—not by asserting our perfection, but by demonstrating our skill and our sincerity." [58]

Looking ahead to the future, Dean spoke with some feeling about the need for understanding. At the Commission level, there could be "no one-man show." The job was too big for one man, and the abilities and experiences of all five Commissioners were needed in making decisions. At the same time, the Commissioners could not know everything about the entire program. They had to trust the general manager and the staff. Dean still believed the Commissioners should know as much as was humanly possible about the program, but that did not mean management by the Commissioners. He admitted that relations with the advisory bodies were sometimes difficult, but the Commission had to realize that it needed help in making the important decisions it faced. If the Commission made sure that other groups in the Government understood the issues, there would be little danger of faulty advice or misguided opposition. The Commission, in other words, would try to work within the existing fabric of Government, to shed some of the trappings of isolation and superiority, and to become part of the American scene. Lilienthal had complained to Wilson that McMahon and Dean were trying to bring politics into the Commission. Dean probably would have rejected that charge, but he might have admitted the reverse—that he hoped to bring the Commission into the American political system.

To complete his team Dean needed a fifth Commissioner to replace Strauss. Since leaving office in April, Strauss had suggested several candidates, the latest being T. Keith Glennan, president of Case Institute of Technology. Some of the Democratic Congressmen on the Joint Committee were urging the appointment of Joseph A. Volpe, Jr., the Commission's general counsel, but both the White House and the Pentagon preferred Glennan. A graduate in science at Yale in 1927, Glennan had spent fifteen years in the motion picture industry before becoming director of the Navy's underwater sound laboratory at Columbia University during World War II. Glennan had a solid business background, some experience in Government, and a great interest in the role of science and technology in modern industry.[59]

Glennan's confirmation on August 22, 1950, left Dean with only one major position to fill. He needed a general manager to replace Wilson. First it was necessary to scale down the status of the general manager. Two days after Wilson left office, McMahon raised with the Joint Committee the idea of revising the Atomic Energy Act to give the Commission rather than the President the authority to appoint the general manager. In reporting a bill to this effect in the Senate on August 30, McMahon declared that "the ultimate responsibility lies with the Commissioners, and they are held accountable accordingly." McMahon concluded that the Commissioners should have the power to select their own general manager.[60]

Even before the amendment became law on September 23, Dean and his fellow Commissioners were looking for a promising candidate. They wanted someone with extensive experience in business and industry. Above all, a man with a sound conservative background would help to scotch the charges Joseph R. McCarthy was making in the Senate that the Commission had ignored the communist leanings of many American scientists. Strauss, now back in the business world, could help in sounding out some of the large corporations for prospects. Robert LeBaron, chairman of the Military Liaison Committee and Assistant to the Secretary of Defense (Atomic Energy), offered the services of the Defense Department.

The choice quickly narrowed to Marion W. Boyer, a vice-president of the Esso Standard Oil Company. A graduate in chemical engineering from MIT, Boyer had spent virtually all of his professional career with Standard Oil. During World War II he had managed the huge refinery at Baton Rouge, Louisiana, one of the nation's largest producers of aviation gasoline and synthetic rubber. Anything but flamboyant, Boyer was a quiet, affable man who looked like a corporation executive. He had a reputation for knowing how to get the best efforts out of his staff without direct pressure. At forty-nine he was one of the most promising executives at the top of the Esso organization.[61]

When Boyer took office on November 1, 1950, Dean's new team was complete. The years of strife seemed over. Now Dean and his associates could put into practice the principles of administration which Dean had been formulating for more than a year. Evidences of the new style would show up most clearly in the Commission's relations with Congress and the Joint Committee. In other administrative areas, such as labor relations and security, the impact of the Korean conflict would be a dominant theme.

LABOR AND THE DEFENSE EFFORT

By late 1950 the Davis panel had built an impressive record in labor negotiations. In sixteen months operating personnel had stopped work only three times, with minor effect. Two of these instances involved a contractor who had not accepted the *status quo* procedures set forth in the panel's charter.[62]

This enviable record did not mean, however, that the Commission's labor policies went unchallenged. At its annual convention in Chicago in November, 1950, the CIO called upon the President, Congress, and the Commission to stop contracting atomic energy work to private corporations. The delegates resolved that the Commission should adopt the Tennessee Valley Authority's system of direct Government operations. Only in this way, the union members argued, could there be genuine collective bargaining between a Government agency and free labor unions. Operation by private contractor gave management the advantage of a double standard. The contractor could claim that a shutdown would threaten the national security. Thus the company could continue to operate the plant at a profit while depriving labor of the right to strike. Adding to labor's concern was the recent announcement by the Monsanto Company of its intention to build a nuclear power plant, the first step, in the union's opinion, toward transferring atomic energy from public to private hands. Even Lilienthal since leaving the Commission had abandoned the TVA principle of direct operation to advocate turning the atom over to private industry.[63]

Perhaps some of the CIO resolution was rhetorical, but one charge was not. The CIO leadership challenged the "invite procedure," under which the Commission in certain instances made available to its contractors derogatory information about job applicants even though the information had nothing to do with loyalty. The CIO complaint arose from a case in late 1949 involving an employee of the Commission's Kansas City, Missouri, weapon plant, operated by the Bendix Aviation Company. The employee had been hired on probation while being cleared. The investigation had revealed character blemishes unconnected with loyalty. After examining the allegations and questioning two supervisors, Bendix had fired the man on the grounds that he lacked the qualifications the company expected of its employees. The Commission's personnel security form had revealed to Bendix information on the employee's union activity. For the Commission's security investigation this was pertinent because at least one union—the Industrial Workers of the World—was on the Attorney General's subversive list. For the company, however, to collect information on union affiliation, except under specific collective bargaining procedures, was illegal under the Taft-Hartley Act. The CIO had brought the case before the National Labor Relations Board. The union accused Bendix of unfair labor practices and claimed that the man had been discharged for union activity.[64]

As a result of the incident the Commission had revised its forms so that they would reveal nothing to the contractor about an applicant's union background. The labor relations board absolved the company of the discrimination charges. Nonetheless, as Carroll Wilson had admitted at the time, the

Commission could improve some of its procedures. One of the deficiencies, which the union had pointed out, was that the employee had no access to the information which had brought about his dismissal. On the other hand, the company had the right to fire employees for reasons other than security. Otherwise the contractor might not be able to meet his obligations to the Government. Certainly the Commission could not disclose information it had received in confidence.

After many discussions with Commission personnel in the field offices, with contractors, union representatives, and officials of the National Labor Relations Board, the Commissioners in March, 1951, approved a codification of security policies for use in collective bargaining. There was no way of bringing all such proceedings into the open, but the Commission concluded that it would serve justice to clear for access to confidential information all parties to the proceedings, including a panel of trial examiners from the labor board, international union representatives, and the counsels of both parties if necessary.[65]

Although the Commission had an excellent record in avoiding work stoppages, Davis was concerned in late 1950 about the increasing number of cases calling for panel intervention. As a temporary expedient, the President appointed three additional members to the panel in November, 1950, but the real question was whether the panel was undermining the normal operation of collective bargaining procedures. Perhaps labor and management were coming to depend on the panel to resolve issues which they themselves should settle at the bargaining table. Davis believed strongly that harmony in labor relations had little value if it were achieved at the expense of free collective bargaining. He insisted that procedures be flexible and that the parties to disputes be left as much latitude as possible.[66]

The room to maneuver was narrowing as the nation moved deeper into the Korean conflict. On July 19, 1950, Truman on radio and television had called for an increase in defense production. After signing the Defense

Production Act, he told the nation from the White House on September 9 that the new legislation would give the Government power to meet defense needs. But the fight against inflation, the President said, involved everyone. The housewife should not hoard, the businessman raise prices, the laborer seek wage increases. He promised that under the new production act he would establish a wage stabilization board. When the Chinese Communists shattered hopes for an easy end to the Asian struggle, Truman proclaimed a national emergency in December, 1950. The wage stabilization board ran into difficulties early in 1951 when union representatives withdrew. As reconstituted, the board had responsibility only for disputes affecting the defense effort.[67]

The Davis panel had to proceed cautiously in handling the Commission's labor disputes so as to preserve what Davis called the "custody of the no-strike pledge" and yet not to encroach upon the functions of the stabilization board. With the expansion of the Commission's production capacity, the panel found the character of its work changing. Now the more dangerous disputes were in construction projects which, because of their importance to the defense effort, involved both the stabilization board and the panel. Davis and his group found themselves exploring wage settlements according to policies established by the board.

Among the labor troubles of the expansion period, those at the new Paducah, Kentucky, plant, mostly involving local disputes with craft unions, caused the most difficulty. In September, 1951, the Sheet Metal Workers' International Association (AFL) demanded an allowance to increase earnings above established area rates. When the demand spread to other crafts both at Paducah and at Dana, Indiana, Dean had to appeal publicly to William Green of the AFL and to the Paducah and Dana contractors to get the men back to their jobs. Davis noted, however, this was the first time that the Commission chairman had been forced to enter directly into a labor controversy since the summer of 1948, when Lilienthal had met with union leaders during the Oak Ridge dispute.[68]

By early 1952 Davis was beginning to think the panel had served its purpose. He had always considered it a temporary device, and it was now well into its third year of operation. Perhaps, he thought, he and the members should submit their resignations to the President. Smith, however, had other ideas. When the panel members met with the Commissioners in May, 1952, he remarked that in three years there had been only five minor work stoppages by operating personnel. No one knew what might have happened without the panel, but Smith doubted the Commission would have had as good a record. The Commission had not used the panel often in construction disputes, but where it had intervened, the work stoppages had ended quickly. In the seventeen months following June, 1949, the panel had taken part in thirty-three disputes. During the same period unions and contractors had negotiated or amended 102 agreements at Commission facilities. Thus 75 per cent of the negotiations took place without panel intervention. The Commissioners assured Davis that they wanted the panel to continue.[69]

Davis was not sure, however, that the panel had met his own standards of success. The flexibility of operations and the use of informal personal contacts made it difficult to tabulate the panel's accomplishments. By the end of 1952 Davis and his associates thought they had avoided both the dangers of Government intervention and prolonged strikes. Collective bargaining practices at Commission sites were now scarcely different from those generally prevailing in American industry. Davis, it seemed, had succeeded in preserving the creative possibilites in labor negotiations, even in a time of national emergency.[70]

SECURITY—CONFLICTING PRESSURES

Under Waters's direction, the division of security began in the summer of 1950 to effectuate most of the administrative reforms and improvements which the Bugas panel had proposed. In this respect the Commission's security forces would be better able to protect information and facilities vital to the national defense without unduly hampering operations. But new requirements were already offsetting the gains in security administration. In the months following the outbreak of war in Korea, the United States moved rapidly toward a war economy, with all the adjustments that process involved. If, as some Americans feared, the North Korean attack marked the opening of a general communist offensive against the West, it was all the more important to protect the remaining secrets of nuclear technology.

Clear evidence of a communist attack on the homefront was emerging as the Korean war began. On May 23, 1950, Federal authorities arrested Harry Gold, a young Philadelphia chemist, on charges of engaging in espionage for the Soviet Union. Gold's confession showed him to be a link between Klaus Fuchs, the convicted British scientist, and a Soviet spy ring. On June 17, newspaper headlines reported the arrest of David Greenglass, a former Army sergeant who had been a machinist at Los Alamos during World War II. Greenglass's confession led on August 17 to the indictment of his sister Ethel Rosenberg, her husband, Julius, and Anatoli A. Yakovlev, a Soviet consular official. Greenglass admitted that beginning in November, 1944, he had furnished information about the Los Alamos project and some technical information on atomic weapon design to his wife, Ruth, the Rosenbergs, and Gold. Fuchs's perfidy, then, was not an isolated instance of betrayal but part of an organized Soviet intelligence operation against the United States atomic energy project. The implications for the Commission's security program were obvious.[71]

The Korean War also increased pressures on the Commission from another direction. The deepening international crisis had sparked efforts to expand the Commission's production facilities. By the summer of 1950, the Commission was well launched on new construction at Hanford and Oak Ridge and was contemplating still another expansion. The need for hundreds of technicians and thousands of construction workers imposed heavy burdens on the security clearance procedures required by the Atomic Energy Act. Demands were also developing within the military services for technical reports containing Restricted Data and for personnel trained in handling nuclear weapons. In short, the division of security was facing conflicting pressures. On the one hand, there was an obvious need for tight security controls; on the other, there were good arguments for more liberal criteria to permit ever larger numbers of personnel to take part in atomic energy activities.

An agreement with the National Military Establishment in 1947 had proved adequate for a time in controlling the dissemination of Restricted Data within the armed forces. In the place of the Commission's regular "Q" clearance, the services granted military and civilian personnel special "M" clearances for access to Restricted Data. The Commission had the right to review the M clearances granted in order to assure that the standards applied were comparable with those the Commission employed. In addition, the Commission permitted the services to give military and contractor personnel access to certain limited categories of Restricted Data without special clearance. As the military need for Restricted Data increased, however, the 1947 agreement became too cumbersome. By March, 1950, the Department of Defense had granted 30,000 M clearances and had 3,000 cases pending. M clearances took from nine to twelve months to complete, and the number required was increasing by 1,000 per month.[72]

A legal technicality in the Atomic Energy Act posed an additional, and potentially, much more troublesome problem. Section 10b provided that the Commission's contractors, as distinguished from Commission employees, could not grant access to Restricted Data to anyone who did not have a Q clearance. Apparently the provision was intended to apply to research and development activities and not to military personnel, but the precise language of the prohibition gave reason for caution. Both the Commission and the Department of Defense had interpreted the law literally, often at heavy cost to operating efficiency. In one instance, military officers going to Oak Ridge for a briefing on aircraft nuclear propulsion could not receive the information directly from the Air Force contractor. First the contractor had to give the facts to a Commission employee, who could then repeat them to the officers, all of whom had the M clearance giving access to Restricted Data within the Department of Defense. In another instance, Los Alamos scientists, as employees of a Commission contractor, could not give Restricted Data to military officers making preparations for the *Greenhouse* weapon tests because the officers had only M clearances.

Facing a real emergency in meeting the schedule for the *Greenhouse* tests, the Commission gave Los Alamos special permission to grant access to the military personnel, but the general problem remained. Always leery of schemes for circumventing the law, Dean favored an amendment to the Act to make clear that Section 10b did not apply to personnel with appropriate military clearances. LeBaron showed little enthusiasm for amending the Act, particularly if the amendment covered only a specific difficulty. The Department, he wrote the Commission on September 18, 1950, was more concerned about the increasing difficulty of operating under the 1947 agreement. LeBaron proposed that the Department abolish the M clearance and grant access to Restricted Data under military security classifications. This change, LeBaron contended, would not require amending the Act, but he would not object if the Commission sought such an amendment.[73]

At least two aspects of LeBaron's proposal troubled the Commission. Abolishing the M clearance would do nothing to remove the statutory obstacle in Section 10b. The division of security objected that LeBaron's idea would create a double standard, one for the Commission and one for the Department of Defense, a dubious arrangement for sound security administration. Volpe, however, predicted that the Attorney General would approve LeBaron's proposal. The best position the Commission could take was to accept the change, with the understanding that the Department of Defense would support the Commission's effort to amend Section 10b. An exchange of letters with Defense Secretary George C. Marshall in the fall of 1950 sealed the agreement.[74]

The next step was to decide what kind of amendment the Commission should support. Dean, again taking the direct approach, was willing to entertain the idea of striking the phrase "Restricted Data" from the Act altogether. As long as the Commission retained full authority over the classification and declassification of atomic energy data, he was not worried about the form of the amendment. Should abolishing the term "Restricted Data" prove too sweeping, McCormack suggested an amendment which would restrict the term to weapon and production data and would permit the Commission and the military services to handle all other material as ordinary defense information, protected by the Espionage Act of 1917. A third possibility was the Commission's original suggestion simply to permit Commission contractors to give Restricted Data to the military.[75]

Not yet reduced to statutory language was another idea drawn from the military security system. The armed forces had long followed the practice of establishing differing degrees of sensitivity for classified information and then establishing for each category the extent of security investigation required. Thus a person having access only to information of low sensitivity could be cleared by a simple check of personnel and police records. Those using information of high sensitivity might require a full background investigation such as that performed for the Commission by the FBI. The difficulty with Section 10b was that it lumped all Restricted Data together regardless of sensitivity. An employee needed the same clearance for drawings of buildings as for weapon data. Just how the needed flexibility could be built into Section 10b was a question requiring more legal study.[76]

The Commissioners considered several of the more immediate solutions in the form of draft amendments during February, 1951. One would have authorized some exceptions to the prohibition of Section 10b in certain circumstances. Another would have permitted the Commission to remove information of low sensitivity from the Restricted Data category. A third embodied McCormack's proposal of limiting the definition of Restricted Data. The Commissioners' first reaction was to eliminate the Restricted Data category altogether, but Boyer and the staff convinced them that a lesser amendment was more likely to win Congressional approval. The amendment the Commissioners finally selected would permit the Commission to hire any individual, or to authorize any Commission employee or contractor to permit any individual to have access to Restricted Data, whenever the Secretary of Defense certified that the individual had been cleared for information of comparable security classification, or whenever access was limited to Restricted Data of the lowest classification.[77]

Hopes for the draft amendment were short-lived. Soon after the Commission sent the draft to the Bureau of the Budget, LeBaron registered the Department's disapproval. In LeBaron's opinion, the amendment continued the double standard to which the Commission had earlier objected. Furthermore, the idea of certifying clearances to the Commission suggested to LeBaron that the Department would be required to reaffirm the decision it had made in granting the clearance in the first place. Without support from Defense, the Commission would probably receive a cool reception from Congress. Another handicap was that, by careful management and hard work, most of the field offices had been able to keep pace with the increasing demand for clearances. It would be difficult to justify to a doubting Congressman that the existing provisions of the Act were still hampering Commission operations by the summer of 1951. The best argument for the amendment was that the heavy burden of clearance actions on the Commission's security groups and the FBI might inadvertently reduce the quality of investigations.

The solution, then, seemed to lie not in amending Section 10 but in somehow reducing the investigative load on the FBI. Dean, still favorable to the idea of abolishing the Restricted Data category, agreed to discuss with J. Edgar Hoover ways of reducing the FBI workload. The result was a variety of suggestions for transferring the burden of investigations for the Commission from the FBI to the Civil Service Commission.[78]

The Atomic Energy Commission had little direct part in the legislation introduced in Congress on August 30, 1951, to accomplish the transfer. In its original form the bill provided simply for assignment of all Commission investigations to the Civil Service Commission. Dean and his colleagues, however, wanted to reserve the right to designate certain sensitive positions for FBI clearance. Dean wrote Senator Tom Murray on October 17, that under the new provision the Commission would require from the FBI only 35,000 of the 90,000 clearances that would be needed in fiscal year 1952. All Commission employees and certain contractor employees in especially sensitive positions would continue to be subject to FBI investigations. The bulk of the contractor clearances would be based on Civil Service findings. Murray had no trouble inserting the provision in the bill, which became law on April 5, 1952.[79]

The Commission had failed in its original effort to remove from Section 10b the language that prevented its contractors from giving Restricted Data to military personnel, but there had been some progress in reconciling the conflicting pressures of the Korean crisis. The abolition of the M clearance system had helped operations within the Department of Defense, and shifting some of the investigative burden to the Civil Service Commission would speed clearances. More fundamental changes in the Act would be the business of another day.

PLANNING FOR LOCAL DEMOCRACY

The appropriation bill which became law in September, 1950, called upon the Commission to take positive steps toward democratic government and free enterprise in the three "atomic cities." Fortunately for the Commission, Richard Scurry had by that time formed his committee and was ready to begin an intensive study of the Commission's community operations. Joining him on the panel were Frederick M. Babcock, a housing finance consultant who had formerly been an official with the Federal Housing Authority; George E. Bean, city manager of Grand Rapids, Michigan; and George Gove, vice-president for housing projects of the Metropolitan Life Insurance Company. Composed of an experienced and capable group of men, the panel had full access to the extensive studies which the Commission's staff had completed during the preceding years. There was also ample occasion to talk with community experts at Oak Ridge and Richland, the two towns which would be the subject of the panel's first report. Thus the panel could observe the Commission's policies in action and follow closely the effects at Oak Ridge to develop a procedure for disposal of vacant land and buildings. When the Commission announced early in 1951 a general increase in rentals at the three sites to make them comparable with rates in the surrounding areas, the panel supported the action as a necessary first step toward eventual disposal of residential real estate.[80]

The Scurry panel had its own report in draft form by early April, 1951. A comprehensive document of 150 pages, the report reflected a professional mastery of vast amounts of legal and technical detail. The panel began with the assumption that the three communities were essential to the Commission's operations and that their continued existence either as Government towns or independent communities depended on attractive living conditions, good community facilities, reasonable living costs, and adequate housing. Incorporation and disposal of Government property at Oak Ridge and Richland would not only establish democratic institutions and the free enterprise system, but would also reduce Government costs, free Commission executives for other activities, and improve relations with workers at the sites. At the same time, the panel recognized that impressive obstacles stood in the way, among them financial requirements, inertia of the residents, loss of Commission control, and lower standards of service. An effective plan, in the panel's opinion, would have to take into account all the Commission's needs and suggest ways of removing all of the obstacles to acceptance of the goal by the residents.[81]

Scurry and his associates acknowledged the many steps the Commission had already taken toward incorporation and disposal, but they stressed the need for Commission initiative in stating intentions clearly, providing planning assistance, obtaining necessary legislation, and working with the residents. The controlling factors in the communities were so interrelated that it was difficult to know where to begin. As for the old question of whether incorporation or disposal of property should come first, the panel did not believe that the Commission could "coerce" the communities to incorporate by withholding property disposal. Disposal was the necessary first step, and the Commission would have to accept the risk that the residents might then fail to establish effective government through incorporation. The new city councils would need help from the Commission in estimating revenue sources and preparing budgets. The Commission would have to clarify what land, buildings, and equipment it was donating and what payments it would make to the communities in lieu of taxes. Commission help would also be necessary in drafting city codes and regulatory ordinances, determining personnel needs, and appraising property for tax purposes. The panel thought the city charters themselves should be left to the residents.

Not satisfied with providing merely the broad outlines of the plan, the Scurry panel added a compendium of precise, practical information on procedures. There was an excellent section on the necessary Federal and state legislation for incorporating the towns, for the disposal of real estate, for financing real estate sales through Federal agencies, and for financial assistance to the new cities. Another section analyzed the thorny question of determining the amount of Federal subsidy to be paid to the communities and the form of payment. The panel concluded from the analysis that both Oak Ridge and Richland should receive annual subsidies for schools and hospitals and that an annual cash subsidy on an agreed-upon declining scale might be necessary to secure prompt incorporation of Richland. Other sections included practical information on classifying real estate, adjusting rents, establishing sales prices, financing sales, drafting occupancy controls and charters, and establishing municipal organization and finance.

Under continual pressure from Congress, Dean grew impatient as the summer of 1951 waned, but the report proved worth waiting for. The staff had made only a few editorial changes and updated a few sections in the April draft, and the Commissioners confined their comments to the announcement that would accompany the release of the report. They were not willing to commit themselves unalterably to incorporation and disposal until the residents of the communities had expressed their views on the report. There was no question, however, what the Commission's intentions were. Soon after publication of the report, the Commission would obtain appraisals of the property to be sold so that residents could determine their interest in purchasing homes. The Commission also offered to poll the residents for their views on incorporation and to support the necessary Federal legislation.[82]

Publication of the report set off a chain of events at both Oak Ridge and Richland. The town council at Oak Ridge organized a citizens' committee to study self-government and various civic and church groups organized meetings to discuss the panel's recommendations. Before the end of the year property boundary surveys were completed at Oak Ridge and nearing completion at Richland. The Commission arranged with the Bureau of Census to undertake public opinion surveys in the two communities, and appraisals began early in 1952. Results of the survey indicated a strong interest among Oak Ridge residents in purchasing homes. As 1952 ended, the Commission was completing plans for leasing vacant land at Oak Ridge and Richland for residential development.[83]

For Los Alamos the goal of self-government and private ownership was still far in the future. In a second report in June, 1952, the Scurry panel maintained the same ultimate objective for Los Alamos as for Oak Ridge and Richland, but the existing system of Government operation would have to continue at least until the laboratory could move its technical facilities out of the town. For all three communities the goal which Moore had set down five years earlier was not yet clearly in sight, but the Commission could now feel confident it was moving in the right direction.[84]

CONGRESS AND APPROPRIATIONS

When Dean took the chairmanship, he recognized that one of his first tasks was to improve relationships with Congress. His personal connection with McMahon would help, but something more was needed. Was it always necessary, he asked Shugg, to be on the defensive? Could not the Commission for once take the initiative and recite its positive accomplishments? Too often, Shugg agreed, the Commission had left Congressional relations to the lawyers.

Somehow the Joint Committee should get a list of "plus items" every few months. Changes in tactics would help, but the underlying question of the balance of power remained.[85]

McMahon returned to the appropriation issue the following spring. On June 7, 1951, he introduced an amendment in the 1952 appropriation bill to require enabling legislation for any construction project costing more than $500,000. Confident that McMahon would not press for any legislation that would endanger the expansion of production facilities, the Commission restrained its opposition to the proposal. If the Commission did not object to the legislation, it could point out some of the difficulties it might create. For example, could the complicated procedures for authorization and appropriation meet the Commission's tight schedules for urgent construction? [86]

Dean told the Joint Committee on August 21 that the main difficulties with authorization would be mechanical. He was not sure how the Commission would coordinate the necessary actions with the Bureau of the Budget, the Joint Committee, and finally the appropriations committees. Dean's reference to practical matters rather than to constitutional issues provided a better climate for discussion. Borden admitted that the purpose was to adopt procedures more like those existing between the Department of Defense and the armed services committees. Holifield took a stronger position. He doubted that the authorization process would hold up construction projects; the Commission could still start engineering and design while the Joint Committee considered the proposal. Furthermore, Holifield was convinced that the committee should have the power of authorization. "It should assume that responsibility," he said to the Commissioners, "and then fight your battles for you on the floor of Congress, because you don't get your battles fought by the Appropriations Committee." [87]

By not protesting too much, Dean was able to keep positions on the amendment tenative. He left it to the Bureau of the Budget to take up constitutional issues. Perhaps as Dean hoped, McMahon soon found other matters engaging his attention. As chairman, Dean would never again have to face the question of authorization.[88]

CONGRESS AND INTERNATIONAL AFFAIRS

In the summer of 1951 Dean saw new opportunities to remove another source of friction with Congress. For years legislative entanglements had harassed the Commission's efforts to exchange technical information with the British and Canadians. Dean had been following the subject since he joined the Commission in 1949. More than once that year he had suggested an amendment to remove the ambiguities in Section 10a. Under that section the

Commission was to control Restricted Data so as to assure the common defense and security, but not to exchange with other nations information which might be applied to industrial purposes. Defining categories of information inevitably led to problems. Already embroiled with Congressional committees over fellowships and management, Lilienthal had feared that any attempt to amend the Act would prove disastrous.[89]

Dean was free of the inhibitions that had bound Lilienthal. That was clear on October 20, 1950, when the Commission discussed the possible amendment of Section 10a. Relations with Britain and Canada were still paramount, but Volpe suggested that any revisions in the Act take into account the advancing efforts of other nations. Congressional guidance would also be necessary in negotiations to purchase uranium ore from Belgium and South Africa. Volpe and his legal staff had considered various statutory provisions which might make cooperation with other nations easier. Perhaps the Commission or the President should have authority to negotiate arrangements with other nations after determining that such action would be in the interest of the common defense and security. To give the Joint Committee a direct hand in such matters, the staff suggested that the law provide for Executive agreements to lie before the Joint Committee for a specified number of days before becoming effective. For security reasons the staff had decided against any provision involving all of the Congress. Dean and the Commissioners thought the proposal had merit, but they were reluctant to suggest it to the Joint Committee in the abstract. It seemed better to wait until a request for technical assistance from Belgium or Canada provided a good case for amendment. In the meantime, the staff could sound out the Department of Defense.[90]

Dean had enough experience with the Joint Committee to know that favorable action on the amendment would depend heavily on support from the Department of Defense. He found it impossible, however, during the first six months of 1951 to come to any meeting of the minds with LeBaron. Finally on June 20 he asked LeBaron to join him in discussing their differences with Deputy Secretary Robert A. Lovett. Dean said the two agencies had been unable to agree on the areas in which the exchange of information would be useful if Congress amended the Act. In some respects the Commission was walking a tightrope. The Canadian heavy-water test reactor at Chalk River provided unique facilities for testing samples of fuel elements being developed for the Commission's new production reactors at Savannah River, South Carolina. But the Canadians could not irradiate the samples without receiving Restricted Data from the Commission. This would involve an exchange of technical information clearly outside the terms of the *modus vivendi* of 1948.

Dean admitted to Lovett that he found the military response to the Commission's appeals stiff and narrow. The trouble lay, he thought, in a fundamental difference in philosophy. The military saw the exchange of technical information entirely in terms of providing complete weapons to the British for defense purposes, a move that would amount to giving the British all the information the United States had on these devices. Yet the military would not consent to a much more limited exchange of specific bits of information which promised a clear advantage to the United States. Dean thought he had made an impression, but Lovett promised no immediate action.[91]

As the summer of 1951 wore on, Dean become more than ever convinced that the advantages of international cooperation extended far beyond the exchange of weapon information by military personnel, as LeBaron contended. He had successfully demonstrated to Lovett how the Chalk River reactor could speed the production of greater quantities of fissionable materials for weapons. Outside the weapon field, the unique facilities of the Canadian reactor would prove invaluable in developing fuel elements for submarine propulsion systems. With some qualms Dean had supported the decision to authorize irradiations for the submarine systems under the *modus vivendi*, on the grounds that only an insignificant amount of classified information need be revealed to the Canadians. When he learned, however, in July, 1951, that the Canadians would need much more information about the test samples to assure safe operation of the Chalk River reactor, Dean had reluctantly requested the Commission to terminate the project. The action was unfortunate, but perhaps Dean hoped that it would help the military leaders to see the need for amending Section 10a.[92]

In almost every area of its activities the Commission could cite the advantages of closer cooperation with the British and the Commonwealth nations. The Commission could save large sums in processing uranium concentrates from Canada if American companies could help the Canadians in designing new refineries. Similar assistance to the Australians might assure the United States new sources of uranium from that country. Further exchanges with the British would be of mutual benefit in producing plutonium, developing new chemical processing techniques, and improving gaseous-diffusion plant operation. Even in the areas of research covered by the *modus vivendi* a more liberal statute would help by permitting research on topics which did not fall precisely into one of the approved areas. On July 19, Dean summed up all these advantages in a memorandum to the White House.[93]

Dean made his case again on August 24, 1951, at a meeting with Lovett and Secretary of State Dean G. Acheson. In his July 19 memorandum he had proposed an amendment which would authorize the transmittal of Restricted Data to other nations after notification of the Joint Committee and a Presidential determination that the arrangement would promote the national security. Both Lovett and LeBaron seemed anxious to exclude weapon information from the amendment. Dean agreed this was possible in theory, but in practice it was often hard to draw the line between weapon and nonweapon information. If the existing provisions of the Act had been in effect during

World War II, Niels Bohr, Enrico Fermi, Edward Teller, and all the British scientists would have been excluded from the American project. Acheson had no objection to Dean's proposal, but he saw no possibility of quick action by Congress. Dean disagreed. He thought he could get the unanimous support of the Joint Committee. What, Acheson asked, would Dean think of the amendment if the committee insisted on changing the requirement for "notification of" the Joint Committee to "approval by"? Dean thought even that condition would be acceptable. At least it would clarify the legal status of an exchange.[94]

By late August, events had all but forced Dean's hand in selecting the issue on which to propose the amendment. The Canadians were running out of time on their plans to expand the Port Hope refinery. Without help from the United States the Canadians would have no choice but to employ a much less efficient British process. There were ways of dodging the statutory restrictions, but Dean was against this course. It was time for Congress to take the responsibility for deciding whether the provisions of the Act should continue to jeopardize the nation's growing nuclear arsenal. Dean decided to see Truman and take the matter to the Joint Committee.[95]

In September, 1951, Dean spent four days discussing Section 10a with the Joint Committee. His skillful performance allayed the committee's fears that the information given to Canada might fall into the hands of the British. News that Guy F. M. Burgess and Donald D. Maclean, two trusted British civil servants, had defected to the Soviet Union had again raised doubts about the adequacy of British security. Dean knew that he was on firm ground with the Canadian issue; in a few years ore deposits in Canada might rival those in the Congo in importance. But Dean did not push his case too hard; otherwise, the committee might limit the application of the amendment to Canada and thus leave the Commission with similar problems in other countries. As further reassurance, Dean proposed that the amendment might require the concurrence of the President and the Joint Committee, with the committee receiving the facts a specified number of days before final action.[96]

Dean knew that if he could persuade Hickenlooper to accept the amendment, he could probably win over the rest of the Joint Committee. The prospects at first were uncertain as Hickenlooper explored the possibility of limiting the amendment to Canada. Then, as Dean may have expected, Hickenlooper brought up the Cyril Smith incident in 1948. Only quick and determined action at that time, Hickenlooper claimed, had prevented an unauthorized disclosure to the British, and he wanted to avoid the chance that loose phrases might permit a similar incident to occur. Not that Hickenlooper doubted the judgment of the present Commissioners, but no one knew who would be filling those positions in five years. Carefully Hickenlooper and his colleagues searched for precise words that would define exact procedures. "We are writing a statute that is important," he said, "and if we can arrive at language that we can all live with and understand, it is better to do it that way." It was too early to say that Dean had won the day, but at least Hickenlooper was looking for solutions. Dean's patient efforts to build a working partnership with the committee at last seemed to be bearing results.

Final action on the amendment seemed agonizingly slow. The Canadians had all but lost hope. Lovett and Acheson seemed mildly sympathetic but offered no real help. According to reports Dean received, LeBaron was not only personally opposed to the amendment but also worked hard to raise military opposition to the amendment. At last, with firm support from the Joint Committee and General Omar N. Bradley, chairman of the Joint Chiefs of Staff, the amended Section 10 became law on October 30, 1951. Under its terms, the Commissioners would have to agree unanimously that exchanging information with another nation would substantially promote the common defense and security. The amendment specifically excluded weapon information, prohibited transmittal to a potentially hostile nation, and required the recipient nation to have adequate security standards. The Commission's recommendation would go first to the National Security Council and then to the President for approval. Then the agreement would have to lie before the Joint Committee for thirty days while Congress was in session.[97]

Dean had chosen his ground well. Because Canada had no interest in developing weapons, that aspect of information exchange remained in the background. Everyone could understand the United States need for ore, even more imperative since the outbreak of war in Korea. It was almost as easy to demonstrate the value of the Chalk River facility in developing American reactors for plutonium production and military propulsion. The checks imposed on the Commission, Dean admitted, were more rigorous than he would have liked, but they were probably inevitable.[98] In any case, Dean had taken a long step forward in removing one of the sources of friction that had troubled relations with the committee since 1947.

The Joint Committee's unruffled discussion of Section 10a illustrated the effectiveness with which Dean handled Congressional affairs. His shrewd instinct for realities helped him to assess the circumstances of the moment and to decide when to fight hard for the issues he believed were important. He tried to direct the course of events by talking with Truman, Acheson, and Lovett and by private conversations with McMahon. The hearing room was not Dean's arena. He was deeply conscious of the Commission's responsibilities to the nation, but he had no exalted conception of the Commission's role in the Federal structure. Nor did he share Lilienthal's tendency to consider the Commission an instrument for reform. Compared with Lilienthal, Dean might have seemed workmanlike and even unpretentious: but these were the very qualities that could help him improve relations with Congress.

Despite Dean's accomplishments. the Commission was still a frequent target for Congressional criticisms and inquiries. The same sparring with the appropriations committees, the ceaseless probing from the Joint Committee, the steady flow of complaints about community management and contract awards continued much as before. But relations with Congress had taken on a new sense of maturity and reason. Much of the uncomprehending hostility had disappeared from the Congressional side, and the Commission's replies no longer reflected the same sensitivity to criticism or patronizing tone that had sometimes enraged the legislators in earlier days. From one point of view the Commission had simply joined the mainstream of the American system; from another, it had sold its individuality and independence for a temporary accommodation. The final verdict lay in the future.[99]

SCIENCE: SHIELD OF THE FREE WORLD?

CHAPTER 15

The outbreak of the Korean conflict in June, 1950, would certainly result in a shift of the Commission's efforts from peaceful to military pursuits. Scientists themselves, both in the Commission's laboratories and elsewhere, accepted work on military projects as a patriotic duty. But the shift in emphasis was always relative, not absolute. Research for military purposes inevitably created knowledge useful in nonmilitary studies. Except in the most extreme circumstances, a large laboratory could always justify supporting some efforts not directly related to military projects. In fact, in the Commission's laboratories during the Korean war many scientists continued studies in basic research without feeling any of the effects of the national emergency.

In the years after 1950, the Commission's research and development efforts did result in significant achievements for national defense. Reactors for propelling submarines and for producing special nuclear materials for weapons were evidence that research had become, as one scientist put it, "the shield of the free world." But the Commission's research activities did more than provide the hardware for national defense. Progress in developing nuclear power reactors, in high-energy physics, transplutonium chemistry, radiation biology, and the other basic sciences made a positive contribution to human welfare. In that broader sense, perhaps science could be an effective instrument for freedom, not only from political oppression but also from ignorance and pain.

SHADOW OF KOREA

For Walter H. Zinn, director of the Argonne National Laboratory, the twilight zone between peace and war ended when fighting began in Korea in late June, 1950. Zinn told the Argonne staff on July 18 that there were many rumors of change in Washington, some stemming directly from the Far Eastern crisis. Others, Zinn guessed, reflected the appointment of Gordon E. Dean as chairman of the Commission. Zinn predicted that the laboratory would have a direct role in developing production reactors and would probably have to step up its work on submarine propulsion. The Commission had already asked him how the laboratory could speed up military projects and how many of the others could be shelved for the duration of the conflict.[1]

Hard on the heels of the Korean conflict were other changes in Washington leadership. Dean's promotion to the chairmanship led to the departure of first Carroll L. Wilson and then Carleton Shugg. Oppenheimer and the General Advisory Committee were already considering replacements for Enrico Fermi, Hartley Rowe, and Glenn T. Seaborg, whose terms were expiring. Oppenheimer and several members told Henry D. Smyth in Los Alamos on July 19 of their fears that the committee might deteriorate into a collection of individuals if men of broad experience and high caliber were not appointed. There was general agreement that Willard F. Libby or Charles D. Coryell would be the best chemist to replace Seaborg. Oppenheimer wanted a very strong physicist if Fermi could not be convinced to remain, possibly John von Neumann or Hans A. Bethe. Robert F. Bacher also seemed a solid choice, not only for his capacities as a physicist but also for his understanding of industry. Smyth related his conversation to Dean, who at Smyth's suggestion called Oppenheimer to discuss the subject.

Dean thought the conversation with Oppenheimer helpful, but he had his own ideas about the appointments. When he wrote to Truman on July 31, he recommended Libby, an outstanding chemist at the University of Chicago; Walter G. Whitman, a chemical engineer at MIT who had directed the Lexington study of aircraft nuclear propulsion in 1948; and Eger V. Murphree, a petroleum executive who had undertaken the first major procurement of equipment for atomic energy research under Vannevar Bush in 1942.[2]

When Dean met with the new members and the rest of the committee in Washington on September 11, 1950, he told them that the Commission too had been discussing the committee's role in making policy. It was not just a matter of posing the most difficult questions to the committee and expecting immediate and simple answers. He thought informal and tentative discussions with the committee would be most helpful to the Commission. The big question at the moment was expansion of weapon and production efforts, and Dean hoped that the committee could participate in formulating plans. Here as in all aspects of the Commission's work, Dean was concerned about improving and strengthening relationships. True, the advisory committee was still firmly in the control of its charter members—Oppenheimer, Cyril S. Smith, Lee A. DuBridge, James B. Conant, and Isidor I. Rabi—a group Dean had differed with in the past, but he hoped the new members, with well-rounded experience in business as well as science, would give the committee better balance in the decisions ahead.[3]

NO PLACE TO HIDE

On June 26, 1950, W. Stuart Symington, former Air Force Secretary and now chairman of the National Security Resources Board, spoke before the annual convention of the American Red Cross in Detroit. For his subject Symington had chosen one of his principal responsibilities, civil defense. It was a timely topic on the day after the communist attack on Korea. For all any American knew, the attack was, as President Truman later suggested, the beginning of a shift of strategy from subversion to outright aggression in the communist world. With the Soviet Union in possession of the atomic bomb, it was time for the United States once again to consider what an atomic attack would mean for the nation's cities.

Symington's words that Sunday afternoon were not very comforting. "In this atomic age," he began, "there is no place to hide." The nation could improve its defenses against atomic weapons, but no amount of money could assure complete protection against surprise attack. The important thing was to understand the nature of atomic warfare and to prepare for it. For almost a year the Commission had been helping in this process of education. As Shields Warren had told the Joint Committee in March, 1950, operational responsibility lay with Symington's organization; the Commission's job was to provide technical data. The Commission had already declassified many documents for civil defense use and had prepared reports on the medical effects of atomic weapons, the use of radiation detection instruments, and the design of protective structures. Of most widespread interest was the handbook *Effects of Atomic Weapons,* which the Commission published in August, 1950.[4]

By September the deepening impact of the Korean war and the Government's educational efforts were beginning to have an effect. *The Bulletin of the Atomic Scientists* devoted a full issue to civil defense against atomic attack, and the Truman Administration began drafting legislation to establish a Federal civil defense agency. On October 18, the first air-raid shelter signs appeared on the streets in New York City, and within a few days the Government began distributing a pocket-size booklet, *Survival Under Atomic Attack.* Warren and his staff had provided material for the booklet and had helped to set up training courses for nurses, civilian defense instructors, and emergency radiation teams. With newspaper headlines full of reports of the sweep of Chinese communist forces deep into South Korea, there was little need to debate the existence of a grave national emergency when the

Senate Armed Services Committee began hearings on the civil defense bill in December, 1950. War with Russia seemed imminent. As the mayor of Boston put it, "Such a war, perhaps the most horrible war in history, will shake the very foundations of the world." After five days of hearings, the Senate was ready to act. The new law was in effect before the end of the year as the nation prepared for the worst.[5]

NATIONAL EMERGENCY

Among American scientists the foreboding news from Europe and the Far East was causing some radical rethinking of their role in the national emergency. Louis N. Ridenour, now serving as special assistant to the Secretary of the Air Force, told the Atomic Scientists of Chicago on November 24, 1950, that the time had come "for the national scientific community to take its proper part in the administration of national scientific affairs." In a world of limited warfare and unlimited resistance to communist aggression, scientists could no longer restrict themselves to part-time service on advisory boards. "Science," Ridenour had said, was "the shield of the free world." Was it too much to ask that science take part in mobilizing for the defense of freedom?[6]

By the time the American Association for the Advancement of Science assembled in Cleveland for its annual meeting during the Christmas holidays, several proposals for mobilization of scientific manpower had become popular topics for discussion. Both the American Institute of Physics and a special group advising General Lewis B. Hershey had recommended expanding the Selective Service System to include a scientific or technical service in its own classification system. Lawrence R. Hafstad, acting as chairman of the Interdepartmental Committee on Scientific Research and Development, had warned Symington that the nation could not afford to deplete its supply of scientific manpower. He urged the creation of a national scientific service to assure a continuing flow of young men and women into the scientific professions and the best use of all scientists in the military services.[7]

Commissioner Smyth took a broad view of the question in a speech at the scientists' convention. He admitted that scientists did not like to concentrate their efforts on instruments of war and that every scientist feared regimentation by government. But the nation's experience in World War II had proved that the full cooperation of scientists was absolutely essential in preparing for modern warfare. "Today," Smyth said, "we face a possible struggle for survival, and so our first concern as scientists must be to ask how we serve this country." He proposed a scientific service corps in which all the nation's scientists would be registered and some assigned, hopefully without coercion, to defense projects.[8]

Within the Commission the crisis in Korea was producing a similar effect. Kenneth S. Pitzer, who had recently resigned as director of research to accept a fellowship in England the following summer, wrote Marion W. Boyer, the new general manager, on December 11 that he had reluctantly decided to stay on the job in order to help carry out the reorientation of the Commission's research and development program. He believed the Commission could now take a much more daring approach to such activities under emergency conditions. Administrative shortcuts would greatly speed directives to the field offices and laboratories. Early in January, 1951, he proposed to Boyer a new statement of research policy. The statement declared that basic research was still important and should be supported as far as possible, but that some applied research was now more important and would have to take precedence. He urged continuing fellowships in the sciences and clearing outstanding scientists for classified research on short notice even when the need for clearance was not immediately apparent. The laboratories should, in Pitzer's opinion, make more use of consultants and the universities should be prepared to undertake classified research.[9]

Boyer readily approved the proposal for the national laboratories, and Pitzer made plans to visit Oak Ridge and Argonne with Hafstad before the end of January to explain the new policy. Other events, however, had overtaken Hafstad. While Pitzer was in the field, Hafstad would be deeply involved in Washington in an effort to adjust the reactor program to new military requirements.

REACTORS FOR THE MILITARY

For Hafstad the dangerous international situation in the closing weeks of 1950 could hardly have resulted in a complete reorientation of the Commission's reactor program. For almost two years he had seen a steady growth of activity on military reactors, first for submarine propulsion and more recently for aircraft. Although the original NEPA project had failed somehow to take hold, Alvin M. Weinberg's growing interest in aircraft nuclear propulsion had helped to stimulate new ideas. Working with the NEPA staff, the Oak Ridge laboratory had given the project a sense of direction in the first half of 1950. Weinberg had confidently expected that by the time the special technical advisory board arrived in the summer of 1950, the Oak Ridge group would have made enough progress to convince the board that nuclear propulsion of aircraft was feasible.

Events during the summer not only justified Weinberg's optimism but also resulted in some important decisions for the future. By early August the board under F. Wheeler Loomis had concluded that research on the aircraft reactor was too diffuse and on too long a time scale. The Loomis committee thought the goal should be, rather than a nuclear-powered supersonic bomber in the 1960's, a demonstration of nuclear propulsion as soon as possible, probably in an existing airframe design, such as the B-52, at subsonic speeds. The board also believed that the exploratory studies by the NEPA group had outlived their usefulness.

Both Hafstad and General Donald L. Putt, director of research and development in the Air Force, saw the wisdom of these recommendations. The NEPA project had lost its sense of mission, and some of its best leaders had resigned. Expiration of the Fairchild contract for NEPA in November, 1950, offered a good opportunity for a change. The plan was that Putt would ask General Electric to take over development of the aircraft engines. One or several of the large aircraft manufacturers would be recruited to devise a modification of an existing airframe. The Oak Ridge laboratory would continue to develop the reactor portion of the plane, first as a small reactor experiment and then as a full-scale nuclear-powered engine on a test stand. The old NEPA project would die in April, 1951.[10]

The results of these decisions were clearly evident when Pitzer arrived in Oak Ridge in late January, 1951. The number of scientists and technicians working on aircraft propulsion—263 people representing thirteen divisions —was greater than for all other laboratory projects combined. Now that all design work on the materials testing reactor was complete, there remained in that group only enough people to operate the original mock-up assembly, which had been converted into a low-power research reactor. The only other reactor project of any significance at Oak Ridge was the homogeneous experiment, which required only about sixty of the laboratory staff.

Most of the research on the aircraft system centered on the aircraft reactor experiment, to be built at Oak Ridge. The decision in the summer of 1950 still stood to use liquid sodium to transfer the heat from the reactor, but research during the autumn had caused second thoughts about the use of solid fuel. By January, 1951, the plan was to place noncirculating liquid fuel in small tubes or "hairpins" that would be immersed in the sodium. Supporting the experiment were other groups studying shielding, control systems, heat-transfer and metallurgy problems, and radiation damage. For the first time since 1946, research on an aircraft reactor seemed to be headed in a positive direction.[11]

Despite these technical accomplishments at Oak Ridge, Hafstad was still worried about the future. A sound technical base at Oak Ridge and unreserved enthusiasm in the Air Force were good arguments for the project, but they were not sufficient. In considering NEPA over the years, the Commissioners had long since learned to discount Air Force claims of feasibility. It would also be dangerous to become too heavily committed to the Air Force without some positive indication of support from the Department of Defense. Hafstad had an opportunity to raise the issue on December 7, 1950, when the

Commission considered the annual Presidential directive for the production of fissionable materials. The aircraft program would require a diversion of 200 kilograms of uranium 235 from weapon use. The deepening international crisis and the mounting requirements for nuclear weapons made such a diversion questionable unless the nuclear-powered bomber was essential to national defense. The Commission decided to ask again for a military opinion.[12]

The letter which Hafstad drafted for Boyer's signature on December 12, 1950, did formally raise the issue of requirements but Robert LeBaron was not hopeful that it would elicit a positive decision from the Joint Chiefs of Staff. He had not yet told the Commission that he had already received from the Joint Chiefs a statement to the effect that the Military Liaison Committee would have to determine the rate and scale of the aircraft project. A similar request from the Navy for a nuclear-powered aircraft carrier had recently gone to the Joint Chiefs. The chiefs' reply would provide a new reading of their attitude.[13]

LeBaron did not have long to wait. On December 21 he received a second demurral from the Joint Chiefs. As with the aircraft reactor, they were willing to go no further than recognizing the technical feasibility of the carrier reactor. Any decision on a formal military requirement would have to await further information from the Commission.

On January 25, 1951, LeBaron dispatched a letter to Dean reporting the Joint Chiefs' response to both requests. Now that the chiefs had committed what Hafstad and Putt considered "a complete abdication of authority," LeBaron was ready to act through the Military Liaison Committee. The next day he wrote Dean that the committee was undertaking a complete survey of the Commission's reactor development program. He arranged for the committee a series of briefings with Hafstad on several nights the following week.[14]

For General Putt and the Air Force, the failure to obtain a military requirement for the aircraft reactor was a severe blow. Perhaps the Military Liaison Committee could keep the project alive, but Colonel Ralph L. Wassell, an Air Force officer who had been at Oak Ridge, had his doubts. He suspected that Weinberg's first interest lay in the homogeneous reactor. Any faltering on the aircraft project might lead to a reversal of priorities at Oak Ridge.

The Joint Chiefs had also caused trouble for Hafstad, but he was not ready to give up. He told Walter A. Hamilton of the Joint Committee staff that he could not move on budget matters without some priority statement from the military and that he would appreciate any help the Joint Committee could give. The hearing which Congressman Carl T. Durham called on February 16 covered little more than LeBaron's role in the events of the previous weeks, but perhaps it would assure the Commission of committee support for the aircraft reactor. Durham and LeBaron would be ready to help if necessary, but the fate of the project now rested clearly on Hafstad and the Commission.[15]

NEW GOALS FOR REACTORS

By the time of the Joint Committee hearing on February 16, 1951, Hafstad had been able to review his plans for all types of reactors, for the production of plutonium and power as well as military propulsion. That same morning he told the Commissioners that he saw the decade ahead as one of competition with the Soviet Union, whether in war or peace. This competition would involve the total military and industrial potential of both countries. The Commission's principal task, in his opinion, was first to supply fissionable materials for weapons and military propulsion and then to strengthen the nation's industrial potential by using nuclear power to increase the nation's electrical energy supply. He estimated that this task would require $12 million more than the $101 million the Commission was proposing for reactor development in fiscal year 1952.[16]

Following this line of reasoning, Hafstad thought Argonne's highest priority should be on the plutonium production reactors for the Savannah River plant and then on a power-producing version of the same reactor. Work on the prototype of the submarine reactor would continue at its existing level, even if that meant higher costs. At Oak Ridge, Hafstad proposed to give highest priority to the homogeneous reactor, largely because of its promise as a plutonium and power producer. In the event of a conflict of priorities, the aircraft reactor would have to take second place, but Hafstad thought Oak Ridge could handle both assignments, particularly if the laboratory diverted much of the development work to industrial contractors as Argonne had done with Westinghouse. For this purpose Hafstad urged the Commission to approve a contract with General Electric at a cost of $3.7 million in 1952 for work on the aircraft reactor. Lesser priorities would go to the submarine project at the Knolls laboratory and to the development of reactors producing uranium 233. Whenever the Joint Chiefs might come up with clear-cut requirements for military reactors, the Commission could adjust its priorities accordingly.

The Commission was hardly ready to act on such a comprehensive proposal, but Smyth had some immediate reactions. Although he thought that work on the aircraft reactor would give Oak Ridge a sense of direction, he suggested that the Commission define the goal somewhat more broadly, in terms of high-temperature systems rather than aircraft application specifically. There were some reservations about the aircraft contract with General Electric, but the idea of building dual-purpose plutonium-power reactors received favorable comment.[17]

When the Commission returned to Hafstad's proposal two weeks later, opinion had crystallized in opposition to a full-scale aircraft reactor at Oak Ridge. Dean was unwilling to proceed without a formal requirement from the

Department of Defense. Pike had joined Smyth in favoring more general studies on high-temperature reactors, and T. Keith Glennan was skeptical about bringing General Electric in to work on hardware at such a preliminary point in development. Only Thomas E. Murray thought Oak Ridge should proceed on the entire project at once. When Hafstad observed that the small aircraft and homogeneous reactor experiments would represent a good start on the study of high-temperature systems, the Commission agreed to authorize their continuation with the reemployment of as much personnel as possible from the disbanding NEPA project. The Commission declined to take any action on the General Electric contract until LeBaron transmitted a formal requirement for an aircraft reactor from the Joint Chiefs on March 13, 1951.[18]

The military propulsion reactors were important to the defense effort, but plutonium production was still the first priority. Even the additional reactors at Hanford and Savannah River, authorized in October, 1950, would not guarantee an adequate supply of plutonium for all foreseeable requirements. In any event the Commission would not realize the full benefits of that action until the Savannah River reactors were completed, probably in 1956.

A further consideration, one which the General Advisory Committee had been following since 1947, was establishing a proper ratio between plutonium and uranium-235 production. Careful analysis of the alternatives the Commission might follow in feeding raw material through the production complex of reactors, plutonium separation plants, and the gaseous-diffusion chain demonstrated the need for increasing plutonium production even with existing plants. Similar analyses, which Manson Benedict and his staff were performing at Commission headquarters, showed that a higher plutonium-uranium-235 ratio would increase the total output of fissionable material with the existing stocks of uranium ore. There was also good reason to believe that military requirements for weapons would again increase, not only in terms of total numbers, but also in terms of models for specific uses. Either type of increase was likely to require more plutonium.[19]

All these considerations caused Hafstad to give increasing attention to plutonium producers in the spring of 1951. The problem as he saw it was not simply one of building more Hanford reactors as they were needed. For one thing, there was a lag of at least two years between the decision to build a reactor and the first delivery of plutonium from it. Furthermore, if the Commission waited until the last minute, there would never be any time to develop a more efficient design. Hafstad had found that very slight improvements in the reactors built at Hanford since World War II would have resulted in enormous savings as well as greater production of plutonium. And what would happen, Hafstad worried, if the military services suddenly needed large amounts of plutonium in the period before 1956, when the Savannah River reactors would be completed?

In the long run the answer might well lie in breeder reactors. Hafstad told Congressman Durham and his reactor subcommittee on May 23, 1951, that he was closely following the progress on the experimental-breeder reactor, which Zinn's staff was completing at the Idaho test station. Another possibility was the old General Electric power-breeder project. In January, 1951, Hafstad had received proposals from Kenneth H. Kingdon and Bethe, now a General Electric consultant, for a new study of the power breeder. Hafstad had made it clear that General Electric first would have to complete the submarine prototype at West Milton, which would provide significant data on both the submarine and power-breeder systems, but he was prepared to act on the General Electric proposal when the time was right.[20]

Among the plutonium producers, Hafstad was still counting on the new Savannah River reactors, the sixth Hanford unit (C), and the homogeneous reactor at Oak Ridge. For short-term contingencies he had authorized a study of a reactor using ordinary water as both moderator and coolant and

slightly enriched uranium as fuel. This design, a cooperative effort by the H. K. Ferguson Company and the Brookhaven laboratory, would avoid the use of scarce materials such as graphite and heavy water and would minimize the diversion of uranium 235 from weapons. In January, 1951, Hafstad also arranged for North American Aviation, Incorporated, to investigate the best possible "quick" design of a production reactor requiring a minimum extrapolation of reactor technology.

The Commissioners were not enthusiastic about Hafstad's recommendations. In a Commission meeting on June 7, 1951, Smyth told his colleagues that momentary preoccupation with plutonium production might distort the future of reactor design. Glennan could see Smyth's point, but he observed that perhaps the Commission was at fault in not stating its priorities clearly for the staff. A second meeting on the proposal two weeks later led to no definite conclusions. Boyer could only say that Hafstad would continue to study the possibilities for better reactors.[21]

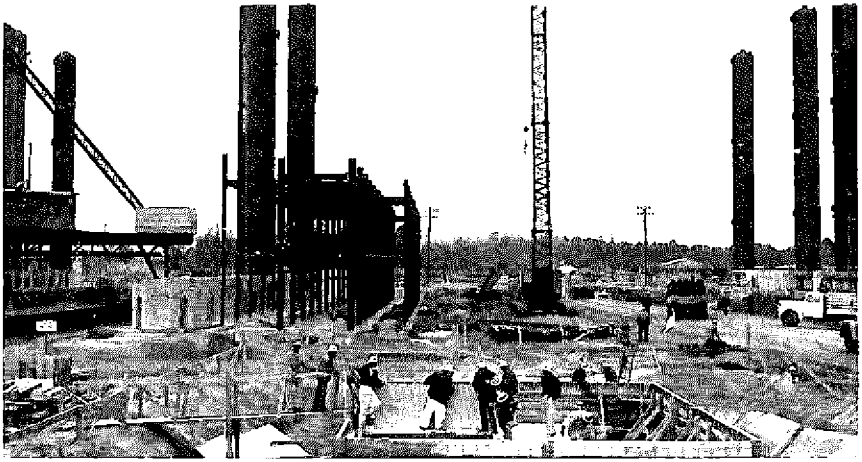
Hafstad himself could be philosophic about the Commission's difficulty in reaching a decision. He could understand how unusually capable and impressive men like Weinberg and Zinn could capture the Commissioners' interest and lead them first toward one reactor and then another. It was also difficult to keep priorities straight with a time lag of two or three years between the start of design and the completion of construction. For the short term he thought it was sensible for the Commission to concentrate on military propulsion reactors and plutonium producers. In the long run, nuclear power would be significant, but Hafstad believed private industry might best do that job.[22]

Before the end of 1950, other companies had followed Charles Thomas of Monsanto in offering to undertake studies of plutonium-power plants. John G. Grebe at Dow Chemical and James W. Parker at Detroit Edison had submitted a joint proposal on November 20. Because additional proposals seemed inevitable, Hafstad had decided to establish ground rules for power

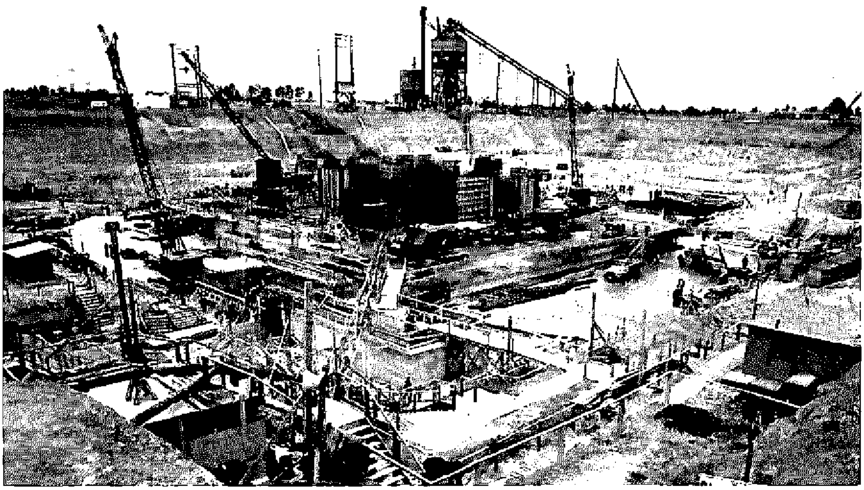
CONSTRUCTION AT OAK RIDGE, 1952 / Grading is in progress on the site of the new K-33 gaseous-diffusion plant as part of the Commission's expansion of production facilities. Other diffusion plants are in the background.

J. E. WESTCOTT

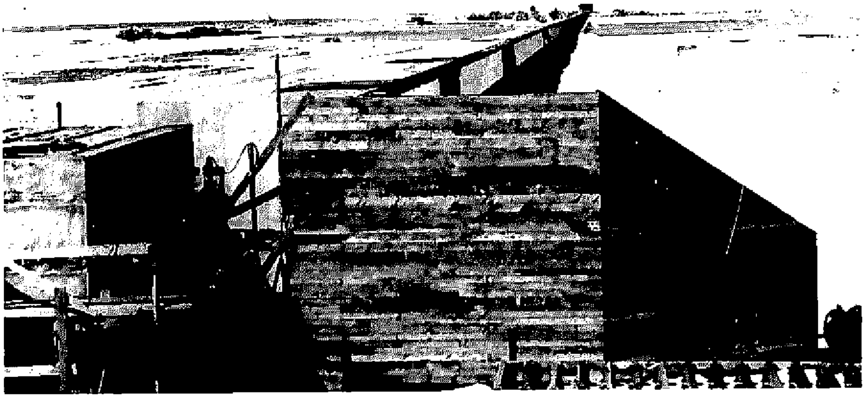
CONSTRUCTION AT PADUCAH, 1952 / Some of the 3,000 production workers on the day shift at the Paducah, Kentucky, gaseous-diffusion plant in 1952. The Paducah plant was part of the expansion program approved by the Commission in 1950.



CONSTRUCTION OF THE SAVANNAH RIVER HEAVY WATER PLANT, LATE 1951 / The first of the towers had been erected by November 28, 1951, for the hydrogen-distillation plant. The hydrogen-distillation process, although costly and dangerous, was selected as the quickest method of producing heavy water for use as moderator in the production reactors at Savannah River.

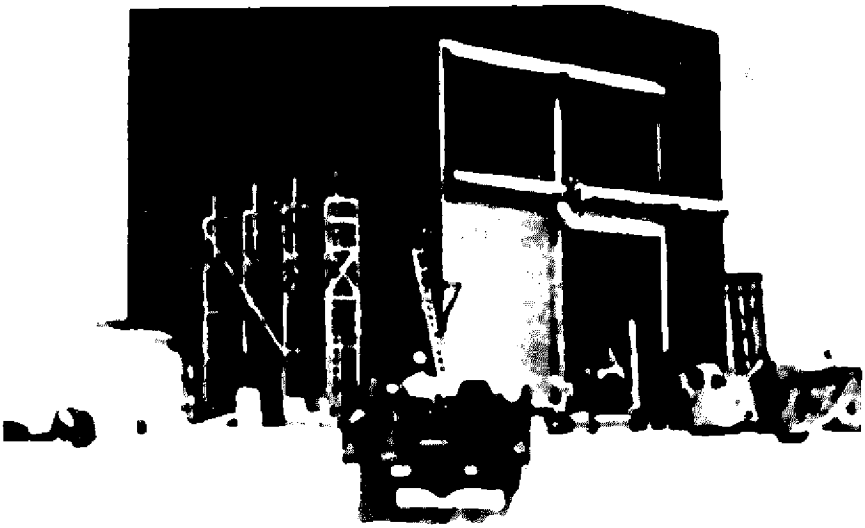


FOOTINGS FOR THE P REACTOR AT SAVANNAH RIVER, 1951 / Footings were being placed as this photograph was taken on November 28, 1951.



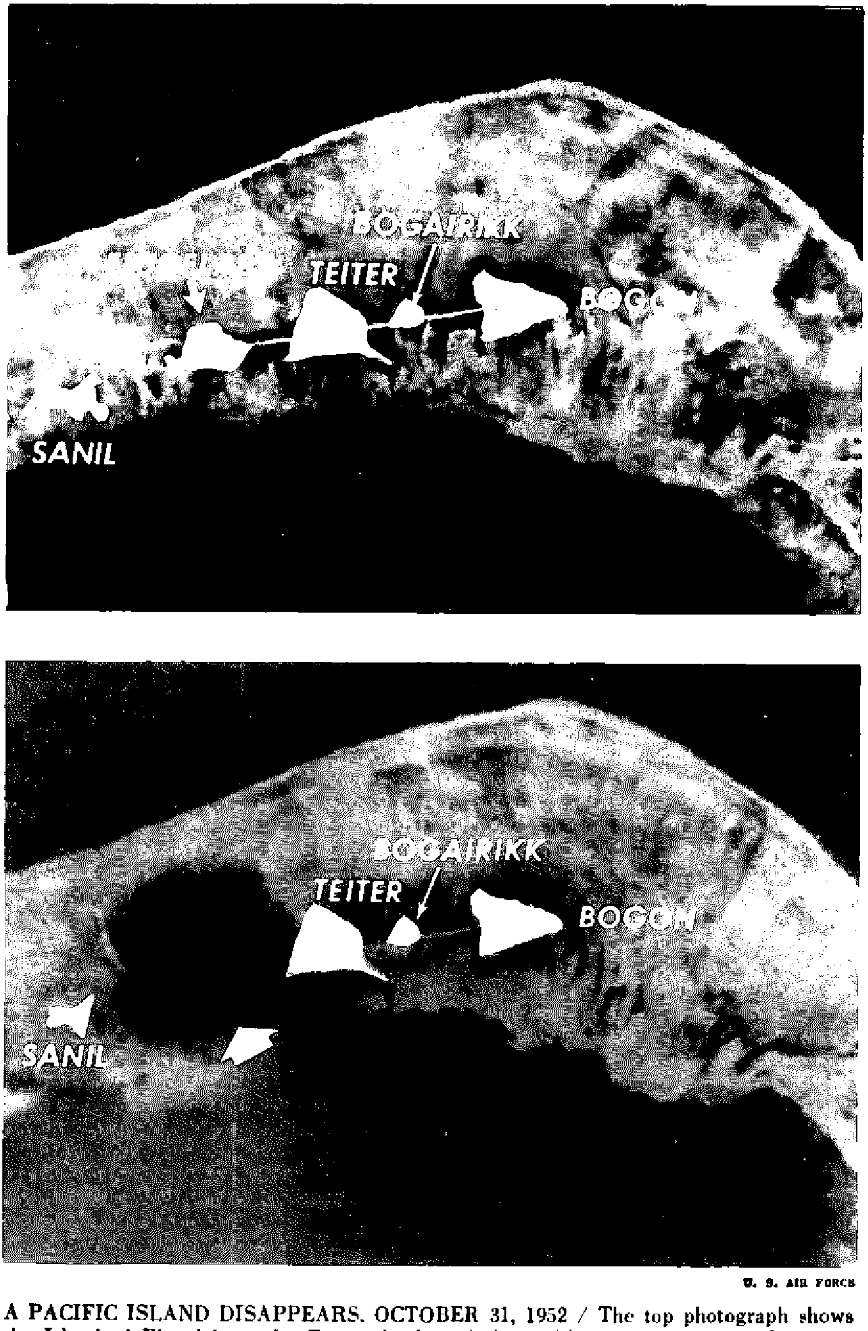
U. S. AIR FORCE

MIKE SHOT, OPERATION *IVY* / Some of the complex instrumentation for the first test of a thermonuclear device at Eniwetok in October, 1952. The large building at the end of the two-mile plywood tube housed the device.



UNITED PRESS INTERNATIONAL

A TEMPORARY HOME FOR MIKE / This structure at Eniwetok housed *Mike*, the first thermonuclear device, which was tested on October 31, 1952.



U. S. AIR FORCE

A PACIFIC ISLAND DISAPPEARS. OCTOBER 31, 1952 / The top photograph shows the Island of Elugelab in the Eniwetok chain before *Mike* was detonated. The lower photograph shows the crater, more than a mile in diameter, created by the first thermonuclear detonation.

reactor studies. The new policy, announced in January, 1951, limited the projects to surveys of existing reactor data. The Commission would clear a limited number of technical personnel and the companies would agree to submit a written report to the Commission. Only if the study projects indicated a feasible reactor design would the Commission consider financing further development. The public announcement brought additional proposals early in 1951 from the Commonwealth Edison Company of Chicago and jointly from the Bechtel Corporation and the Pacific Gas and Electric Company.[23]

Hafstad hoped the Commission would not commit itself too heavily to its own power-breeder projects until the industrial groups had surveyed the possibilities of private development. He had often pondered the ultimate conflict between the virtually unlimited military demands for fissionable material and the growing trend in Congressional hearings to conclude that the nation's expenditures for atomic energy were already large enough. The trouble was that the atomic energy industry was a tax-consuming rather than a tax-producing activity. As a Government monopoly, he thought, it was bound to be an anomaly in a basically free enterprise system. Hafstad had not forgotten discussing this subject six years earlier with Admiral William S. Parsons. The solution, they had concluded, was to build up a nuclear industry which could sustain itself in peacetime in energy production and which could readily turn to plutonium production in time of crisis. If the Commission could attain this goal, and it still seemed possible, there would be no need for plutonium-producing reactors at Hanford or Savannah River. Atomic energy would no longer be an anomaly in the American economy.[24]

REACTORS ON THE DESERT

Long-term planning was essential in reactor development, but the immediate future rested with reactors then under construction. Three of these, the experimental-breeder reactor, the materials testing reactor, and the submarine thermal reactor, were now taking shape at the reactor testing station in Idaho. Striking changes had occurred on the Idaho desert since June, 1949, when Leonard E. Johnston had set up the first Commission office in Idaho Falls. Perhaps because the Commission had not yet taken title to the old naval proving ground that made up most of the site, Johnston had hastened to establish a *fait accompli* by drilling wells and starting work on access roads. Even before Zinn had selected the Bechtel Corporation as the construction contractor for the breeder reactor, Johnston had hired a local firm to start digging foundations in November, 1949.[25]

An unusually severe winter stopped almost all work on the site for several months, but by spring Bechtel was making rapid progress on the building for the breeder reactor. The Fluor Corporation had been selected to build most of the materials testing reactor facility, and broke ground for the plant in May. The Mark I version of the submarine thermal reactor was still in the midst of design at Argonne and the Bettis Field plant, but the Rust Engineering Company had already chosen the site for the reactor halfway up the road from the central facilities to the materials testing reactor.

Construction progress slowed during the summer, not through any fault of the Idaho contractors but rather because construction was running ahead of blueprints. Both Argonne and Oak Ridge, even with the help of experienced architect-engineers, were discovering that building reactors was not an ordinary type of construction activity. So scarce were blueprints for the materials testing reactor in July, 1950, that Idaho gave up any hope of enclosing the main reactor building before winter set in.

Even harder hit was the experimental-breeder reactor. With relatively low priority, the project commanded less than a dozen members of the Argonne staff. What had started as a small reactor experiment at Argonne had suddenly become a substantial engineering enterprise. No one at Argonne was any longer naive enough to think that satisfactory reactor components could be procured by mailing out specifications to manufacturers. Leonard J. Koch, in charge of procuring components, found it necessary to check on specifications as the work progressed with companies across the country. Even then there were components the laboratory simply had to fabricate itself, often without the proper equipment or experienced technicians. The hard lessons learned on the breeder project would save time on both the testing and the submarine reactors.

By August, 1950, F. H. McGraw & Company had broken ground for the submarine reactor building. Bechtel, now far ahead of the blueprints on the breeder, was turning to construction of a chemical processing plant for the Idaho site. Originally intended for processing fuel elements from the materials testing reactor, the plant would now be employed to process uranium-235 fuel slugs used in the Hanford reactors to produce tritium. The need to recover the relatively large inventories of uranium 235 for weapons made construction of the chemical processing plant the first order of business at Idaho.

Despite some disappointments, progress by the end of 1950 had been impressive. For the breeder reactor only some large bellows valves and the main reactor tank were still on the critical list; Bechtel was confident the building would be ready for the reactor by the end of February, 1951. Construction of the materials testing reactor was beginning to gain momentum. The plant was only 12 per cent complete, but it was not too early to select the operating contractor. Largely for the talents of Richard L. Doan, formerly at the Metallurgical Laboratory, the Commission had selected the Phillips Petroleum Company. On the submarine reactor, McGraw was making good progress on the site, and Argonne and Westinghouse had agreed on the design of all components and systems for the reactor.

THE EXPERIMENTAL BREEDER

For the experimental breeder reactor, 1951 would be the critical year. Meyer Novick was the first of the Argonne staff to arrive in Idaho Falls with his family, in January, 1951. Harold V. Lichtenberger and seven others joined Novick in March and were ready to install the reactor when Bechtel finished the building on April 10. Work started first on the heat exchangers, pumps, and piping for the sodium-potassium system that would carry heat from the reactor to the small turbine. Then came the reactor tank and the thousands of internal parts. Final installation of the wiring, the calibration of instruments, and last-minute modifications proceeded in the fleeting weeks of the Idaho spring.[26]

Late in May Zinn arrived for the first attempt to reach criticality. This was to be a touchy, painstaking procedure. Unlike any previous reactor, the breeder would use uranium 235 as fuel. Only because the amount required was small and could be recovered quickly for weapons had the Commission permitted its use in the reactor. Lichtenberger had set up special facilities at Argonne for fabricating the uranium 235 into pencil-like rods and inserting them with a sodium-potassium bond into stainless-steel jackets. Unusual precautions were necessary to insure against any accidental assembly of a critical mass or against a fire in handling of the sodium-potassium alloy. Without the help of computers or any critical assembly of the reactor core, Zinn could really only guess at the number of rods needed to reach criticality. His best estimate was 40 kilograms of uranium 235, or 179 rods, but as a margin for error he had ordered 200.

The slow approach to critically began on May 29. After the crew had inserted thirty rods in the core, a neutron source was added and the safety rods withdrawn to check on neutron multiplication. From these data Zinn could begin to estimate the critical mass. Proceeding in ever smaller steps as he approached 40 kilograms on June 1, Zinn reluctantly concluded that criticality would require at least 52.5 kilograms. With all 201 rods inserted on June 2, the reactor was still not critical. Zinn estimated that he was 7 kilograms short, an agonizingly small error, but at least he could correct it without rebuilding the reactor core. He decided to add the necessary uranium by slightly increasing both the diameter and the length of some of the fuel rods. This decision required an additional authorization for uranium 235 from the Commission and refabrication of about fifty rods at Argonne.

Not until late August did Zinn have the necessary rods to resume operation. Following the same cautious procedure, Zinn at last brought the reactor just to the point of criticality on the twenty-first run on the afternoon of August 24, with a little more than 52 kilograms of uranium 235. During most of the autumn Lichtenberger and Novick operated the reactor at "zero" power while control and safety rods were calibrated, the negative temperature coefficient was measured, and fast-neutron experiments were started. Then came some low-power runs, further tests of the control system, and the construction of more concrete shielding around the reactor.

On a wintry morning five days before Christmas in 1951, Zinn had his staff gathered for what they hoped would be a historic experiment. For the first time they would attempt to produce electrical energy from nuclear power. Zinn first started the reactor and leveled off at low power. At 9:50 A.M. the reactor cooling system was connected and the sodium-potassium alloy started circulating through the reactor. Then Zinn increased the power to about 250 kilowatts, or just enough to turn over the steam turbine and the generator. Shortly before noon, Zinn shut off the turbine and raised the power to 340 kilowatts. Novick made a check of the power output and Zinn went up to 410 kilowatts. Now the chain reaction was producing significant amounts of heat in the "blanket" of natural uranium surrounding the core, where plutonium

breeding would occur. Fifteen more minutes of checking instruments and all was ready. Zinn ordered the resistance load connected to the generato . He recorded in the log book:

> 1:23—Load dissipator connected to generator.
> Electricity flows from atomic energy.
> Rough estimate indicates 45 kw.[27]

Purely as a scientific experiment the test run on December 20, 1951, was all that Zinn could ask or expect. The theories and techniques he and his team had built into the reactor had proved valid, and it would now be possible in sustained power runs to produce data on fast neutrons and particularly on the possibility of breeding. In this respect the generation of electric power was only incidental to the larger purposes of the experiment. For the scientist there was nothing new in generating electric power from heat; the generating system was simply a means for dissipating energy so that the reactor could operate at higher power levels.

The fact was, however, that the accomplishment on December 20 was more than a scientific experiment. It was a practical demonstration to the world that the atomic nucleus could serve mankind as a source of power. There was added significance in that a reactor designed to breed fissionable material had first produced power from the nucleus. For two years leaders of American industry had been intrigued with the idea of building a power breeder. Now they had Zinn's sparkling achievement to fire their enthusiasm.

RESEARCH IN THE SHADOW OF WAR

Commission support of the basic sciences continued and even grew during the national emergency created by the Korean war. As Zinn had told the

Congressmen at Argonne in March, 1950, even in an all-out crisis it did not speed results to put every scientist on applied research. For the most part, basic research in the national laboratories and the universities continued.

Only in a few special areas were scientists diverted to immediate tasks. On the suggestion of the General Advisory Committee, Pitzer asked the laboratories to help out in developing chemical processes for separating uranium from low-grade ores such as the Florida phosphates. Oak Ridge continued to devote a large part of its effort in chemistry to processes for recovering plutonium, uranium 238, and uranium 233 from reactor-irradiated materials. The new chemical processing plant at Idaho had been originally conceived as an experimental facility for reactor products, specifically uranium 235 canned in aluminum, but propulsion reactors for submarines and aircraft would require a variety of special processes at the "head-end" of the plant.[28]

In biology and medicine Warren continued to exercise his responsibilities for industrial health and safety and for providing technical assistance to the Federal Civil Defense Administration. With the increasing tempo of weapon testing, especially after the continental test site came into use in the *Ranger* series in 1951, the hazards of radioactive fallout took on increasing importance. In the spring of 1949, Nicholas N. Smith, Jr., at the Oak Ridge laboratory had undertaken a theoretical study of the number of fission weapons that would have to be detonated to cause serious damage to human populations through crop contamination. Smith decided that the most dangerous isotopes would be plutonium, strontium 90, and yttrium 90, which would fall out downwind from a fission detonation in an area of 350,000 square miles. Smith estimated that it would take three thousand such detonations in a single growing season to cause a serious hazard in the area; however, he acknowledged that scientists had only a fragmentary knowledge of strontium metabolism in the human body and that many more experimental data would be necessary for sound estimates.[29]

In the spring of 1951, after the *Ranger* tests, Boyer suggested the need for a reappraisal of Project *Gabriel*, as Smith's earlier study was now called. Warren suggested waiting until data from *Ranger* and *Greenhouse* were available. The result was that Smith did not complete his revised report until late November. His conclusions, based on recent fallout data, were that ten thousand nominal weapons (20,000 tons of TNT each) could be detonated without undue hazards from secondary effects. Warren organized a special committee of recognized experts in operations research, meteorology, soil technology, biology, and physics to examine the report. The committee agreed with Smith's conclusions about long-term effects, but the experts pointed to the potential hazards of heavy fallout near a nuclear detonation or even many hundreds of miles away if extensive precipitation should occur in the radioactive cloud. In short, fallout posed a definite potential danger, but not an immediate one in terms of existing weapon stockpiles or test plans. Apparently no one raised the question of genetic effects, which was to cause widespread controversy a few years later.

Military requirements had relatively little impact on the construction of major research facilities at the national laboratories. Although the Commission continued to defer Weinberg's request for a new research reactor at Oak Ridge, it readily approved construction of a new version of the CP-3 reactor at Argonne in May, 1951, when the old reactor at the Palos Park site showed signs of old age, mostly in the form of tank corrosion. The Brookhaven research reactor, completed in the summer of 1950, was at last becoming the focus of research in the eastern laboratory.[30]

Only at Berkeley did the national emergency have measurable effects on the construction of high-energy accelerators in the billion-electron-volt (bev) range. After completion of the quarter-scale model of the bevatron in the spring of 1949, Ernest O. Lawrence diverted most of his high-energy crew

to the materials testing accelerator. Thereafter only occasional work, often by young physicists waiting for security clearances, was possible on the bevatron. In May, 1951, Luis W. Alvarez told the General Advisory Committee that the magnet for one quadrant of the accelerator had been wound and that the linear accelerator which would serve as the injector was being assembled in the bevatron building. Major developmental work on the vacuum system was still necessary. Alvarez estimated that the war effort had already slowed down the bevatron by nine months, and further losses could be anticipated.[31]

The war had almost no effect on the development and construction of the Brookhaven cosmotron. Early in 1951 G. Kenneth Green devoted several weeks to designing a small 18-inch, high-current cyclotron for special neutron reaction measurements for the weapon program, but otherwise the Brookhaven staff could concentrate its efforts on the large machine. By the summer of 1950 the cosmotron building was virtually complete. Most of the 188 individual magnet blocks had been tested and were being assembled on the ring foundation. The large, hollow, water-cooled copper bars which would bring power to the magnet were being wound in special shops at Brookhaven and installed in the magnet. Green had supervised development of the power supply system, and John P. Blewett and his group were completing the design of a radio-frequency accelerator of a new type. One aspect of the design which had not received sufficient attention was the vacuum system, a feature of the cosmotron that required intensive effort throughout 1951. The chamber, about four feet wide and one foot high, had to sustain a very high vacuum, have very thin walls to conserve space in the magnet gap, and yet have good structural stability. The final design called for stainless-steel panels supported by tie-rods and sealed with a blanket of synthetic rubber.[32]

The long process of assembly and tune-up began in the fall of 1951 with completion of the magnet, power supply, Van de Graaff injector, and first section of the vacuum chamber. Testing and modification of the vacuum chamber to eliminate leaks and short circuits took many weeks, and not until early 1952 was Green ready to trace the beam through the first quadrant of the magnet. By March the Brookhaven group was able to follow the beam around the entire circle, an occasion that called for champagne, but many adjustments were still necessary to get up to significant power. On May 20, 1952, the cosmotron first attained the bev range, and after some further adjustments in the radio-frequency system reached 1.3 bev on June 10, the highest energy theoretically possible without energizing special pole-face windings on the magnets. This magnificent achievement more than justified the years of careful work. It would take the rest of 1952 to get up to full power and to make the machine available for experiments in high-energy physics, but successful operation now seemed assured.

BUILDING THE ACTINIDE SERIES

In some departments of the national laboratories basic research continued almost independent of international pressures. One example was the work by Glenn T. Seaborg's group at the Radiation Laboratory in Berkeley. The procedures which Seaborg's team had developed in the middle 1940's for producing and separating the actinide elements were the pattern for further research in transplutonium chemistry during the last years of the decade. The new elements americium and curium were to be the steppingstones to heavier members of the actinide family. Because of its long half-life, americium 241 seemed the most practical isotope of that element, but the intense alpha activity of curium 242 made that material extremely difficult to manipulate. Nelson Garden and his staff at Berkeley designed equipment for handling these materials safely. The production of these elements was a tedious process. The americium, created after long irradiation of plutonium in the Hanford reactors, had to be separated in milligram amounts; the americium could be irradiated to form curium, which could be separated in microgram quantities.

Even after sufficient quantities of the two elements were available, the efforts of Seaborg's group to find element 97 proved unsuccessful during 1948 and most of 1949. From its position in the actinide series, element 97 appeared capable of some oxidation above the +3 state in solutions. If this proved true, it would be possible to recover significant quantities of the new element.[33]

The greatest difficulty was predicting the properties of the undiscovered elements. Until Stanley G. Thompson and Albert Ghiorso could get some idea of the possible distribution of alpha energies of the new materials, it would be almost impossible to distinguish them from other actinides in the multichannel analyzer. Because the heavier elements were likely to be increasingly unstable, it was all the more important to be able to perform the separation and analysis quickly, before the element disintegrated. As Seaborg and his associates perfected their techniques and refined their estimates of the chemical and nuclear properties of 97, they came closer to their goal. Finally, on December 19, 1949, using a combination of the oxidation-reduction and ion-exchange processes, they identified an alpha emitter with a half-life of 4.6 hours. Further tests, showing that the decay products of the material were americium and curium, established its identity as element 97 by the middle of February, 1950. Seaborg and his group with reasonable confidence designated the isotope 97^{243}.

Immediately after the discovery of 97, Seaborg with Thompson, Ghiorso, and Kenneth Street, Jr., began looking for element 98 in small samples of curium 242 exposed to helium ions in the 60-inch cyclotron. The discovery of 97 helped to confirm earlier predictions that element 98 would not be susceptible to oxidation above the +3 state. From the properties of dysprosium, the lanthanide analogue of element 98, Thompson, Street, and

Seaborg were able to estimate the elution order of the new element. The alpha measurements on element 97 by Ghiorso also indicated that 98 would have a relatively high-energy alpha emission, which would be clearly distinctive among the heavier elements. The estimates proved correct, and the isotope was identified as 98^{244} on February 9, 1950.[34]

In naming the new pair of elements, Seaborg and his associates were at last forced to abandon the analogy to the lanthanides. They were able to claim that the name "berkelium" for element 97 was appropriate for its analogue, terbium, which was named for the Swedish town of Ytterby, where that element was first discovered. Finding no good analogue for dysprosium, they called element 98 "californium." The naming of two successive elements "berkelium" and "californium" prompted the *New Yorker* magazine to suggest that they had erred in not calling the elements "universitium" and "ofium" and reserving "berkelium" and "californium" fer elements 99 and 100. Seaborg's reply was that someone else might discover 99 and 100 and subvert the scheme by naming them "newium" and "yorkium." The Berkeley scientists had matched wits with the eastern editors. Moreover, their knowledge and experience would assure them a good chance of earning the right to name elements 99 and 100 when they were discovered.[35]

FROM X-RAYS TO GAMMA RAYS

During the same years Arnold H. Sparrow and his associates at Brookhaven were methodically pursuing their studies of radiation effects in plant genetics. After completing the initial X-ray experiments in the summer of 1948, they set about expanding the data they had collected on chromosome breaks induced by radiation. How could they explain the great variation in sensitivity from one stage of cell division to another? Perhaps, Sparrow reasoned, sensitivity was related to the amount of nucleic acid in the chromosomes at the time of irradiation. By the summer of 1949 Sparrow's group had prepared 6,000 slides from irradiated material and 1,200 from control plants. The additional data made possible some elaboration of the effects of radiation. Sparrow found that chromosome breakage alone was not the best measure of radiosensitivity; later studies took into account the extent to which the broken chromosomes rejoined to form rings or bridges. He also made allowance for spontaneous chromosome breakage, which could not be attributed to radiation.

Until spring of 1949 Sparrow did not have a convenient source of neutrons for his experiments. Although the research reactor at Brookhaven was virtually complete, certain inadequacies in design and construction had postponed operations almost indefinitely. But Sparrow had acquired a reliable and versatile source of gamma rays. From the Oak Ridge reactor he obtained a 20-curie source of the radioisotope cobalt 60. After constructing a simple device for raising the source in a vertical pipe from a shielded underground chamber, Sparrow could arrange plants for irradiation in concentric rings around the source. Since the amount of radiation varied inversely with the square of the distance from the source, Sparrow could expose the plants to almost any amount of radiation he desired. Furthermore, since the gamma source had a long half-life, the Brookhaven scientists could expose plants to almost constant radiation during an entire growing season. The source had to be lowered into the shielded cavity for only a few hours each day to tend the plants and check results.[36]

Sparrow and other biologists began using the gamma field in the spring of 1949 to study the effects of chronic radiation on common food plants like corn and potatoes. The gamma field also offered Sparrow new opportunities for experiments in cytology. For these he chose the spiderwort *Tradescantia paludosa*, a plant quite sensitive to gamma rays and easy to propagate. The large amount of data which biologists had collected on *Tradescantia* in earlier decades would provide good correlation for studies of radiation damage. Irradiation in the gamma field, first with the 20-curie source and in 1951 with a new 200-curie unit, produced results comparable with those obtained with *Trillium*. The experiments also helped to determine the amount of radiation necessary to kill the plants and the effect of radiation on undifferentiated cells.

By the end of 1951, Sparrow and his associates had amassed an impressive amount of data on radiation effects on the plant cell, but there were still vast areas of the unknown for them to explore. Measurements of nucleic acid content had failed to show any correlation with sensitivity, and the reasons for the great differences in sensitivity at the various stages of cell division were not yet clear. The fact that radiation did cause chromosome breakage suggested the importance of radiation in genetics, but no one yet knew enough to state that gene mutation occurred at the point of chromosome breakage. Research in radiation cytology was only beginning.[37]

RESEARCH IN JAPAN

The initial field studies of the effects of radiation on the Japanese population as a result of the wartime nuclear attacks had provided convincing evidence of the value of this research, and the Commission readily granted requests for additional funds from the field group, now called the Atomic Bomb Casualty Commission. From $450,000 in fiscal year 1948, expenditures were expected to rise to almost $1.4 million in 1949 and $1.9 million in 1950. Even then

there would not be enough money to build the control station at Sasebo. Temporary laboratories were completed at Hiroshima and Kure in October, 1948, and regular clinical examinations began at Hiroshima in March, 1949. By that time there were fifty Americans, a few Australians, and one hundred fifty Japanese working for the casualty commission in Japan. Financial pressures and the lack of Japanese interest in the control studies later caused abandonment of the Kure station, and most of the work was ultimately centered at Hiroshima.[38]

Results of the studies, however, were significant despite the shortage of funds. By the spring of 1950 the casualty commission had collected data on more than 150,000 persons in the bombed areas. These data revealed a small but marked increase in the incidence of leukemia and forty cases of eye cataracts caused by radiation among eight hundred persons within 3,000 feet of the detonation. The appearance of these effects almost five years after the bombings justified the earlier insistence on long-term studies. The genetics group had amassed data on 20,000 births, still only a fraction of the number needed for sound conclusions. But the important fact was that under Dr. James V. Neel's direction the group had gathered the priceless reference data on the first generation and preserved it in a form that would make possible increasingly valuable future studies in human genetics.[39]

The dislocations in Japan stemming from the Korean War and the impending termination of the American occupation raised questions during the summer of 1951 about the future of the casualty commission. The Atomic Energy Commission, discouraged by the failure of other Federal agencies to pick up some of the costs, proposed to cut expenditures to $1 million in fiscal year 1952 and to drop the project altogether in 1953. At first believing that operation at the reduced level was impossible, the National Academy of Sciences eventually accepted some proposals for streamlining the organization. A compromise agreement with the Commission assured the indefinite continuation of the project.[40]

OF MICE AND MEN

In the biomedical sciences, the first three years of Commission operations had done little to allay the concern of those who saw in the growing use of radiation new threats to the world of living things. To be sure, research at Commission laboratories was already revealing fascinating information about the processes of cell growth and metabolism, as Sparrow's work at Brookhaven illustrated. These fundamental studies had the advantage of analyzing relatively simple phenomena, which were easy to measure but difficult to extrapolate to man. Conversely, the Atomic Bomb Casualty Commission observed radiation effects directly in man, but the experiments were not reproducible and the compilation of results would take decades.

Fortunately, by 1950 preparations were well advanced for a major experiment which would strike a balance between basic studies in cytogenetics, with little direct application to man, and the long-term research going on in Japan. The project found its origins in Alexander Hollaender's efforts to bring new vitality to the moribund work in biology at the Clinton Laboratories. As director of the radiobiology laboratory at the National Institutes of Health in Bethesda, Maryland, Hollaender had over the preceding decade used radiation to probe the inner secrets of the living cell. In 1939, after studying the effects of ultraviolet radiation on fungi, he had suggested the possibility that the nucleic acids, and not the protein of the cell, carried the genetic information in reproduction. The extraordinary array of radiation sources available at the Clinton Laboratories attracted Hollaender's attention in 1946, and he went to Oak Ridge with the idea that he might be able to pick up the staff and equipment for a new Institute for Radiation Health in Bethesda.[41]

Hollaender's temporary assignment in Oak Ridge as an Institute employee turned into a career. Amid the futility and confusion at Clinton in the year after the war, Hollaender found the ingredients of a viable and promising research institution. In the old Y-12 area, where the racetracks for the electromagnetic process now stood silent, there were several large buildings which the Manhattan District had hastily constructed in 1945 for chemical extraction of uranium 235 but had never used. Carbide, now responsible for the Y-12 area, urged Hollaender to take the buildings off the company's hands. Before the end of 1946, Hollaender had decided to stay in Oak Ridge and had drafted a comprehensive research proposal for the new biology division of the Clinton Laboratories.

Hollaender's proposal reflected the thinking of most geneticists of the day. He intended to focus upon "the basic aspects of the effects of radiation on living cells." This meant relatively less attention to the wartime project of determining radiation tolerances for workers in atomic energy plants. Instead Hollaender would expand the study of cell constituents begun at Bethesda; undertake new studies of radiation effects in the chromosomes of the fruit fly *Drosophila* or the spiderwort *Tradescantia,* which were especially amenable to observation; and start work on what then seemed the most promising new frontier in genetics, the study of radiation effects in microorganisms.[42]

Beyond these logical extensions of existing research there emerged early in 1947 a daring challenge for the new biology division. By chance Hollaender learned that William L. Russell, an outstanding geneticist, was thinking of leaving the Jackson Memorial Laboratory at Bar Harbor, Maine, where he had been conducting some interesting genetic experiments with mice. Russell was convinced that his experiments, if pursued on a very large scale, would produce important data on the mutagenic effects of radiation. To propose genetic studies in a mammal, where the embryo took form in an

environment sealed off from the observer, was an ambitious undertaking, but if the effort were successful it would provide information much more relevant to man than that from *Drosophila* or *Tradescantia.*

The prospects of bringing Russell to Oak Ridge were interesting, but there was a real gamble involved in the mouse project. Even Russell could not deny the difficulties of genetic experiments in mammals. To provide reliable results, the project would have to be the largest mouse experiment ever undertaken. That would mean high costs, a considerable fraction of the division's budget. It might take ten years to get results. and a failure after that investment might well destroy all of Hollaender's plans for Oak Ridge. Many geneticists thought that the project was much too difficult and that they had already acquired all the essential data in experiments with *Drosophila.* Others saw the future of genetics in studies of microorganisms. Physicians like Shields Warren were impatient with basic studies of the mechanisms of genetics and wanted more work on the total manifestation of radiation effects with direct application to man.

Hollaender liked long shots and he believed in Russell's ability. He found added reason for confidence in discussions with Sewell Wright, Russell's mentor and professor of genetics at the University of Chicago. Herman J. Muller, the dean of American geneticists, was slower than Wright to appreciate the possibilities of Russell's proposal. but he too eventually gave his support. Hollaender persuaded Warren to give the project a chance and convinced Russell that Clinton had more the atmosphere of a university than an industrial research laboratory.[43]

When Russell arrived in Oak Ridge in November. 1947, the biology division was still housed in the old temporary structures near the X-10 research reactor. The buildings which Hollaender had acquired at Y-12 would need extensive modification. Before that work started, Russell had to design the cages, racks, and other equipment needed to accommodate tens of thousands of mice. From the outset, Russell understood that the unprecedented scale of his experiment would demand the ultimate in labor-saving devices. An automatic cage-washing machine was but one of the innovations which Russell and his group developed for their laboratory. Just as important was building up populations of mice in the proper strains for the main experiment. The disastrous fire at Bar Harbor in October, 1947, had destroyed the best source of supply and Russell had only three cages of mice in the strains he needed.[44]

The building at Y-12 was not ready for occupancy until early in 1949, and generation of the mouse population took still another year before the main experiment could begin. In the meantime, however, some valuable research was possible even with the limited stocks of mice. Russell's young wife, Liane, had come to Oak Ridge early in 1948 to complete her dissertation for a doctorate in genetics at the University of Chicago. Mrs. Russell had the interesting idea that she might be able to estimate the rate of mutations produced by radiation in the somatic cells of mice simply by measuring the area of splotches in the coats of offspring from irradiated mice. If she could irradiate the pregnant mouse at just that point in embryo development when the cells determining coat color were being formed, she reasoned that any mutations in somatic cells would be multiplied by cell division so that mutation of a single cell in the embryo would turn up in a gross pattern easily identified in the mature offspring. Her idea, although sound in theory, ran afoul of a practical difficulty. It was impossible to measure accurately the size of the splotches produced and thus she could not accurately determine the mutation rate.[45]

Despite this disappointment, Mrs. Russell's experiment led to some arresting if unexpected results. To produce changes in coat color, she had found it best to irradiate the female mice about 10¼ days after conception. Earlier studies by other geneticists had shown that a variety of abnormalities could be produced by irradiating mouse embryos, but Mrs. Russell's precision in controlling the time between conception and irradiation had revealed a strong correlation between the time factor and the kind of abnormality produced. Even with the limited number of mice available in 1948, she was able to see the outlines of the emerging pattern. Abnormalities in the eye and skull tended to occur in embryos irradiated on days 7½ to 9½ after conception; in extra digits at 8½ days; in the tail, from 9½ to 11½ days, in rib number, after 10½ days. Elaboration and refinement of these preliminary data in 1949 gave a much clearer picture of the effect of both the time and amount of irradiation in producing abnormalities.[46]

Important as these results were, the embryology experiments revealed a general pattern that had profound implications for humans. Mrs. Russell found that irradiation before the fertilized egg became implanted in the mouse uterus (before day 5½) resulted in a significant prenatal mortality, although the surviving offspring showed almost no abnormalities. The rate of prenatal mortality declined sharply after day 5½, but the number of abnormalities and neonatal deaths increased to even higher levels when irradiation was employed after that time. Translated to human embryo development, the most sensitive period was the second to the sixth week after conception, when many women would not be aware of their pregnancy. Even more alarming was Mrs. Russell's discovery that X-ray doses even as low as 50 roentgens, in the range of fluoroscopes commonly used in doctors' offices, produced a pronounced if slightly different pattern of abnormalities from those at 200 or 300 roentgens. Although initially there was some reluctance in the medical profession to accept the data from mouse experiments, Mrs. Russell's results did in time produce a change in medical practice.[47]

Meanwhile Russell had been preparing for the main genetic experiment. His aim was to measure mutation rates in certain genes located at specific points or "loci" in the mouse chromosome. Obviously he had to select genes determining characteristics which, after mutation, would be clearly evident in the offspring. Because most mutations would be from dominant to recessive, Russell needed a strain of mice possessing a number of these traits as recessives to the dominant character in the normative or "wild-type" mouse. The "laws" of heredity dictated that requirement. If, for example, "wild-type" males were mated to females containing recessives for the specific genes determining coat color, the first-generation offspring would have the dark coat color fixed by the dominant gene of the male. If, however, the males were first irradiated and a mutation occurred in this particular gene, both parents would have the recessive and the offspring would have the easily recognized light coat color.[48]

Russell had no trouble acquiring a good strain of "wild-type" mouse in 1948, but the strain possessing the required recessive traits did not even exist. From a small number of mice with six of the necessary recessives, he bred a new strain with a seventh, the maximum number he could follow without confusing his results. By early 1949, Russell had bred and tested the first mice containing all seven recessives. Now it was a matter of multiplying the stock to the number needed for the experiment.[49]

During 1950 while the colony was growing, Russell began some pilot tests with the few mice available in order to develop the most economical methods for the main experiment. From the earlier work with *Drosophila*, he did not expect to find mutations at the selected loci in the pilot tests. When at least six probable mutations appeared at four of the seven loci by the summer of 1950, Russell had some assurance that the main experiment would produce enough mutations to give a reliable indication of the induced rate. Preliminary results in the main experiment enabled Russell to report in the summer of 1951 that examination of over 48,000 mice, whose sires had been exposed to 600 roentgens of X-irradiation, showed more than fifty mutations at five of the seven loci. Among the almost 38,000 mice in the control experiment, in which no radiation was used, only two mutations at the specific loci had been found.[50]

From this evidence Russell had shown that radiation could cause genetic mutations in the mouse. By crossbreeding of about half the mutants he had proven that the changes indicated by external appearance were truly genetic. Russell was also beginning to get some data on the number of mutations at each locus and some indication of which mutations had lethal or semilethal effects. In interpreting the data for humans, Russell was careful to point out that his work involved only a very small number of loci in the mouse chromosome and that the only mutations he could detect were those with visible effects. Thus the data were best used not in extrapolation to man but in comparison with data on *Drosophila.* Even this comparison was difficult, but Russell estimated in 1951 that the mutation rate in the mouse was significantly higher than that in *Drosophila.*

If Russell's estimates were correct, data on *Drosophila* might no longer be acceptable for establishing radiation safety criteria for humans. Additional concern developed in 1952 when Russell found indications that larger doses of radiation did not seem to produce a proportionately larger number of mutations. It was much too early to draw any conclusions, but there was a possibility that the cells producing spermatozoa in the male differed in their sensitivity to mutation and that the more sensitive cells were more easily killed by radiation. The implications of this hypothesis for humans caused Russell to undertake a new experiment with doses of 300 roentgens, but it would take several years to produce reliable data.[51]

By the end of 1952 the Oak Ridge experiments in mouse genetics were beginning to provide information of potential value in determining the effects of radiation in man. A sound understanding of the mechanisms of radiation damage was still far in the future, but Russell and others had taken the essential first steps toward that goal.

PLUTONIUM, PROPULSION, AND POWER

Hafstad's plans for reactor development in 1951 clearly reflected the major demands which the national emergency had placed upon the Commission. First was the need for increasing amounts of fissionable material, which would require more reactor capacity for plutonium. Second were the requirements established by the Joint Chiefs of Staff for propulsion reactors for submarines and aircraft. Third, the national emergency had created a shortage of electric power in the United States. How the Commission, the military services, and American industry proposed to respond to these demands was the central theme in reactor development for the next several years.

The obvious advantage of a reactor which would meet more than one of these requirements had stimulated interest in power-breeder systems such as the homogeneous reactor which Weinberg was studying at Oak Ridge or the power breeder which Kingdon was hoping to build at the Knolls laboratory. But other combinations were also possible, as the story of the carrier reactor demonstrated.

Late in 1950 the Navy had asked the Joint Chiefs of Staff to establish a formal requirement for a reactor capable of powering a large naval vessel such as an aircraft carrier. With Argonne and Westinghouse already fully committed to the submarine reactor, Hafstad was reluctant to impose any additional burdens in the absence of a firm military requirement, on which the Joint Chiefs had deferred action in late 1950 pending further information from the Commission. By summer, however, developmental work on the Mark I reactor at Idaho was beginning to ease at Argonne and Bettis, and Hafstad agreed to let Westinghouse begin some paper studies of various reactor designs that might be suitable for a carrier. To make sure that the study did not interfere with work on the submarine reactor, Hafstad maintained direct control of the study in his own office under the veteran George L. Weil.[52]

The lure of propulsion and power was too great to allow a leisurely, methodical approach. The Navy took the first step to speed up the effort by assigning Captain Hyman G. Rickover the task of Navy liaison on the project. Then Commissioner Murray, disturbed by estimates from Weil that the paper studies would require as much as a year, urged Boyer to transfer the project to Rickover. Finally, in October, 1951, the Joint Chiefs approved a formal requirement for "a single shorebased prototype of a nuclear-powered propulsion unit suitable for driving one shaft of a major warship such as an aircraft carrier, and for use after completion of shore installation for the production of plutonium and electric power." What better justification for a reactor than that it meet all three of the Commission's goals? Another advantage of the Joint Chiefs' action was that it gave Westinghouse, a major supplier of electrical generating equipment, an opportunity to develop a power reactor under the aegis of a military requirement.[53]

It was not surprising under the circumstances that General Electric responded with a new proposal for the power breeder. Openly acknowledging the company's interest in power reactors, Henry V. Erben, General Electric's executive vice-president, wrote the Commission that the company considered the submarine intermediate reactor at West Milton an important first step toward a power breeder. Although its principal purpose was to develop a submarine propulsion plant, it would "greatly add to our knowledge of high temperature intermediate reactors." After completing the West Milton unit, General Electric proposed to build a much larger reactor which would produce power and some plutonium.

Erben's letter was but one of several expressions of General Electric's interest in plutonium and power reactors. Kingdon at the Knolls laboratory was still championing the power-breeder idea, and Harry A. Winne was interested in long-range development of a nuclear plant that would produce electric power at competitive costs without the benefit of plutonium credits. It was obvious to Gordon Dean that not all parts of the General Electric organization had the same interests, but by early 1952 a single company plan began to emerge. Rickover had alerted the company that its next assignment after the West Milton reactor would be a more powerful submarine propulsion system. This task the company would assign to the operating division at Knolls. The technical division under Kingdon would then be free to develop the power breeder.[54]

The separation of propulsion from the power and breeder functions of the reactor also occurred in the carrier project. In February, 1952, Westinghouse completed its survey of possible reactor designs for the carrier propulsion system. Westinghouse found five of the six reactor designs investigated suitable for the carrier. After studying the report, Rickover's group favored a design similar to the Mark I submarine. The reactor would use ordinary water as coolant and moderator, and slightly enriched uranium as fuel. Rickover was well enough satisfied with the design to terminate all further paper studies by Westinghouse. On March 6, 1952, the Commission transferred responsibility for the project from Weil to Rickover, and Westinghouse began development work. Although the reactor system might be capable of some power and plutonium production, its primary function was propulsion, as assignment to Rickover's naval reactors branch seemed to make clear.[55]

With propulsion reactors now assigned to the military services, Hafstad and the Commissioners could limit their planning to production of plutonium and power. Nothing had happened since the summer of 1951 to change Hafstad's opinion that the immediate goal had to be plutonium. Under the relentless pressures of increasing military requirements for weapons and the watchful eye of the Joint Committee, the Commission was again considering a major increase in the production of fissionable materials. The big question was whether it would be practical to develop dual-purpose reactors which would produce power as well as plutonium, or whether, in the interest of immediate additions to the stockpile, the Commission should concentrate on single-purpose plutonium producers.

Support for the plutonium-only position was impressive. The General Advisory Committee, meeting in Washington in December, 1951, had cast a jaundiced eye on the future for nuclear power. Oppenheimer saw no great need for the committee to revise the rather pessimistic appraisal it had released in 1948. The only change in the situation which Oppenheimer would concede was the large increase in the supply of uranium ore. This fact in itself did not bring competitive nuclear power any closer than before, but it did suggest a declining importance for breeders and eventually a much greater economic impact for nuclear power if all or most of the fissionable material in weapons could ultimately be used to generate electricity. Some members of the committee thought the United States should concentrate on plutonium and propulsion and leave power to the British.

Chauncey Starr, an experienced reactor physicist with North American Aviation, substantiated some of these opinions in a detailed technical analysis which he presented to the committee. Under a Commission contract, Starr's group had studied a variety of reactor designs to find the best one for short-term plutonium production. Minimum cost would be achieved in a single-purpose reactor using slightly enriched uranium as fuel. Starr admitted that the same reactor type would produce power as well as plutonium at a very attractive price, but breeding did not look attractive unless ore costs greatly increased or nuclear power costs declined.

There was some question of whether a new reactor capable of producing plutonium at much lower costs deserved a high priority in view of the large number of reactors then under construction, but after some discussion the advisory committee agreed with Hafstad that additional production reactors were probably inevitable, if only as replacement units. Hafstad argued that the development of power reactors with existing technology could safely be left to private industry. The Commission, in his opinion, should concentrate its efforts on the reactors of the future. For this purpose he was asking Zinn to form a task force at Argonne to select one design for a new group of production reactors. He had decided to establish a production reactor group in his own division and to do more work on evaluating reactor costs.[56]

Hafstad's confidence in private industry to develop power reactors stemmed from the initial reports of the four industrial study groups to which the Commission had offered classified information in the spring of 1951. The first report, submitted by Dow-Detroit Edison in December, 1951, found that atomic energy had an important potential for power production even if reactors were not yet economical for that purpose alone. Although they did not find that a specific design would be economically feasible, the two companies were interested in developing with the Commission a high-temperature, fast-breeder reactor. The other study groups had submitted interim reports early in 1952. Commonwealth Edison and the Public Service Company of Northern Illinois were interested in a helium-cooled graphite reactor of the Brookhaven type. Pacific Gas and Electric and the Bechtel Corporation were convinced that a dual-purpose reactor was feasible, and they were exploring arrangements under which private companies might lease reactors from the Commission. Monsanto and the Union Electric Company of Missouri were still investigating several reactor types. All the companies had expressed enthusiasm for further studies.[57]

Hafstad had examined all these possibilities before he presented his new proposal for production reactors to the Commission on March 27, 1952. The highest priority would go to improved designs for new reactors at Hanford and Savannah River. Next in order of priority would come more economical plutonium producers, a power-breeder using fast neutrons, a production reactor or breeder capable of economic power production, and a reactor for producing materials other than plutonium, such as uranium 233 or polonium. Under these priorities, Argonne would concentrate first on the new production reactors and then on the fast power breeder. Oak Ridge would study homogeneous systems, both in the short and long term. General Electric would finish the West Milton reactor and then turn to the fast plutonium breeder. Westinghouse would restrict its activities first to the submarine reactor and then to the carrier propulsion system. Hafstad would leave power reactors to private industry.[58]

The discussion revealed anything but a consensus in the Commission. A majority seemed anxious to avoid any commitment to build additional production reactors, but Murray favored more action on all fronts. He thought the highest priority should go to improvements in existing production reactors—those operating at Hanford and those under design for Savannah River. He feared that Hafstad's stress on dual-purpose reactors would slow down the development of plutonium producers. Dean countered Murray with the opinion that the Commission would never build another production reactor that would not also yield power. There was some feeling that Hafstad's statement of priorities could be clarified, but just what the priorities should be was not decided.[59]

Hafstad's efforts to reflect Commission opinion in revising his proposal were not particularly successful. A new version, which he submitted to the Commissioners on April 8, 1952, clearly recognized the paramount need to improve the current designs of new production reactors for Hanford and Savannah River. The plan also would "place the Commission in a position to construct" large-scale versions of production reactors, rather than "to develop and construct" them. Although they had lower priorities, the improved production reactor and the fast breeder were still prominent on the list.[60]

In discussing Hafstad's proposal on April 17, Murray left no doubt that he considered it unsatisfactory. He could not understand the high priority for a more economical plutonium producer; if the Commission needed more plutonium, it should build more graphite reactors. Dean was inclined to agree with Murray that the new production reactor design was of doubtful value, especially if it did not provide for power as well as plutonium. Glennan, anticipating a $10-billion expansion program in the next several years, thought it would be prudent to have a better design on hand. In a similar vein, Glennan supported Murray's contention that the Commission should put more effort on a reactor for producing uranium 233. Dean thought the Commission should have better data on the economics of uranium-233 production before starting reactor design.

As the discussion proceeded, Dean saw the possibilities for a compromise. If his colleagues saw little value in undertaking the design of an improved plutonium producer, Hafstad could revise his instructions to Zinn's Argonne task force. Under his existing mandate, Zinn was to produce a design for the new production reactor within a year. Why not, Dean asked, add a requirement for power production and give the laboratory more time? He was also willing to accept the idea of designing a uranium-233 producer.

Hafstad thought the revisions were feasible. Zinn, he guessed, would welcome some relaxation of the time schedule. The laboratory could probably handle both the plutonium and uranium-233 projects. Hafstad's only concern was that, by deleting construction as the goal, the Commission might be destroying the incentive for an all-out effort in the laboratories.

The Commissioners probably saw their action as placing more stress on short-term plutonium production. After all, they had given the highest priority to improving current designs and the performance of existing production reactors. For Hafstad, however, reactor development involved long-range plans, not short-term goals. In his view, the Commission's action gave a high priority in the long term for power reactors. The industrial study groups might well come up with some good ideas, but how could the Commission itself participate? An obvious possibility was the fast breeder which General Electric had been proposing for years. The disadvantage of that idea was that the company was having difficulty meeting its existing obligations to the Commission and hardly seemed prepared to take on new ones. A meeting with Erben, Winne, C. Guy Suits, and Kingdon on May 13, 1952, confirmed these reservations. On May 29, General Electric agreed to restrict its activities in reactor development to submarine propulsion.[61]

In a way General Electric's decision illustrated a more fundamental difficulty, which Weinberg had identified in a discussion with Hafstad. In Weinberg's opinion, it would always be harder to get money for long-term projects than for those aimed at pressing needs. Power reactors might in the long run be more important, but in the dangerous world of 1952 the preoccupation with propulsion and plutonium was not surprising. A telephone call to Zinn brought Hafstad no encouragement. Argonne had all the work it could handle. A new assignment to develop a power breeder would mean dropping something else, and Zinn had nothing but contempt for any idea of using a team of laboratories and industrial organizations to develop such a reactor.

Hafstad could not escape the unpleasant conclusion. Under the surface, particularly in American industry, there was a growing, even restless interest in nuclear power, but until the Commission met the requirements of national defense, it could not give the peaceful promise of atomic energy the attention it deserved.[62]

BUILDING REACTORS

Far from the policy papers and conference rooms of Washington the Commission's laboratories and industrial contractors were making steady progress in constructing and operating the reactors which had existed only on paper in the autumn of 1948. Two were already operating in Idaho. The experimental-breeder reactor continued to run at design power for extended periods in 1952 until a leak in a heat exchanger caused a temporary shutdown in June. While Novick was making repairs, Lichtenberger removed some of the fuel rods for analysis. In October the first results from Argonne suggested that the reactor would demonstrate the possibility of breeding.[63]

After almost six years of study and development, the materials testing reactor went critical on March 31, 1952. Long and careful training at Oak Ridge and in Idaho had prepared Richard Doan's team from the Phillips Petroleum Company to take over operation of the reactor from Marvin M. Mann and the Oak Ridge staff. Within a month the reactor was up to full power of 30,000 kilowatts and on August 5 began to fulfill its function as a testing reactor.

Not too far behind was the submarine thermal reactor, which was taking shape on the Idaho desert a few miles to the south. Within the large steel building, engineers had assembled a full-scale section of a submarine hull to be submerged in a tank of water. In the winter and spring of 1952 workmen from the Electric Boat Company installed the main turbine, the condenser, the reduction gear, and hundreds of other parts that would make up the engine room. In May the main pressure vessel for the Mark I reactor arrived for installation in the reactor compartment. Now with the highest priority in the Navy's submarine program, the project was moving at top speed. Two thousand miles to the east, at Groton, Connecticut, on June 14, President Truman laid the keel for the *Nautilus*, the world's first nuclear-powered submarine. During the Idaho summer Westinghouse engineers, working on two shifts and then around the clock on three, installed reactor systems and began leak tests. In the autumn the control drives and main coolant pumps arrived from Bettis. In November the reactor was complete except for the nuclear fuel and two heat exchangers. Barring unforeseen troubles, the nuclear propulsion plant for the submarine in the desert would soon come to life.[64]

At West Milton, New York, the huge spherical containment shell and auxiliary buildings for the second land prototype of a submarine reactor were well on the way toward completion by the end of 1952. Not authorized by the Commission until February, 1952, the project involved component testing at Knolls and contract negotiation until August, when foundations were poured. Erection of steel plates for the sphere proceeded rapidly during the autumn while General Electric coordinated the final design and fabrication of components for the submarine intermediate reactor Mark A. In November the Navy selected the name *Seawolf* for the submarine in which the Mark B reactor would be installed.[65]

The third Navy reactor, for an aircraft carrier, was in the early design stage at the Westinghouse Bettis laboratory in 1952. The Commission had authorized the project in March, and contract negotiations proceeded during the summer with Westinghouse, which would build the reactor, and with

Newport News Shipbuilding and Drydock Company for the shipboard features. Westinghouse already had a good technical base for the project in the work on the Mark I reactor at Idaho. Before the end of the year the company was already planning exponential experiments for the reactor and starting boiler design. During the summer the Navy had started looking for a site for the reactor, which Rickover hoped could be built somewhere near the Bettis laboratory rather than in Idaho. The carrier reactor was as yet little more than an idea, but under Rickover's drive and tight administration, the Commission and the Navy could expect rapid progress in the years ahead.[66]

The scope and variety of reactor development at Oak Ridge was a tribute to Weinberg's efforts to make the laboratory a national reactor center. In January, 1952, Weinberg's staff had completed the small homogeneous reactor experiment. Criticality came on April 15, followed by a series of zero-power tests during the spring. After several months of correcting minor faults, Weinberg was ready for high-power runs during the autumn. The reactor performed well until December, when a gasket leak caused a substantial loss of the liquid fuel. The question still remained whether difficulties with corrosion would ultimately overbalance the distinct advantages of the homogeneous system.

Aircraft nuclear propulsion was still a major concern at Oak Ridge despite the decision in the spring of 1951 to transfer most of the project to General Electric. Oak Ridge continued to test thermal convection loops for a liquid-cooled system even after the General Electric group under Miles Leverett decided to go back to the "direct cycle," in which air heated in the reactor passed directly to the turbines of the jet engines. In February, 1952, as the building for the aircraft reactor experiment neared completion at Oak Ridge, Weinberg switched the reactor design from one using a static to one using a circulating liquid fuel, a change reflecting his lack of confidence in General Electric's decision. Work proceeded during the summer at Oak Ridge on design of components for the small reactor experiment, but in terms of dollars and personnel most of the effort on aircraft nuclear propulsion was shifting to General Electric's plant at Lockland, Ohio, and to the northern end of the Idaho test site, where General Electric would build test facilities for the direct-cycle reactor.

The decision to develop alternate designs for the aircraft reactor and to build the extensive facilities at Idaho caused cost estimates to skyrocket in the spring of 1952. The Commission's share of the General Electric project was now running at $16 million per year, plus $33 million for construction of the Idaho facilities. As Commissioner Eugene M. Zuckert remarked in June, 1952, the split of responsibility between the Commission and the Air Force was permitting the project to get more funds than either agency alone would have allowed. Furthermore, keeping a rein on the enthusiasm of the Oak Ridge and Lockland groups probably would require the administrative fiber of a Rickover. Hafstad raised the question of leadership with Boyer and then with General Laurence C. Craigie of the Air Force in July, 1952. The best solution seemed to be a single liaison man like Rickover, and the best hope seemed to lie in General Donald J. Keirn, who had followed the project for the Air Force since 1946. Even if Craigie could get Keirn's services, the chances at this late date of establishing the kinds of controls Rickover had achieved in the Navy seemed small indeed.[67]

REACTORS FOR THE FUTURE

The Commission's tentative decisions on power and production reactors in April, 1952, gave Hafstad some of the guidance he needed to devise a new plan for all the Commission's reactor development activities. Further help came from the Argonne task force, which found in July that the design for the new "Jumbo" reactor at Hanford would provide plutonium at the minimum cost possible with proven technology. The task force expected to have a report on the Savannah River design early in 1953. These studies would help to determine what the Commission would need for plutonium production or what the future of power breeders might be. There were some indications both in Hafstad's planning and in the work of the industrial study groups that the dual-purpose reactor was no longer the solution for the nuclear power industry. The power reactor, in other words, would have to be competitive with conventional plants without the subsidy provided by plutonium credits. By the time the last of the four industrial groups submitted its report in the summer of 1952, industry's approach to nuclear power was much more sober and tentative than it had been when Charles A. Thomas had made his proposal in the spring of 1950.[68]

In thinking about the future, Hafstad could draw not only on the work of the industrial groups but also on many studies by the Commission's own contractors, including North American Aviation, MIT, Oak Ridge, H. K. Ferguson, and Knolls. The number of options had greatly increased and the distinctions between them had blurred since the Commission had adopted the four-reactor program in 1948. At that time only a few designs seemed ready for development and then only by the Commission's own laboratories. Now dozens of reactor designs were under consideration, and many of these were the result of industry studies. Although annual costs for reactor construction and operation had almost tripled, public interest in reactors, especially for power generation, had grown at an even greater rate. Hafstad would have to choose carefully to make the best use of his resources. By December, 1952, his choices were still only tentative. Construction of military propulsion reactors and improvement of production reactors would continue to receive high priority. For power generation, Hafstad was considering a full-scale reactor using pressurized water as moderator and coolant, to be developed in parallel with the carrier reactor; a sodium-cooled graphite-moderated reactor, which would generate power and test the possibilities of breeding uranium 233; and somewhat larger pilot-scale models of the breeder and homogeneous reactor experiments. The weeks between the presidential election and the beginning of the new Republican Administration in 1953 were no time to be making long-range policy on reactors. Perhaps when the time did come, a new set of conditions would prevail; in the meantime Hafstad's tentative plans would have to serve.[69]

A MOMENT FOR PERSPECTIVE

The increasing tempo of activities in the 1950's left those associated with the nation's atomic energy program little time for considering the long view. Perhaps more than ever before, the average work day for the Commissioners and senior staff involved spending a little less time on each of a larger number of matters. Agendas, whether for the Commissioners, the general manager's staff, or the General Advisory Committee, tended to get longer with each passing year. Yet in the spring of 1952 Oppenheimer and the committee had an unusual opportunity for viewing the atomic energy program in broad perspective. In July the last three of the charter members—Oppenheimer, Conant, and DuBridge—would retire. There had been talk for some time of a summary report to the President, and Conant raised the question specifically at the committee's meeting on April 27.[70]

It would have been no exaggeration for Conant to say that when he and Oppenheimer left the committee, much of its spirit and direction would go with them. Perhaps there would be some value, as Conant suggested, in summarizing what the committee had tried to do, what it had accomplished, and what it saw in the future. Most of the committee members accepted the idea, provided the report did not dwell too much on the past or appear to be a "whitewash" of either the Commission's or the committee's actions. Oppenheimer thought the committee might well describe what it had accomplished in helping to build the nuclear arsenal, and what the outlook was for nuclear power. Conant, remembering the committee's experience with the decision to accelerate development of the thermonuclear weapon, wanted the report to speak to the real difficulties the President faced in making decisions involving highly technical considerations. As a case in point, he thought the President should be made aware of the results of Project *Gabriel* on the number of nuclear weapons that could be detonated without causing a health hazard. The discussion ended with the suggestion that Oppenheimer prepare a draft for the June meeting.

During the following weeks Oppenheimer found time between other activities to work on the draft. DuBridge, Conant, and Oliver E. Buckley all provided ideas and portions of draft which Oppenheimer found useful. After some work, he concluded that two statements were necessary. The first, for public release, would attempt to explain how the committee had gone about its business during the previous six years, the kinds of decisions it had made, how problems were selected for consideration, and how the committee approached problems that were not strictly technical. The second report, for the President alone, would deal directly with the Commission's program and policy decisions.[71]

The reports were not the only concern on Oppenheimer's mind during those weeks. On May 16, Dean called him in Princeton to warn him of impending personal troubles. Dean would not elaborate on the telephone, but he told Oppenheimer the following week that the Justice Department was preparing to indict Joseph W. Weinberg, at one time a graduate student in physics at the University of California, Berkeley, for perjuring himself in testifying that he had never attended a meeting with Communists. The Government's case presumably rested on evidence of such meetings, one of which was allegedly held in Oppenheimer's Berkeley residence in 1941. Furthermore, Dean had heard reports that some scientists at the recent meeting of the American Physical Society in Washington had viciously attacked Oppenheimer on patriotic grounds. Dean was in frequent touch with McMahon, the Justice Department, and Oppenheimer's attorneys in an effort to keep Oppenheimer's name out of the Weinberg case, but he had no reason to believe he would be successful. Presumbly if the case could be delayed at least until Oppenheimer left the advisory committee, the press might spare Oppenheimer.[72]

On May 23 the Weinberg indictment hit the nation's headlines, but fortunately for Oppenheimer his name was not mentioned. Dean was still concerned and wanted to talk with Oppenheimer before the meeting of the General Advisory Committee in Washington on June 13. Oppenheimer offered to save Dean a trip to Princeton by coming to Washington a day before the meeting.[73]

When the committee met on Friday afternoon, June 13, Oppenheimer had drafts of both statements ready. After a brief discussion, the committee agreed to consider the reports at length that evening. Second drafts, prepared by Oppenheimer, Rabi, and von Neumann, were ready the following morning for further discussion, which lasted until noon. The final session was on Saturday evening with the Commissioners at Smyth's residence. The public statement won quick approval. Dean offered to include it in the Commission's semiannual report, which would be sent to Congress on July 1, and agreed that it might appropriately be published in *Science*.[74]

There were a few more changes in the letter to the President, but much of Oppenheimer's original remained. He began by referring to the "very great changes" that had occurred over the previous six years, mostly in the area of military affairs. Oppenheimer referred to the "many important and beautiful discoveries in basic science," some of which were made possible by Commission support; but he also noted, as Conant had suggested, that most of the developments in atomic energy still rested on basic discoveries made before World War II. The Commission's accomplishments in weapon production Oppenheimer indicated by citing figures on the size of the stockpile. The remarkable increase was, in Oppenheimer's words, "no mean technical achievement," one based on substantial discoveries of uranium ore, plant improvements, and better weapon design.

Looking to the future, Oppenheimer described the recent accomplishments in developing a thermonuclear weapon. What the final result would be depended upon actual tests. "Yet we think it very likely that the feasibility of weapons hundreds, and perhaps thousands of times more powerful than the first atomic bomb will be manifest within the next years." The extraordinary increase in fissionable material production not only guaranteed a large weapon stockpile but would also prove a great national resource for energy production if military requirements should disappear. In the absence of international control every major power would soon be able to possess nuclear weapons. "Thus atomic armament, which is now held to be the shield of the free world, may in a foreseeable time become the gravest threat to our welfare and security."

This fact, the committee believed, raised for the President the most serious problems of national and international policy. The difficulties of such decisions would be compounded by the complexities and rapidly changing nature of modern technology. The committee hoped that the Government could give more attention to methods of bringing scientific knowledge to bear on the great decisions of state.

The letter was an eloquent plea from one of the nation's most influential science advisers, now leaving a key government position, to a president soon to depart the government service. During their years in government the nation had felt the full impact of modern technology. Despite their mistakes, both the adviser and the president had helped the nation to find its place in the second half of the twentieth century. Whether atomic energy would be the shield of the free world or the scourge of mankind, others would have to decide.

QUEST FOR THE SUPER

CHAPTER 16

The summer of 1950 arrived with few questions about the hydrogen bomb answered. Los Alamos did not know how to fashion a Super. The Commission did not know how much its production facilities would have to be increased, how many reactors would be needed for plutonium or tritium, or how much new gaseous-diffusion capacity would be required for uranium 235. Some determination of the size of the expansion of the production complex would come through the Commission-Department of Defense report to President Truman on the scale of effort needed to provide materials for the hydrogen bomb. Whether the conclusion would satisfy the demands of the Joint Committee on Atomic Energy was problematical. Somehow, to achieve a thermonuclear bomb, materials and theory had to be brought together to reach a temperature higher than that in the sun.

A few days after summer solstice these questions took on sudden urgency when communist forces attacked South Korea. In Washington there was no way of knowing whether Korea was just the first step down the road to darkness. If it was, then Europe as well as Asia would be threatened.

THE ALARM

To meet the contingency of a world war, the Joint Chiefs of Staff moved to reinforce American power in the West. One measure they urged was to store nonnuclear components of atomic weapons in Britain. Then only the nuclear cores would have to be sent if the situation grew worse. Action now could save planes and time under conditions when both might be in short supply. On July 10, Robert LeBaron and the Military Liaison Committee discussed the Joint Chiefs' recommendation with the Commissioners. General Frank F.

Everest of the Air Force set forth the military advantages of the proposal and described precautions to guard the components. For a few moments the committee left the room so that Dean and his colleagues, along with a few members of the staff, could talk freely. The Commissioners agreed that the President should make the transfer. Although they could not judge the military factors, the reasoning underlying the request seemed persuasive. At noon the next day Truman saw Dean and Secretary Louis A. Johnson. In a brief meeting the President agreed to the transfer.[1] It must have seemed to Dean a natural action to bolster the nation's strength, and not unlike the steps taken during the Berlin crisis in 1948. Only nonnuclear components were involved so far but Dean wondered whether civilian custody had been breached.

In the face of the darkening news from Korea, Carleton Shugg reported to the Commission various ways of speeding production. Some of the ideas garnered from the staff dealt with technical improvements designed to increase plant output; others would make certain that fissionable material used in research and development projects could be recovered quickly for weapons. Remembering his wartime experiences with a shipbuilding company, Shugg was well aware that the future might bring shortages of equipment. He had asked the staff to keep in close touch with the National Security Resources Board and the Munitions Board, both of which handled priorities and allocations of scarce materials. Walter J. Williams had set the division of production to compiling lists of critical suppliers.

Another threat was the shortage of manpower which might result from a call-up of reservists. Oscar S. Smith, director of the office of labor relations, found that for 1949 the Commission and its contractors had employed about 3,500 reservists, about 8 per cent of the total employment in the atomic energy program, exclusive of construction labor. At certain locations the figure was even more disturbing: 69 per cent of the key personnel at Los Alamos were reservists.[2] No doubt the Commission could make a good case for retaining key staff; on the other hand the military services had to be certain they had personnel fully trained to handle atomic weapons.

Korea increased Brien McMahon's concern about the adequacy of the nation's atomic energy effort. On June 26, 1950, he asked Pike for the cost of increasing by 50 per cent the existing and planned production rates over the next few years. The Commission was still gathering data for a reply when Truman submitted a request to Congress on July 7 for a supplemental appropriation of $260 million for the Commission. McMahon announced his support of the request, but he also warned against any feeling of complacency. The sum was not large compared to total defense expenditures; indeed, he interpreted the amount as indicating that a hydrogen bomb program was not terribly expensive. From this deduction he drew the corollary that such an effort was well within the capability of the Soviet Union.[3]

Again McMahon turned to William L. Borden to provide the philosophical underpinning for a further expansion. Borden set down his ideas in three pages. He believed the Russians were moving with all the vigor, impetus, and confidence gained from their success in breaking the American nuclear monopoly. After the war, while the Americans had been drifting, the Russians had put large numbers of people into their program. To their own efforts the Russians could add the American secrets betrayed by Fuchs and others. Borden warned that the Americans had a long history of underestimating the Soviet Union. They had expected the regime to fall in 1917, to collapse in the turmoil between the wars, and to succumb to the Nazi attack. The Soviet detonation of 1949 was a grim warning not to err again.

Borden found the Commission response to the Soviet challenge too weak. What was needed was a second Hanford with three to five graphite reactors. Even if these were not the most advanced models, they alone could produce material for weapons within a comparatively short time. It was niggardly to look at expense: "If we act to increase our supply of atomic weapons and they turn out to be unnecessary, we may lose a few hundred million dollars. If we fail to produce these weapons and they do turn out to be necessary, we may lose our country." McMahon read the paper with approval. He wrote Dean that he would read it to the Joint Committee on July 21.[4]

The Military Liaison Committee was also pressing for expansion. On July 10, 1950, Shugg learned that the committee was thinking of proposing an increase of about two and a half times the existing capacity. Shugg turned to Edward J. Bloch for a measure of the economic impact of such an expansion. Bloch saw no difficulty in getting materials and equipment to complete the facilities then under construction, but he thought that the situation could change if military requirements forced the President to establish a priority system. The contingency against which Bloch warned occurred on July 19, when Truman asked Congress for authority to establish priorities and allocate materials. That evening over radio and television, Truman asked Congress for the powers to guide the flow of materials into essential uses; the Government would have to adopt measures to prevent inflation and national production had to be increased.[5]

Truman's request for control came at a time when Dean could show progress in the expansion of the Commission's production facilities. Richard W. Cook, the Commission's manager at Oak Ridge, could report in July that K-29 was scheduled for completion in mid-1951 and K-31 at the end of 1952. Together the two plants, added to the war-built K-25 and K-27, would more than double the gaseous-diffusion capacity. At Hanford, David F. Shaw, the Commission manager, reported that the DR waterworks were on schedule. If all went well, Shaw would have five graphite reactors in operation in early 1951.

In Washington Shugg could see progress in du Pont negotiations. Crawford H. Greenewalt had come down from Wilmington on July 20, 1950, and for an hour and a half had made, in Shugg's opinion, a superb presentation of the company's position. In brief, du Pont thought heavy-water reactors were feasible, and the dual-temperature process the best way to provide heavy water. In talking with Walter H. Zinn, the du Pont engineers had come away impressed with the amount and quality of the Argonne work. Greenewalt saw Zinn's group as the primary source of technical aid. Although North American Aviation lacked reactor experience, the engineering capability of the company was good and its support would be welcome. Greenewalt emphasized that du Pont intended to provide the economic inducement to assure top management personnel to the project.[6]

The next step was to brief the Joint Committee on production plans. To Shugg the tenor of the meeting on July 21 must have been easily predictable. Only two days earlier at a reactor subcommittee hearing he had heard Representative Henry M. Jackson demand urgency. The Congressman was present as McMahon led off by questioning the adequacy of the Commission's production plans for thermonuclear materials. Dean responded that until Los Alamos could say how much material was needed in one weapon, it was hard to define a production effort for a stockpile of weapons. The Commission was attempting to balance the uncertainties. One could enlarge the present production of tritium; but, Dean and LeBaron warned, such a course meant decreasing plutonium for weapons.

To Jackson, the argument reinforced his belief that the Commission should build up to use all the uranium available. McMahon referred to a committee report that there was enough uranium to fuel five new Hanford-type reactors for the next few years. When Dean repeated that heavy-water reactors were more efficient and furthermore that Hanford could not process the additional output, McMahon and Jackson were unmoved. From LeBaron they heard that the Military Liaison Committee had just completed a paper on the need for another major jump in production capacity. The basis for the increase lay in the possible tactical uses of atomic weapons, and for this purpose there seemed to be no limit to the military needs. McMahon was pleased to learn of the analysis. He promised a hearing with the Joint Chiefs of Staff to learn how they set their requirements. "We are really going to find out next week." [7]

The Joint Chiefs of Staff were continuing their efforts to strengthen the military position of the United States in the face of the Korean emergency. On Saturday evening, July 29, 1950, LeBaron telephoned Dean to alert him that the Joint Chiefs might ask for another transfer of nonnuclear components, this time for an advance base in the Pacific. To LeBaron's query, Dean replied that he had heard nothing on the matter from the White House.

On Sunday morning, LeBaron called again. General Omar N. Bradley thought some action might be needed over the weekend. Still Dean had no word from Truman. Shugg proposed releasing the components already in the hands of the military for training purposes. As a practical approach, the suggestion was good, but it was no solution to the need for Presidential approval. From James McCormack, Dean learned that at Sandia, General Robert M. Montague and Carroll L. Tyler were aware of the situation. At three o'clock in the afternoon, Kenneth D. Nichols called, but still Dean had heard nothing. Half an hour later the phone rang again. It was Secretary Johnson. Truman had been cruising on the Potomac and could not call Dean directly. Johnson hoped, however, that his assurance that the President had authorized the transfer would be accepted. Dean released the components. His had hardly been a comfortable position.[8]

McMahon was ready to discuss production expansion on August 2, 1950. As he glanced around the hearing room, he must have felt a deep sense of satisfaction. Across the table were the Secretary of Defense and the chairman of the Joint Chiefs of Staff. Nearly all of the committee were present; even Senator Richard B. Russell of Georgia made one of his rare appearances. From the House came such stalwarts as Chet Holifield, Melvin Price, Henry M. Jackson, W. Sterling Cole, and James E. Van Zandt.

After stating that the Commission estimated ore receipts would permit a doubling of present and planned production, McMahon drove to the heart of the issue. If the Joint Committee had any reason for existence, he declared, it was to make certain that atomic energy efforts were sufficient to defend the country. Secretary Johnson paid tribute to the committee for its understanding and to the Commission, which with Dean as chairman, was now fully cooperating with the Department of Defense. Occasionally as he spoke, Johnson asked that his remarks be kept off the record, but testimony which remained left no doubt of his position: The military considered the existing atomic energy effort too small. In his view, with which Bradley concurred, all raw material available should be processed for weapon production as soon as possible.[9]

Truman too, was convinced of the need to increase production. For some time, at least since mid-July, Truman had been considering reestablishing the special committee of the National Security Council to examine the matter. On August 8, he directed the Department of Defense and the Commission to prepare for the special committee a study of the scale and rate of effort required to increase the output of fissionable material in the immediate future. The study was to take into account the degree of mobilization in effect and the possibility of full mobilization. It was also to show the cost in facilities, manpower, and dollars. These were the areas the Department of Defense had begun to analyze.[10]

EXPANSION AGAIN

Of the members of the Joint Committee, McMahon and Jackson were the most vocal in urging expansion. On August 9, 1950, Jackson wrote to Secretary

Johnson, sending a copy to Dean, that anything short of doubling the authorized output would be detrimental to the United States. Going beyond this mark would be even better. If plant capacity outran the supply of uranium, the proper step was to increase ore procurement. McMahon had a heavy responsibility to see that the atomic energy program met the defense needs of the nation. It was a duty he welcomed. He asked Dean and Johnson on August 22 for their opinions on doubling the authorized production rate by 1954. He wanted their assurances that the program they were to recommend to the President would meet national requirements. For Dean he had more specific questions: What did the Commission think of building more graphite reactors at Hanford or elsewhere, of adding to the gaseous-diffusion capacity at Oak Ridge or elsewhere, of constructing more heavy-water reactors and linear accelerators, of restarting the Y-12 electromagnetic plant, and of increasing efforts to secure more raw material? [11]

The Commission staff met with the Military Liaison Committee on August 11 to set up the ground rules for the study which Truman had requested on the rate and scale of effort. They reviewed the tentative requirements set by the Joint Chiefs of Staff for 1954, an approach which Shugg thought was more realistic for defining production goals than setting an arbitrary percentage increase in nuclear material. Nonetheless, the staff agreed with the Military Liaison Committee on August 29 that preliminary planning for gaseous-diffusion expansion would be based on doubling the production of uranium 235.

Williams was averse to adding more capacity at Oak Ridge. Union Carbide had worked up plans for an installation which could be built at the Tennessee location or at another site and operated in close conjunction with the existing facilities. Williams pointed out that a new location would allow for future expansion should that prove necessary. Bloch reported that the National Security Resources Board was trying to find areas with power supply which, within the next year and a half, could meet the operating requirements.

As for reactor products, Williams, recently returned from Hanford, concluded that the site could accommodate another graphite reactor, but not within the eighteen months so often given as the construction period, unless other important projects were delayed. He still felt that heavy-water reactors were the best approach and he had already told du Pont that it might be asked to build four or five reactors instead of two.[12]

Shugg, acting general manager since Carroll L. Wilson's resignation in mid-August, tried to give the Commissioners on September 1 some perspective of the size of the endeavor. From current and pending appropriations, the Commission would have about $1.6 billion to operate the production plants and to construct authorized additions. The total scheduled expenditure for fiscal year 1951 was $883 million, a fantastic total in Shugg's opinion, since the amount exceeded the peak expenditures of the Manhattan project. The end was not yet in sight. Undoubtedly there would be more expansion; perhaps another billion dollars would be needed. Adding this amount to the $1.6 billion already anticipated gave him a total of $2.5 to $3 billion for operations and construction, compared to $2.2 billion for the wartime project.[13]

Expansion plans and Los Alamos reports lay before the General Advisory Committee as it assembled in Washington on September 10. From Williams the committee received no sense of a rationale for expansion save the need to build enough facilities to consume projected ore deliveries. The members could find no basis for the proposed ratio of plutonium and uranium production. They thought a better balance could be achieved by adding reactors. Kenneth S. Pitzer's presentation, advocating large-scale design and construction of the Berkeley materials accelerator, received a mixed reception. Some of the committee thought that the raw material estimates were not sound enough to show that a shortage of uranium was certain. Unless there were such a shortage, the accelerator would have no advantages over reactors. Others saw the project as a new and challenging approach by an enthusiastic and able group.

When Oppenheimer had planned the meeting, he realized that for Los Alamos the time might not be opportune for a formal report on the thermonuclear weapon, but he assured Norris E. Bradbury that even informal accounts would be helpful. Edward Teller and John A. Wheeler had submitted an analysis which, Bradbury had cautioned McCormack, was more an expression of individual views than a laboratory report. In their survey the two physicists had found a few areas of encouragement, but for the most part months of hard work had shown only more clearly the enormous difficulties blocking the way to success. Further calculations by Stanislaw M. Ulam, with Cornelius J. Everett's assistance, had not relieved the pessimism.

Enrico Fermi and Ulam were working on another part of the problem: how the fusion reaction would proceed in a volume of deuterium once ignition was achieved. There was little doubt that the reaction would die before most of the material was consumed. One continuing obstacle which Teller and Wheeler saw was the lack of qualified theoretical personnel. The advisory committee pondered over the information received, in the words of Oppenheimer, with "frustrated gratitude." [14]

The time for decision was approaching fast. Soon, Oppenheimer pointed out to Murray, du Pont had to know whether to design its reactors for plutonium or tritium. Soon Los Alamos had to be told how to divide its effort between fission weapon development and thermonuclear research. The lack of a basis for decision bothered Murray. Carefully he asked each member for an estimate of success in the quest for the thermonuclear weapon. By and large the answers were pessimistic. In contrast, the committee had found striking progress in fission weapon development. It might be possible to offer the military small weapons which would allow a greater choice of targets and means of delivery. The committee thought some of the advances might have the effect of doubling the atomic stockpile. The members warned that Los Alamos could not be allowed to let the preparations for testing thermonuclear principles in 1951 jeopardize work on fission weapons.

After the meeting Oppenheimer summarized the situation for Bradbury. The committee had tried to preserve the laboratory's freedom of action, but Bradbury had to understand that the Commission was pressing for answers. These had to come soon. The next meeting would be in October at Los Alamos. Some of the new members had been impressed by arguments for a new weapon laboratory. At Los Alamos they would be able to see the practical difficulties of such a step.[15]

Shortly before the General Advisory Committee met, the working group from the Commission and the Department of Defense had completed a draft of the report to the President. The group had started from the premise that the minimum production capacity and stockpile requirements established by the Department of Defense were about double those of the existing authorized programs. Later these requirements might even have to be increased. To meet the new goals, however, the Commission would have to expand its facilities so that that they would consume almost all the uranium ore available to the free world at a reasonable price. More specifically, a new gaseous-diffusion installation would be built at a site other than Oak Ridge and reactor capacity would be increased by raising the total of heavy-water reactors from two to five. Assuming quick approval and a vigorous procurement effort, the group believed that the additional gaseous-diffusion capacity could be achieved in November, 1953. The first of the reactors could be finished in January, 1953, with the remaining four coming into operation at four-month intervals. Over-all capital costs were estimated at $1.4 billion.[16]

Priorities were still an unanswered question. Joseph A. Volpe, Jr., recalling the experience of the Manhattan project in getting materials and equipment, thought it would be a mistake for the Commission to accept as sufficient the assurances from the military that the atomic energy effort would have at least as high priority as others in the defense program. In notifying Johnson on September 15 of the Commission's acceptance of the joint paper, Dean stated that the Commission would need top priority.

Within the Department of Defense, the three service secretaries approved the new expansion. General Frederick W. Timberlake of the Munitions Board gave his opinion to LeBaron that the requirements in manpower, steel, copper, and aluminum did not raise significant difficulties. Only in columbium, used in stainless steel, might there be a conflict. Timberlake had matched the requirements against NSC-68, a National Security Council paper resulting from Truman's directive to Dean G. Acheson and Johnson on January 31, 1950, to reexamine the national objectives in peace and war, and the effect on these aims of the Soviet nuclear capabilities demonstrated by the detonation of August, 1949.

Because the Commission had not seen the paper, Dean was reluctant to make a formal statement that the new expansion was consistent with NSC-68. However, from his own private knowledge of the document, he was confident that the program requirements were not out of line. It did not take long for Truman to act. He received the paper on October 2 and approved it on October 9.[17]

The next day Truman announced his trip to the Pacific to see MacArthur.[18] The war news was good. An amphibious assault at Inchon had suddenly reversed the military situation, and United Nations forces breaking out of the grim perimeter of Pusan joined in the pursuit of the shattered North Korean army over the 38th parallel. With MacArthur's brilliant success came the possibility of uniting Korea. For Secretary Johnson it was too late. In his efforts to carry out Truman's defense policies he had aroused strong opposition. The triumph that might have vindicated him must have had a taste of bitterness. Once again Truman had turned to George C. Marshall. As the nation's third Secretary of Defense, Marshall had entered upon his duties on September 21, 1950.

GLOOM AND THE SUPER

Progress on fission weapons was the first concern of the General Advisory Committee at Los Alamos in late October. Bradbury and Marshall G. Holloway, leader of the W division responsible for new weapon development, reported recent progress, but they admitted that tests in the spring were needed to confirm the laboratory advances. Oppenheimer thought Bradbury's plan sound for the next year and a half, although he did suggest more effort on fission weapons. Reducing the amount of material needed in a bomb would be the quickest way to increase the stockpile, because production from new plants would not come for years. Oppenheimer brushed aside Bradbury's comment that the stockpile directives showed no trace of this thinking. The laboratory could not expect to get detailed guidance on such complex matters from the military.

For much of the time, the committee considered the Super. During an inconclusive discussion of the underlying philosophy, Oppenheimer remarked that the military interest in large-yield weapons stemmed in part from the desire to compensate for errors in hitting the targets. Turning to the Super itself, the committee members heard Carson Mark summarize the calculations of Ulam and the ENIAC. From this account John von Neumann concluded that a thermonuclear reaction was possible, but not by the method which would be easiest to develop. Mark also presented the pessimistic findings of Fermi and Ulam, stressing that under the pressure of time the two men had made several assumptions to cover some of the uncertainties. Reducing the uncertainties, Teller argued, might change the results. Fermi admitted the possibility, but he countered that better data would probably only reinforce the appraisal. The lack of computers was a continuing hindrance. Mark thought that some of the most difficult questions would have to wait until well into the following year. Wheeler proposed various experimental verifications of key hypotheses and explained the test of thermonuclear principles planned for *Greenhouse* the next spring. Fermi was favorably impressed: "A test should have a probability of failure to be a good one."

Teller took the floor to summarize the Super. In his briefing he could offer little more than determination. He saw more theoretical work as essential. He thought Los Alamos lacked people to perform the detailed calculations and to carry on imaginative thinking. More than once he stressed how much there was to explore. He admitted to von Neumann that the practicality of the Super depended on the amount of tritium that might be needed and that the trend was unfavorable. He had no new ideas. In some way success

would be grasped—how, he did not know. Even the victory might be dangerous to Los Alamos. If the spring, 1951, test showed the Super impossible, Teller believed the laboratory was strong enough to continue its work, but if the reverse were true—if the test showed the Super was possible—the laboratory might not be strong enough to exploit the triumph.[19]

If nothing else, the Los Alamos meeting gave further evidence of the growing polarity of opinions on the Super. Teller held that boldness, imagination, and unremitting effort would win. Oppenheimer felt otherwise. Theoretical analyses showed that a thermonuclear reaction might be started, but that it would not propagate. Unenthusiastic about the Super, unwilling in a vain pursuit of the Super to squander skills that might increase fission-weapon efficiency, Oppenheimer and others feared the effort was aground upon the unyielding rock of natural phenomena. They saw no shrewd and clever tricks, no subtle scientific insights, around this harsh reality.

Oppenheimer could make his views felt. Not only was he chairman of the General Advisory Committee, but he had also been chosen to head an *ad hoc* panel to establish the military objectives in the use of atomic energy. He had been chairman of a similar panel in 1948. As LeBaron had told Dean on October 16, 1950, the first report needed revision. Although Oppenheimer was the obvious chairman for the new study, LeBaron was aware that some of those who followed the thermonuclear effort closely distrusted the physicist's attitude toward the Super. It was not inconceivable that Oppenheimer might use the report to check a further increase in the effort. By careful selection of the other panel members, LeBaron thought he could run the risk.

In its report on December 29, 1950, Oppenheimer's panel emphasized fission weapons. Citing Korea as grim evidence that limited wars were possible and believing that a general war with Russia could happen, the panel saw an important place for atomic weapons. Certainly atomic bombs would have a place in the larger struggle. They might also be used in smaller wars. Much depended upon time. If an all-out war came soon, victory might depend on the ability to use atomic weapons in several military situations. Fortunately the increasing mastery of weapon development by Los Alamos opened up that possibility, and the laboratory had to continue its effort to reduce the dimensions of fission weapons and to increase their efficiency. As for thermonuclear weapons, feasibility could not be established without more analysis. Perhaps there were ways through the difficulties, but none proposed so far seemed practicable or attractive. "In fact, we believe that only a timely recognition of the long-range character of the thermonuclear program will tend to make available for the basic studies of the fission weapon program the resources of Los Alamos Laboratory." After the Commission and the Military Liaison Committee made some minor changes the General Advisory Committee approved the report.[20]

PRODUCTION

Although Los Alamos might have seemed blocked in its thermonuclear quest, the effort to produce thermonuclear and fissionable materials was gaining momentum. Du Pont, with the help of the Corps of Engineers, had studied hundreds of locations for the new reactors, a task made easier by Truman's injunction to Dean to let political pressures play no part in the decision.

An area on the Savannah River, near Aiken, South Carolina, appeared favorable because the chemical composition of the river water was good and the climate promised a long construction season. Even though an advisory committee had confirmed the choice, the Commissioners were troubled. For a possible six reactors, du Pont recommended acquiring 240,000 acres, rather than the 160,000 acres originally planned. Moreover, three rural communities —Ellenton, Jackson, and Snelling—fell within the proposed boundaries. In November Smyth and Commissioner T. Keith Glennan had inspected the site. They believed that a slight shift in boundaries would save Ellenton, but du Pont justified the need for the area, and on November 28, the Commission announced its selection. The Commission appointed Curtis A. Nelson as local manager. Nelson, an engineer with broad construction experience, had been a colonel in the Manhattan project; as the Commission's liaison officer at Chalk River, he had gained familiarity with the Canadian heavy-water reactor technology.[21]

November saw the completion of the pilot plant for the dual-temperature process of heavy-water production. Because reactor development moved more swiftly, the Commission would have to speed up heavy-water production. Dean and his colleagues accepted a du Pont recommendation to add six dual-temperature production units to the pilot plant. If all went according to plan, the first unit would be completed in mid-1951, with others following at monthly intervals. Putting the six units at the Wabash ordnance works would strain the capacity of the local utility system, but probably no more so than would any other location. In recognition of the growing importance of the Wabash plant, the Commission in October had renamed its facility the Dana plant, and set up an area office reporting to Nelson.[22]

Progress in reactors could be matched by additions to gaseous-diffusion capacity. In November, 1950, the Commission approved constructing a new gaseous-diffusion plant near Paducah, Kentucky. The plant was to be built in two stages: C-31 was scheduled for completion in November, 1952, and C-33 in July, 1953. The Commission selected F. H. McGraw and Company as the construction contractor, despite Dean's fears that some of the Commission's critics would charge political influence because the company was located in McMahon's state of Connecticut. As the Paducah plant would operate closely with Oak Ridge, Carbide would manage both. Commission coordination would be assured by having Kenneth A. Dunbar, manager of the new Paducah area office, report to Samuel R. Sapirie, the Commission's manager of Oak Ridge operations. Sapirie could see in the Oak Ridge production reports in mid-December the effect of K-29, although the entire facility would not be completed until January, 1951, about five months ahead of schedule. K-31, however, would dwarf K-29. Authorized in November, 1950, K-31 was to be completed in December, 1951, and when it became fully operational, it would double the capacity of the K-25-K-29 complex.[23]

NATIONAL EMERGENCY

In late November, 1950, Chinese communists caught MacArthur's forces unprepared and forced them back through winter snows and biting winds that swept down from the rugged mountains. In New York the United Nations Security Council considered a resolution calling upon the Chinese to withdraw in exchange for promises that their frontier would be held inviolate and that United Nations forces would leave Korea once a unified, independent, and democratic government was established. At his press conference on November 30, Truman slowly read a statement acknowledging the seriousness of the Chinese intervention and the United Nations determination to resist aggression. He laid the paper aside to face a barrage of questions: What of general mobilization, of his relations with MacArthur, of criticisms in the European press on the conduct of the war? Truman said that the nation would take any necessary steps to meet the situation. Swiftly came the next question: "Will that include the atomic bomb?" "That includes every weapon we have," Truman replied.

Charles G. Ross, the press secretary, heard the President with dismay, knowing that the quick rejoinder was bound to have wide repercussions. Later that day Ross issued a clarifying statement. Any nation possessing atomic weapons would have to consider their use under certain circumstances but, Ross stressed, only the President could authorize American employment of them. This the President had not done. Hence, the remarks that morning represented no change in policy. The following day Truman sent a special message to Congress, asking for an additional $16.8 billion for defense and a little over $1 billion for the Atomic Energy Commission to produce more fissionable material and atomic weapons.[24]

To Western Europe, and Britain in particular, the Washington atmosphere seemed ominous and bellicose. Some members of Parliament addressed a letter to Prime Minister Clement R. Attlee, protesting the possible use of the bomb. Cheers echoed in the House chamber when Attlee announced he would fly to see Truman. On December 4, 1950, the Prime Minister and his party arrived in Washington and late that afternoon were driven to the White House. For an hour and a half they heard Marshall, Acheson, and Bradley present the American views. In this and succeeding meetings, conversations ranged widely over the risks and hazards of broadening the war, the role of Chiang Kai-shek, the future of Japan, and the defense needs of Britain. Truman was pleased that Attlee acknowledged the need to fight on in Korea. On certain matters, such as Chinese representation in the United Nations, they agreed to differ. Not until late in the conference did Attlee raise the question of the atomic bomb. Truman replied that there had been no change in American policy. For the public the two leaders agreed upon a few cautious words: "The President stated that it was his hope that world conditions would never call for the use of the atomic bomb. The President told the Prime Minister that it was also his desire to keep the Prime Minister informed of developments which might bring about a change in the situation." [25]

Attlee must have had some long thoughts as he departed. Almost five years earlier he had come to Washington to discuss atomic energy with Truman and Mackenzie King. Then Attlee had been interested in preserving the special relationship that Churchill had established with Roosevelt. Subsequent events had been disillusioning. His letter of June 7, 1946, to Truman on atomic energy had long gone unanswered; the promise of the *modus vivendi* was largely unfulfilled. From Truman's statement Attlee could conclude that the Americans would not use the bomb without informing the British. "Inform" was not the same as "consent," the term which Roosevelt and Churchill had used to describe the obligations between their two nations, but Attlee could rightfully claim that on the use of the atomic bomb he had taken a big step toward resuming the partnership.

The Attlee conversations revealed no fundamental cleavage between the United States and Great Britain, a calm and reassuring note among the flood of bad news from Korea. Even before Attlee had departed, Truman had begun his preparations to proclaim a national emergency. In one meeting after another in mid-December, Truman talked with cabinet members, Congressional leaders, and the heads of the main Government agencies to explain his plans and to gain support. Dean attended the meeting of December 14. From the White House he returned to his office and talked with Marion W. Boyer, the new general manager, on the effect the proclamation might have on the atomic energy program. Neither foresaw any great impact. Boyer thought Los Alamos might receive a psychological lift and perhaps the rest of the program might gain a similar benefit, but in his opinion events had forced the Commission into an expanded effort before the latest developments in Korea. There was little, under the present circumstances, which Boyer could suggest.

Two days later, the President issued the proclamation, framed in the traditional sonorous phrasing, "Whereas recent events in Korea and elsewhere constitute a grave threat to the peace of the world . . . I summon our farmers, our workers in industry, and our businessmen to make a mighty production effort to meet the defense requirements of the nation. . . ." [26]

Korea gave further impetus to McMahon and Jackson in their drive to increase the size of the atomic energy program. Both men wanted more graphite reactors. McMahon urged building more than one production accelerator, placing more emphasis on making the fissionable material uranium 233 from thorium, and making greater efforts to develop processes for treating low-grade ore.

A few days from the close of 1950, Dean set forth again the Commission position to McMahon: To meet danger in the near future, increasing production from the Hanford reactors was a better solution than new graphite reactors; another 350-mev accelerator was premature until the Mark I had proved itself; the Commission was doing all it could on thorium and processing low-grade ore.[27] It was a balanced and logical reply, but hardly the stuff to calm McMahon.

The need for an additional Hanford reactor was still a live issue. When Williams briefed the General Advisory Committee on Friday, January 5, 1951, he found the members reaffirming their earlier recommendation for increasing the plutonium-uranium ratio by building an additional graphite reactor. On Tuesday, Williams ordered David F. Shaw at Hanford to ask General Electric for a schedule and an estimate of manpower, costs, and materials for a reactor to be located about two and a half miles from an existing unit. Shaw and General Electric already had plenty of data from earlier studies. If a new reactor were built as a twin of an existing unit, operation could be expected about twenty months after authorization. The same reactor, but located in a new Hanford area, could be built within the same time, but at greater costs and labor. Williams presented the estimates to the Commissioners on January 22. He favored building a twin reactor of the most advanced design, a task he thought could be completed in less than twenty months. The Commissioners gave their approval, and the next day Williams wired Shaw to begin work on the sixth Hanford reactor, to be known as "C." [28]

The impact of Korea could also be seen in the preparations during January for the first atomic tests held in the United States since the Trinity detonation in 1945. The advantages of a continental test site had long been obvious, but as Pike had remarked in March, 1949, only a national emergency could justify testing within the United States. Korea had fulfilled that condition. Shortly after the outbreak of fighting, Dean had proposed that the Commission and the Department of Defense search for a continental test site. In October, 1950, the two agencies had recommended an underground test at Amchitka Island in the Aleutians in the late fall of 1951. Although Truman had given his approval, there was still the need for a more convenient site and the search continued. On December 14, 1950, the special committee recommended the Las Vegas bombing and gunnery range.

The selection of the Nevada site to carry out the *Ranger* weapon tests had the hearty approval of the General Advisory Committee. The range seemed a good choice for the test series needed to verify some of the Los Alamos improvements in fission weapons. But differences had arisen in Washington over issuing a public announcement of the coming tests. Secretary of Defense Marshall and his deputy, Robert A. Lovett, thought it unwise in the tense international situation to reveal that the United States had small nuclear weapons. Truman overruled the defense officials, and on January 11, 1951, the Commission released a statement. Dean flew to the test site on January 31 and returned on February 2. Three days later he saw Truman to report that the tests had been successful.[29] In fission weapons, at least, there was progress.

THE POSSIBILITY

For much of the nation, 1950 ended somberly, and the future seemed ominous, foreboding, and uncertain. On its isolated mesa, Los Alamos was prey to its own anxieties. The laboratory had accomplished much during the last year, and those working on fission weapons could look with anticipation to the *Ranger* tests at Nevada.

To others, involved in the quest for the hydrogen bomb, the outlook seemed bleak. Ulam's superb mathematical analysis was confirmed by computer. His feat had been a remarkable accomplishment, but it had not disclosed a new line of advance. January began with long debates which sometimes boiled over into angry recriminations among those of the T division and staff who had to decide the next step. At Cornell, Hans A. Bethe could sense the tension in correspondence and conversations. Nothing had changed his dislike of the Super but, as he wrote Teller, he worked honestly on the effort, making no attempt to suppress good or bad results. Bethe thought that the differences separating him from Teller were narrow, and he saw as a valuable adjunct to his own role the part of an assayer of Teller's ideas.[30]

From Washington Dean viewed the Los Alamos scene with growing perplexity. He had information describing tension between Teller, Wheeler, and von Neumann on the one hand, and Bradbury, John H. Manley, and Holloway on the other. The schism was not only between those who urged a more vigorous assault instead of a more measured approach to the hydrogen bomb. It also divided those who were largely outside the laboratory hierarchy and those who as regular members of the staff had performed so effectively in the critical period after the war when Los Alamos was finding itself. In early February, Dean learned that Teller was in Washington, marshalling support for his own views. Wheeler was about to abandon Los Alamos for Princeton where, as Dean understood the plan, he would organize a group to work with the Princeton computer. This move Bradbury apparently opposed on the belief that Wheeler's task would consume a year and would weaken the effort at Los Alamos.

Dean heard too a charge that Oppenheimer had effectively dampened enthusiasm over the Super, and would rather see Los Alamos follow a more deliberate approach. Dean confided to his diary: "I do not know the answer to this one, but we will have to find one, no matter how unpleasant the results may be." And finally, Dean learned that Los Alamos had not completed all the "most fundamental calculations" on the fusion reaction. On February 9, he received Lewis L. Strauss and in the privacy of his office listened to the former Commissioner read a long memorandum advocating more effort on the Super. Dean was disturbed that Strauss chose to throw his memorandum into the fireplace rather than leave a copy behind. Dean was also troubled to learn a little later that Strauss was thinking of taking the matter to the White House.[31] The pressures on Dean were enormous, but those fighting for the Super had no choice. Lacking any convincing evidence that a Super could be built, they could but struggle for time, hoping that with each day gained, Teller and his group would find a way.

To Teller and Strauss, for the United States to be first with the hydrogen bomb was worth almost any price. Their thoughts were focused mainly on the Super, for theoretically there was no upper limit to the yield, a possibility which attracted some physicists and repelled others. The Super was, however, only the leading candidate of several proposed thermonuclear weapons. This fact Bradbury had recognized in early 1950 when he asked Teller to head a "family committee" and coordinate the laboratory's thermonuclear work. Within the committee and the T division, ideas flowed from one group of physicists and mathematicians to another.

In this atmosphere, sometimes abrasive but always stimulating, Ulam suddenly saw a path through the obstacles. On February 23 he penned a letter to von Neumann. After a prosaic opening paragraph on hopes for an early meeting with the Princeton mathematician, Ulam continued, "Had the following couple of thoughts (ideas) about bombs. . . ." He needed only a few sentences to sketch a scheme which could be applied to several members of the thermonuclear family, even the Super. He had mentioned his idea to Teller: "Edward is full of enthusiasm about these possibilities; this is perhaps an indication they will not work." [32]

Teller was indeed enthusiastic. He listened to Ulam describe a particular approach to apply his idea. Teller's mind raced over the possibilities. He rejected Ulam's approach as posing enormous technical difficulties. He had a scheme of his own, based partly on the nuclear mechanics which were to be used at the *Greenhouse* test of thermonuclear principles. In March Teller and Ulam completed a joint report in which each presented his own scheme to achieve the conditions which Ulam had suggested.[33]

Within a new framework scattered ideas began to assume a pattern of promise, but whether these new hopes would have more substance than the old could not be determined until intense analysis had charted areas of unknowns and devised means to explore them. Much more work was needed to see whether the new member of the thermonuclear family would survive. Consequently the meeting of the General Advisory Committee at Argonne in March, 1951, was largely a continuation of the same refrain heard earlier. Willard F. Libby again urged a large experimental program of hundreds of people to hasten the development of the Super. The other members still saw no value to a large-scale effort without more theoretical data.[34] The arguments were stale and weary. In mid-March of 1951 they could not be anything else.

CUSTODY—THE BREACH

Whether, in the stream of events that flowed through 1950, Dean ever stopped to compare his circumstances as chairman with those of Lilienthal cannot be known. Of all the Commission battles which Lilienthal fought, probably the one he believed most important was over the civilian custody of nuclear weapons. Although Lilienthal had won his case before Truman, the issue of civilian custody continued.

In March, 1950, McCormack had raised with the Commission the question of asking the President to approve the transfer of nonnuclear weapon components to the military. Arguments for the transfer were based on the growing military competence to maintain the components and relieve the Commission of part of its custodial burden. Since the Commission would continue to control the nuclear components, civilian custody would still be maintained. Pike and Dean had demurred, believing that Truman had not made his 1948 decision on technical grounds, and that to reopen the matter with such arguments was unwise. Nonetheless, the Commissioners had decided to seek the advice of Bradbury and Los Alamos. Dean did not like the idea of transferring the nonnuclear components. He believed that to do so was to reduce civilian control to a fiction.[35] Dean could not have received much comfort from the casual manner in which Truman had arranged to release a number of nonnuclear components to the military in the summer of 1950 and had informed the Commission only after the fact.

During the dark days in the fall of 1950, the question of the use of atomic weapons came up before the special working group of Commission and Defense officials. Dean read an agenda for a meeting of the group which Captain James S. Russell, the Navy deputy in the division of military application, was to attend. Among the items was a list of State Department questions about procedures for obtaining Presidential permission to use an atomic weapon. Of the fifteen points, Dean was particularly interested in what effect the use of the atomic bomb would have on public opinion—in the United States, allied countries, and Asia and whether the United States should receive the prior concurrence of the United Nations. From Russell's report of the next day, Dean learned that if the Joint Chiefs of Staff recommended using an atomic bomb at a given place, the Secretaries of State and Defense and the chairman of the Atomic Energy Commission would advise the President. Dean was satisfied. This procedure would assure Commission participation.[36]

Dean clearly saw that the custody issue and the procedures used to make the Commission's voice heard were both aspects of civilian control. Both facets were relevant in the spring of 1951. A few months after taking office as Secretary of Defense, Marshall had established procedures by which he would funnel requests for atomic weapons to the special committee of three agency heads. On April 5, 1951, Dean learned that the Joint Chiefs were about to request the transfer of a limited number of complete atomic weapons. He immediately alerted his colleagues. That afternoon he set down his views on the salient issue of civilian and military control.

Dean was concerned lest the Commission, without sufficient thought, drift into a position from which it could no longer exercise its responsibility as the civilian custodian of atomic energy. Not only did the Commission have the best understanding of weapon effects and technical problems, but the moral and psychological implications inherent in the use of atomic weapons needed more than military consideration. From the legislative history of the Act, Dean did not draw the conclusion that the civilian interest in atomic weapons terminated at their transfer. He saw two Commission responsibilities: readiness to transfer weapons to the military as soon as the President gave his approval, and safeguarding of the country against wasteful or unwise expenditure of fissionable material.[37] In this latter role Dean saw the Commission's responsibility for safeguards as transcending custody.

Uncertain of Truman's intentions, Dean telephoned James S. Lay at the White House to ask whether the Commission and the State Department would see the Joint Chiefs' recommendation. At Truman's request, Dean went to the White House on the afternoon of April 6. He found that the President had decided to sign the memorandum prepared by General Vandenberg of the Air Force requesting transfer of a number of nuclear and nonnuclear components. As Truman talked, however, Dean began to see that the President was willing to have the Commission and State Department participate in any decision to use nuclear weapons. Dean returned to his office and worked out the means to implement the transfer. Looking back on the day, Dean realized its importance. The President's action, "marked the end of the Commission's civilian responsibility over a portion of our war reserve." [38]

Just how the President would receive civilian advice before deciding to use nuclear weapons was still an open question. After a meeting with Acheson and Marshall on April 16 to set up the ground rules for such a study, Dean asked Glennan to serve as the Commission member of the working group. By April 27, the group had finished its task. It had seen its job as outlining procedures under which the President could most effectively obtain advice whenever he might be called upon to decide under what circumstances atomic weapons should be used. It was a baffling assignment and difficult to grasp. Certainly the recommendation to employ atomic weapons would come from the Joint Chiefs, but it was impossible to predict what the circumstances might be. The more time the President had, the more civilian sources he should consult. In an extreme emergency the President might have little time. Even so, he should seek the advice of at least the Secretary of Defense, the Secretary of State, and the chairman of the Atomic Energy Commission—the members of the special committee.[39]

The Commissioners approved the report on May 1, but the action was not decisive, as the Joint Chiefs subsequently took the position that no agency had the right to interpose itself between them and the President on matters touching military operations.[40] Because the President had ultimate authority in such matters, the Joint Chiefs' position in a strict sense did not violate the principle of civilian supremacy in the Government. But that position did raise questions about the mechanism, if not the principle, of civilian control. With their responsibilities under the Act, with the technical information they had acquired on atomic weapons, how could the Commissioners make their views known most effectively to the President?

TENSION AT LOS ALAMOS

As the time drew near for the *Greenhouse* tests, scheduled for late April and early May, 1951, an increasing amount of the Los Alamos effort went into the preparations. There would be more than one shot, but most crucial for the thermonuclear work was the test of fusion principles. Success would give experimental proof of theory. Failure would mean a severe setback, perhaps even the abandonment of the quest for a thermonuclear bomb. Teller and his coadjutor, Frederic de Hoffmann, watched the preparations tensely. They wondered whether the test of thermonuclear principles was not premature. In their view some of the basic calculations were hurried and incomplete. Teller's dissatisfaction with Los Alamos erupted again when Bradbury on March 6 distributed plans for reorganizing the laboratory.

From the replies Bradbury had a good cross-section of the opinions among his division leaders. Mark wanted more data and that meant more personnel. Darol K. Froman shrewdly warned that Los Alamos was politically vulnerable, since many people outside the laboratory thought its sole aim was to devise a thermonuclear weapon. Of course this contention was not true, and Froman thought some reorganization and some definite goals might relieve the pressure. He saw enough areas needing investigation to base a laboratory program on, even if it was still too early to plan a thermonuclear test after

Greenhouse. Because Ulam was not directly involved in organizational matters, he confined himself to technical affairs. Certainly the feasibility of the Super had to be settled once and for all; if the MANIAC were operating by summer the answer should be ready in the fall. For the other approaches on the thermonuclear weapon, he saw years of work. The idea that he and Teller had set forth in their March report would require much theoretical effort. Perhaps years might be needed to evaluate the approach. Some small-scale experimental work could provide data, but even so, Ulam foresaw a long future of hard analysis.

Teller's reaction to Bradbury's proposal was forthright and critical. Much of the present laboratory effort had gone into preparations for *Greenhouse*, leaving little time for thermonuclear research. As long as the program was a part-time project directed by a committee, Teller could see no chance for success.[41]

Establishing a separate division for thermonuclear research was the obvious rejoinder to Teller's charges that Los Alamos was ineffectual in this area. Froman found the idea of a new division to raise more problems than it solved. It would be hard to define the tasks and to reassign personnel without damaging morale. In details the present organization could be improved, but it was important to maintain the flexibility of calling upon the various divisions for their special resources. Lothar W. Nordheim believed that a new division would cause delay, and suggested a task force led by some prominent physicists.

Teller wanted a new division. He was convinced that effective results could only come from people who had no other mission. The division would need certain facilities, and at first might consist of about a hundred individuals, most of whom would be scientists. Bradbury was well aware that Teller, with all of his brillance, was no manager. Froman, however, was an administrator who might be able to coordinate the relations between a group under Teller and the rest of the laboratory. Froman's ideas were much less grandiose than Teller's. A group of about twenty-five, under Teller, would be free to attack any problem and to call upon any part of the laboratory for help. Froman knew his assignment would be difficult. He realized that he and Teller might disagree over priorities as well as other matters. If differences did develop, Froman declared that he had to have the backing of Bradbury. There could be no other alternative.[42]

Some of Teller's anxiety might have stemmed from his realization that he was, at last, upon the right track. His report with Ulam had done little more than to point out possible approaches. Another idea, based upon the first, came to him probably in the latter part of March. De Hoffmann began a mathematical analysis, feeling fortunate, as he worked night and day, that the calculative techniques he had worked out for some of the *Greenhouse* tests were applicable to Teller's latest suggestion. The results looked good. In early April de Hoffmann signed the report with Teller's name. The approach could have been called the "New Super." [43]

Teller came to Washington and for two hours in the morning of April 4 was closeted with Dean. Teller argued that Froman's twenty-five-man group was far too small, and the right to call upon the rest of Los Alamos of little value, since so few in the laboratory knew enough to help. Yet Dean did not feel that Teller was raising insurmountable obstacles; for so intense an individual he seemed very objective. For two hours on April 16, Dean heard the Los Alamos part of the story from Bradbury and McCormack.[44]

Soon after returning to Los Alamos, Teller on April 20 summarized his position in a memorandum to Dean. Only at a new laboratory could there be assembled the people with the skills and talents who, working with single-minded devotion, offered the best chance of success. After considering several locations, Teller had decided that Boulder, Colorado, offered the best possibility for the 50 senior scientists, 82 junior scientists, and 228 assistants that he saw as needed. If the Commission acted quickly, a theoretical group might be in the preliminary facilities by fall, some experimental work in progress by Christmas, and routine operation achieved by the summer of 1952. Dean must have known how strong Teller's position was. As the most ardent scientific advocate of the thermonuclear bomb, he had strong ties with McMahon, Borden, and Strauss. In de Hoffmann, Teller had an able and shrewd scientific aide of high managerial and political ability. Dean must have sensed that the chances of compromise between Teller and Los Alamos were small.[45]

GREENHOUSE

Eniwetok preparations for *Greenhouse* were proceeding under General Elwood R. Quesada of the Air Force, commander of Joint Task Force 3. Dean found time to leave Washington with all of its pressures, to witness the test of thermonuclear principles. He was vividly impressed as he saw the bulky volumes of complicated operation orders and procedures take on meaning. Initial worries over squally weather faded as the sea and wind fell on the day of the test. The firing team took its position in the control station on Parry Island and all began smoothly. Forty-five minutes before detonation a short occurred in the monitoring arming circuit. Tension mounted, falling most heavily upon Alvin C. Graves. As Quesada's scientific deputy and leader of the Los Alamos J division, Graves had to make the decision. He listened to accounts of the difficulty and warnings that the test might fail. He chose to go ahead.

Soon came the blinding light, the boiling and seething clouds that reached high into the atmosphere. Dean was awed. A little later he put down his impressions: the 300-foot tower containing the device, a concrete shelter housing experimental equipment, some cast-iron structures—all had vanished. Where once they stood was a crater into which rolled the waters of the lagoon. As the first data came in, Dean watched the enthusiasm and satisfaction of the scientists. He noticed how Teller kept his feelings in check, but he remembered Teller's remark that Eniwetok would not be big enough for the next test.

It would take time to sort the data, but enough was known for Teller to inform Los Alamos: "It's a boy." Frederick Reines, physicist from Los Alamos, studied the preliminary results and in his comment to Bradbury back in New Mexico summed up the feelings of many, "We are all very well satisfied." [46]

PRINCETON

Dean thought that the next logical step was a strategy meeting to discuss the results of *Greenhouse* and to plan the next moves. Princeton appeared a good place for the gathering. There Oppenheimer could be host to those members of the General Advisory Committee particularly interested in weapon development, the Commissioners and a few members of the staff, Bradbury and a small Los Alamos group, and a few others who in one way or another over the years had followed the work on the hydrogen bomb.

Teller was elated. *Greenhouse* had done more than successfully test thermonuclear principles; it had shown that the mechanism he had described might well make a thermonuclear weapon possible. "It is now my conviction that the thermonuclear program is past its ignition point," he wrote to Smyth.[47]

At Los Alamos, Froman drew up the laboratory plans for the Princeton gathering. In distributing his proposal to the division heads and a few other key personnel, he warned that the laboratory resources would be so fully committed that new ideas or a shift of emphasis could be accepted with only the greatest of difficulty. The heavy burden upon the laboratory provoked the most comment. Bethe wondered whether too many assignments were being given to Mark's theoretical division. Maybe greater use could be made of Wheeler's group, now getting established in Princeton. Eric R. Jette worried about overtaxing his men in the CMR division, which performed chemical and metallurgical research on fissionable material and produced nuclear components for weapons. He saw in the near future the possibility that his people might be so fully engaged that they would have no time to develop new ideas or recognize them when they appeared.[48]

Of high priority in the Los Alamos plan was the need to analyze the data from *Greenhouse.* Whatever approach would be chosen for a thermonuclear weapon, these results were of crucial importance. Despite the unfavorable calculations of Ulam, Everett, and the ENIAC, the Super was still in the running; indeed some recent data showed its chances to be slightly improved. If this trend continued, the Super might be tested in the spring of 1954. The New Super also appeared promising, but because its origin was so recent, there had been no time for close and critical study. Teller, Mark's T division, and Wheeler's group were to undertake the analysis as a main task. It was too soon to establish a test schedule for the New Super, but if a general feasibility study were finished in October, 1951, and showed promise, perhaps a test of a device based on the New Super principle could be held in the spring of 1953. Los Alamos would not carry all the approaches through the testing stage. As soon as one became less attractive than the others, it would be dropped until eventually the effort would narrow to a single approach. Los Alamos would not attempt another test, similar to *Greenhouse,* to acquire further data on thermonuclear phenomena. To do so would detract from the effort to test a full-scale device.[49]

Bradbury recognized that at Princeton some of the emotions surrounding the Los Alamos effort might be unleashed. If, however, he could focus attention on the laboratory program, it might be possible to avoid some stormy sessions. In his view, the purpose of the meeting was to show that Los Alamos was attacking the right problems with the right emphasis. As an agenda, Bradbury proposed a report by Mark on thermonuclear data from *Greenhouse*, a discussion by Froman of the laboratory plan, and a few remarks by himself on the laboratory philosophy and the division of effort between fission and fusion development. Bradbury did not include Teller in the list of laboratory spokesmen so that the physicist could express his own views freely. His thoughts on the meeting Bradbury sent to Teller, with the observation that Nordheim and Wheeler could also speak with no strings attached.[50]

Dean must have seen the Princeton meeting as an end to a period of uncertainty. He could now begin to see where thermonuclear weapon development and increased production could meet. At Savannah River, clearing and grading were in progress and foundations were being poured. The heavy-water plant at Dana was well along. Because of increasing estimates of the amount of heavy water needed, the Commission had approved constructing six more dual-temperature units, but at Savannah River. At Hanford, building of the C reactor had little more than begun in June. K-31 at Oak Ridge was offering the pleasant possibility of completion at the end of January, 1952, about six weeks ahead of schedule. Labor problems, design changes, and difficulties in attracting qualified personnel within the salary limits were slowing down the C-31 plant at Paducah. Although Berkeley enthusiasm for the materials testing accelerator continued, there was a growing uncertainty over cost estimates. The Commission had approved Weldon Spring, Missouri, as the site for the Mark II, but had decided not to begin construction until Mark I at Livermore yielded operating experience. One concern that must have both-

ered Dean was the growing shortage of materials as the national defense effort gained momentum.[51]

Oppenheimer welcomed an impressive group of men on June 16 in the long conference room at the Institute for Advanced Study. From the General Advisory Committee, in addition to himself, were Fermi, Cyril S. Smith, Isidor I. Rabi, and Lee A. DuBridge, all of whom from the earliest days of the committee had watched the Commission activities. Some of the new element in the committee was represented by Walter G. Whitman and Richard W. Dodson, the committee's executive secretary. From Washington had come all of the Commissioners—Dean, Smyth, Glennan, Murray, Pike—and Boyer, Williams, and McCormack from the staff. Bradbury headed the Los Alamos delegation of Mark and Froman. Somewhat independent, as far as organizational allegiance was concerned, were Teller, Bethe, Nordheim, von Neumann, and Wheeler.

For two days the group reviewed the laboratory program, the results from *Greenhouse*, and the status of the various thermonuclear approaches. To Mark's presentation of the *Greenhouse* data, Wheeler added a technical briefing on how the information might be applied. His young Princeton group, barely established in recently acquired and poorly equipped buildings some miles away from the Institute, had adopted the designation "Project Matterhorn" and labored over their calculations. Kenneth W. Ford, one of Wheeler's group, charted data and plotted graphs up to the last possible moment, and then raced across town to hand the charts through the window as Wheeler began to speak. To those parts of the meeting which dealt with what he considered a rehash of stale data on old approaches, Teller listened with obvious impatience and restlessness, betraying occasionally his dissatisfaction with Los Alamos. With impassioned eloquence he portrayed how the data from *Greenhouse* opened the way for the New Super. Bethe thought the main task was to discover how the proposed thermonuclear devices would work. Although the data at hand were more than preliminary, much remained to be done. He and Wheeler opposed another test to verify thermonuclear principles or to cast light on some of the unknowns. The effort it would cost would not be worth the results. As for the laboratory program, the group after a very few changes, gave its approval.[52]

To most participants, the meeting had been significant, but not particularly startling. They had known of the *Greenhouse* results and the possibility of applying them to the New Super. What flowed from the discussion was a feeling of confidence, shared by Oppenheimer, that success was at last possible. The period of tense anxiety and frustration was over. Now there was a course to follow. Never had prospects for the thermonuclear weapon appeared so bright. Nor had the pursuit of the chimera of the Super been in vain, for Los Alamos had gained data and experience which it could quickly adapt to the New Super. However, there was a legacy of bitter feeling. One evening at Princeton, Dean took Bethe aside and asked whether there was any way to ease the tension between Los Alamos and Teller. Bethe shook his head: This was a problem to which he saw no solution.

FORGING THE ATOMIC SHIELD

CHAPTER 17

The conference at Princeton over the weekend of June 16, 1951, had marked a turning point in the quest for a thermonuclear weapon. From Norris E. Bradbury and his Los Alamos associates, and especially from Edward Teller, the Commissioners and the General Advisory Committee had gained a feeling of confidence that the end of the search was in sight. The *Greenhouse* test six weeks earlier had given Los Alamos desperately needed experimental data on thermonuclear principles. Not until Los Alamos had completed further study of the results would it be possible to determine whether the Super, the New Super, or another approach, was promising enough for a full-scale test, an essential step in developing a weapon. Nonetheless, the New Super which Teller had described in his April report had aroused great interest. Probably as the group at Princeton listened to Teller's impassioned arguments favoring the New Super, few of them could have disentangled the individual contributions of Teller, Stanislaw M. Ulam, and others. Nor were such distinctions important at the time. What mattered was that the thermonuclear effort move as fast as possible. For Gordon Dean and the other Commissioners the question was whether establishing a second laboratory would hasten or delay progress. Of one thing they could be certain: there was still much to be done before a thermonuclear weapon would be part of the nation's atomic shield.

There were other matters than Los Alamos and a second laboratory for the Commissioners to consider. The Joint Committee and the military were continuing to press for more plutonium and uranium 235. Despite the construction of more reactors and additional gaseous-diffusion capacity, there seemed to be no end to the demand for fissionable material. The flow of ore concentrates from the Colorado plateau and from Canada were increasing, and promising to remove ore supply as a limit to production. Of growing concern to Dean was the competition with the defense establishment for material and equipment falling into short supply as the nation rearmed itself.

However, the major issue for the Commission, the President, the Joint Committee on Atomic Energy, and the Department of Defense was this: How large should the nation's atomic energy program be?

THE TRUMPET SOUNDS AGAIN

The demand from Capitol Hill for more and bigger weapons, unceasing from the time McMahon had assumed chairmanship of the Joint Committee, showed every sign of growing more intense. An obvious ally for McMahon was the Department of Defense. In May, 1951, the senator had sent Secretary George C. Marshall a Joint Committee resolution urging expansion of the Commission's production facilities. A few days before the Princeton conference, McMahon had asked Dean and Marshall for a cost estimate for increasing production capacity by 50, 100, and 150 per cent. A week later, Robert LeBaron, Marshall's assistant for atomic energy and chairman of the Military Liaison Committee, told Dean that the Joint Chiefs of Staff were moving in the same direction. Not casting the question in such gross terms as percentage increases, the chiefs were interested in exploring every means for maximizing production. They needed cost estimates, construction schedules, and a full appraisal of the engineering possibilities. LeBaron observed that the Commission and the liaison committee would review the study before he sent it to the Joint Chiefs. He had also been in touch with the Joint Committee about the study. The strong identity of interest between the Department of Defense and the Joint Committee drew from Marshall a cordial invitation for McMahon to come to lunch and an offer to work closely with LeBaron and the Department of Defense.[1]

Even with massive help from the Commission's staff and contractors, Dean thought it would take forty or forty-five days to make even rough estimates of costs for McMahon. As an expedient, Dean offered to discuss with McMahon the practical difficulties in compiling the information. The Commission moved more gingerly on LeBaron's proposal. Marion W. Boyer suggested that some of the LeBaron group could take part in the current studies, but others of the Commission were not certain whether this was a responsive answer to the request. At times discussion turned to the advantages of reconvening the special committee of the National Security Council, which President Truman had previously used in reaching major policy decisions on atomic energy and defense, and which had the merit, from the Commission's point of view, of bringing into the balance the State Department's opinions.[2]

To Commissioner Thomas E. Murray, deliberating over administrative procedures was temporizing. The main thing was to get data for the studies as soon as possible, but Murray did not limit his concern to the reports. Within the Commission he searched for ways to hasten the production of weapons and fissionable materials. He was anxious to find a contractor and a director for a second weapon laboratory which he thought might be located at Sandia Base, near Albuquerque. He advocated splitting the headquarters division of military application into two divisions, one for weapon production and the other for weapon research and development. He supported Commissioner T. Keith Glennan's interest in improved reactors, so long as the search for efficiency did not take precedence over the immediate need for more production. Murray was eager to find a new site and contractor for more production reactors, and explored with Union Carbide officials ways of increasing the flow of uranium 235 from the gaseous-diffusion plants.[3] With his restless energy Murray combined an impatience for administrative detail.

McMahon was not waiting for the cost study before plunging into the intricacies of the Commission's operations. He told Dean on June 22 that the Joint Committee had voted eleven to six to ask the Commission for top secret data on production and the weapon stockpile. McMahon was pleased at the action: The vote was historic and it cut across party lines. As a step in that direction, Commissioner Henry D. Smyth briefed William L. Borden, executive director of the Joint Committee, on the recent Princeton meeting. On July 5, McMahon and Congressman C. Melvin Price met in the Pentagon for lunch with Marshall, Deputy Secretary Robert A. Lovett, and LeBaron. The conversation reinforced McMahon's conviction that the nation needed "thousands and thousands" of atomic bombs. Both Lovett and Marshall spoke enthusiastically of the tremendous impact large numbers of nuclear weapons would have on military strategy. Elated to find such a close meeting of minds, McMahon left the Pentagon more determined than ever to end what he considered the Commission's fumbling, half-hearted efforts to build the nuclear stockpile.[4]

In a budget hearing on August 16, 1951, General James McCormack gave to the Joint Committee some idea of how far the Commission had gone toward creating an arsenal of reliable, sophisticated, and specialized nuclear weapons. The supplemental budget would provide funds for developing almost a score of different weapon models, including several for missiles. As always, McCormack's testimony was impressive, but there was another reason for giving his remarks close attention. This occasion was his last appearance before the Joint Committee as director of the division of military application.[5]

Nonetheless, McMahon still worried. He had received from General Kenneth D. Nichols, chief of the Armed Forces Special Weapons Project, an estimate of the number of weapons necessary to cripple the industry of the Soviet Union. Nichols had concluded that the Commission's most optimistic forecasts of weapon production would not meet military requirements.

The following week, McMahon read to the Commissioners a memorandum prepared for him by J. Kenneth Mansfield of the committee staff. Mansfield argued that the military answer to the hordes of the Soviet bloc was tactical atomic weapons. He feared, however, that full implications of this fact had not permeated military thought; rather, the pace of technical development had outstripped military doctrine. Opening the question of tactical uses of atomic weapons might revive bitter interservice rivalry as each arm of the military sought to define its role, but national security demanded realistic estimates of the need for tactical and strategic atomic weapons. Mansfield thought the committee should ask the armed forces to accelerate their study of the tactical possibilities for nuclear weapons and come up with new requirements based on military judgment.

The memorandum struck a responsive chord in McMahon, who found it "challenging." Dean, in the course of explaining that the Commission dealt every day with such arguments, chose the more deliberate adjective "thoughtful." [6] There were obviously two sides to the argument, and a decision would have to wait the outcome of the Commission's studies.

HANFORD

For any appreciation of the Commission's growing production capabilities, McMahon and the Joint Committee would have to understand some of the developments at the Commission's field installations, especially at Hanford. At the August hearings, Walter J. Williams, the deputy general manager, had described the first successful operation of the Redox plant just a few days earlier. Like most of the Hanford facilities, the Redox building was massive, over 450 feet long with a thirteen-story silo at one end. The desert, stripped of sage brush, bunch grass, and greasewood, was criss-crossed with truck trails leading to the clutter of construction equipment around the building. A railroad track for heavy shielded cars carrying irradiated fuel elements from the reactors, entered the low end of the building. Inside, remotely controlled machinery unloaded the car and transferred the fuel to the first cell, where it was dissolved in acid and fed through a labyrinth of pipes, tanks, and pumps in the series of cells extending the length of the "canyon" building. In the silo at the far end stood the packed columns which separated the plutonium, uranium, and waste products.

The long and uninspiring history of Redox went back to the Manhattan project, but most of the recent effort stemmed from the survey which du Pont had completed for the Commission in the spring of 1949. The du Pont engineers had begun with the premise that, although prospects for obtaining uranium ore were improving, it was still vital to recover uranium from the chemical processing operations at Hanford. The bismuth-phosphate process, developed during the war, removed plutonium from the irradiated fuel but left uranium in the wastes. The Commission wanted a process which would not only recover the uranium from wastes but would also separate plutonium, uranium, and wastes from current reactor production. The uranyl-ammonium phosphate technique which Carbide at Oak Ridge had carried into early development stages looked good for waste recovery but not for current production. The situation was similar in the work by the Kellex Corporation on a solvent-extraction process for uranium recovery. Only Redox, which General Electric was studying at Hanford and Knolls, and which had attracted the attention of other laboratories, offered the possibility of handling recovery and current operations in a single process. Redox too presented difficulties, but du Pont had concluded that the best course was to build one plant to treat current reactor production before constructing another to recover uranium from the wastes.[7]

General Electric had come to a similar conclusion about the same time, and with this kind of agreement, the Commission in May, 1949, had approved the idea of using Redox for both purposes. Before the end of the year, however, research at Oak Ridge on other types of solvent extraction had opened new possibilities. Redox was still the best method for processing current production, but for the material in the waste tanks the Commission decided to switch to a solvent-extraction process using tributyl phosphate (TBP) as the solvent. Theoretically the TBP process, developed at Oak Ridge National Laboratory, could be coupled to the existing bismuth-phosphate plant at Hanford to accomplish the purpose of Redox. Economic analysis showed, however, that Redox offered the greatest assurance for steady production at the smallest capital cost. Williams had at once ordered General Electric to abandon all work on a second Redox plant and terminated Kellex's efforts to design a link between the bismuth-phosphate process and TBP.[8]

General Electric's long development effort on Redox made it possible for the company to start final design of the plant almost immediately. Construction had started early in 1950, and by fall there was every assurance that the plant would be completed by August, 1951.

TBP had encountered the troubles often experienced in transferring a process from the laboratory work bench to the engineering drawing boards. Kellex had not been able to start design until the fall of 1950, and construction work had lagged far behind Redox during 1951. Some of the reason for the slower pace was the delay in delivering plant equipment, a consequence in part of the growing burden on industry from the Korean war. When operations started in the new Redox plant in August, 1951, the TBP plant was not yet half complete.[9]

The only other major construction project at Hanford was the new production reactor, C, which the President had authorized in October, 1949. Limited to only minor improvements in the original Hanford units, design of the new reactor progressed rapidly and construction had started in the spring of 1950. Despite the usual troubles with priorities and labor, C reactor was completed almost on schedule in November, 1952.

By the middle of 1951 both General Electric and the Commission's staff at Hanford were overcoming the construction difficulties that had plagued the project in earlier years. One factor was General Electric's growing experience with large construction enterprises. Another was the leadership of Wilfrid E. Johnson, a tough-minded engineer who understood the nerve-racking art of building a complicated facility with construction crews pressing hard on the heels of designers. Matching Johnson in talent and experience was the Commission's own construction expert at Hanford, William K. Maher. Working together, Johnson and Maher were giving Hanford a new reputation for accomplishment in construction.

NEW SOURCES OF URANIUM

If at last the Commission could recover uranium from reactor slugs and wastes, the nation was still vitally dependent upon overseas sources for most of its uranium needs. About three-fourths of the Commission's raw material still came from the Belgian Congo; the rest from Canada and the Colorado Plateau.

The most striking development had been the sharp increase in domestic ore receipts in late 1950. By December, deliveries from the Colorado Plateau had exceeded the 1950 forecast by 60 per cent, and for the first time American production was greater than Canadian. Much larger quantities were in prospect from new deposits near Grants, New Mexico. The Commission's laboratory at Watertown, Massachusetts, and the Bureau of Mines laboratory at Salt Lake City had found the New Mexico ore amenable to treatment despite a high lime content. To encourage further production on the plateau, the Commission in February, 1951, had offered a new bonus for the first 10,000 pounds of acceptable but relatively low-grade ore to be produced from new or existing mines. The Commission also increased the guaranteed minimum price schedule for uranium ores. Miners on the plateau could deliver their ores directly to the Commission's processing plant at Monticello, Utah, to the Commission's ore buying station at Marysvale, or to private ore-purchasing depots. All these incentives, the Commission hoped, would soon make the plateau a major producing area.[10]

Jesse C. Johnson, director of the division of raw materials, was supporting research that he hoped would produce uranium at low cost from phosphate beds in the West and in Florida. Although the uranium content was low, the large amounts of phosphate processed in the fertilizer industry made the recovery of by-product uranium attractive. In the summer of 1951 Johnson's main concern was that personnel limitations imposed by Congress on the Commission and the Geological Survey would slow down exploratory drilling for new deposits.

Sumner T. Pike, the Commissioner with the best knowledge of the mining industry, still considered South Africa the largest potential source of uranium ore. Frank W. McQuiston, Jr., who was Johnson's deputy, had returned from the Transvaal with encouraging news. Mine owners, who had previously limited their cooperative efforts to gold mining and marketing, were now showing an interest in working together on the technical aspects of uranium processing. McQuiston believed the first South African plant should be in production by March, 1952, and three more by October. Additional uranium might come from running gold mine tailings through flotation mills, an operation Commission officials would discuss with the South Africans in the fall of 1951. The obstacles McQuiston found were shortages of sulfur, water, electric power, and skilled labor near some of the most promising sites.[11]

The outlook for uranium deliveries from other Commonwealth nations was improving in 1951. Canada's difficulties in obtaining American technical assistance in enlarging its refinery capacity disappeared when Dean succeeded in obtaining an amendment to Section 10a of the Atomic Energy Act in October. With these statutory difficulties removed, the Commission could soon expect substantial increases in deliveries from the new processing plant to be built in the Lake Athabaska region. There were also hopes for uranium ore from South Australia. Thomas Playford, premier of the state, met with the Commissioners on August 21, 1951, during a visit to Washington, to sound out American interest in uranium deposits at Radium Hill. Subsequent investigations showed sufficient quality and amounts to justify negotiations.[12]

As promising as all of these developments were in the summer of 1951, the Belgian Congo showed every evidence of continuing to be the main source of uranium for the Americans for several years to come. At least to Borden and the Joint Committee, the important point was that ore deliveries were likely to exceed requirements by the end of the year. At last, availability of raw materials would no longer be a limiting factor in the nation's atomic energy effort.

REACTORS FOR SAVANNAH RIVER

The Commission's growing stocks of uranium concentrates would help to fuel the new production reactors which the du Pont Company was starting to build at Savannah River in South Carolina. The du Pont assignment included not only the five reactors but also facilities for preparing the reactor fuel, separating plutonium or tritium from the irradiated fuel elements, and producing the heavy water that would serve as moderator in the reactors.

For technical assistance in designing the reactors, du Pont depended heavily on Walter H. Zinn and his staff at Argonne National Laboratory. Stuart McLain coordinated the laboratory effort on the project and served as liaison with du Pont on technical matters. Argonne had also agreed to accept some du Pont engineers—preferably young men with advanced degrees and some years of experience with the company—for training and work in physics, physical chemistry, chemical engineering, and inorganic chemistry. By August, 1951, sixty-six du Pont employees were working at Argonne. Much of the effort centered on the metallurgy of the fuel elements, particularly on fabrication techniques and the behavior of various alloys under irradiation. For some of these tests, Argonne was depending on the very high flux of neutrons in the Canadian NRX reactor at Chalk River. The successful use of critical assemblies in designing the submarine propulsion reactor at Argonne led to Zinn's decision to build a similar zero power reactor, called ZPR-II, which McLain expected to have operating before the end of 1951.[13]

By that time McLain's group would need about twenty-five tons of heavy water for reactor experiments. Zinn proposed to take four tons from his own laboratory, about seventeen tons from stocks at Oak Ridge, and one ton from the Trail plant in British Columbia. The rest Oak Ridge would have to produce from contaminated materials in storage. Heavy water would still be in critically short supply until January, 1952, when six dual-temperature production units would go into operation at the Dana, Indiana, plant. The Dana operation had already provided valuable corrosion data for the larger, permanent dual-temperature units being built at Savannah River.

The Commission had recognized from the beginning that Savannah River would be a huge installation, but some of its dimensions were not fully apparent until the autumn of 1951. A rough estimate of costs for the entire plant was more than a billion dollars. With almost 25,000 workers on the site, the project was rapidly transforming the whole area along the river below Augusta, Georgia. Because the Commission had firmly decided to avoid operating a Government town at Savannah River, dozens of trailer camps and low-cost housing projects were springing up around the site. Drawing on Oak Ridge experience, the Commission had built some barrack-type dormitories for construction workers, but times had changed since 1943. Most of the barracks stood empty as workers preferred to live off the site, even in substandard accommodations, with their families. Curtis A. Nelson, the Commission's local manager, had all the headaches that a gigantic construction camp created, but he could take comfort in the fact that his problems were temporary.[14]

Compared to the intricacies of building production reactors and chemical separation plants, it was an easy task for the Commission to add gaseous-diffusion capacity for producing uranium 235. The original K-25-27 plant at Oak Ridge consisted of 2,800 stages, each of which included a "compressor" or pump for moving the uranium-hexafluoride gas, a "converter" or tank containing the barrier tubes which separated the uranium 235 and 238 isotopes, and the associated valves, piping, and instruments. Increasing capacity simply meant adding more stages to the long chain or "cascade" of separative units.

The new K-29 plant at Oak Ridge was an example of Carbide's mastery of gaseous-diffusion technology. Although the new plant incorporated many design changes, including the use of axial-flow compressors, improved barrier, and remote controls, it had gone into full operation almost five months ahead of schedule in January, 1951. By August, 1951, some of the units of the new K-31 plant were also operating. When K-31 was completed in December, it would raise the total number of stages in the Oak Ridge cascade to 3,700. With their higher efficiencies, the new plants would greatly increase the output of uranium 235.[15]

By the summer of 1951 construction was moving rapidly on the C-31 and C-33 diffusion plants at Paducah, Kentucky. Despite a plague of labor disputes, construction forces by late summer had erected most of the structural steel for C-31 and had completed most of the excavation for C-33. The new plants, containing almost 900 stages of very large compressors and converters, would perform the big task of processing the great quantities of

already depleted uranium which had come from the "bottom" of the Oak Ridge cascade. The gaseous-diffusion cascade was lengthening, and with it would come a multiple increase in uranium-235 production.[16]

TROUBLES AT LOS ALAMOS

While Dean could see progress in the growing production capacity for fissionable material, problems at the weapon laboratory steadily resisted solution. Pressures of military requirements seemed to force Los Alamos to work from test to test, a pattern which made long-range research on weapons difficult. Dean could see some validity in Murray's arguments for another weapon laboratory. Perhaps two such installations could do more than one. Perhaps results might come more quickly if two laboratories tackled the same problem. But there were other factors which Dean had to consider. Deciding what work to take from Los Alamos and recruiting a new staff could be devastating to the morale of the laboratory on the mesa, and might even cause such confusion as to delay the thermonuclear test planned for late 1952.

Uncertain in his own mind, Dean asked the other Commissioners to study the question. When Murray, Smyth, and Glennan made their report on August 23, they agreed that continued growth in weapon research was probably inevitable and that a much larger laboratory was probably not practical. Smyth and Glennan had not yet decided on the best solution, but Murray was convinced that the Commission should either establish a second laboratory or move thermonuclear work from Los Alamos.

The tangled situation at Los Alamos was further complicated by personalities. Never satisfied with the resources Bradbury was willing to devote to the thermonuclear project, Teller had grown increasingly restless. More than once there had been rumors he was about to leave the laboratory.

When in Washington, Teller unburdened himself to Borden or McMahon, either of whom would offer a sympathetic ear. Dean usually felt the repercussions of a Teller visit. The week after his discussion of Los Alamos with the Commissioners, Dean received an invitation from Borden to join him, Teller, and McMahon for dinner at the Metropolitan Club in Washington. Believing acceptance would compromise his position, Dean had declined. McMahon was too busy with the Senate debate on the mutual aid bill to attend but he had sent a warm letter to the physicist assuring him that his services were vital to the nation and the free world.

Knowledge of the close ties between Teller and McMahon must have been at least in part responsible for Dean's concern when Frederic de Hoffmann, Teller's trusted assistant, told him by telephone late on September 11, 1951, that Teller had resigned. What made this resignation significant to Dean was that for once Teller had put his intentions in writing. Dean did not relish the task of giving the news to McMahon, LeBaron, and Lewis L. Strauss.[17]

Dean received more detail on the Los Alamos situation when Bradbury arrived the next afternoon to report on the laboratory work. Bradbury's obvious mastery of the facts renewed Dean's confidence in the laboratory and its director. Colonel Kenneth E. Fields, McCormack's replacement as director of military application, gave the same impression. An outstanding engineering officer already marked for big things in the Army, Fields had acquired a good background for his new assignment by serving under General Groves with the Manhattan project and for a brief period as McCormack's assistant. With his usual political acumen, Dean decided that a similar briefing of the Military Liaison Committee by Bradbury would dispel some of the uncertainties about the common thermonuclear effort. A telephone call found LeBaron willing. The day had been a busy one for him. At 10:00 A.M. Secretary Marshall had told him that the new Secretary of Defense would be Lovett. There would be other changes in the Department, and as a whole LeBaron thought they would strengthen the role of his group.

The next day the threatening storm over Los Alamos blew over, but the atmosphere remained charged. The first break in the clouds occurred when de Hoffmann came to Dean with news that Teller once again had reconsidered his decision to leave Los Alamos. The second break was Bradbury's performance that afternoon before LeBaron's committee. In a survey of the several approaches to the thermonuclear weapon, Bradbury reported that so far the New Super was easily the most promising. Despite the fact that some of the data were still preliminary, Bradbury could speak with confidence about possible yields, preliminary specifications for materials, and tentative schedules for testing, probably in September, 1952.[18]

Both Dean and Boyer realized that two briefings could not cure the troubles at Los Alamos, an observation Oppenheimer reinforced a few days later in a conversation with Dean. In talking with Teller, Oppenheimer had concluded that the physicist might agree to stay at Los Alamos if Enrico Fermi, Hans A. Bethe, or Oppenheimer took over the direction of the thermonuclear project. Bethe and Oppenheimer had feared that the arrangement would only create awkward problems. Discerning in Teller signs of fatigue and strain, Oppenheimer thought Dean would have to accept as an ever-present risk the possibility that Teller might resign. Even should this happen, Oppenheimer had hopes that Teller would at least be available as a consultant.

Events at Los Alamos were not making life there any easier for Teller. In reorganizing the laboratory, Bradbury had proposed to give Teller responsibility for all theoretical work and initial design of the New Super test device. Marshall G. Holloway of W division was to coordinate Teller's theoretical work with engineering design and fabrication. Of all the scientists at Los Alamos, Holloway seemed the best for this job. As director of weapon development he had a reputation for toughness and administrative ability, both crucial qualities for meeting the 1952 test schedule. Fields agreed with Bradbury's appraisal of Holloway, but there were difficulties in the appointment. Holloway and Teller had already differed on several matters, particularly test schedules. Teller was furious. Holloway's appointment was, as one observer remarked, "like waving a red flag in front of a bull." Two days later Teller told Dean, Smyth, and Boyer in Washington that he was leaving Los Alamos, but not the thermonuclear effort. He would return to the University of Chicago, but would visit Los Alamos when needed.[19]

Los Alamos was clearly moving along the course Teller had charted in the spring of 1951. Others had made important contributions, but Teller's restless, driving, nervous energy had been the goad. In the twenty-one months since President Truman had issued his directive, Los Alamos had moved from a vague theoretical possibility to a firm idea ready for engineering and development. Perhaps the time had passed for Teller's most effective participation, but he himself was largely responsible for the accomplishments which brought about that situation.

McMAHON ON THE MARCH

On August 31, 1951, Dean sent McMahon the Commission's cost study of the expansion proposals. In sticking closely to the three cases McMahon had proposed—expansions of 50, 100, and 150 per cent—the staff had decided not to consider other possibilities that might have given better results in terms of economics or composition of the stockpile. Even if preliminary, the cost estimates were revealing. For the 50 per cent expansion, construction would cost about $2.8 billion and annual operating costs would run about $220 million. The figures for the 150 per cent expansion were over $7 billion and

$774 million, respectively. Although more Hanford reactors would be the quickest route to greater plutonium production, the Commission had used the Savannah River design in its assumptions because of its promise of better performance. To meet McMahon's production goals would require from six to eighteen additional reactors at one or two new sites. The various possible combinations in gaseous-diffusion operation made the calculations for uranium-235 production more complicated, but in any case a site other than Oak Ridge or Paducah seemed desirable for strategic reasons. The new facilities would make a significant impact on the national supply of nickel and stainless-steel tubing for equipment and hydrofluoric acid and sulfur for plant operation. Estimates of the demand for labor and electric power were just as impressive.[20]

McMahon did not miss the implications of the Commission's report, but he believed the expenditure in money and material would prove economical. He told the Senate on September 18, 1951, that atomic weapons were the new hope for defense. The rhythm of recent history showed staggering national budgets, increasing centralization of government, more official secrecy, and greater restrictions on the rights of citizens. From this pattern there seemed only two choices: military security at the risk of economic disaster, or economic safety at the price of military disaster.

McMahon asserted that these need not be the alternatives. Nuclear weapons would give the United States "peace power" at bearable cost. Atomic energy could deter Stalin until his enslaved peoples could break their bonds and unite with America in peace and brotherhood. The amount the nation was spending on atomic bombs was only three cents of every defense dollar, a ratio reflecting outdated thought. McMahon proposed building an atomic army, navy, and air force. Then the nation could reduce the number of men in uniform and the heavy expenditures for conventional weapons. He then introduced two concurrent resolutions: one calling for the United States to "go all-out in atomic development and production," the other asking the people of the world to join a moral crusade for peace and freedom.[21]

From that day, McMahon was on the march. The next morning he went to the Commission's headquarters building for the Joint Committee's first briefing on weapon stockpile data. A few days later he began a series of hearings on his expansion proposals with Defense and Commission officials. McMahon was now convinced that even the 150 per cent expansion was feasible, given the money, priorities, and manpower.

Within the space of a few days McMahon and the Joint Committee heard the three service secretaries declare their appreciation of the value of nuclear weapons. In one way or another, each asserted that the Commission was not producing enough fissionable material to meet defense needs. They believed unhesitatingly that expansion of production would be in the interest of national security: anything less would squander a priceless asset for defense. Most of the testimony was of necessity behind closed doors, and judging from the fragmentary evidence, only once did Dean get a chance to describe his understanding of how the military set its requirements for fissionable material. With Hickenlooper in corroboration, Dean said he believed that the services based their estimates on the Commission's production capacity, plus a few percentage points for an incentive.

The session with the Commissioners concentrated on the prospects for the New Super. Smyth explained that Los Alamos still did not have the computers necessary for reliable calculations, and he doubted work could go much faster without them. Most of the qualified people, in Smyth's opinion, were already contributing to thermonuclear research at Los Alamos. He thought the limiting factor was not personnel but the need to proceed one step at a time. Dean pointed to the enthusiasm over the New Super at the Princeton meeting and the steady progress since that time. Differences of opinion at Los Alamos were to Dean the sign of a healthy spirit. He admitted that Teller's departure would be a loss, but he reminded McMahon that Teller's services would still be available.

Only on the question of a second laboratory did the Commissioners reveal a difference of opinion. Dean wanted more time to study the need for a second laboratory. Murray frankly disagreed. He thought Los Alamos was already overworked and faced even heavier burdens in the future. Admittedly it would take time to move thermonuclear work out of Los Alamos but Murray could not see why the Commission could not make the decision at once.[22]

As Dean left the hearing room, he learned from Walter F. Colby, the Commission's director of intelligence, that there was evidence of a second Soviet nuclear test. Dean could only vaguely recall the incidents surrounding the first detection of a Soviet test just twenty-five months earlier, but within a few days he was feeling the same concerns that had troubled the Commissioners then. As in 1949, Truman wanted to keep a tight lid on the information until the evidence was strong enough to warrant a public announcement. Dean wondered what the Soviet propaganda machine would do if the United States never made an announcement. More to the point, he saw that complying with the President's request might well jeopardize his relations with McMahon and the Joint Committee. He thought it would be safe to tell McMahon even if the President did not wish to make a public statement at once. Within a few days, however, Dean had worked out a public statement with LeBaron and James S. Lay at the White House. The brief statement, released on October 3, 1951, did little more than acknowledge the event and point out that it discredited the Soviet claim of exclusive devotion to the peaceful uses of atomic energy.

As Dean expected, the news of the second Soviet test quickened McMahon's pace. If Dean and Smyth had done anything at the September 28 hearing to convince McMahon that the second laboratory question needed more study, news of the Soviet test placed the issue again in a context of urgency. McMahon had but one question for Dean: "Could you do more than you are doing to speed the hydrogen program and improve chances of ultimate success?" McMahon was convinced there could be only one answer.[23]

DEFINING MILITARY REQUIREMENTS

The study the Joint Chiefs had requested in June the Commission sent to LeBaron on September 25, 1951. The Commission's first inclination had been to make the exercise into a broad policy study involving the State Department, but LeBaron had convinced the Commissioners that only an engineering study for the Joint Chiefs was needed at this moment. Both the Commission and the liaison committee would review the study before it went to the chiefs. With these understandings, the Commission staff, with help from LeBaron's group, restricted the analysis to the technical dimensions of the expansion effort. If the United States continued to acquire most of the uranium mined in the free world, it would be feasible to triple the production of plutonium and perhaps even of uranium 235. Requirements in manpower and critical materials would be high but not limiting, provided the effort had the highest priorities.

Instead of calculating across-the-board percentage increases in uranium and plutonium production, the group analyzed several combinations. For plutonium production, the analysts proposed two new sites, one for graphite reactors, the second for heavy-water units. For uranium 235, there were several possibilities, but one of the most attractive was a new site so that not all the gaseous-diffusion capacity would be a concentrated target for an enemy attack, and so that the heavy power demands could be met by a different utility net. Replete with tables of cost data, construction schedules, and possible stockpile combinations, the study gave some idea of the complexity of the issues and the need for careful weighing of alternatives before a final decision was made.[24]

Dean stressed this point in a conversation with LeBaron on October 1. The Commission was not yet ready to recommend a course of action and wanted to discuss the report with LeBaron's committee. Apparently LeBaron understood, for he assured Dean that the Joint Chiefs had taken no position on the subject.

That there had been a misunderstanding became evident on October 5 when the Commissioners met with the liaison committee. With misgivings, Murray, Smyth, and Glennan heard LeBaron announce that he had already sent the study to the Joint Chiefs. Dean, in California on a speaking engagement, was not present to take up the Commission's cause. Admiral Frederic S.

Withington added to the Commissioners' uneasiness by remarking that the committee had also recommended certain percentage increases to the Joint Chiefs.

In Dean's absence, Smyth spoke for the Commission. He thought the military were moving too swiftly. The issues were too complex. A quick decision could foreclose a course of action which more analysis might prove to be better. Because of the probable impact of the expansion on the national economy, Smyth held that not even the Joint Chiefs and the Commission together could make the decision. That power rested with the National Security Council, the President, and the Congress. LeBaron did not deny Smyth's assertion; he simply stated that the logical first step was to define military requirements. Smyth still had his reservations. As a citizen, he was worried about undertaking a huge and costly program which would not add to the stockpile for years.[25]

Beneath the immediate issues were the philosophical differences that had disturbed the Commission's relations with the military establishment since 1946. Lilienthal's struggle over custody of the stockpile in 1948, Dean's insistence in 1950 upon a civilian voice in any decision to use nuclear weapons were both related to the fundamental question of the Commission's part in making national policy. Did the Commission, as Dean believed, have an obligation under the Atomic Energy Act to participate in policy matters which bore upon the production or use of nuclear weapons? Or was LeBaron correct, as a memorandum from his committee had suggested, that in the development of atomic weapons, the Commission and the Department of Defense fell inevitably into a contractor-buyer relationship? It was an interpretation of roles the Commission did not accept. To Dean and his associates the Commission was an independent agency, with a positive responsibility to the President and the Congress. It was not a contractor to the Department of Defense for the atomic weapon program.

The actual course to be followed probably fell somewhere between the two positions. As Fields suggested, the Act seemed to indicate that both agencies were to work together for the common good. In practical terms, there was no disagreement on the need for further expansion, but only a question of size and speed. The answer would depend in large part on the capabilities of American industry and the supply of critical materials.[26]

While the Commissioners were debating with LeBaron, Boyer was trying to gauge the reaction of key contractors to the proposed expansion. In New York, Ralph J. Cordiner and Harry A. Winne of General Electric expressed some interest in new reactors at Hanford, but they were less certain about a new site. They thought they might have trouble convincing their board of directors that the company should take on a large project which promised small monetary returns. A second site using graphite reactors would compete with Hanford, and any larger role for General Electric would interfere with defense orders for turbogenerators. At du Pont, R. Monte

Evans and Granville M. Read saw no difficulty in building more heavy-water reactors at Savannah River, but they too hesitated over a new site. They wanted nothing to do with graphite reactors and had reservations about taking on the construction job.[27] Boyer must have listened to these arguments with understanding. His industrial background made it easy for him to sympathize with manufacturers who found their plant capacity increasingly absorbed by military demands triggered by the Korean war. On the other hand, as general manager he knew how few companies could meet the Commission's needs. Somehow McMahon's enthusiasm and industry's realism had to be brought into harness.

A QUESTION OF NATIONAL POLICY

From experience the Commission could be confident that when national policy questions arose, the Joint Committee would speak out. In a hearing on October 8, 1951, Representative Henry M. Jackson explored not only what the Commission could do, but also how the committee could help to speed expansion. The next day he urged in the House a large commitment in money and resources. Many of his arguments were similar to McMahon's, but Jackson put more stress on the tactical value of nuclear weapons. Because the number of strategic targets seemed limited, military planners had seen no need for large numbers of weapons. Jackson thought that argument, if ever valid, was no longer true. The nation's military strategists were in the midst of an intellectual revolution and were beginning to see the whole range of possibilities for nuclear weapons. This new conception of nuclear defense might cost the nation $6 to $10 billion annually. Jackson's appeal for tactical weapons inevitably raised questions about their possible use in Korea. Although truce talks had begun in July at Kaesong, American newspapers were still carrying stories of "Heartbreak Ridge" and "Bloody Ridge," names which reflected the stalemate in which General Matthew B. Ridgway's forces were locked along the 38th parallel.[28]

Glennan pondered over the course of events and with Smyth wondered whether the Commissioners were measuring up to their responsibilities. Few Americans had the facts to judge the need for expansion. By and large, Glennan believed, the statements of Congressional leaders, military officers, and newspaper reporters were misleading. Except for the Joint Committee, the nation's elected representatives knew little more about atomic energy than the people themselves. Glennan thought this lack of understanding surely caused the troubles the Commission had encountered in appropriation hearings. The amounts the Commission had requested in the past would seem small compared to those likely in the future. These considerations, Glennan admitted to his colleagues, probably came too late, as did most soul-searching, but he was not convinced of the need for haste nor could he find it easy to support the expansion effort with the information available.[29]

Some of these thoughts were in the air when the Commissioners met with the General Advisory Committee on October 11, 1951. Smyth urged the committee not to confine itself to technical matters but to take up the broad question of production goals and national policy. Perhaps recalling events in the fall of 1949, the committee declined to enlarge the scope of the discussion, but there were some observations reassuring to the Commissioners. Because the expansion effort would not produce results for several years, the committee thought the Commission should concentrate on maximizing production from existing facilities. Moreover, improvement by the military in their delivery systems was the equivalent of enlarging the stockpile. The committee also heartily endorsed Bradbury's plans for weapon development and preparations for the *Buster-Jangle* tests that would begin in a few days in Nevada.

The only policy issue the committee was willing to consider was the question of a second weapon laboratory. Willard F. Libby argued that the best way to ease the burden on Los Alamos was to move thermonuclear weapon development to a new site. Isidor I. Rabi countered that a second laboratory would cause a scramble for the few good people available. Bradbury argued that competition made no sense in research. He thought the proper course would be to relieve Los Alamos of routine production assignments it had acquired in recent years. When the discussion ended, the committee, except for Libby, would go no farther than to recommend a reduction of workload at Los Alamos. The only argument the committee could find for a second laboratory was to make use of people who would not work at Los Alamos, and the committee knew of no one in that category.[30]

The failure to gain broad support from the General Advisory Committee was but the first disappointment the Commissioners encountered that week. The chances of stopping a headlong rush into a huge expansion now seemed slim. On Wednesday, October 17, McMahon sent Dean a copy of the resolution Jackson had been discussing on October 8. Stripped of its parliamentary phrasing, the resolution called upon the Commission and the Department of Defense to send the committee by January 3, 1952, a report "on maximizing the role which atomic energy can and should play in the defense of the United States. . . ." The committee wanted a definite plan, complete with cost estimates, numbers and specific types of facilities, lists of priorities, and appraisals of the probable impact on other defense projects and the national economy.[31]

The second shock came on Thursday morning when Dean heard that the Joint Chiefs had come to a decision on the expansion effort. Dean and Smyth hurried to the Pentagon to see Lovett. No determination should be reached, they argued, until other Executive agencies—the Bureau of the Budget and the Defense Production Administration, to name two—had been consulted. Lovett said he would try to keep the matter open, but pressures for budgetary funds and allocating critical materials were forcing the Joint Chiefs to take a position. Further, Lovett observed, their action was only the first step toward a decision.[32]

On Friday Dean received the official notice that the Joint Chiefs had recommended a specific expansion in plutonium and uranium-235 production. Furthermore, this was to be only an interim plan because the Commission's engineering study had shown that uranium concentrates would be available for a larger increase. Military requirements would determine the final figure, and the Joint Chiefs warned that it might exceed ore supplies.[33] The Commission's first reaction to the Joint Chiefs' statement was one of exasperation. Smyth wanted to search the record for proof that Defense had agreed not to act without consulting the Commission. Dean took the pragmatic view that the expansion was inevitable. Before he left for a trip to Los Alamos, he pointed out that it was the Commission's task to accomplish the increase in production capacity swiftly and effectively.

BUSTER-JANGLE

Dean left Washington on Friday afternoon for Los Alamos. He had many things to discuss, but the preoccupation at the moment was the start of *Buster-Jangle*, the second test series of the year in Nevada. The double name for the series reflected the complexities of management and planning that had overtaken weapon testing. *Buster* had been the designation for the Los Alamos plan for developmental tests of new weapon models. *Jangle* had been assigned to a number of experiments on weapon effects, originally scheduled for the canceled *Windstorm* series in 1951. *Jangle* had grown into an elaborate study of physical effects of blast, radiation, and heat as related to the special interests of the armed services, the Federal Civil Defense Administration, and the U. S. Public Health Service.

Meshing the two series at the Nevada Proving Ground with their differing aims and large numbers of personnel had placed additional burdens on the Commission's Los Alamos staff headed by Carroll L. Tyler. An added complication was the Army's decision to use the tests for a combat training exercise. Tyler found that some of the military equipment to be tested had been so hastily set up that it would be difficult to obtain any reliable data. He concluded that in the future the Commission would have to assume complete jurisdiction over Nevada tests; there could be no more joint operations with the military participating with its own units in its own areas.

The first shot in the series was to have been on the day Dean left Washington. When everyone was in place and the test group had completed the elaborate countdown procedure, the test director gave the order to fire. For once the blinding flash and thunderous roar did not shatter the desert peace. A failure in the control circuit, not in the device itself, had been the cause. Still, Dean remarked, "It must have been an awfully funny feeling." Fortunately, the event turned out to be only a minor incident in an otherwise successful series.[34]

THE COMMISSION TAKES A STAND

Dean returned to Washington on October 24. Only two days earlier the White House had announced the third Soviet nuclear test. Although he could expect the demand for expansion to increase more than ever, among his colleagues nothing much had changed. Pike was adamant, holding that the Commission had a responsibility to pass on the need and goals of the expansion. To him

the Commission was more than a technical adviser to the Department of Defense. Glennan was inclined to accept the Joint Chiefs' interim goal, but he thought final action should await further studies of priorities for manpower and materials. Only Murray was ready for immediate action. He urged the Commission to join the Department of Defense in recommending the Joint Chiefs' proposal to the National Security Council. He pressed for the Commission to begin selecting plant sites and contractors and to adopt a new ore procurement goal of 10,000 tons per year by 1955.[35]

A session on October 25 with Charles E. Wilson, head of the Office of Defense Mobilization, gave Dean a better idea of the priorities situation. Among the requirements for the Joint Chiefs' proposal, only those for nickel and stainless steel would prove troublesome. Structural steel, not on the list, would be in short supply through 1952. For the highest or overriding priorities, the Commission would need approval from the Defense Department or the President. Wilson was against superpriorities, because once they were established for one project, other similar priorities tended to creep in and so defeat the purpose. The best thing the Commission could do would be to define its needs quickly and replace rumor with fact.[36]

From exploring priorities with Wilson, Dean and his associates turned back to considering the course they should follow. They had two choices: accept the Joint Chiefs' goal and join in a recommendation to the National Security Council, or try to bring the entire question of expansion, with all of its ramifications, before the council. Dean agreed with Smyth that the latter alternative was better. The council would be a forum for Secretary Dean G. Acheson's assessment of the international implications as well as for Wilson's estimates on economic effects. Only the council could consider such aspects as the value of expansion as a national investment, and the possible psychological advantages of producing fissionable material in excess of military requirements. Save for Murray, all the Commissioners agreed that they should bring the matter before the council, along with their opinion that expansion beyond the level set by the Joint Chiefs would place a severe strain on the economy.

Murray dissented because he believed that misunderstandings between the Commission and the Department of Defense were causing confusion and delays in the nuclear weapon program, which was vital to national security. Not until the role of each agency was clarified would doubts and hesitations be swept away. For his part, Murray believed the Department of Defense should decide the size of the expansion, and the Commission its technical feasibility. On this basis he was prepared to approve the Joint Chiefs' proposal. He had never accepted the argument that ore supply was the limiting factor to plant expansion. He was certain that a vigorous effort would reveal sufficient quantities to support a multiple increase in fissionable material production.[37]

Lovett read both the majority opinion and Murray's dissent. He had no objection to referring the broad issue of expansion to the National Security Council so long as there was no question about the interim goal or the responsibility of the Joint Chiefs and the Department to determine military requirements for atomic weapons. These qualifications swept away the last bit of ground on which the Commissioners were trying to stand. They were no more successful than Lilienthal had been in 1949 in challenging the Department to reveal the basis for military requirements. In time, however, Lovett's one concession might prove important. The very process of preparing a study for the National Security Council and the President might afford the Commission an opportunity to raise issues beyond those of technical feasibility.[38]

REPORT TO THE PRESIDENT

Whatever success the Commission might ultimately have in raising the broader issues, the first step was to obtain the technical data for the study. This task was the prime responsibility of Major General Thomas F. Farrell, who, as assistant general manager for manufacturing, had inherited most of Carleton Shugg's duties as a top-level expediter. Farrell had served for twenty years as a civil engineer on large public works projects in New York and about as long as an Army officer in the Corps of Engineers during both World Wars. His knowledge of atomic energy stemmed from his service as General Groves's deputy in the final months of World War II, as a member of the evaluation board for the Bikini weapon test in 1946, and as an adviser to Bernard M. Baruch in the United Nations Atomic Energy Commission. Farrell had returned to active duty in the Army for the Korean War and came to the Commission from the Defense Production Administration.[39]

By the middle of November, 1951, Farrell had both headquarters and the field offices preparing for expansion. The Corps of Engineers and Stone & Webster Engineering Corporation were investigating new sites for a reactor facility and for a gaseous-diffusion plant. Du Pont at Savannah River, General Electric at Hanford, and Carbide at Oak Ridge were planning the steps they would take should the President approve the new expansion. As data flowed in from the field, the headquarters divisions compiled information on critical materials and equipment for the Munitions Board. Manly Fleischmann, administrator of the National Production Authority, did his best to help the Commission in procuring scarce items, meeting electric power requirements, and obtaining priorities. The headquarters staff was also collecting data for the expansion plan McMahon had requested and a separate study of the requirements for tripling existing production capacity.[40]

The Commissioners were concentrating their attention on the report to the council. Lay, after talking to Smyth, suggested that the Commission confine its formal study to technical matters, and leave policy issues to a covering letter. Lay's proposal might have made easier the preparation of the report, but there was still much to be done. If the White House deadline of the end of November were to be met, the Commission would have to make a special effort with the Department of Defense to reach an understanding of many aspects of the study.[41]

That common ground would be difficult to find was apparent in the Commission's discussions with the Military Liaison Committee on November 20. LeBaron saw in McMahon's goal of maximizing production a mandate for the Commission to stockpile as much ore as possible before new plants were completed. Manson Benedict, director of the Commission's operations analysis staff, explained that ore stockpiling alone was not the most effective means of accumulating resources. It would be more economical to run the new material through the gaseous-diffusion plant as rapidly as possible so that it would be at least partially enriched for further processing in an emergency. To the suggestion that the Commission obtain as much thorium ore as possible, Dean replied that there were no plans to develop weapons using uranium 233.[42]

Priorities seemed to be the biggest stumbling block to agreement between the Commissioners and the committee. LeBaron was mainly concerned about materials and equipment which were needed for new facilities but which were also in short supply for military projects. Until the Commission provided detailed schedules, the Munitions Board could make no firm commitments. The Commission, however, was worried less about the future than about plants presently under construction. Boyer held that completion of the first Savannah River reactor had already fallen behind six months. In most cases the amount of material responsible for delays was small in comparison with requirements for the whole defense effort. Boyer argued that giving the Commission top priorities on these small amounts of critical material would not jeopardize the big military projects. LeBaron made it clear that he would not support a Commission claim to priorities that would override those available to the military. He saw no choice for the Commission except to struggle along from one delivery crisis to another and to meet construction schedules as best it could.

In the closing days of November the Commissioners were hard pressed to follow all the ramifications of the expansion report to the President. The study of technical feasibility alone, which Boyer presented on November 27, contained a number of perplexing questions. It seemed likely, for example, that Jesse C. Johnson and the division of raw materials could procure the 6,500 tons of uranium concentrates required for the expansion effort by 1955, but how much could the Commission count on obtaining the 12,500 tons needed by 1961? Construction of additional reactors at Hanford and Savannah River would meet the Joint Chiefs' recommendation for the increase in plutonium production, but the increase in uranium-235 output would require a third site for a gaseous-diffusion plant. A 200 per cent increase, tripling the production of both materials, would probably require several new sites. Estimates of needed critical materials, manpower, and money seemed fantastic. The Joint Chiefs' plan would cost $5 billion for plants and equipment and would require $1.3 billion for annual operations. The same figures for the 200 per cent expansion were $10 billion and $1.8 billion.[43]

The striking fact was that, even with all this expenditure of money and resources, neither expansion would have any appreciable effect on the weapon stockpile before 1956. Even then, the Joint Chiefs' plan would have a much greater impact than the "200" plan for several more years because the large amount of uranium needed to fill reactors would not be available for weapons. Boyer and the staff concluded that the chiefs' plan appeared feasible and appropriate, but the 200 plan appeared inadvisable in view of the heavy incremental costs and the meager contribution to the stockpile before 1961. Boyer thought the Commission could better spend its money and effort on improving procurement schedules in existing construction projects, designing more efficient reactors and production processes, and improving weapon design.

The Commissioners decided that with a few minor changes the feasibility report could serve as the basis for a recommendation to the President. One revision was to delete the word "appropriate" from Boyer's statement that the plan was "feasible and appropriate." The second adjective seemed to go beyond the Commission's authority. Murray's unflagging optimism that with sufficient effort enough ore could be found to meet any expansion required another change. Smyth would add to the memorandum transmitting the study to the National Security Council a statement that the Commission would increase its efforts to stockpile ore, whether or not the President approved a new expansion.

The memorandum which accompanied the feasibility report added certain qualifications to the general statement that the Joint Chiefs' plan was feasible. The Commission observed that it was already embarked on an expansion effort which would be completed by January, 1955. Improvements in weapon design would have the effect of still another addition to the stockpile. With the new plants under construction, the Commission could eventually reach any weapon goal; more expansion would only ensure reaching that goal by a specific date. Because a new expansion would have no immediate effect on the stockpile, a recommendation for additional facilities would have to rest on the premise that otherwise production after 1956 would not be adequate. The memorandum contained a final warning about the need for overriding priorities of the type the Manhattan project had enjoyed.[44]

Following Smyth's earlier suggestion, the Commissioners wanted to submit a general policy statement going beyond questions of technical feasibility. As a first draft, Smyth had prepared a list of topics which he believed the National Security Council should consider before making any recommendation to the President. Many of these clearly went beyond the Commission's purview. How did estimates of the danger of Soviet attack fit with the fact that any new expansion would not be effective until 1956 or 1957? What understanding did the United States have with its allies about the use of nuclear weapons on hostile troops occupying their territory? Considering the already impressive destructive capacity of the stockpile, was another major expansion justifiable or desirable? What were the assumptions underlying requirements for strategic or tactical weapons? What were the limitations imposed by radiological hazards on the use of nuclear weapons? How did improvements in weapon design or the promising outlook for a thermonuclear weapon affect requirements? Obviously the Commission could not answer such questions; but, as Smyth stated in a covering memorandum, the representatives of State, Defense, and the Commission would have to consider these and other matters in coming to a decision.[45]

The Commissioners accepted most of the topics in Smyth's draft, although Murray took exception to some of the phrasing. The remedy, which Smyth himself proposed, was to make clear in the covering memorandum that the Commissioners did not necessarily approve the precise language in agreeing that the topics deserved consideration. With this qualification, Smyth's draft could go to the White House. It would now be up to Smyth as the Commission's representative to carry these ideas forward in discussions with State and Defense.[46]

A SECOND LABORATORY?

Priorities, procurement goals, construction schedules, and all the other questions which the expansion proposals raised were still overriding concerns when the General Advisory Committee arrived in Washington on December 13, 1951. Smyth described the Commission's efforts in preparing the feasibility study and some of the reasoning that went into it. Boyer and the staff needed most of the afternoon to explain the tables in the feasibility report and the troubles the Commission had encountered in getting adequate priorities for current construction projects.[47]

Important as the issues surrounding the expansion plans were, the uncertain future of Los Alamos was of even deeper concern to those assembled in the Commissioners' conference room. Bradbury's convincing defense of Los Alamos at the committee's October meeting had merely staved off proposals for a second laboratory. If anything, opinions had hardened in the two months since the October meeting. In a letter to Fields, Bradbury had spoken caustically of the "rather thinly veiled criticism" that progress on weapon research and development at Los Alamos was not adequate to the national need. He could only "invite attention to the somewhat ironic fact that every current weapon development has arisen out of the suggestion (and in many cases, the urging) of this Laboratory." Bradbury found it hard to accept criticisms of the laboratory's research efforts at the very time Los Alamos was being called upon to assume a greater burden of what might be called routine production tasks for national defense. Even harder on morale was the Commission's lack of confidence in the laboratory. At least, Bradbury read that attitude into the Commission's repeated delays in approving construction of badly needed buildings and the exasperating requests to justify and rejustify space requirements. As for the charge that Los Alamos had failed to attract personnel, Bradbury pointed to the extensive campaign that John A. Wheeler had organized for thermonuclear research at Princeton. Out of more than a hundred scientists approached only eight had accepted.[48]

If Bradbury's arguments were covered with a veneer of reasonableness and practicality, Teller's were frankly emotional and intuitive. Far from dampening his interest in a second laboratory, Teller's departure from Los Alamos had increased his concern. Early in November, he had called on Oppenheimer at Princeton to express his lack of confidence in Los Alamos. With an intensity few others could muster, he told Oppenheimer that the General Advisory Committee had been wrong in failing to support the proposal for a second laboratory at the October meeting. He wanted a chance to talk to the committee in December. Oppenheimer had agreed.[49]

Teller met with the advisory committee on the morning of December 13. He began by expressing his great respect for his former colleagues at Los Alamos. They were experts in their craft, but their tendency to set for themselves a sequence of limited goals stultified the spirit of research. In the past this approach had made good use of the laboratory's limited resources, but it could not exploit all the possibilities for thermonuclear research. The inflexibility of the Los Alamos organization had been discouraging to some scientists interested in thermonuclear development. Teller did not demand that the new laboratory have the responsibility for all thermonuclear research, but he thought that should be its chief interest. The new facility should also be free to explore other kinds of nuclear weapons and engage in pure research. The laboratory should be as small as possible, probably requiring not more than three hundred people.[50]

The committee's reactions to Teller's remarks ranged over many questions. If there were a new laboratory, how would it recruit personnel? What would be its relationship to Los Alamos? If there were no second laboratory, what changes would bring Los Alamos up to Teller's standards? Throughout the debate Teller insistently maintained the need for urgency. The United States had been slow to take up the thermonuclear weapon; perhaps the Russians were already ahead. Teller warned against postponing the decision on the new laboratory until the test of the New Super device. Success of the test would bring a spirit of complacency which would make recruiting for a new laboratory all the more difficult. To Teller the success or failure of the test device was largely irrelevant to the second laboratory issue, for the test, although important, was only a step toward the goal of a thermonuclear weapon. Beneath his arguments ran the theme that fission and thermonuclear weapon development had grown too large for Los Alamos alone.

Perhaps to give some balance to Teller's views, Oppenheimer had asked Darol K. Froman from Los Alamos to attend the meeting. Ostensibly Froman was there to discuss the results of the *Buster-Jangle* tests and to describe the laboratory's plans for the future, but inevitably the conversation turned to the second laboratory. Froman spent the lunch hour discussing Teller's ideas with the committee members. In the session after lunch he told Oppenheimer and the committee that he could not support Teller's proposals. He repeated familiar Los Alamos arguments: A new laboratory would lead to competition for already scarce talent, while a new thermonuclear division at Los Alamos would create administrative complications.

In the final session of the meeting on December 14, the Commissioners heard Oppenheimer summarize the committee's opinions on a second laboratory. There was general agreement with Teller and Murray that the situation called for more effort and perspective than Los Alamos was bringing to thermonuclear research. It was also important to find some solution that would make the best use of Teller's abilities. Between Teller's insistence on a new laboratory and the limited organizational shifts Bradbury was willing to make, the committee saw an intermediate possibility. A new division at Los Alamos, explicitly charged with broad, long-range assignments and carefully protected from immediate demands, might be the solution. The new division would need a leader acceptable to both Bradbury and Teller, and the committee would have to be diplomatic in suggesting the idea to Bradbury. Rabi did not wish to confront Los Alamos with an ultimatum, but rather to ask the laboratory for suggestions. Individual members of the committee might be able to talk informally with Bradbury. This common-sense approach appealed to the Commissioners, although Murray thought more should be done. Oppenheimer ended with one further point: If the Commissioners accepted the proposal, they would have to act soon. The time for decision was short.

Fields and the division of military application shared the committee's reservations about the need for a second laboratory. A few days after Teller's appearance, Fields presented a comprehensive study of the Los Alamos workload. His report had originated in the September discussions of the second laboratory. In recent years, Fields admitted, Los Alamos had taken on certain production operations on an emergency basis; but the long-term trend was to transfer nonresearch functions elsewhere. New facilities at Sandia; Kansas City, Missouri; and Burlington, Iowa, since 1949 had taken over much of the production and testing of weapon components; and a new plant then under construction at Rocky Flats, Colorado, would further relieve the burden on Los Alamos. After considering past accomplishments at Los Alamos, predicting trends in weapon development, and analyzing the value of competition as a stimulus to research, Fields concluded that a second laboratory was neither desirable nor necessary. One point in Fields's summary intrigued the Commissioners. He suggested that a sense of responsibility for results would be a more effective spur to progress than competition between two laboratories. This argument, plus a catalog of undeniable difficulties a second laboratory would raise, was convincing. If Fields could reduce the workload at Los Alamos, as he proposed to do, there would be no need for a second laboratory. With only Murray dissenting, the Commissioners accepted Fields's recommendation. Bradbury had won the second round.[51]

Before the end of December, Bradbury sent the Commission his plans for the next eighteen months. In fundamental research, the laboratory would continue theoretical and experimental studies of nuclear reactions, cross-sections, and the fission process. Chemistry, radiochemistry, and cryogenics would receive a share of the effort, as would metallurgy and research on high explosives—particularly the mechanism of detonation, equations of state, and hydrodynamics. In describing plans for reactors, accelerators, and computers, Bradbury expressed the hope that the MANIAC would come into operation at Los Alamos during the period. He cited a number of important areas for research on both fission and thermonuclear weapons. For what he hoped was the last time, Bradbury presented his plans for fabricating weapon components at Los Alamos. By July, 1952, he expected all production and stockpiling activities to be transferred elsewhere.[52]

Bradbury's plans for full-scale nuclear tests were impressive. At the Nevada Proving Ground there would be the *Snapper* series in the spring, *Upshot* in the fall of 1952, and a third series in the spring of 1953. At Eniwetok there would be tests in both years. Most attention, however, centered on the Eniwetok series in the fall of 1952. That series, already called Operation *Ivy*, was designed to test the New Super approach.

Through December, 1951, the Commission staff and the Military

Liaison Committee pressed hard to complete the expansion studies for the President and for McMahon and the Joint Committee. One of the most difficult parts of that task was formulating military requirements. As Lovett pointed out to Lay on December 11, the Joint Chiefs were now developing military requirements based on actual needs and independent of uranium ore supplies or production schedules. Therefore the expansion of plutonium and uranium-235 production recommended by the Joint Chiefs was only an interim measure. Lovett did not believe that the Joint Chiefs of Staff could ever state categorically that one certain number of weapons would assure the security of the United States. There were too many variables. Enormous strides in weapon technology had widened the variety of targets suitable for atomic weapons, and new delivery systems, including artillery, would soon be available. Still another factor was the estimation of Russian capabilities. For all these reasons the total number of atomic weapons needed was uncertain, if not unlimited. He believed that the recommendations of the Joint Chiefs should be adopted, with the understanding that a complete study of weapon needs would probably lead to greater requirements.

Lovett's position crystallized the doubts held by Smyth and Glennan. Smyth saw no hope of getting an understanding of weapon requirements that would permit him to judge the need for expansion. Convinced that the nation could no longer assume that there were unlimited resources for defense, he did not see how the President could separate atomic energy from the rest of the military effort. Glennan had come to the same conclusion. He did not construe the Atomic Energy Act as granting the military a blank check for ordering military weapons. The heart of the Commission's concern lay in Lovett's letter of December 11 to Lay. After setting forth that the Joint Chiefs' proposal was only interim, Lovett had acknowledged that ultimately the President would ask, "How much is enough?" Lovett had given no real answer. "It is my opinion that we must err, if we must, on the side of rather too much rather than too little, within our economic capabilities and the over-all defense effort." [53] The wording was vague, the qualifications obscure, but the meaning was plain. Lovett was offering to the Commissioners nothing they could accept to justify spending $5 billion on expansion.

THE END OF THE QUEST

CHAPTER 18

Gordon Dean might have had some reason to hope that 1952 would bring major decisions on issues affecting the Commission. As the year began, he was preparing for a meeting with President Truman, Secretary of State Dean G. Acheson, and Secretary of Defense Robert A. Lovett on expanding fissionable material production. No doubt there would be an expansion, but Dean could not have guessed how thoroughly the group would consider the basis for military requirements or would assess the impact of expansion on the national economy. At least the Commission had been successful in creating a situation in which these matters could be examined if the President desired. The meeting would also give Dean a chance to raise the need for priorities on scarce materials, a rasping issue between the Commission and the Department of Defense. He might also have suspected that the year would see a decision one way or another on a second weapon laboratory.

Of one thing he could be certain: The quadrennial cycle of the American political system would bring a summer and fall of presidential campaigning. The election would take place near the time planned for the detonation of the thermonuclear device, designed as a full-scale test of the principles of the New Super. Success of the test would ratify the decision made almost two years earlier that the nation had to have a thermonuclear weapon as part of its atomic shield.

THE CHURCHILL INTERLUDE

As 1952 began, official Washington awaited the arrival of Winston S. Churchill, for the second time prime minister of Great Britain. Even before the Conservative victory in October, 1951, observers in the American Embassy had predicted Churchill would reorganize the British atomic energy program and strive to restore its close ties to the United States. Judging from experience, the Americans could expect their old friend to use all the eloquence at his command and it behooved them to look to their negotiating position.

In preparing for the Churchill meetings, R. Gordon Arneson incorporated the State Department's ideas in two position papers, one for the Commission, the other for the Department of Defense. For the impending negotiations Arneson saw the United States goals as continuing existing arrangements under the *modus vivendi* and convincing the British of the need to tighten personnel security procedures. To these the Commissioners added a third purpose: to determine whether new elements in the British program offered promising areas for additional cooperation. For their part, the Joint Chiefs of Staff cautioned vigilance to assure that the United States retained full freedom to decide when and where to use the atomic bomb.

On January 5, 1952, the British party landed at the National Airport. After the usual honors, Truman led the seventy-seven-year-old Churchill to the battery of microphones. "I hope," said Truman, "you will enjoy your visit. I hope it will be a satisfactory one." After Churchill responded briefly, Truman added: "Peace on earth is what we are both striving for." [1]

The next evening Churchill was host at the British Embassy to Acheson, Lovett, and General Omar N. Bradley. After dinner the Americans sat around a table with Churchill; Anthony Eden, again secretary for foreign affairs; Sir Oliver Franks, British Ambassador; and Lord Cherwell, Churchill's scientific adviser and a veteran negotiator with Americans on atomic energy.

The conversation ranged widely, from the Near East, where Mohammed Mossadegh of Iran was causing difficulties over oil, to the Far East, where the Americans and British differed over policy toward Chiang Kai-shek. Korea brought up the subject of the atomic bomb. What would happen, the British asked, if there were no armistice, or if an armistice were later broken? The resulting speculation included suggestions of a blockade and air attacks against China. In response to Churchill's opinion that use of the bomb would be unwise, Bradley observed that in the present circumstances there were no suitable targets for this weapon in the Far East. Presumably events could change the situation, but Bradley thought any such discussion was highly theoretical.[2]

In the late afternoon of January 7, Churchill and Truman met at the White House with their advisers to discuss atomic energy. The Prime Minister recalled the days of cooperation during World War II, mentioned the restrictions of the American Atomic Energy Act, and referred to British progress. He disclaimed any desire to go beyond the Act, but he felt certain that talks between Cherwell and the appropriate American authorities could replace the existing unsatisfactory situation with effective cooperation. He suggested a number of areas in which mutual assistance would be beneficial.

Churchill's proposal made sense to Truman. Quickly Acheson and Lovett cautioned that conditions of cooperation had changed. A recent amendment to Section 10a of the Act stipulated that a nation receiving American atomic energy information would have to have an adequate security system. Churchill was confident the British would meet the requirement.[3]

Dean had been out of Washington, first at Savannah River and then in New York when Churchill arrived. On January 9, Dean met Cherwell at a dinner party at the McMahons'. The next morning in Dean's office Cherwell met Smyth, Robert LeBaron, and Arneson. Dean had outlined in advance the points he wanted to cover: the difficulties caused by Fuchs's defection, the limitations on information exchange imposed by the Act, the recently added requirements for adequate security standards, and the spirit in Congress which militated against any general exchange of information.

Cherwell began by setting forth the principle that any cooperation which enabled the British to make more effective use of uranium would be to the advantage of the United States. Agreeing in general, Dean asked for specific topics for information exchange. Cherwell offered several areas, some of which Dean thought verged on weapon information, a topic expressly excluded by the amended Section 10a. LeBaron observed that his department had taken no part in formulating the amendment, and would doubtless have to exercise its own judgment on each request for information. Sensing a dangerous challenge, Cherwell promptly and vigorously reminded the Americans of the spirit of the Churchill-Truman conversations a few days earlier. The logical extension of LeBaron's position, Cherwell believed, would only lead to an unimportant exchange of unclassified information. LeBaron observed that the only significant data in atomic energy fell into the prohibited category of weapons. Cherwell countered by pointing to British efforts to develop power reactors.

It was evident, as Dean frankly admitted, that the Commission and the Department of Defense had differing views. Dean suggested, with LeBaron's concurrence, that the two nations try exchanging information for a year to see if further legislative changes were needed. Before the meeting broke up, Cherwell asked again whether the Commission considered exchange with the British in the United States' interest. Dean firmly agreed, and Smyth voiced his hope that within a year or so it would be possible to coordinate their production efforts.[4]

Cooperation with the British was still a sensitive subject, to be treated cautiously and with deference to Congressional and Defense sensibilities, but it no longer held the explosive power which had caused so much anxiety only a year or two earlier. Probably several factors accounted for the change. The second and third Russian detonations must have been grim reminders of who was friend and who was foe. The British program was now substantial, and its leaders could confidently expect to test a nuclear device in the fall of 1952. There was also reason to hope that tighter personnel security regulations would alleviate some American concern. Undoubtedly the amendment to Section 10a exerted a calming influence. Although Dean and his colleagues were left with little discretion, the procedures prevented the misunderstandings, doubts, and confusion that had caused the first Commission and the Joint Committee so much tension.

A PRESIDENTIAL DECISION

Technically the Commission's report to the Joint Committee on maximizing the role of atomic energy in national security was overdue in January, 1952. Despite the effort required to complete the feasibility study for the National Security Council, the Commission staff could have finished the report by the end of 1951, but Truman had asked Dean to hold it until the Executive Branch had made its decision on expansion. When that would be Dean did not know, but probably not until after the State of the Union message and the President's annual economic report to Congress.

Events in the intervening weeks gave the Commissioners reason to believe that the expansion issue would receive broad consideration. In a sense, the procedure would be as important as the decision itself. Certainly the spectrum of opinion suggested the need for a full-scale review. On one hand, Acheson had endorsed the plan on the grounds that it would give the United States overwhelming superiority in nuclear weapons in a period when the Soviet nuclear capability would be substantial. On the other hand, Charles E. Wilson in the Office of Defense Mobilization agreed with Dean that the Joint Chiefs had not yet presented any justification for building plants that would not come into production for years. As no one else, Wilson was aware of the heavy demand the expansion would make on critical materials.[5]

Lovett firmly accepted the position that on matters of military requirements the Joint Chiefs and the Secretary of Defense were answerable only to the President. On this particular issue, however, the President was changing procedures. In the past the Secretary of State, the Secretary of Defense, and the chairman of the Atomic Energy Commission as a special committee had jointly proposed written recommendations to the President. This time Truman wanted to hear a discussion of the alternatives in a joint meeting. LeBaron thought that the change might be the result of the Commission's argument that it could not support expansion without knowing the basis for the requirements. While members of the Defense group working on the study felt that Truman should look to Lovett and Bradley on this matter, they did prepare charts on weapon requirements for Truman, to be used either at the meeting or, if he desired, privately.[6]

On January 14, 1952, the Commissioners discussed their strategy for the meeting with the President, now only two days off. Murray thought Dean should state that attaining the production goal in the Joint Chiefs' proposal was possible, and that perhaps an even greater increase was practicable.

Smyth thought Dean should be free to use his own judgment, particularly if the discussion raised points unknown to the Commission. Dean promised to circulate a draft of his proposed remarks. On one matter there was complete agreement: It had to be crystal clear that meeting any expansion schedule depended upon correcting the priority situation.[7]

On the afternoon of January 16, Dean went to the White House armed with charts and his statement, not knowing whether the meeting would end with a decision or an assignment of further studies. Truman began by declaring that the further expansion of atomic energy production was one of the most important matters ever to come before him, a curious statement from one who had decided to use the atomic bomb in World War II and had determined that the nation must have thermonuclear weapons.

Lovett built his presentation around the theme that the rapid development of nuclear weapon technology had made tactical weapons possible and had changed the basic assumptions for military requirements. From the standpoint of energy released per dollar, fissionable material was less expensive than conventional explosives. Furthermore, if atomic weapons were never used, the fissionable material would later be available for peaceful purposes. Dean was ready to pick up the idea when Lovett turned to him. The argument was valid, Dean said, but hardly a good justification for the expansion. But was it not true, the President asked, that the nuclear components could be converted to civilian uses? Again admitting the fact, Dean believed that peaceful applications could not justify an effort which would place so heavy a burden on the national economy.

In Bradley's absence, General Hoyt S. Vandenberg spoke for the Joint Chiefs of Staff. He cited the number of weapons believed necessary to assure the national security in the event of an all-out war. There was, he said, nothing magical about the figure; it was derived from the estimates of the various services. As Vandenberg talked from the charts, Dean commented briefly on some of the assumptions. Acheson used only a few sentences to set forth his views. He saw no signs that international tensions were decreasing. The Russians were undoubtedly doing all they could; the Americans could hardly do less.

Dean was next. Carefully he explained that the Commission's reluctance to accept the recommended expansion did not stem from opposition to the proposal, but from an obligation which the Act imposed on the Commission. He and his colleagues were convinced that any expansion had to rest on the assumption that production from existing facilities and those under construction would not be sufficient. The Commission thought the Joint Chiefs' plan was feasible if overriding priorities were granted. Wilson frankly admitted that the estimated requirements for critical materials and equipment had appalled him. The Commission's construction schedule would require some miracles. In view of the military importance of the project, Wilson saw no alternatives, but he warned that there would be trouble, especially in 1952 and 1953.

Truman asked Frederick J. Lawton, director of the Bureau of the Budget, a few questions and made some general remarks about military requirements. Then he paused. "In view of these considerations, does anyone feel we should not undertake this?" There was no response. The President nodded and asked Lawton to get the necessary budget documents ready for Congress.[8]

The next day James S. Lay told Dean that Truman wanted the Commission, in collaboration with the Department of Defense and the Office of Defense Mobilization, to draw up a Presidential directive carrying out the decision. Dean was relieved that the Commission would have the major responsibility in preparing the document. The Commission could best decide how to meet production goals and therefore would be in a better position to get the necessary priorities. Dean felt, as well, that previous cooperation with the Department of Defense had been cumbersome and caused tension. Lay also wanted Dean's advice on a public statement by the President. Truman was thinking of a background press conference on Saturday, January 19, when he might refer to the expansion part of the budget he was sending to Congress on Monday. Dean feared Brien McMahon might call a hearing before Monday. Since McMahon was to see the President just before noon on January 17, perhaps Truman could ask him not to call the hearing before the budget was delivered. Truman adopted the suggestion, but much to his anger McMahon broke the news to the press as he left the White House.[9]

McMahon's precipitous action, which received little attention in the newspapers, no doubt reflected some of the frustration he had felt in recent weeks. In the summer of 1951, he and the Joint Committee had taken the initiative to promote the expansion, but the Administration had neatly shunted the committee aside until its own proposal was ready. Not until January 17 did McMahon receive the report he had requested on "maximizing the role" of atomic energy for military purposes. Closely tied to the chiefs' proposal, the report contained the Commission's feasibility study as an attachment. Also transmitted was the usual opinion from Murray that any failure to obtain the required amounts of uranium ore would be the result of a lack of effort, not the paucity of nature.[10]

McMahon tried to regain the initiative. On January 22 he held a meeting with the Commission to examine the expansion decision. It was evident from a memorandum which William L. Borden had prepared in advance that McMahon and his aide were not completely convinced that the expansion was large enough or that the Commission would prosecute the effort with sufficient vigor. On February 6, McMahon tried to entice Lovett into recommending a larger program by citing Murray's views that ore supplies were ample to support a still greater effort. Lovett avoided the lure. The chiefs' plan, he said, would enable the nation to meet its stockpile goals ahead of previous schedules. In all honesty, he could not say a greater expansion was warranted. McMahon and Jackson still held doubts, but they could take some comfort from the fact that a decision had been made.[11]

THE BUYER-CUSTOMER RELATIONSHIP

As the hearings had shown, the Commission and the Department of Defense could now speak with a fair degree of unity on the subject of expansion, but achieving that unity had raised again the old question of custody. As Dean later learned, Lovett had discussed with Truman on January 29 the Commission's role in advising the President on the use of nuclear weapons. Truman again turned to the special committee of Defense, State, and Commission leaders for a recommendation.

The Joint Chiefs held that the number of nuclear weapons entering the stockpile was revolutionizing military thought and changing the development pattern for future delivery systems. Nuclear weapons were now a central factor in military planning. Because the Joint Chiefs had to be prepared for emergencies, they were strongly opposed to any agency placing itself between them and the President on military matters. The Commission merely produced atomic weapons; the Department of Defense as consumer should have custody. The chiefs thought the existing divided responsibility was inimical to the nation's best interest.[12]

Before framing the Commission's position, Dean discussed custody with LeBaron and Arneson. Then he asked Roy B. Snapp, the Commission's secretary, to pull together a historical summary of the custody debate. For Snapp's guidance, Dean outlined some of his thoughts. No system of custody, he reflected, would be feasible if it involved substantial delay in transferring a Presidential order to the military commanders. His bedrock philosophy was: "No system of custody should give to the military exclusive control of the fissionable material which the country looks to the civilian Commission to hold for peaceful purposes, if not exploded in war." At the very least, weapons deployed in an emergency were only on loan.

The size of the Commission's files on custody gave Snapp some difficulty in preparing his report; but with swift and careful judgment he selected the materials and completed the assignment within a week. Dean sent Snapp's paper to Oppenheimer, who was in Washington for a meeting of the General Advisory Committee. On February 17, Oppenheimer summed up the views of the committee. It shared the concern of the Joint Chiefs that delays in the use of atomic weapons had to be kept to an absolute minimum, and recognized that there were certain targets where the loss even of hours could have serious consequences. Moreover, the committee agreed that under existing arrangements for storage and deployment, delays were inevitable. Therefore the group hoped that some way could be found to minimize these difficulties. Changing custody, however, did not seem to be the entire answer. Further, the Joint Chiefs had stated that no other agency should interpose itself between them and the President in recommending military courses of action, nor in determining when, how, and in what numbers and types atomic weapons were to be used; and that the Department of Defense had the military and technical competence in atomic weapons to be the principal source of advice to the President. These arguments the advisory committee rejected, finding that they seemed to limit the authority of the President to consult with civilians in bringing political considerations to bear on strategic planning. The summary was a hurried effort, Oppenheimer admitted to Dean, but it could be used if the custody struggle erupted again. As for himself, Oppenheimer confessed that he could not decide whether to take the military position in such matters, as set forth in the document, seriously or as a "relatively meaningless piece of insolence."

By this time Dean may well have concluded that he was merely going through another round in a continuing struggle. He and Oppenheimer might reject as captious the buyer-customer relationship, but the plenitude of nuclear weapons was unquestionably changing military perspectives. Every successive expansion of the Commission's production capabilities had raised the custody issue in a new form. There was no reason to believe the current expansion would lead to any different result.[13]

Dean probably had some intimation of the tension caused among the armed services by the increasing size and versatility of the nuclear stockpile. On February 27, 1952, he and his fellow Commissioners called for copies of the Project *Vista* report. The project had been established in the summer of 1951 under Lee A. DuBridge at the California Institute of Technology to study military problems which would confront the NATO forces in the event of Russian aggression. Robert F. Bacher had led the group which was analyzing the tactical role of atomic weapons. In the fall of 1951 he had asked Oppenheimer to look at the preliminary draft of the team's work. Oppenheimer had gone to Europe with a few members of the project to talk to Eisenhower, had pondered the conclusions, and with his usual facility had polished the language. In tactical situations the Project *Vista* group found a need for atomic weapons which could be delivered accurately in any weather to support ground forces. Tactical uses of hydrogen bombs received light treatment. Some of those who followed the project saw in the report a threat to the mission of the Strategic Air Command and its claim to most of the atomic stockpile. Some remembered that Oppenheimer in the military objectives panel study issued in December, 1950, had called for development of atomic weapons and relegated thermonuclear weapon work to a lesser priority. In both instances it was possible to interpret the conclusions as further evidence of Oppenheimer's distaste for the hydrogen bomb effort.[14]

As for the Presidential directive on expansion, Dean's major worry was that the Joint Chiefs might insist on including a specific requirement for a third reactor site. The Commission staff did not think another reactor complex was needed. In November, 1951, the idea had been to build three new reactors at Hanford and three at Savannah River. But by February, 1952, studies by General Electric had demonstrated the larger production capacity of the new "Jumbo" design. It would save both money and material to build two Jumbos at Hanford and an improved heavy-water reactor at Savannah River. On February 20, the day Dean sent the draft directive to the President, Richard W. Cook authorized David F. Shaw, the Hanford manager, to begin preliminary planning for the Jumbo reactors.

The Presidential directive was short and simple. It cited the annual production rates which would require constructing new reactors at present sites, increasing existing gaseous-diffusion capacity at Oak Ridge and Paducah, and building a diffusion plant at a new location. Roughly the plan would cost the nation about $4.9 billion for construction and would add about $700 million in annual operating costs when all the plants were running. Truman's only remaining concerns were the probable economic impact and the political effects in an election year. He discussed both aspects privately with Dean, Murray, and McMahon on February 11. Two weeks later, on February 25, he signed the directive. The Commission was free to forge ahead.[15]

NEW LIFE FOR LIVERMORE

Although McMahon had been unable to change the President's decision on the expansion, he still hoped to convince the Commission to increase its efforts on the thermonuclear weapon. An important step in that direction, in McMahon's opinion, would be the establishment of a second weapon laboratory. On February 21, 1952, he summoned the Commissioners to a closed hearing. He was worried that the Soviet Union might be the first nation to test a thermonuclear device and to have a deliverable hydrogen bomb. He had before him most of the documents expressing the Commission's position on the expansion effort and the second laboratory since the fall of 1951. Now he wanted to know what progress the Commission was making.

After Smyth summarized work at Los Alamos, Kenneth E. Fields described how other contractors were beginning to take over the development and fabrication of components for the test of a thermonuclear device in the fall of 1952. Briefly he described the work of American Car and Foundry, the Arthur D. Little Company, and the National Bureau of Standards. In one aspect of the work, Fields thought the Commission had almost every qualified scientist employed. Every individual who might be expected to work at Los Alamos was already there; even Edward Teller visited the laboratory frequently. Dean said he knew of no one who would work at a new laboratory but not at Los Alamos. Murray, however, contended that a new laboratory might attract competent scientists not already involved in the project. He paid tribute to Los Alamos, but he would not accept the proposition that competition was not a good stimulus for research. It was a difficult matter, McMahon admitted, but the Commission would have to decide. Nothing could be allowed to keep the United States from being first with the hydrogen bomb.[16]

A few weeks later McMahon asked Lovett for his views on the thermonuclear effort and the second laboratory. McMahon was sowing his questions on fertile ground. For several months military interest in a second laboratory had been growing, especially in the Air Force. David T. Griggs, an energetic young geophysicist at the University of California at Los Angeles, had followed the development of the thermonuclear weapon with great interest as part of his duties as the Air Force's chief scientist. He had been as susceptible as most people to Teller's enthusiasm for the thermonuclear weapon. Furthermore, Griggs learned that Teller's hopes for establishing a second laboratory were more than an idle dream.

On February 2, during a visit to Berkeley, Ernest O. Lawrence had taken Teller to Livermore, where most of the Radiation Laboratory's senior

staff were working on Lawrence's latest pride and joy, the materials testing accelerator. Lawrence's daring idea was to build a linear accelerator of incredible size and power which would provide neutrons for generating plutonium or tritium. The massive vacuum tank for the accelerator stood in a barnlike, corrugated-metal building as long as a football field. Looming above the valley floor, it was visible for miles. The Mark I accelerator at Livermore, however, was but a small section of the full-scale machine which the Commission was planning to build at a new site near Weldon Spring, Missouri.[17]

When Teller visited Livermore in February, the Mark I was nearing completion and the first tests were to begin in several weeks. Lawrence was confident the machine would work and would soon make possible the production of large amounts of fissionable material without consuming substantial quantities of uranium 235. Once the production model had been built at Weldon Spring, the Livermore site would provide excellent facilities for Teller's second laboratory. Back in Berkeley that evening, Lawrence asked Teller if he would consider leaving the University of Chicago to establish the new laboratory at Livermore. Teller said he would, provided the mission included thermonuclear work. In Lawrence, Teller had an advocate whose enthusiasm for new ideas matched his own. Both men were convinced they could find the scientists to staff the laboratory.

A few days later Griggs called Teller to tell him that Air Force Secretary Thomas K. Finletter had agreed to see Teller in Washington. Once in Finletter's office, Teller found the Secretary preoccupied and rather cool to Teller's ideas, but as the scientist talked, the Secretary's interest began to grow. As a result of the meeting, Finletter agreed to visit Los Alamos to review the work on thermonuclear research himself. As usual Carson Mark and the Los Alamos staff provided an unimpassioned and soundly factual account of the work that had to be done before the New Super could be tested.

The crucial question for Teller was how quickly he could bring his ideas to bear on Pentagon policy. His meeting with Finletter obviously had not influenced Lovett's statement to McMahon on March 9 that it would be a mistake to move thermonuclear work from Los Alamos at that time. The only source of encouragement was Lovett's concession that steps to create a second laboratory should begin at once. In the following weeks Teller made faster headway. On March 19, Griggs arranged for him to brief Lovett and the three service secretaries. After the meeting the secretaries asked Lovett to take the question of the second laboratory to the National Security Council. On April 1, 1952, Dean went to the Pentagon for a Teller briefing with Acheson and Deputy Secretary of Defense William C. Foster. There was now no doubt that a second laboratory would be established at Livermore.[18]

Norris E. Bradbury spent two days at Berkeley in May to work out arrangements for weapon work at Livermore. He suggested that eventually Livermore should undertake weapon tests, but for the moment the new laboratory should concentrate on the New Super. These tasks would serve the dual purpose of educating the Livermore group and bringing the two labora-
tories into direct contact. Bradbury's main concern was that Los Alamos not become a recruiting ground or a supply house for Livermore.

The choice of Livermore as the second laboratory site looked even better as the fortunes of the materials testing accelerator declined during the summer of 1952. Despite troubles with minor leaks in the huge vacuum chamber, the accelerator had passed the first vacuum and voltage tests in April. Not only were technical results heartening, but the scientists from the Radiation Laboratory had also built an excellent working relationship with the engineers from the California Research and Development Corporation under the energetic and practical leadership of Frederick Powell. As summer approached, however, the question of whether the accelerator would be useful in the production effort began to overshadow the claims of technical success. Until Mark I was actually operating, the Commission decided to postpone the construction of Mark II at Weldon Spring. Lawrence was already turning to a new idea of building a production cyclotron, an approach Smyth doubted Congress would ever support. In April, Manson Benedict and his operations analysis staff in Washington had concluded that there was no economic justification for building production accelerators. Against the growing supply of uranium and the improving efficiency of production reactors, the production accelerator could not compete. On August 7, 1952, the Commission deferred all plans for Mark II and left the Mark I to die a natural death at Livermore.[19]

By September, 1952, weapon development had replaced the production accelerator as the driving force at Livermore. When Lawrence and Teller met with the Commissioners on September 8, both were pleased with the laboratory's rapidly developing capabilities for weapon research. Original plans for diagnostic measurements at Livermore had evolved into more ambitious projects related to new weapon designs. Lawrence felt confident that close cooperation with Los Alamos would prevent duplication. Teller and Herbert

F. York outlined Livermore's plans in some detail and Wallace B. Reynolds, the Radiation Laboratory's business manager, pointed out that there were already 123 scientific and technical people working on weapons at Livermore. He thought the total, including supporting personnel, would reach 1,000 in two years. Whatever the reservations in the past, the Commission now had a second laboratory. Livermore had found a new role in the nation's atomic energy program.[20]

LOOKING TO THE FUTURE

The political skirmishing in the early months of 1952 was an unmistakable sign of a Presidential election year. These first tremors of the upheaval to come must have given Dean cause to speculate about his own future. His term would expire in June, 1953, but conceivably he might wish to leave the Commission sooner than that. By the time the national political parties held their conventions in July, Dean was better able to judge how extensive the changes might be. In March, Truman had decided not to seek a second term, a move which threw the Presidential race wide open. In July at Chicago the Republicans had nominated Dwight D. Eisenhower and a few weeks later in the same arena the Democrats had selected Adlai E. Stevenson. Undoubtedly many of Dean's associates in the Truman Administration would be leaving Washington in January, 1953. Dean thought Acheson would almost surely go, and Lovett would probably welcome a chance to return to private business.

One event Dean could not have predicted was the loss of Brien McMahon. After a brief illness he died of cancer at Georgetown Hospital in Washington on July 28. Not yet forty-nine years old, McMahon had left an indelible mark on the history of atomic energy. More than any other American, he had come to personify the new force of atomic energy in the nation's life. From Vista, California, Dean issued a statement calling McMahon a statesman of vision and energy, a good friend of the Commission, and a champion of world peace. Truman in Kansas City, Missouri, paid tribute to McMahon, whose greatest achievements, in the President's estimation, were those he made as chairman of the Joint Committee.[21]

How serious McMahon had been about seeking the Presidency was not easy to say. In the maneuvering of Democratic leaders after Truman's decision not to seek reelection, McMahon had entered the lists as a favorite son, perhaps with hopes of becoming the Vice-Presidential nominee. From his sickbed he had telephoned the Democratic state convention in Hartford that, if elected, he would direct the Atomic Energy Commission to manufacture hydrogen bombs by the thousands. A man moved by strong convictions, McMahon never faltered in his determination that in war and peace his nation would be first in atomic energy.

FORGING THE SHIELD

Whatever the future might bring, the Commissioners still faced the day-by-day task of translating the Presidential directive into the plants, fissionable material, and weapons the national security required. One unpleasant task Dean could not ignore was ironing out his differences with Defense over control of the weapon stockpile. The encounter with Lovett and the Joint Chiefs in February, 1952, had done no permanent damage, but it had failed to resolve the misunderstanding. More than anything else, Dean and his colleagues resented the Joint Chiefs' assertion that divided responsibilities for the custody of the stockpile were inimical to the best interests of the United States. Dean, Glennan, and Murray were all willing to see a substantial portion of the stockpile under military control. There was no escaping the fact, however, that both the military and the Commission had statutory responsibilities for building and maintaining the stockpile. What both sides needed, in Dean's opinion, was a clear understanding of their own part in that task.[22]

A special committee consisting of Dean, Acheson, and Lovett succeeded in September, 1952, in defining a procedure for carrying issues of atomic energy policy to the President. The National Security Council, the new statement declared, had the statutory responsibility to advise the President on domestic, foreign, and military policies as they affected national security. The special committee representing Defense, State, and the Commission would give its counsel on Presidential directives affecting all three agencies. These opinions were to be clarifications only and were not to alter the positions of the Joint Chiefs as the main source of military advice. As for custody, the armed forces were to control a much greater share of the stockpile so that they would have the necessary flexibility for military operations. The Commission would retain custody of the remaining weapons and would have access to the entire stockpile for technical purposes. In establishing military requirements, the Department of Defense would state the needs for numbers and types of weapons; the Commission would propose production rates for meeting the goals; and the President from both views would determine the schedule for weapon production. Hopefully, the new formula would more nearly fit the rapidly changing structure of weapon technology.[23]

Although the directive the President had signed on February 25, 1952, had granted the Commission the manpower and materials it would need to meet construction schedules, priority difficulties continually dogged the new expansion program. Manly Fleischmann, as head of the Defense Production Administration, was close enough to the Commission's troubles to appreciate them. In late January, he had asked the Joint Chiefs to establish a single priority for certain Commission projects. While waiting for a response, Fleischmann and Henry H. Fowler, head of the National Production Authority, did what they could. Each appointed a deputy on Commission priorities. Fowler assigned a representative to Savannah River and established a branch office at Wilmington, Delaware, with the sole mission of helping du Pont.

The Joint Chiefs' reply finally came on March 5, 1952. Although admitting that the Commission should have help, the chiefs thought a superpriority would jeopardize attempts to correct some of the existing difficulties. They proposed further consideration of a detailed list of critical items. To Dean more study meant more delay. The measures which Fleischmann and Fowler had taken were inadequate, but they had shown that there were few actual conflicts between the Commission and the Department of Defense. On July 7, John R. Steelman, now acting director of Defense Mobilization, agreed to put Savannah River at the top of the Defense master urgency list. Until February 1, 1953, and with a limit of $45 million, the

Wilmington office of the National Production Authority could issue in two days top priorities for critical items certified by du Pont.[24]

Despite priority difficulties, the construction outlook was improving by the summer of 1952. The first Savannah River reactor was scheduled for completion in March, 1953. Four of the twenty-four dual-temperature heavy-water units were undergoing preliminary testing. The C reactor at Hanford was nearly complete, and the working force in November would turn to building the Jumbo reactors, now called KE and KW. In August, Cook gave the Commissioners some impressive statistics on the new units. In dimensions, amount of graphite, number of process tubes, cooling water requirements, and above all in power level, the new reactors were much larger than the old. Improved technology, however, made possible a reduction in the number of water pumps and a simplified water plant.

Oak Ridge in the summer of 1952 was procuring construction material for the K-33 gaseous-diffusion plant, and Samuel R. Sapirie, the Oak Ridge manager, hoped to supplement his tentative construction estimates with a firm schedule in October. Labor difficulties still hampered construction at Paducah, where the C-35 and C-37 diffusion plants were to be added to the C-31 and C-33 installations. The new gaseous-diffusion plant called for in the expansion program was to be built at Portsmouth, Ohio. Kenneth A. Dunbar, the Commission's manager at the new site, knew that Peter Kiewit's Sons would do the construction, but the operating contractor had not been chosen. By the end of August, the Goodyear Tire and Rubber Company was the leading contender for the contract.

New facilities were also springing up at other locations to enlarge and strengthen the production chain from ore to weapons. A new feed materials production center at Fernald, Ohio, near Cincinnati, would relieve some of the heavy burden the Mallinckrodt Chemical Works had been carrying since 1942 in refining uranium concentrates to provide feed for the reactors and diffusion plants. As part of the weapon production complex, new component plants were under construction at Rocky Flats, Colorado, and Amarillo, Texas. Caught up in the Commission's total construction activities in the summer of 1952 were about 150,000 workers, including Commission and contractor employees but not military personnel serving with the Commission.[25]

THE DEAN ADMINISTRATION

By the autumn of 1952 it was clear that the Dean Commission was well along in its search for a thermonuclear weapon. That pursuit had been a dominating force upon Dean and his associates, and had given them and the staff a unifying purpose which the Lilienthal Commission had lacked. Moreover, the somewhat chaotic character of the early days when trial and error had been necessary had yielded a harvest of experience, and Dean had beneath him a mature and seasoned staff. With these factors Dean's personality combined to give a style which characterized the Commission in 1952.

Marion W. Boyer readily accepted the restricted role of the general manager. As he told reporters, his was "strictly a production job"; he left matters of policy to the Commissioners. Aware that his lack of background in atomic energy and of experience on the Washington scene were his limitations, Boyer wisely and effectively concentrated his efforts on building a smooth and efficient staff. Membership of the staff had changed since Carroll L. Wilson's resignation. Joseph A. Volpe, Jr., Wilson's trusted legal adviser, had gone into private practice at the end of 1950, and had been succeeded as general counsel by his deputy, Everett L. Hollis. Carleton Shugg had found working with Boyer pleasant enough, but he missed the free-wheeling days of 1949 and 1950. Seeking more challenge than the job as Boyer's deputy offered, Shugg had resigned in January, 1951, to return to the shipbuilding industry. Walter J. Williams, a stalwart of the Washington staff, had succeeded Shugg as deputy general manager and Cook had come to Washington as director of production. Lindsley H. Noble, whom Wilson had appointed controller in 1950, had resigned in May, 1952. Fletcher C. Waller, who had served Wilson in several capacities, but mainly as director of organization and personnel, had resigned the following month and had been succeeded by Oscar S. Smith, the director of labor relations. In response to Dean's pleas, the Department of Defense had extended General James McCormack's tour as director of military application for six months at the end of 1950, but Dean welcomed the assignment of Colonel Kenneth E. Fields, an outstanding officer with a sound knowledge of the Commission's activities, as McCormack's replacement in June, 1951. In the research and development part of the Commission's program, only Lawrence R. Hafstad was still in harness as director of reactor development. Thomas H. Johnson, a physicist from Brookhaven, had replaced Kenneth S. Pitzer as director of research in June, 1951, and John C. Bugher, deputy director of biology and medicine, had succeeded Shields Warren in June, 1952. Of those who had been appointed in 1947, only Morse Salisbury, director of the public and technical information service, was still on the job.[26]

At the Commissioners' level the last remnant of the Lilienthal regime disappeared with Pike's resignation in December, 1951. Aware of Pike's intention in November, Donald Dawson at the White House had already found a replacement in Eugene M. Zuckert, Assistant Secretary of the Air Force in charge of management operations. Although McMahon liked Zuckert, he was concerned about appointing someone from Connecticut. Dean too thought this might cause trouble. Once Zuckert had joined the Commission, however, Dean found him to have an incisive mind and a good sense of administration. Just forty years old, Zuckert had studied law at Yale and business administration at Harvard. After three years in Washington as an attorney with the Securities and Exchange Commission, Zuckert had returned to the Harvard Business School as a professor and an associate dean during World War II. Having helped to organize the Department of the Air Force in 1946, he had become assistant secretary to W. Stuart Symington a year later. Six years in the Pentagon had left Zuckert a seasoned veteran of the Washington scene.[27]

TOPNOTCH

Dean and his colleagues saw policy matters as touching every facet of the Commission's operations. As a consequence, the Commissioners' conference room had replaced the general manager's office as the cockpit for discussions and decisions. The growing demand of the Commissioners for information had its hazards. In May, 1952, Glennan complained that so many of the staff were attending Commission meetings that it was hard to get frank expressions of opinion. As a partial solution he suggested regularly scheduled oral reports to the Commissioners on such matters as construction progress, finance, production rates, the weapon stockpile, and reactor development.[28]

Having assumed full responsibility for making policy decisions, Dean and his fellow Commissioners no longer relied on the general manager to flush out important issues. To keep tabs on policy matters, Snapp had set up a small policy analysis staff in his own office under the direction of Philip J. Farley, who had served in the secretariat since 1947. Before joining the Commission, Farley had earned his doctorate in English at the University of California. His keen mind and intellectual bent had helped him to master all the subtleties and nuances of the Commission form of administration. From his broad knowledge of the Commission's program, he could grasp the crucial issues and present them to the Commissioners in a provocative way.[29]

One of Farley's policy studies in August, 1952, suggested the long-term possibility that private industry and other agencies of Government might eventually assume all the Commission's responsibilities, leaving the Commission with no reason for existence. The Department of Defense might well take over weapon production; private industry might produce all the plutonium necessary and generate electric power. The mining industry might finance uranium exploration and production. The National Science Foundation could conceivably take over the government's responsibility for basic nuclear research and the Public Health Service the regulation of radiation uses. Farley's point was not to contend that such a trend should or would occur, but rather to suggest the importance of examining the Commission's functions and relationships against the rapidly changing pattern of American life.

Farley's paper succeeded in stimulating a discussion of long-term policy questions among the Commissioners. Glennan, who was always seeking a higher perspective for looking at Commission business, became fascinated with the discussion and suggested that the Commissioners get away from Washington for several days in September to consider some of the broad questions Farley had raised. Dean, never losing touch with the practical, expressed the hope that Farley could have several of his policy studies ready for the conference, which soon acquired the name *Topnotch.*[30]

The agenda which Farley submitted to the Commissioners several weeks later reflected many of the concerns of the Dean administration. How could the Commission more sharply define the role of the field offices? Did decentralization of authority still make sense? What could be done to free the Commissioners from the deluge of meetings and papers? Could the use of cost-plus-fixed-fee contracts and reliance on a few proven contractors yield to more relaxed and normal Government practices? How could the Commission best "educate" the new President who would replace Truman in 1953? How could the Commission improve relationships with the military? All these questions were much on the minds of the Commissioners, but the letter for the new President seemed the best subject around which to organize *Topnotch.* With drafts of the proposed letter, the Commissioners, Boyer, Snapp, and Farley set off by train for the Greenbrier at White Sulphur Springs, West Virginia, on September 25.[31]

When the conference opened on Friday morning, September 26, the first topic was the letter to the President and the Commissioners' relationships with the Chief Executive. The consensus was that through the special committee of the National Security Council the Commission had reasonable access to the President, but the Commissioners could not speak so highly of ties to the Department of Defense thrcugh the Military Liaison Committee. Part of the trouble was that Dean found it difficult to work with LeBaron. The Commissioners also favored a new committee in which military members would have the authority to speak for the Department of Defense. The Commissioners hoped that something could be done, perhaps by amending the Atomic

Energy Act, to put senior representatives of the military departments on the committee. The Commissioners also discussed the division of responsibility with the Department of Defense in matters of weapon production.[32]

In considering relations with private industry, the Commissioners at *Topnotch* saw very little opportunity in the next ten or fifteen years for private industry to participate in atomic energy activities, except perhaps in building and operating power reactors. There was, however, great interest in nuclear power plants in the autumn of 1952, and the Commissioners were unanimous in supporting any actions which would assist private industry to enter the field.

In the final session on September 29 the discussion turned again to the briefing for the new President, members of the Cabinet, and the Joint Committee. In all of these the Commissioners themselves would bear the main burden of presentation. The last topic was to develop a new schedule which the Commissioners would follow each week in conducting their business. As Dean and his associates started back to Washington on the evening train, they agreed that *Topnotch* had been a success. It had been exhilarating to shake off for a few days the daily routine of details and tc look again at the fundamental responsibilities. One of these was approaching culmination: The test of the thermonuclear device was little more than a month away.

IVY-MIKE

On the morning of June 30, 1952, Dean entered the President's oval office as he had done many times before, but this was no ordinary discussion of priorities or even of military requirements. Anyone acquainted with the Commission's staff might have guessed that the subject was weapons when Bradbury and Fields followed the Commissioners into the White House. Once seated in the President's office, Fields opened a wooden carrying case to reveal a small model of the thermonuclear device—christened *Mike*—which would be detonated in the Pacific on November 1, 1952, as part of the *Ivy* series. The purpose of the session was to show Truman the model and to explain how the device would work. It was not an occasion for policy matters.[33]

That there were policy issues Bradbury knew. The *Mike* device would be the most powerful detonation ever created by man. Its very size would lead the public to associate it with the thermonuclear effort. Another complication was that the test would come only three days before the Presidential election. Oppenheimer and Hans A. Bethe had already raised the possibility of postponement. They feared that the test, coming at a time of heightened political emotion, would be seized upon by irresponsible elements in a last-minute attempt to sway the vote. Bradbury could see no technical reasons for delay except adverse weather conditions. On the average, there would be five days in October, three in November, and one or two in December suitable for the test. Reversing the order and firing a smaller device first might damage the test structures built for *Mike*. The Los Alamos laboratory, its contractors, their subcontractors, and the military task force with its ships, planes, and men were all aiming at an October 31 date—November 1 in the Pacific.

To change the schedule was not a light task. Within a limited period the schedule could be shifted, but Bradbury thought that a delay past mid-November would throw the test over to March of the next year. Such a delay would conflict with the already overscheduled spring tests and hurt the morale of those who had labored under the insistent demands for speed. Bradbury hoped Eisenhower, Stevenson, and Truman could be apprised of the difficulty.[34]

Dean discussed the possibility of changing the date in August with Lovett and, in Acheson's absence, with Arneson and Paul H. Nitze from the Department of State. Lovett was opposed to altering the timetable, and he confirmed his initial reaction by a quick check with Bradley and Foster. Their reasons were not identical, Lovett noticed with amused interest, but all agreed delay would cause more harm than holding to the schedule. Doubtless some people would draw political implications from the close coincidence with the election date, but was this any worse than obviously postponing the test for political reasons? Besides, a carefully worded announcement issued in advance would draw the sting of some of the adverse reaction. Arneson thought the matter would come up naturally when Truman authorized the expenditure of fissionable materials for the test. These recommendations to the President usually contained test dates. Dean rather thought that among themselves they should be able to formulate a position for the President. When Bradbury telephoned on August 12 to learn if there had been a decision, Dean could not give a definite answer.[35]

The request for Presidential approval went to the special committee of the National Security Council on August 15, 1952, but with no date specified. Although Dean himself had no strong opinions, all his colleagues wanted to postpone *Mike* until after the election. Dean was anxious to confirm the date for the benefit of the testing group, and told Lay that Truman should be aware of the implications when his approval was requested. On August 28 Lay told Dean that the President would not change the date, but he would certainly be pleased if technical reasons caused a postponement. Lay did not see how four or five days could make much difference in the cost. On September 9, the Commission and the Department of Defense issued their press release that in the autumn months Joint Task Force 132, under the command of Major General Percy W. Clarkson, would hold atomic tests in the Pacific. There would be no other public announcement until the tests were over, and then only a brief statement.[36]

On October 15, Fields, just back from Eniwetok, told the Commissioners in executive session that there was every indication that *Mike* would be ready by October 31. The hope that somehow technical delays would intervene was gone. If *Mike* were to be held up a few days—and the Commissioners felt it should—some justification had to be found quickly. From the discussion came the idea of sending Zuckert to Eniwetok to see if it were possible to postpone the test. If it were, Zuckert was to authorize the delay. Obviously Zuckert would need a mandate from the Secretary of Defense as well. Lovett was reluctant, but he would accept the scheme if Dean gained Truman's approval. Dean hurried to the White House and saw the President, about to leave on a campaign tour at 4:15 in the afternoon. Truman accepted the suggestion.[37]

In Washington, the Commissioners and Lovett waited for word from Zuckert. Dean had Truman's campaign itinerary from Monday, October 27, when the President would be at Gary, Indiana, to November 2, when he would be at home in Independence, Missouri, until after election day. When Dean heard from Zuckert that postponement would be exceedingly difficult, he called Lay to ask whether a messenger who would not be identified by the press with the atomic energy effort could deliver a letter to Truman. Lay suggested a telephone call. Of course Dean would have to make his comments oblique, but Lay thought it would not be too difficult to make the subject clear to Truman. Dean drafted a few remarks—almost as a letter—and waited.

Wednesday, October 29, was one of those days Truman enjoyed. Beginning at nine o'clock he made platform remarks at Waterloo, Iowa, then at Cedar Rapids, West Liberty, and Davenport, and then crossed the Mississippi to halt briefly at Moline, Illinois. In the later afternoon he spoke at the Negro War Memorial in Chicago. At eight o'clock Washington time, before Truman began a major address at the Hotel Sherman, Dean placed his call. Truman understood the situation at once, and appreciated the information.[38]

On October 31—November 1, at Eniwetok—Dean waited in his office. Shortly after 2:30 P.M. Dean received a telephone call from General William M. Canterbury at the Pentagon. Canterbury had news; he could be in Dean's office in ten or fifteen minutes. Dean called Fields and together the two men met Canterbury and his group. After Canterbury confirmed that the detonation had taken place, Dean called Borden, to suggest that he stop by later in the afternoon. A few minutes later Dean took another telephone call. It was Morse Salisbury, the Commission's director of information. Salisbury had just hung up from a conversation with a *Time* magazine reporter who was seeking information about the H-bomb that had just gone off. Obviously there had been a bad leak.[39]

With rumors in the press, Dean thought he should notify Truman. At four o'clock on November 1, the President's train should reach St. Louis, Missouri. Dean could not tell him over the phone that the detonation—later measured to be 10.4 megatons—had erased from Pacific charts the island of Elugelab. But he could convey that the test had been successful. He placed the call and soon heard the familiar voice of Truman, a few weeks from the end of his presidency. Truman was pleased at the news.[40] Dean too, must have felt relieved. Fears that the *Ivy-Mike* test—the thermonuclear effort—would be injected into the campaign had proved groundless. Truman might have used the test in a last-minute attempt to assert that his party was well along in the search for a superweapon, a claim that he might have hoped would counter the military prestige of the Republican candidate. To his credit, Truman had not done so.

A SHIELD FOR THE FUTURE

Truman had reason for satisfaction. The United States had been first to achieve a thermonuclear detonation. A hydrogen bomb was possible. Yet the achievement was not the true measure of the revolution which had occurred since the Atomic Energy Commission had taken the direction of the nation's atomic energy program. The change was to be seen on the stocks in Groton, Connecticut, where the hull of the *Nautilus* was taking shape. It was to be seen in sleek aircraft, capable of carrying nuclear weapons, rising from isolated bases and the decks of carriers. It was to be seen in the huge artillery piece being readied for the inaugural parade. Through nearly every military sphere the effects of atomic energy were evident. Nor was this the sum and substance of nearly six years of anxiety and travail. The gauge of progress was to be seen in the reactors at Hanford and Savannah River, and the gaseous-diffusion plants at Oak Ridge, Paducah, and Portsmouth. From these came the material for the experimental reactors standing on the lava beds of Idaho, and for the laboratories where technology was at work to harness atomic energy to peaceful uses. Surely it was significant that probes for secrets of life, for knowledge of the microcosmos were taking place under Commission auspices. The new world had shown hazards and peril for all mankind, but also wonder and hope. Perhaps under the atomic shield all these could now be explored.

SOURCES

The development of atomic energy in the United States from 1947 through 1952 was essentially a Commission enterprise. Many private corporations, universities, research institutions, and other Government agencies had a part in the Commission's work, but the Commission supported and determined the course of most of that activity. Except in some areas of basic research, virtually every document was "born classified" and therefore subject to strict security procedures and document control. As a result, only a small amount of this material has ever been available to the independent historian. But to those who have been admitted behind the security barrier, the riches of historical documentation are almost unparalleled. Although some of these records may not be available to the public for many years, historians may take some comfort in the fact that such a record collection exists and that it will, hopefully, help historians of another generation to understand the role of atomic energy in the history of the United States in the years following World War II.

UNPUBLISHED SOURCES

COMMISSION RECORDS

The most important single collection of documents relating to the history of atomic energy in the United States is that held by the Secretary to the Commission at the headquarters building in Germantown, Maryland. Since 1947 the Secretary and his staff have been responsible for ordering the daily business of the five Commissioners. The secretariat receives memorandums and other official papers from the staff, processes staff papers and correspondence for Commission consideration, schedules Commission meetings, prepares the minutes of meetings, and assures that appropriate action is taken to carry out Commission decisions.

The secretariat has carefully documented each of these functions in the official files. For each subject coming before the Commission, the secretariat has prepared a file of the pertinent documents, annotated and arranged in chronological order. The files include internal memorandums and reports, staff papers, correspondence with other Government agencies, contractors, and private individuals, summaries of Commission action, and implementing papers. From the subject files alone, the historian can easily trace at least the broad outlines in the evolution of policy.

Among the variety of documents in the subject files, the staff papers are of special value for historical research. These papers, prepared by the secretariat from material submitted by the staff, follow a prescribed format based on that used by the Joint Chiefs of Staff during World War II. The papers contain a statement of the problem or issue, background information, a discussion of factors or alternatives to be considered, recommendations of the general manager, and appendices of related material. Although the format and the sometimes stilted language of staff papers often obscure the human quality in policy formulation and occasionally even the real issue, they are indispensable for understanding Commission decisions.

Not a part of the subject files but almost as important are the official minutes of Commission meetings. The secretariat has recorded the minutes of each formal meeting in numerical sequence since the first meeting in November, 1946. In order to assure a free exchange of opinions, the original Commissioners decided against verbatim transcripts of meetings, and that decision has prevailed. Instead, the Secretary and his staff take long-hand notes which later provide the information for the official minutes. The minutes during the first six months of 1947 reflect the absence of a trained secretariat, but the quality of the minutes rapidly improved under the direction of Roy B. Snapp, the first full-time Secretary. On most subjects the minutes provide at least a summary of the decisions, usually some indication of the issues raised in the discussion, and often the position taken by individual Commissioners. To those who may object that the secretariat has presumed upon the function of the historian, we must confess that we are grateful to the members of the secretariat's professional staff who used their good working knowledge of the Commission's activities in preparing the minutes. They have rendered a valuable service in summarizing in about one thousand pages what surely would have been hundreds of thousands of pages of redundant, contradictory, and often misleading information in verbatim transcripts.

Less formal records, among them the papers of the individual Commissioners, are also in the Secretary's files. These collections vary in historical usefulness. Some Commissioners kept a good bulk of correspondence and memorandums while others retained nothing. David E. Lilienthal's papers are extensive but are overshadowed by his published journals. Important for the period from mid-1949 through mid-1953 are the office diaries of Gordon Dean. These contain a record of his appointments, extensive accounts of telephone conversations, and occasionally memorandums. Carroll L. Wilson and Marion W. Boyer during their tenures as general manager kept office diaries which are little more than appointment lists. The diaries of Walter J. Williams and Carleton Shugg give personal perspective to the problems they faced in directing operations. They are less useful in throwing light on policy evolution.

The Secretary also holds the minutes of the Commission's statutory advisory committees and several international policy groups. By far the most illuminating collection in this category are the minutes of the General Advisory Committee. Well-written, detailed, and covering the entire scope of the Commission's activities, these minutes are essential, particularly for the early years of the Commission's existence when the committee members knew more about some aspects of the atomic energy program than did the Commissioners and the staff. More formal and less detailed are the minutes of the Commissioners' meetings with the Military Liaison Committee. Valuable insights into policy formulation and negotiations on atomic energy with the United Kingdom and Canada can be found in the minutes of two other groups: the American members of the Combined Policy Committee, consisting of representatives of the Commissioners and the Secretaries of State and Defense, and the Combined Policy Committee itself, composed of officials of the three governments. After early 1950 the value of these minutes decreases, because the broad outlines of cooperation with Britain and Canada had been established and much of the committee business concerned implementing policies. Minutes of the Combined Development Agency, another tripartite organization, are burdened with details of the procurement of uranium ore, and do not contain much of policy significance.

Several of the headquarters divisions have maintained historical files. Very helpful are those for the divisions of military application and production, which had well-defined missions from the start and were led by directors with broad interests. The division of research has a large collection of administrative material containing a few papers of importance on policy formulation. When the division no longer had the responsibility for reactor development and biology and medicine, the files were divided and appropriate material given to the new divisions. This decision, which must have seemed reasonable at the time, later proved disastrous for the historian. Sometime before 1958 the division of reactor development destroyed virtually all its files, an act which greatly complicates research on early reactor policy. One alternate source is an extensive documentary collection held by the division of naval reactors.

Commission records at field installations fall into two groups. Those at the Commission offices tend to be heavily administrative while records held by the contractors are usually voluminous and highly technical. Memorandums and correspondence between and within the laboratories often throw light on the field reaction to Washington policy decisions, particularly during 1947–1948 when organizational patterns and laboratory responsibilities were being established.

On production matters the field offices hold large volumes of technical records. The best sources of information on the gaseous-diffusion plants are in the Union Carbide and Commission files at Oak Ridge. The Richland Operations Office has extensive and detailed records on the operation and construction of the Hanford production reactors, supporting facilities, and the Redox plant. Oak Ridge, Argonne, and Schenectady took part in Redox development, and all can document their part. Argonne has extensive coverage of its role in developing heavy-water production reactors for Savannah River.

For a history of nuclear weapons down to 1953, the best single source is the Los Alamos Scientific Laboratory. The mail and records unit at the laboratory has preserved intact virtually all records it has received. Because of its highly sensitive nature, information on weapons was segregated at Los Alamos, with the result that these records may be superior to those held at Washington headquarters on many topics. An equally large collection of records, to some extent duplicating the laboratory files, was until recently maintained by the Commission's Los Alamos Area Office. Most of these records, except for those of obvious historical value, have recently been destroyed and the remainder removed to the Commission's Albuquerque Operations Office for eventual transfer to the Federal Records Center in Denver.

On reactor development the records of the laboratories are more valuable for the period before 1949 than those at headquarters. The collection at Oak Ridge is essential to the understanding of the ill-fated Daniels reactor, the vaguely defined aircraft propulsion effort, the high-flux reactor, and the activities of the Navy group. Argonne has thorough coverage of the experimental breeder, the materials testing reactor, and the submarine thermal reactor. Because Argonne was the center of the Commission's reactor development program during these years, the laboratory files contain the kind of policy records the historian would expect to find at headquarters, and happily this collection largely compensates for the loss of the headquarters division's files. The Idaho Operations Office and the various contractors on the site maintain records on the origin of the National Reactor Testing Station and on the technology of reactor projects. Knolls Atomic Power Laboratory has excellent technical records on the intermediate-power-breeder and the submarine intermediate reactor.

Research—physical, biological, medical, and metallurgical—is a function of many Commission laboratories and installations, although some specialize in certain disciplines. As the two oldest and largest Government laboratories for nuclear research, Oak Ridge and Argonne are of primary interest for the historian of science and technology. At both laboratories, the operating contractors have maintained extensive files on the many areas of research under investigation. The Commission's files at these sites contain administrative records, but far more important to the historian is the Oak Ridge file of all technical reports prepared since 1947 under Commission research and development contracts. The Division of Technical Information Extension at Oak Ridge maintains the file and provides photoreproductions of reports upon request.

The records of other laboratories are neither so extensive nor so comprehensive as those at Oak Ridge and Argonne. The Lawrence Radiation Laboratory at Berkeley has an excellent collection of materials on high-energy physics and transplutonium chemistry. It also holds the Ernest O. Lawrence papers, one of the most valuable collections in modern American physics. The Brookhaven National Laboratory has some useful historical records on formation of the laboratory and early research efforts.

A word of warning is necessary about the Commission's records. Facing the ever-increasing pressure of the document explosion, management is constantly consolidating and moving record collections. Materials which the authors saw in one location may now be in another. In a few instances some records of historical interest may have been destroyed, but the authors found the Commission's record officers eager to preserve historical material.

OTHER GOVERNMENT ARCHIVES

Other Government archives contain material which throw a different perspective on the Commission. The military aspects of atomic energy and the complicated relations between the Commission and the military establishment cannot be traced without the help of documents in the Modern Military Records Division, National Archives and Records Service of the Washington National Records Center at Suitland, Maryland. The center holds the records of the Manhattan project, the Military Liaison Committee, the Research and Development Board, the Armed Forces Special Weapons Project, and some records from the Office of the Secretary of Defense. The historian's office in OSD holds some records of historical interest and controls access to the Forrestal diaries, which are located in the Office of Research Administration at Princeton University. The manuscript diaries differ from the published edition in details, many of which pertain to conversations with the British.

The Armed Forces Special Weapons Center at Kirtland Air Force Base, Albuquerque, New Mexico, has exceedingly valuable records showing the difficulties of transition during 1946 and 1947 in working out the relations between the Army, the Air Force, and the Commission. The Naval Historical Division, Department of the Navy, Washington, has some useful documents on Navy reactor development.

The records of the Department of State on the negotiations with the United Kingdom and Canada on cooperation in atomic energy often duplicate the materials held by the Commission and the Department of Defense, but some of the files are unique. Most helpful in State archives were memorandums by Dean G. Acheson and James E. Webb reporting conversations with President Truman. These documents reflect the President's attitude toward cooperation with Britain and Canada, and toward Congress on this subject.

Other Government archives are less significant. Materials open to the scholar at the Harry S. Truman Library at Independence, Missouri, including the papers of Sumner T. Pike and Clark M. Clifford, contain little information about atomic energy. In Washington, the historian will find some helpful documents in the unclassified files which the Joint Committee on Atomic Energy has transferred to the National Archives. This material, however, is rather low-grade ore and appears to represent cullings from the extensive files still held by the committee. Unfortunately the authors were not granted access to the committee's classified files, a fact which made our task more difficult. Although the Commission's files contain most of the classified correspondence and the classified transcripts of Joint Committee hearings relating to the Commission, the committee apparently holds valuable records relating to other Government agencies and officials.

A large group of records of interest to historians of atomic energy and American science generally is the J. Robert Oppenheimer collection at the Library of Congress. The extensive correspondence files contain letters from scientists and political leaders in all parts of the world. Like the Joint Committee's unclassified files, however, this collection merely complements the main body of records which are still classified. For an accurate picture of Oppenheimer's role in atomic energy, the historian must consult the classified portion of Oppenheimer's records in the Commission's custody.

PRIVATE ARCHIVAL SOURCES

We know of only a few collections of archival material on atomic energy in private hands. David E. Lilienthal's personal papers at the Firestone Library at Princeton consist of scrapbooks, drafts of articles, and correspondence. The latter are useful in supplementing his journal. The library also has the microfilm of Mr. Lilienthal's journals, which contains very little information not in the published journal. The personal papers of James V. Forrestal have been placed by his estate in the custody of the Curator of Manuscripts of the Firestone Library. These papers are mainly routine correspondence and not particularly helpful on atomic energy matters.

PROJECT HISTORIES

Most of the project histories touching upon the Commission's activities are still classified. In this category is the "Semiannual History of AFSWC (Armed Forces Special Weapons Center), April 1, 1952—December 31, 1952," Vol. I, "Narrative Account," in the historical collections at the Kirtland Air Force Base, Albuquerque, New Mexico. Another is Lee Bowen's "The Development of Weapons," Vol. IV of "U.S. Air Force, A History of the Air Force Atomic Energy Program, 1943-1953," in the files of the USAF Historical Division Liaison Office, Silver Spring, Maryland. These accounts are valuable because they are based on military records not otherwise available. In this sense, however, they are not primary sources and must be used with some caution.

Frederic C. Alexander, Jr., an employee of the Sandia Corporation, has written several historical studies, including "History of Sandia Corporation," completed in 1962. Mr. Alexander's other works include classified histories of the development of early models of nuclear weapons. Some years ago the Joint Committee on Atomic Energy compiled "The Scale and Scope of Atomic Production: A Chronology of Leading Events, Jan. 30, 1952." This is a selective catalogue of events showing the committee's role in weapon development and fissionable material production. The main value of the chronology is its quotations from documents held by the committee and not otherwise available. Of similar value is Russell S. Greenbaum's "Nuclear Power for the Navy, the First Decade (1939-1949)," which is focused on administrative matters within the Department of the Navy. The work is helpful but, as Greenbaum admits, suffers because he did not have access to all sources.

PUBLISHED SOURCES

BOOKS ON NUCLEAR TECHNOLOGY

One of the major sources of information on nuclear technology is the multivolume *Progress in Nuclear Energy* series, published partly by McGraw-Hill and partly by Pergamon Press. Twelve series of volumes cover such topics as physics and mathematics, reactors, process chemistry, metallurgy and fuels, biology, medicine, law and administration, and plasma physics. This series supplements the earlier *National Nuclear Energy Series.* Written by the scientists themselves, the volumes are technical in approach.

Especially valuable among books on nuclear technology are the volumes presented by the United States to the Second International Conference on the Peaceful Uses of Atomic Energy held in Geneva in 1958. These volumes cover reactor technology, biology and medicine, and uranium metallurgy and processing. Of particular interest is Glenn T. Seaborg's *The Transuranium Elements* (New Haven, 1958), in which he relates the discovery of transuranium elements. A more general approach dealing with this subject is by Glenn T. Seaborg and Evans G. Valens, *The Elements of the Universe* (New York, 1958).

Certain books on particular aspects of nuclear technology deserve mention. Robert R. Wilson and Raphael Littauer in *Accelerators, Machines of Nuclear Physics* (Garden City, N. Y., 1960) present an unusually readable explanation of particle accelerators. Samuel Glasstone as editor of *The Effects of Nuclear Weapons* (Washington, 1962) has written the most detailed published account of this subject. His *Sourcebook on Atomic Energy* (Princeton, 1958) is a comprehensive survey of the principles of atomic energy and its applications. A good quick reference source is John R. Hogerton's *The Atomic Energy Deskbook* (New York, 1962).

PERIODICALS

In the months following World War II articles about atomic energy appeared in many periodicals, but in time only a few regularly followed the Commission's activities. The largest coverage by far was in the *Bulletin of the Atomic Scientists,* which had been started as a part of the scientists' movement on atomic energy legislation in 1945 and 1946. During the early years the contents of the *Bulletin* were almost exclusively related to atomic energy matters and provided a running account of scientific opinion. More general in coverage but still useful are the weekly issues of *Science,* which document the evolution of a national policy for scientific research and development during these critical years. Many scientific journals and engineering periodicals provide grist for the historian's mill. Most frequently consulted for this book were the *Physical Review* and the *American Journal of Biology.* Occasional articles of historical interest appeared in *Scientific American.*

GOVERNMENT PUBLICATIONS

The Commission's Semiannual Reports to the Congress, required under the Atomic Energy Act of 1946, are indispensable reference sources for the historian of atomic energy. The first report, submitted in January, 1947, consisted of only a few pages on organizational matters; but later issues, especially those concentrating on specific aspects of the Commission's activities, contain solid information on administration and management. Frequently the appendices include reports by the Commission's advisory committees.

One Commission publication requiring special mention is *In the Matter of J. Robert Oppenheimer* (Washington, 1954). Over 900 pages long and indexed only by the names of witnesses, the document is difficult to use. Although it reveals much information on Oppenheimer's role in the General Advisory Committee and his part in decisions on weapon development, the document is at best the raw material for history. Public interest in the hydrogen bomb decision and the paucity of other sources on the subject have caused some writers to overlook this fact, with bizarre results. The experienced historian will recognize the limitations of this fascinating document and sympathize with the witnesses who were trying in an atmosphere of tension and sometimes high emotion to recall the details of events long past.

Congressional publications provide a large but cumbersome source of information. Although the Joint Committee on Atomic Energy published few documents in the early years, a growing stream of publications began to appear in 1949 with the release of the *Investigation into the United States Atomic Energy Project*, the record of the committee's investigation of Senator Hickenlooper's charge of "incredible mismanagement." These hearings and others on such matters as the Commission's community management policy provide a wealth of detail on Commission activities. Another Congressional source is the annual budget hearings before the House and Senate appropriation committees. Scattered within hundreds of pages of financial detail the historian will find excellent descriptions of the Commission's programs and management problems. The Joint Committee has also published useful handbooks containing all atomic energy legislation to date and lists of committee membership for each Congress since 1946.

The Department of State has explained the United States policy at the United Nations in *The International Control of Atomic Energy, Policy at the Crossroads* (Washington, 1948), which covers the period from October 15, 1946, to May 17, 1948. As a reference work, the Department also issued two volumes of *Documents on Disarmament 1945–1956* (Washington, 1960). The first volume contains selected documents for 1945–1946.

PERSONAL NARRATIVES

Two of the Commissioners who served between 1947 and 1952 have written of their experiences. *The Journals of David E. Lilienthal*, Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964) contains almost daily entries providing candid descriptions and impressions which do much to explain the character of the first Commission. More formal in spirit and autobiographical in style is Lewis L. Strauss's *Men and Decisions* (Garden City, N. Y., 1962). Mr. Strauss has organized recollections of an eventful life around a series of decisions. Those dealing with his first term on the Commission are the decisions to establish a system to detect nuclear detonations and to accelerate development of a hydrogen bomb. Both narratives are revealing accounts by a participant looking back upon key points in his own career.

Gordon E. Dean's *Report on the Atom* (New York, 1957) reflects some of his personality but supplies little historical information. Dean was a shrewd and perceptive man, and one can only regret that his early death robbed him of the opportunity to write his memoirs. Thomas E. Murray's *Nuclear Policy for War and Peace* (New York, 1960) contributes little to the early history of the Commission.

Personal narratives by prominent men whose careers at some point touched upon atomic energy are largely disappointing. Harry S. Truman's *Memoirs* (2 volumes, Garden City, N. Y., 1955–56), relate events with the same vigor and simplicity that characterized his decisions as President. Written more to defend than to explain his actions, the *Memoirs* must be used with other sources. Even less useful are *The Forrestal Diaries* (New York, 1951), edited by Walter Millis, and *The Private Papers of Senator Vandenberg* (Boston, 1952), edited by Arthur H. Vandenberg, Jr. Both provide occasional glimpses of interesting personal relationships but severely condense atomic energy problems and give little clue to their complexity.

Although many scientists are highly skilled in presenting research results, very few have written about their part in policy matters. A noteworthy exception is *The Legacy of Hiroshima* (Garden City, N. Y., 1962) by Edward Teller with Allen Brown. The book expresses Teller's deeply personal views on developing the hydrogen bomb, establishing the Lawrence Radiation Laboratory at Livermore, California, and framing reactor safety criteria.

SECONDARY ACCOUNTS

Although there have been several good secondary works on the development of the atomic bomb, there have been surprisingly few on the postwar history of atomic energy. Perhaps the quest for the atomic bomb had a singleness of purpose which was lacking in the later period, when the Commission was not only developing atomic and hydrogen weapons, but also establishing research programs in the physical, biological, and medical sciences, and trying to build reactors for power and propulsion.

Some authors have seized upon the hydrogen bomb decision as the scaffolding for dramatic narrative. Because neither the most crucial technical difficulties nor the means to overcome them can yet be made public, there has been a tendency to focus on personalities. Another weakness lies in the failure to master the details of technology and the historical setting. Both these defects are apparent in Nuel Pharr Davis's *Lawrence and Oppenheimer* (New York, 1968), which includes scores of factual errors and portrays the attitudes and relationships of the scientists almost in caricature. Not much better is *The Hydrogen Bomb* (New York, 1954), by James R. Shepley and Clay Blair, Jr. Robert Gilpin's *American Scientists and Nuclear Weapons Policy* (Princeton, 1962) takes a scholarly approach to the subject, but is weakened by overdrawn analysis.

There have been few biographies of the leading personalities, probably because most of them are still living. The most substantial work yet to appear is by Herbert Childs: *An American Genius: The Life of Ernest Orlando Lawrence* (New York, 1968), written with full access to the Lawrence papers and Lawrence associates at Berkeley. Giving a sympathetic portrayal of Lawrence's human qualities, the book avoids the hard questions of historical interpretation. A biography of Enrico Fermi and several books on Oppenheimer are in preparation, but we had no opportunity to consult them in our research. Another work, *The Atomic Submarine and Admiral Rickover* (New York, 1954), by Clay Blair, Jr., is a journalistic account of little value to historians.

Some scholarly research has been done on various aspects of the atomic energy program. Morgan Thomas, in *Atomic Energy and Congress* (Ann Arbor, Michigan, 1956), used extensive interviews to explore the complicated and dynamic relations between the Commission and Congress. More recent and more penetrating, focusing sharply on the Commission and the Joint Committee, is the work by Harold P. Green and Alan Rosenthal, *Government of the Atom* (New York, 1963). Richard A. Tybout, in *Government Contracting in Atomic Energy* (Ann Arbor, Michigan, 1956), details the Commission's use of various types of contracts and the development of the Commission's contract policy.

INTERVIEWS

The common criticism of historians writing about the contemporary scene is that they lack perspective, that time has not yet sifted the seed from the chaff. Contemporary historians, it is said, cannot tell what is significant and what is not. The charge is also made that the historian of recent events has difficulty in gaining access to the papers of living men and even more trouble in writing the truth about them. But the contemporary historian does have compensating advantages over students of the more distant past. He has himself sampled the flavor and tone of the period he is describing and he enjoys the priceless boon of being able to interview the actors who figure in his narrative. From conversations he can discover relationships and ideas that often bring to life the restrained prose of an official document.

Interviews require careful preparation to prevent them from becoming random recollections of humorous anecdotes. No doubt each interviewer has his own technique. Ours was to master the documentary evidence we possessed, to discuss our ideas and interpretations, and to draw up together questions which we believed struck at the central issues. In a few instances we drafted working papers which summarized our understanding of events or technical processes, and submitted them for critical comment. Most often we conducted our interviews jointly, one asking questions while the other took notes. We did not attempt to record the voices of those we interviewed for fear that the presence of a tape recorder might inhibit the free flow of thought. Among the satisfactions of the oral historian are seeing the expression of interest light up a face, hearing the cautious warning over too simple an interpretation, and receiving new insights freely volunteered.

We have talked with about 200 individuals, ranging from former Commissioners who searched their memories and files to laboratory technicians who patiently explained techniques and equipment. We talked to military and naval officers, Government officials, scientists, and engineers. We hoped to interview many others, but time and circumstances denied us the benefit of their recollections.

David E. Lilienthal discussed with us the events during his term as chairman. Others who helped us to understand the difficulties facing the new Commission were Robert F. Bacher, G. Lyle Belsley, John H. Burchard, John A. Derry, James B. Fisk, William T. Golden, Paul M. Green, John K. Gustafson, Lawrence R. Hafstad, Ralph P. Johnson, David B. Langmuir, James McCormack, Philip Mullenbach, Richard O. Niehoff, Sumner T. Pike, Wallace S. Sayre, Carleton Shugg, Oscar S. Smith, Lewis L. Strauss, Joseph A. Volpe, Jr., Shields Warren, William W. Waymack, George L. Weil, Walter J. Williams, and Carroll L. Wilson.

For our understanding of the Dean Commission we turned to Marion W. Boyer, John H. Burchard, T. Keith Glennan, Lawrence R. Hafstad, John A. Hall, Philip Mullenbach, Kenneth S. Pitzer, Philip N. Powers, Oscar S. Smith, Henry D. Smyth, Oliver Townsend, Shields Warren, Walter J. Williams, and Eugene M. Zuckert.

For perspective from other organizations—such as the General Advisory Committee and the Military Liaison Committee—we had the assistance of Donald F. Carpenter, Edward U. Condon, Lee A. DuBridge, David T. Griggs, Leslie R. Groves, John H. Manley, Kenneth D. Nichols, Robert Oppenheimer, Isidor I. Rabi, Cyril S. Smith, Glenn T. Seaborg, Anthony A. Tomei, and William Webster. Congressman Chet Holifield and William L. Borden helped us to understand how atomic energy matters looked from the Joint Committee.

Views from field offices and laboratories are often very different from those at headquarters. Consequently we visited the major Commission installations to talk with individuals and read documents. For the perspective from Argonne we talked to Austin

M. Brues, Harold Etherington, John J. Flaherty, William B. Harrell, Norman Hilberry, John R. Huffman, Harold V. Lichtenberger, Winston M. Manning, David Saxe, and Walter H. Zinn. For similar help on Brookhaven we talked to John P. Blewett, Howard J. Curtis, G. Kenneth Green, Mariette K. Kuper, Isidor I. Rabi, Arnold H. Sparrow, Emory L. Van Horn, and Clarke Williams. On the activities of the Knolls Atomic Power Laboratory and the General Electric Company in Schenectady we met with William C. Bartels, Harvey Brooks, Earl B. Haines, Henry Hurwitz, Jr., Kenneth A. Kesselring, Kenneth H. Kingdon, James Marsden, Stanley W. Nitzmann, Thoma M. Snyder, and C. Guy Suits. For our understanding of the trials and accomplishments of Los Alamos and Sandia, we owe much to Hans A. Bethe, Norris E. Bradbury, William M. Canterbury, G. Foster Evans, Darol K. Froman, Leslie R. Groves, Marshall G. Holloway, Robert D. Krohn, James McCormack, J. Carson Mark, Ralph Carlisle Smith, Edward Teller, Carroll L. Tyler, and Stanislaw M. Ulam.

At the National Reactor Testing Station in Idaho we met Charles B. Amberson, Deslonde R. deBoisblanc, William A. Erickson, John D. Ford, William L. Ginkel, James R. Howard, Sidney Kauffmann, Fred R. Keller, Phil C. Leahy, Joe P. Lyon, Fred L. McMillan, Howard E. Noble, Meyer Novick, Ronald G. Reid, George Smith, and L. Joe Weber.

In several trips to the Lawrence Radiation Laboratory at Berkeley and Livermore we sought the counsel of many individuals: some for their recollections, others for assistance in understanding laboratory techniques. Those who helped included Luis W. Alvarez, Hugh Bradner, William M. Brobeck, Donald M. Cooksey, Burris B. Cunningham, Eleanor Davisson, Harold A. Fidler, Albert Ghiorso, Jere L. Green, Harry H. Heckman, Arthur J. Hudgins, Robert W. Kenney, William A. S. Lamb, Edward J. Lofgren, Edwin M. McMillan, Burton J. Moyer, Wolfgang K. H. Panofsky, Isadore Perlman, Wallace B. Reynolds, Duane C. Sewell, Emilio Segre, Frances M. Smith, Robert L. Thornton, James T. Vale, James C. Wallman, and Daniel M. Wilkes.

Although many of the scientists have left Oak Ridge, Hanford, and Savannah River, most are still available for interviews. To get the perspective from Oak Ridge we sought the recollections of Frank P. Baranowski, Harold Etherington, John C. Franklin, Alexander Hollaender, John R. Huffman, Miles C. Leverett, Stuart McLain, Merlin D. Peterson, C. Nelson Rucker, Liane B. Russell, William L. Russell, Alvin M. Weinberg, Eugene P. Wigner, Walter J. Williams, and Gale J. Young. The excitement and activities at Hanford were portrayed for us by Mark H. Arndt, Joseph T. Christy, Milton R. Cydell, Herbert M. Parker, Marvin R. Schneller, Carleton Shugg, and Donald G. Williams. Our understanding of the operation of the Savannah River plant was immeasurably increased by Gerhard Dessauer, Julian D. Ellett, Isaac A. Hobbs, Stewart W. O'Rear, Wilcox P. Overbeck, and George O. Robinson.

Certain decisions in atomic energy were of crucial importance to the history of the United States. First in this category was the decision on the hydrogen bomb. Those to whom we talked about the detection of the Soviet detonation, the decision to build the bomb, and the course of its development were Luis W. Alvarez, R. Gordon Arneson, Robert F. Bacher, Hans A. Bethe, William L. Borden, Norris E. Bradbury, Frederic de Hoffmann, Lee A. DuBridge, Spofford G. English, G. Foster Evans, Paul C. Fine, Kenneth W. Ford, Darol K. Froman, Albert Ghiorso, David T. Griggs, Chet Holifield, Marshall G. Holloway, David E. Lilienthal, Alexander K. Longair, John H. Manley, J. Carson Mark, Lothar W. Nordheim, Robert Oppenheimer, Isidor I. Rabi, Glenn T. Seaborg, Robert Serber, Cyril S. Smith, Ralph Carlisle Smith, Henry D. Smyth, Sidney W. Souers, Lewis L. Strauss, Edward Teller, Carroll L. Tyler, Stanislaw M. Ulam, William Webster, John A. Wheeler, Carroll L. Wilson, and Walter H. Zinn.

On the various aspects of reactor development, we spoke to Charles B. Amberson, William C. Bartels, Manson Benedict, Harvey Brooks, Deslonde R. deBoisblanc, Harold

Etherington, John D. Ford, Lawrence R. Hafstad, Earl B. Haines, Norman Hilberry, John R. Huffman, Henry Hurwitz, Jr., Donald J. Keirn, Kenneth A. Kesselring, Kenneth H. Kingdon, Miles C. Leverett, Earle W. Mills, Stuart McLain, Meyer Novick, Merlin D. Peterson, Donald G. Reid, Hyman G. Rickover, Henry D. Smyth, Thoma M. Snyder, C. Guy Suits, L. Joe Weber, George L. Weil, Alvin M. Weinberg, John A. Wheeler, Eugene P. Wigner, Carroll L. Wilson, Abel Wolman, Gale J. Young, and Walter H. Zinn.

On physics, biology, and medicine, and on the development of research policy, we received help from Luis W. Alvarez, Karl P. Baetcke, John P. Blewett, William M. Brobeck, Burris B. Cunningham, James B. Fisk, Albert Ghiorso, G. Kenneth Green, Alexander Hollaender, Arthur J. Hudgins, Ralph P. Johnson, William A. S. Lamb, David B. Langmuir, Edward J. Lofgren, Edwin M. McMillan, Holbrook M. MacNeille, Burton J. Moyer, Bruce D. Old, Robert Oppenheimer, Wilcox P. Overbeck, Wolfgang K. H. Panofsky, Herbert M. Parker, Isadore Perlman, Kenneth S. Pitzer, Virginia Pond, Anne Rogers, Liane B. Russell, William L. Russell, Emilio Segre, Duane C. Sewell, Thoma M. Snyder, Arnold H. Sparrow, Robert L. Thornton, James T. Vale, Shields Warren, Alvin M. Weinberg, and Clarke Williams.

To help us understand the complications of international relations we turned to R. Gordon Arneson, Donald F. Carpenter, James B. Fisk, Edmund A. Gullion, John A. Hall, Frederick T. Hobbs, Ralph P. Johnson, David E. Lilienthal, Alexander K. Longair, Frederick H. Osborn, Sumner T. Pike, Cyril S. Smith, Lewis L. Strauss, Joseph A. Volpe, Jr., William Webster, Carroll L. Wilson, and Walter H. Zinn.

PHYSICAL SURVIVALS

Historians have always tried to visit the scenes of the events they narrated. In our age travel is less arduous and less adventurous, but the effort is still rewarding. Somehow a sense of the physical surroundings often helps in understanding the context of events.

As Commission employees, both of us worked in the old headquarters building on Constitution Avenue and visited the T-3 building in the shadow of the Washington Monument. As historians we visited the laboratories at Argonne, Berkeley, Brookhaven, and Oak Ridge, and saw accelerators, reactors, and research efforts in the life sciences, many of which had their origin in the years we have chronicled. We toured the production sites and saw the heavy-water reactors standing among the pines at Savannah River, the graphite reactors along the bank of the Columbia, and the gaseous-diffusion plants sprawling along the Clinch River at Oak Ridge. Many of these facilities are silent now, having accomplished the task for which they were intended. At Livermore, the site of the materials testing accelerator, almost nothing is left but the huge building itself, which dominates the flat valley floor. We saw the Brookhaven cosmotron as it was being dismantled. On the ancient lava beds of Idaho we saw the first fruits of the new reactor technology: the Zinn fast-breeder—now recognized as a national historical landmark, the materials testing reactor, and the Navy submarine thermal reactor. Of the ill-fated intermediate-power-breeder little remains at Schenectady; the West Milton site, planned for the breeder, is now used by the Navy for nuclear propulsion development.

No one can grasp from reports, interviews, statistics, or photographs the immense size of some of the production facilities, or the incredibly complicated and delicate techniques demanded by research. An appraisal of the physical remains and of their environment is part of the historians' craft. Undoubtedly our visits tempered some of our early judgments.

NOTES

The notes which follow are a guide to the material we consulted, not rigorous citation of documentary evidence. From them the reader should be able to find the documents of major interest to him. Citation, however, does not imply that the documents are unclassified or available for inspection. Nor do the notes indicate information gained through interviews. Many people with whom we spoke are still active; many of the topics which we discussed are controversial. Consequently some individuals would speak freely only if no attribution was made of their opinions. We preferred the benefits of recollections freely tapped and issues thoroughly explored, to the trappings of scholarly annotation.

THE NOTES

ABBREVIATIONS

AEC	Records of Headquarters, U. S. Atomic Energy Commission, Washington, D. C.
AFSWC	Records of the Armed Forces Special Weapons Center, Kirtland Air Force Base, Albuquerque, New Mexico.
ALOO	Records of the Albuquerque Operations Office, U. S. Atomic Energy Commission, Albuquerque, New Mexico.
ANL	Records of the Argonne National Laboratory, Argonne, Illinois.
BNL	Records of the Brookhaven National Laboratory, Upton, New York.
CM 1	Commission Meeting 1, U. S. Atomic Energy Commission.
DEL	Papers of David E. Lilienthal, Princeton University Library, Princeton, New Jersey.
DS	Records of the U. S. Department of State, Washington, D. C.
GAC 1	Meeting 1 of the General Advisory Committee to the U. S. Atomic Energy Commission.
HST	Harry S. Truman Library, Independence, Missouri.
JCAE	Records of the Joint Committee on Atomic Energy, National Archives, Washington, D. C.
JFP	James Forrestal Papers, Princeton University, Princeton, New Jersey.
JRO	Papers of J. Robert Oppenheimer, Library of Congress, Washington, D. C.
KAPL	Records of the Knolls Atomic Power Laboratory, Schenectady, New York.
LAAO	Records of the Los Alamos Area Office, U. S. Atomic Energy Commission, Los Alamos, New Mexico.
LASL	Records of the Los Alamos Scientific Laboratory, Los Alamos, New Mexico.
LRL	Records of the Lawrence Radiation Laboratory, Berkeley, California.
MLC 1	Joint Meeting 1 of the Military Liaison Committee with the U. S. Atomic Energy Commission.
NHD	Records of the Naval Historical Division, Department of the Navy, Washington, D. C.
ORNL	Records of the Oak Ridge National Laboratory, Oak Ridge, Tennessee.
OROO	Records of the Oak Ridge Operations Office, U. S. Atomic Energy Commission, Oak Ridge, Tennessee.
OSD	Records of the Office of the Secretary of Defense, Washington, D. C.
WNRC	Washington National Records Center, Modern Military Records Division, National Archives and Records Service, Suitland, Maryland.

CHAPTER 1

1. New York *Times*, Washington *Post*, Jan. 28, 1947; Lilienthal, *Journals*, Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), p. 133.
2. Joint Committee on Atomic Energy, *Confirmation of Atomic Energy Commission and General Manager*, Jan. 27–31, Feb. 3–8, 10–12, 17–22, 24–26, Mar. 3–4, 1947 (Washington, 1947), pp. 1–7 (hereafter cited as *Confirmation Hearings*).
3. New York *Times*, Jan. 23, 25, 1947.
4. R. G. Hewlett and O. E. Anderson, Jr., *The New World, 1939–1946*, Vol. I of *A History of the U. S. Atomic Energy Commission* (University Park, Pa., 1962), pp. 488–509.
5. *Ibid.*, pp. 531–79.
6. *Confirmation Hearings*, p. 7.
7. *Ibid.*, p. 15.
8. Lilienthal, *Atomic Energy Years*, p. 133.
9. *Confirmation Hearings*, p. 26.
10. *Ibid.*, pp. 31–32; Lilienthal, *Atomic Energy Years*, pp. 134–35.
11. Lilienthal, *Atomic Energy Years*, p. 138.
12. Strauss, *Men and Decisions* (Garden City, N. Y., 1962), pp. 1–200; *Confirmation Hearings*, pp. 38–43.
13. Lilienthal, *Atomic Energy Years*, pp. 30–31, 130–32, 136–40; Hewlett and Anderson, *New World*, pp. 556–58; *Confirmation Hearings*, pp. 99–100.
14. Lilienthal to the Commissioners, Jan. 31, Feb. 4, 1947, *AEC*.
15. Lilienthal, *Atomic Energy Years*, pp. 140–41.
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20. Washington *Post*, Feb. 13–15, 17, 1947; New York *Times*, Feb. 14, 1947.
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22. Arthur H. Vandenberg, Jr., ed., *The Private Papers of Senator Vandenberg* (Boston, 1952), pp. 352–55; *Confirmation Hearings*, pp. 287–91, 691–92.
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CHAPTER 2

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3. Notes on Weapons Subcommittee Agenda, Apr. 4, 1947, *LASL*; Report of Weapons Subcommittee, May 15, 1947, *AEC*.
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54. Lilienthal to Brereton, Apr. 25, 1947, Notes of MLC Meeting, May 21, 1947, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 196–99.
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70. The pending bills had been introduced by Representatives G. W. Landis (H.R. 2543) on Mar. 13, 1947, *Congressional Record,* 80 Cong., 1 sess., p. 2051, T. A. Jenkins (H.R. 2791) on Mar. 26, 1947 (p. 2685), and W. A. Winstead (H.R. 3217) on Apr. 25, 1947 (p. 4115) and by Senators W. F. Knowland (S. 1004) on Mar. 31, 1947 (p. 2853), K. D. McKellar (S. 1118) on Apr. 16, 1947 (p. 3466), and Z. N. Ecton, G. W. Malone, J. H. Overton, J. R. McCarthy, and E. D. Thomas (S. 979) on Mar. 25, 1947 (p. 2530).

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75. New York *Times,* July 9, 1947; New York *Sun,* July 10, 1947; Washington *Post,* July 11, 13, 1947; Washington *Times-Herald,* July 12, 1947; *Newsweek,* July 21, 1947, p. 22; *The Nation,* July 19, 1947, pp. 60–61, Aug. 2, 1947, pp. 117–19.
76. Lilienthal, *Atomic Energy Years,* pp. 222–23; MLC 9, July 2, 1947, *AEC.*
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78. MLC 10, July 14, 1947, *AEC;* Lilienthal, *Atomic Energy Years,* p. 203. This entry is dated June 15, 1947, but it is clear from the Lilienthal appointment book and internal evidence that the correct date is July 15, 1947.
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80. JCAE, Minutes of Executive Session, July 22, 1947, Lilienthal to Joint Committee, July 21, 1947, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 227–28, 231.
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CHAPTER 4

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3. GAC 5, July 28–29, 1947, Oppenheimer to Bacher, Aug. 6, 1947, *AEC.*
4. Bacher to Oppenheimer, July 22, 1947, Box 18, *JRO;* Items of Interest to the GAC, July 24, 1947, *AEC.*
5. GAC 5, July 28–29, 1947, *AEC.*
6. Strauss to Bacher, July 29, 1947, *AEC;* Lilienthal, *Journals,* Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), pp. 229–30.
7. GAC 5, July 28–29, 1947, Draft Note on Atomic Power, Draft #1, July 29, 1947, encl., Oppenheimer to the Commissioners, July 29, 1947, *AEC.*
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CHAPTER 5

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CHAPTER 6

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56. Lilienthal, *Atomic Energy Years,* pp. 508–12, 524–30; Johnson and Lilienthal to Truman, Apr. 6, 1949, CM 263, May 3, 1949, Lilienthal to Truman, May 9, 1949, CM 268, May 11, 1949, *AEC.*
57. E. J. Bloch to W. J. Williams, Nov. 21, 1947, J. B. Knapp to Williams, Apr. 14, 1949, Program for MLC at Hanford, Apr. 12–14, 1949, A. V. Peterson to Williams, May 11, 1949, Williams to McCormack, May 11, 1949, Expanded Production Program, May 13, 1949, R. W. Cook to Williams, May 20, 1949, Webster to Lilienthal, May 26, 1949, *AEC.*
58. Bowen, "Development of Weapons," pp. 415–16.
59. CM 283, June 23, 1949, CM 284, June 24, 1949, Wilson Diary, June 27, 1949, Lilienthal to Webster, June 28, 1949, *AEC.* The Hickenlooper investigation is described in Chap. 11.
60. McMahon to Johnson, July 14, 1949, *AEC.*
61. CM 292, July 20, 1949, Truman to Souers, July 26, 1949, *AEC;* Lilienthal, *Atomic Energy Years,* p. 559.
62. *Time 54* (July 4, 1949), 5.

CHAPTER 7

1. Weinberg to Oppenheimer, Jan. 6, 1948, *ORNL.*
2. Weil to Zinn, Jan. 9, 1948, *ANL;* Zinn to Fisk, July 23, 1948, *AEC.*
3. Teller, Report . . . on Intermediate Neutron Energy Metal-Cooled Reactor, May 12, 1948, Teller, Report . . . on Proposed ANL Fast Neutron Alloy-Cooled Reactor, Jan. 25, 1948, *AEC.* For a minority view on the Schenectady proposal see C. H. Giroux to the Commission, Nov. 18, 1947, *AEC.*
4. Richard P. Feynman, an early member of the RSC, resigned before the Oak Ridge meeting. A brief history of the RSC is in Summary Report of the RSC, Aug. 11, 1949, *AEC.*
5. Huffman, Leverett, and Weinberg, Feasibility Report on Clinton High Flux Pile, MonT-433, Dec. 1, 1947, M. C. Leverett, C. R. McCullough, L. W. Nordheim, Hazards of Piles at Y-12, M-3335, Jan. 9, 1947, *AEC.*
6. Teller, Report . . . on the Proposed High Neutron Flux, Water Cooled Thermal Reactor, Feb. 10, 1948, *AEC.*
7. Zinn's analysis is in Zinn to Weil, Apr. 22, 1948, Report of the GAC Subcommittee on Reactors on the Safeguards for the High Flux Reactor, Apr. 24, 1948, *AEC.*
8. Spaatz to Bush, Jan. 7, 1948, *WNRC;* Bush to AEC, Dec. 23, 1947, Spaatz to Chairman, AEC, Dec. 30, 1947, *AEC.*
9. Hafstad to Commission, Jan. 9, 1948, Mills to Commission, Jan. 20, 1948, *AEC.* The date of the General Electric meeting is not known. The subjects covered are in "Notes on Conference with General Electric Company," dictated by Rickover and dated in pencil Jan. 5, 1948; the Westinghouse reference is in J. A. Hutcheson, Memorandum, Jan. 15, 1948. Both are in *AEC.*
10. GAC 8, Feb. 6–8, 1948, Program Council, Program to Develop Nuclear Engines for Aircraft, Feb. 3, 1948, *AEC.* References to negotiations between the Commission and the Bureau of Ships are in Director of Military Application, Nuclear Propulsion of Ships—Status of Bureau of Ships, Apr. 16, 1948, *AEC.* On Feb. 5, 1948, Mills presented his plans to Conant's committee. The comments Conant read to the GAC were circulated to the Research and Development Board on Feb. 17, 1948, as advisory. The Conant committee met again on Mar. 4, 1948, and concluded that it need take no more action since the staffs of the Commission, the MLC, and the

Bureau of Ships had begun to develop a plan. See Committee on Atomic Energy to Research and Development Board, Mar. 5, 1948, *AEC.*

11. CM 151, Feb. 18, 1948. A good summary of negotiations with MIT shortly before conclusion of the contract is in McCormack to Wilson, Apr. 30, 1948, *AEC.*
12. Rickover, Proposed Bureau of Ships Nuclear Power Research Program, Mar. 22, 1948, *ANL.*
13. There is some doubt as to what Mills actually said. An unclassified version is in Mills, "Navy Bureau of Ships Nuclear Power Program," Joint Committee on Atomic Energy, *Atomic Power and Private Enterprise* (Washington, 1952), pp. 203–206. AEC files contain a complete copy, but there is no indication whether this version was used at the symposium or reconstructed afterwards. Parts are taken from an earlier speech written by Rickover for Groves on Feb. 23, 1948, and portions can be identified from correspondence in *AEC.* For various and not always consistent accounts of the meeting see Ridenour to Lilienthal, Apr. 16, 1948, *AEC;* Ralph E. Lapp, *The New Force, The Story of Atoms and People* (New York, 1953), p. 168; Clay Blair, Jr., *The Atomic Submarine and Admiral Rickover* (New York, 1954), pp. 108–12.
14. CM 167, Apr. 22, 1948, Pike to Chief of Bureau of Ships, Apr. 27, 1948, *AEC.*
15. Division of Military Application, Nuclear Propulsion of Ships—Status of Bureau of Ships, Apr. 16, 1948, Pike to Chief of the Bureau of Ships, Apr. 27, 1948, Solberg, Report of Conference Held . . . on May 4, 1948, May 5, 1948, *AEC;* Tammaro to Zinn, Apr. 27, 1948, *ANL.*
16. Mills to Lilienthal, May 12, 1948, McCormack to Program Council, May 12, 1948, Weil to Fisk, May 12, 1948, *AEC.*
17. Wilson Diary, May 6, 1948, Winne to Wilson, June 3, 1948, *AEC.* The Winne letter mistakenly refers to the meeting as being held on May 21, 1948.
18. GAC 10, June 4–6, 1948, *AEC.*
19. D. B. Langmuir, Minutes of Meeting To Discuss Nuclear Energy for Propulsion of Submarines, June 16, 1948, *AEC.*
20. Wilson to Mills, July 28, 1948, Mills to Lilienthal, Aug. 2, 1948, *AEC.* Rickover reported to Wilson on July 26, 1948; see McCormack to Wilson, July 23, 1948, Wilson Diary, July 26, 1948, Mills to Secretary of the Navy, Aug. 3, 1948, *AEC.*
21. Mills summarized the status of his efforts in Mills to Sullivan, Aug. 3, 1948, *WNRC.* The memorandum received the endorsement of Admiral Denfeld, Chief of Naval Operations, that same day, with the comment that the Commission should be asked to provide views on how to make the greatest progress on submarine nuclear propulsion.
22. Weinberg to Rucker, Mar. 10, 1948, in Tentative Proposal . . . ORNL Program, undated but about Mar. 22, 1948, *AEC.* Useful on the status of zirconium research at Oak Ridge is W. L. Sibbitt, An Evaluation of Zirconium as a Structural Material for High Temperature Thermal Piles, ORNL-11, Jan. 9, 1948, *AEC.*
23. Leverett, The Poor Man's Pile—First Approximation, ORNL-26, Mar. 26, 1948, Weinberg to Rucker, Apr. 22, 1948, Weinberg and Peterson to Rucker, May 12, 1948, *ORNL.* A reflection of the feeling at Oak Ridge is evident in a remark by L. B. Emlet on the X-10 reactor, "In my opinion, the only reason the Atomic Energy Commission continues the Laboratory in Oak Ridge is because the pile is located here." Emlet to Rucker, Apr. 14, 1948, *ORNL.*
24. Weinberg to Zinn, May 20, 1948, *ANL.*
25. R. P. Johnson, Memorandum for Record, June 1, 1948, *AEC;* F. H. Belcher to R. W. Cook, June 2, 1948, *OROO;* Fisk to Zinn, June 9, 1948, *ANL.*
26. Weinberg to Rucker, June 16, 1948, *ORNL.*
27. Rucker to F. H. Belcher, June 18, 1948, *ORNL.*
28. Zinn to Weil, June 10, 1948, Weil to Fisk, May 26, 1948, Fisk to Manley, June 3, 1948, *AEC.*
29. Records of the RSC show no formal discussion of the high-flux reactor during the Hanford meeting. How-

ever, Zinn asked that the results of the natural convection test, which Teller witnessed, be called to the committee's attention and Zinn later stated that the committee did review possibilities of reducing the hazards. Zinn to Weil, June 10, 1948, Zinn to Fisk, July 23, 1948, *AEC*. The first mention of the exclusion formula is in Weil to Wilson *et al.*, June 21, 1948, and enclosures which describe the Hanford meeting, *AEC*. In his letter to Fisk, July 23, 1948, Zinn describes the formula as recently developed. The radius in miles of the three areas is derived by multiplying the square root of the power level expressed in kilowatts by 0.01 for the area of complete control; 0.1 for the area of less than 100,000 population; and 0.3 for the area in which there must be no vital installations.

30. Zinn to Fisk, July 23, 1948, *AEC*.
31. GAC 8, Feb. 6–8, 1948, GAC 10, June 4–6, 1948, *AEC*.
32. Harter to Parker, Aug. 9, 1948, *AEC*.
33. Carpenter, Memorandum of Visit to Argonne Laboratory, Aug. 13, 1948, *AEC*.
34. Memorandum of Discussion with Admiral Mills, Captain Rickover, and General Wilson, Aug. 13, 1948, *AEC*.
35. Minutes of Bureau of Ships, MLC-AEC Conference on NEPS, Aug. 25, 1948, Carpenter to Wilson, Mills, and Parsons, Sept. 2, 1948, *AEC*. The statements which Rickover read at the meeting were from Burris to Johnston, Aug. 24, 1948, and Memorandum of Telephone Conversation with Mr. George Bucher of Westinghouse, Aug. 25, 1948, *AEC*.
36. Rickover, Memorandum Report of Travel, Sept. 8, 1948, Rickover to Mills, Sept. 9, 1948, *AEC*. Rickover's questions about General Electric's motives stemmed in part from the fact that Winne was a member of the long-range objectives panel.
37. Wilson to Program Council, Sept. 20, 1948, Bacher to the Commission, Sept. 20, 1948, *AEC*.
38. Wilson Diary, Sept. 28, Oct. 5, 1948, Wilson to Program Council, Oct. 5, 1948, *AEC*.
39. Wilson Diary, Oct. 11, 1948, Greenewalt to Wilson, Oct. 14, 1948, *AEC*.
40. Franklin to Wilson, Oct. 14, 1948, *AEC*.
41. Zinn to Weil, Aug. 13, 1948, *AEC*.
42. Franklin to Center, Aug. 23, 1948, Weinberg, Research Pile at ORNL, Aug. 17, 1948, *AEC;* Rucker to Weil, Aug. 24, 1948, *OROO;* Weil to Weinberg, Aug. 26, 1948, *ORNL*.
43. Teller, Report . . . on Intermediate Neutron Energy Metal-Cooled Reactor, May 12, 1948, C. H. Giroux, Further Remarks . . . , Nov. 18, 1947, Wilson to Shugg, Feb. 13, 1948, Report on Reactor Site Study for Knolls Atomic Power Laboratory, July 30, 1948, SNY LEJ-1, *AEC*.
44. K. H. Kingdon and H. Brooks, Objectives of the KAPL Reactor, Sept. 7, 1948, Winne to L. E. Johnston, Sept. 7, 1948, *AEC*.
45. English to Fisk, June 14, 1948, Weil to Zinn, July 9, 1948, *AEC;* Zinn to Weil, Aug. 11, 1948, *ANL*.
46. Teller *et al.* to Weil, Sept. 10, 1948, *AEC*.
47. Huffman to Zinn, Sept. 14, 1948, *ANL;* GAC 9, Apr. 23–25, 1948, *AEC*. Possible safety features were summarized for the committee in J. R. Huffman and S. Untermyer, Information for Reactor Safeguard Committee Meeting, Sept. 9, 1948 (High-Flux Research Pile), Aug. 26, 1948, CF-48-8-348, *AEC*.
48. Huffman to Zinn, Sept. 14, 1948, *ANL*.
49. Teller, Statement on Danger Area Regulations and on Schenectady Intermediate Reactor, Nov. 17, 1948, *AEC*.
50. Division of Engineering, Acquisition of Land for Location of Intermediate Reactor, Aug. 30, 1948, Winne to Johnston, Sept. 3, 1948, CM 191, Sept. 10, 1948, Wilson Diary, Sept. 2, 1948, Trapnell to Commissioners, Sept. 16, 1948, CM 195, Sept. 17, 1948, and CM 197, Sept. 21, 1948, *AEC*.
51. Weil to Weinberg, Sept. 9, 1948, *OROO;* Transcript, Reactor Meeting, Oct. 5, 1948, *ANL*.
52. Weinberg to Weil, Sept. 17, 1948, *AEC;* Weinberg to Shugg, Oct. 12, 1948, *ORNL;* Weinberg to Zinn, Oct. 12, 1948, *ANL*.
53. Wilson to Program Council, Oct. 5, 1948, CM 208, Oct. 19, 1948, Shugg Diary, Oct. 29, 1948, *AEC;* Franklin to Shugg, Nov. 2, 1948, *OROO*.

54. H. M. Roth, Monthly Major Problem Report for Nov. 1948, Dec. 1, 1948, *OROO;* Shugg Diary, Nov. 8, 10, 29, 1948, Shugg to Zinn, Nov. 8, 1948, *AEC;* Zinn to Shugg, Nov. 30, 1948, *ORNL.*
55. Williams to Program Council, Sept. 10, 1948, Johnson to Williams, Sept. 17, 1948, Krug to Lilienthal, Nov. 26, 1948, Gingrich to Warner, Nov. 30, 1948, Preliminary Report by the RSC, Dec. 15, 1948, Shugg Diary, Dec. 13, 1948, Minutes, Program Council, Dec. 16, 1948, T. O. J[ones] to M. A., Dec. 31, 1948, *AEC;* unsigned note, "Phone Conversation with G. L. Weil and," Dec. 31, 1948, *ANL.*
56. Etherington *et al.*, Study of a Water-Cooled Pile for Naval Application, Sept. 1, 1948, ORNL-133, *AEC.* The other studies were not completed until the first quarter of 1949. See Members of the Naval Reactor Division, Level I Report, A Helium-Cooled Beryllium-Moderated Reactor for Naval Application, Feb. 1, 1949, ANL-4242, E. K. Falls, R. K. Winkleblack, S. Untermyer, Preliminary Study of NaK Cooled Thermal Reactor for Naval Propulsion, Mar. 1, 1949, ANL-4256, Falls *et al.*, Preliminary Study of Bi-Alloy Cooled Thermal Reactor, Mar., 1949, ANL-4267, *AEC.*
57. An account of Westinghouse interest in nuclear propulsion and relations with the Navy is in Russell S. Greenbaum, "Nuclear Power for the Navy, the First Decade (1939–1949)" (Washington, unpublished, n.d.), pp. 154–56. A copy is in *NHD.* The Mills-Rickover views are in a memorandum from a staff member of the Joint Committee, E. L. Heller, Memorandum for the Record, Aug. 27, 1948, *JCAE;* Wilson to Program Council, Sept. 20, 1948, *AEC.*
58. Zinn to Shugg, Nov. 8, 1948, *AEC.*
59. Shugg Diary, Nov. 16, 1948, Letter contract, Dec. 10, 1948, signed by A. Tammaro and C. H. Weaver, Fine to Bacher, Jan. 13, 1949, *AEC.*
60. Suits to Johnston, Sept. 30, 1948, Kingdon to Johnston, Oct. 27, 1948, cited in D. Cochran *et al.*, Nuclear Power Submarine, A Comparison of Development Program, KAPL-132, Apr. 15, 1949, Shugg Diary, Nov. 3, 17, Dec. 2, 1948, L. E. Johnston and H. G. Rickover, Conference Memorandum, Dec. 9, 1948, *AEC.*
61. Wilson to the Program Council, Oct. 5, 1948, CM 208, Oct. 19, 1948, *AEC.*
62. GAC 11, Oct. 21–23, 1948, *AEC.*
63. Franklin to Files, Sept. 15, 1948, Holland to R. P. Johnson, Dec. 13, 1948, *OROO.*
64. CM 215, Nov. 10, 1948, *AEC.*
65. General Manager's Bulletin 22, Division of Reactor Development, Sept. 15, 1948, Wilson Diary, Oct. 12, 1948, Murphree to Wilson, Dec. 17, 1948, Wilson to Hafstad, Jan. 12, 1949, *AEC.*
66. Smith, Hinchman and Grylls, Survey on Fort Peck, Montana and Pocatello, Idaho Sites . . . Interim Report, Feb. 5, 1949, *AEC.* The final report was Survey Report Fort Peck, Montana—Pocatello, Idaho, Sites, March, 1949, *AEC.* Warner to Snapp, Feb. 10, 1949, Minutes, Program Council, Feb. 14, 1949, Division of Engineering, Site Selection for Reactor Testing Station, Feb. 15, 1949, Teller to Weil, Feb. 17, 1949, CM 246, Feb. 18, 1949, Minutes, Executive Meeting of the Joint Committee, Mar. 14, 1949, Warner to All Division Directors, Mar. 29, 1949, Snapp to Hafstad, Mar. 23, 1949, *AEC.* Commission approval of Feb. 18, 1949, was contingent upon certain revisions of the paper. These revisions were circulated for the information of the Commission on Mar. 1, 1949. Technically the Commission could be said to have approved the Pocatello site on Mar. 1, 1949, rather than on Feb. 18, 1949. AEC Press Release 162, Mar. 22, 1949, Press Release 165, Apr. 1, 1949, Press Release 174, May 13, 1949, Press Release 176, May 18, 1949, *AEC;* Idaho Falls *Post-Register,* May 18, 1949; Joint Committee, *Selection of Site for Reactor Test Station,* Apr. 14, May 10, 1949 (Washington, 1949).
67. Wilson to Webster, Dec. 8, 1948, Webster to Joint Chiefs of Staff, Mar. 25, 1949, *AEC;* Carpenter to Files, June 26, 1948, *WNRC;* T. A. Sims to Commanding General, Air Materiel Command, Jan. 6, 1948, *OROO;* Borden to Hafstad, Mar. 25, 1949, Hafstad to Borden, Apr. 15, 1949, *AEC.* Oppenheimer and Conant opinions are

in Russell to McCormack, Dec. 20, 1948, *AEC.*

68. S. Naymark, Summary of Fuel Element Conference, ANL-HE-22, Dec. 16, 1948, *AEC;* Etherington, Program for Development of a Nuclear Reactor for Submarine Propulsion, ANL-HE-27, Feb. 17, 1949, *ANL.*
69. Etherington *et al.*, Study of a Water-Cooled Pile for Naval Application, ORNL-133, Sept. 1, 1948, *AEC;* Etherington to Zinn, May 12, 1949, *ANL.* See also Note 66.
70. Brooks, A Review of the Breeding Problem in Nuclear Reactors, KAPL-48, Mar. 29, 1948, W. R. Kanne, F. A. White, I. H. Dearnley, S. B. Dunham, Preparatory Work for the Plutonium Alpha Experiments, KAPL-64, May 7, 1948, Brooks, Status of Alpha for Plutonium in Relation to Reactor Design Progress, KAPL-136, Mar. 30, 1949, *AEC.*
71. Suits and Kingdon, Preliminary Feasibility Report on the KAPL Reactor, KAPL-116, Jan. 12, 1949, Weil to Hafstad, Mar. 10, 1949, *AEC.*
72. Kingdon, Review of the Objectives and Merit of the KAPL Power-Breeder Reactor, KAPL-189, May 17, 1949, *AEC;* Weinberg to Weil, May 11, 1949, *ORNL;* Zinn to Weil, May 6, 1949, *ANL.*
73. Technical Division Report for Quarter Ending Nov. 30, 1948, ORNL-215, Report for Quarter Ending Feb. 28, 1949, Part I, ORNL-323, J. L. English, Interim Report on the Corrosion of Beryllium, ORNL-298, Mar. 17, 1949, Cunningham to Peterson, Oct. 5, 1948, *AEC;* J. Shilling to File, June 7, 1948, W. B. Allred to Files, Nov. 12, 1948, J. L. Gregg to J. H. Frye, Feb. 24, 1949, S. B. Roboff to Files, Feb. 25, 1949, *ORNL;* Minutes, Thirteenth Meeting of the Materials Reactor Steering Committee, May 16, 1949, *ANL.*
74. Shugg Diary, Jan. 3, 7, 25, 26, Feb. 13, 18, 28, Mar. 1, 1949, CM 256, Apr. 7, 1949, *AEC.*
75. Hafstad to Zinn, Mar. 28, 1949, Zinn to Hafstad, Apr. 1, 1949, *ANL;* McLain, Materials Testing Reactor, Estimated Capital and Operating Costs of Project, Apr. 26, 1949, *AEC.* The steering committee estimate was $16.1 million, which was corrected to $18.1 million. McLain to Hafstad, Aug. 15, 1949. A good description of the Oak Ridge meeting is in M. H. Studier to W. M. Manning, May 9, 1949, *ANL.*
76. Wende to Hafstad, May 16, 1949, *AEC.*
77. Reopening the Question of the Location of Materials Testing Reactor in Oak Ridge, Apr. 1949, Baranowski to Felbeck, May 4, 1949, M.T.R. Reactor Proposal by Weinberg, Rough Draft, May 18, 1949, *ORNL;* Felbeck to Wilson, May 19, 1949, *AEC.*
78. R. G. Hewlett, "The Experimental Breeder Reactor No. 1, The Life Story of a Nuclear Reactor" (Washington, unpublished, n.d.), *AEC.*
79. GAC 14, June 2–4, 1949, Oppenheimer to Lilienthal, June 6, 1949, *AEC.*
80. Shugg Diary, June 6, 1949, CM 279, June 14, 1949, *AEC.* The June 13, 1949, meeting was informal and does not appear in the Commission minutes.
81. Smyth to Manley, July 12, 1949, *AEC.*
82. GAC 15, July 14–15, 1949, *AEC.*
83. Rickover, Nuclear Powered Submarine Development at Argonne National Laboratory, July 15, 1949, Etherington to Zinn, Aug. 16, 1949, Huffman to Zinn, June 21, 1949, McLain to Hafstad, Aug. 15, 1949, *ANL;* Felbeck to Wilson, Aug. 5, 1949, CM 298, Aug. 3, 1949, Webster to Lilienthal, Aug. 2, 1949, *AEC.*
84. Rickover to Files, Oct. 4, 1949, *AEC.*
85. Zinn to Hafstad, Oct. 13, 1949, *AEC.*
86. Hafstad to Zinn, Oct. 25, 1949, Shugg to Winne, Nov. 9, 1949, *AEC.*
87. Wigner, "Where Are We Going in Reactor Development?", *Journal of Metallurgy and Ceramics* 5 (June, 1950), pp. 33–37.

CHAPTER 8

1. Ridenour to Lilienthal, Apr. 16, 1948, *AEC;* Alice K. Smith, *A Peril and A Hope* (Chicago, 1965), pp. 345–46.
2. For a description of the "area of availability" doctrine, see Chap. 4.
3. R. G. Hewlett and O. E. Anderson, Jr., *The New World, 1939–1946,* Vol. I of *A History of the U. S. Atomic Energy Commission* (University Park, Pa., 1962), p. 633.
4. Discussion of ORNL, Mar. 1948, C. N. Rucker to J. C. Franklin, May 20, 1948, *ORNL.*
5. Minutes, Board of Governors, ANL, Mar. 13, 1948, *ANL;* Notes on Discussions at Chicago, unsigned, Apr. 9, 1948, *AEC.*

6. Brookhaven Report, The Founding of Brookhaven National Laboratory, Jan. 15, 1948, N. F. Ramsey, Early History of Associated Universities and Brookhaven National Laboratory, Report BNL 992, Mar. 30, 1966, *AEC.*
7. Work at Brookhaven in 1947 is described in the following reports: BNL-S-3, Scientific Progress Report, July–Dec. 1947, BNL-A-2, Administrative Progress Report, Dec. 15, 1947. On early accelerator plans see R. F. Van Wye to W. E. Kelley, May 12, 1947, *AEC.*
8. Lawrence to Groves, Oct. 17, 1946, E. B. Kelly to Lawrence, Mar. 7, 1947, *LRL.*
9. This reasoning is reflected in R. P. Johnson to L. L. Strauss, Jan. 16, 1948, *AEC.*
10. The nontechnical reader will find the best general explanation of accelerators in Robert R. Wilson and Raphael Littauer, *Accelerators, Machines of Nuclear Physics* (Garden City, N. Y., 1960). For a good technical survey see M. Stanley Livingston and John P. Blewett, *Particle Accelerators* (New York, 1962). Philip Morrison reviewed the status of nuclear physics in 1946 in *Journal of Applied Physics 18* (1947), 135–43.
11. Lawrence described the invention of the cyclotron in his Nobel Prize address, Dec. 11, 1951, *Les Prix Nobel en 1951* (Stockholm, 1952), pp. 127–34. See also Lawrence to W. Weaver, Feb. 24, 1940, *LRL.* For personal background on Lawrence, see Herbert Childs, *An American Genius: The Life of Ernest Orlando Lawrence* (New York, 1968), pp. 277–323.
12. Wilson and Littauer, *Accel rators,* pp. 104–16; Livingston and Blewett, *Particle Accelerators,* pp. 193–235.
13. V. I. Veksler, "Concerning Some New Methods of Acceleration of Relativistic Particles," *Physical Review 69* (1946), 244; E. M. McMillan, "The Synchrotron—A Proposed High Energy Particle Accelerator," *Physical Review 68* (1945), 143–44.
14. Wilson and Littauer, *Accelerators,* pp. 123–25.
15. McMillan to Lawrence, July 4, 1945, *LRL.*
16. J. Reginald Richardson, "Frequency Modulated Cyclotron," *Physical Review 69* (1946), 669–70; Lawrence to Weaver, Nov. 2, 1946, *LRL;* Livingston and Blewett, *Particle Accelerators,* pp. 352–54; W. M. Brobeck *et al.,* "Initial Performance of the 184-Inch Cyclotron," *Physical Review 71* (1947), 449–50.
17. McMillan to Lawrence, Nov. 29, 1945, *LRL;* Livingston and Blewett, *Particle Accelerators,* pp. 397–402; F. K. Goward and D. E. Barnes, "Experimental 8 Mev Synchrotron for Electron Acceleration," *Nature 158* (1946), 413; F. R. Elder *et al.,* "A 70-Mev Synchrotron," *Journal of Applied Physics 18* (1947), 810–18.
18. Alvarez's early considerations are described in Alvarez *et al.,* "Berkeley Proton Linear Accelerator," *The Review of Scientific Instruments 26* (1955), 111–12. See also Livingston and Blewett, *Particle Accelerators,* pp. 310–12, 328–29.
19. Lawrence to Groves, Oct. 17, 1946, Panofsky to McMillan, Jan. 9, 1947, *LRL;* P. F. Kromer, Jr. to Area Engineer, Berkeley, Jan. 22, 1947, *AEC.*
20. Brobeck, Drawing of a 10-Bev Proton Accelerator (Bevatron), Nov. 12, 1946, Brobeck, Design Study for a

Ten-Bev Magnetic Accelerator, Aug. 22, 1947, *LRL*. This study with minor revisions was published under the same title in *Review of Scientific Instruments 19* (1948), 545–51. Childs, *American Genius*, pp. 400–02. H. R. Crane of the University of Michigan first suggested the idea of straight sections. See his article, "The Racetrack: A Proposed Modification of the Synchrotron," *Physical Review 69* (1946), 542.

21. M. L. Oliphant *et al.*, "The Acceleration of Charged Particles to Very High Energies," Physical Society of London, *Proceedings 59* (1947), 666–77; J. S. Gooden *et al.*, "Theory of the Proton Synchrotron," Physical Society of London, *Proceedings 59*, 677–93; Livingston and Blewett, *Particle Accelerators*, pp. 437–46.
22. The Founding of Brookhaven National Laboratory, Jan. 15, 1948, pp. 22–23, *BNL*.
23. Brookhaven Scientific Progress Report BNL-S-3, July–Dec. 1947, pp. 12–19, *BNL*.
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25. Seaborg describes the discovery of the actinide series in *Man-Made Transuranium Elements*, pp. 38–40.
26. Seaborg, *Transuranium Elements*, pp. 79–80; G. T. Seaborg, R. A. James, and A. Ghiorso, "The New Element Curium (Atomic Number 96)," *Research Papers*, pp. 1554–58.
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29. B. B. Cunningham, "The First Isolation of Americium in the Form of Pure Compounds," *Research Papers*, pp. 1363–70.
30. S. G. Thompson, L. O. Morgan, R. A. James, and I. Perlman, "The Tracer Chemistry of Americium and Curium in Aqueous Solutions," *Research Papers*, pp. 1339–62.
31. A. H. Sparrow and B. A. Rubin, "Effects of Radiation on Biological Systems," in G. S. Avery, Jr., *Survey of Biological Progress*, Vol. II (New York, 1952), p. 1.
32. A good summary of the status of genetic research with radiation is in *Genes and Chromosomes, Structure and Organization*, Cold Spring Harbor Symposium in Quantitative Biology, IX (Cold Spring Harbor, N. Y., 1941).
33. For a general summary of Sparrow's work on *Trillium*, see A. H. Sparrow, M. J. Moses, and R. Steele, "A Cytological and Cytochemical Approach to an Understanding of Radiation Damage in Dividing Cells," *British Journal of Radiology 25* (1952), 182–89. For a general introduction to cytology, see C. P. Swanson, *The Cell* (Englewood Cliffs, N. J., 1960) and E. W. Sinnott, L. C. Dunn, and T. Dobzhansky, *Principles of Genetics* (New York, 1958).
34. Brookhaven National Laboratory, Scientific Progress Report, July–Dec., 1947, BNL-S-3, Jan.–June, 1948, BNL-S-4, Progress Report, July–Dec., 1948, BNL-AS-1, *BNL*; A. H. Sparrow, "Relative X-Ray Sensitivity of Metaphase and Interphase Chromosomes," *Nature 162* (1948), 651–52.
35. A. W. Oughterson and S. Warren, *Medical Effects of the Atomic Bomb in Japan*, Vol. XIII, Part 8 of the *National Nuclear Energy Series* (New York, 1956).
36. J. V. Forrestal to H. S. Truman, Nov. 18, 1946, F. B. Jewett to Lilienthal, Jan. 7, 1947, L. H. Weed to C. L. Wilson, Feb. 25, 1947, Minutes, Com-

mittee on Atomic Casualties, Mar. 25, June 6, June 26, Sept. 10, 1947, S. Warren to C. L. Wilson, Apr. 2, 1948, *AEC;* "Genetic Effect of the Atomic Bombs in Hiroshima and Nagasaki," *Science 106* (Oct., 1947), 331–33.

37. ABCC Progress Report, Apr. 15, 1948, *AEC.*
38. Statement of Principles Concerning the Proposed Joint Program, encl., C. L. Wilson to P. F. Lee, Jan. 14, 1948, *AEC.* The ONR program is described in House Committee on Appropriations, *Department of the Navy Appropriations for 1949,* Feb. 14–Mar. 8, 1948 (Washington, 1948), pp. 963–81.
39. Conference Report, Feb. 3, 1948, Wilson to Lee, Mar. 4, 1948, AEC Press Release 99, Apr. 23, 1948, *AEC.*
40. Establishment of Unclassified Areas of Research, Apr. 3, 1948, CM 163, Apr. 6, 1948, Report of the GAC Subcommittee on Research, Apr. 25, 1948, GM Bulletin 93, June 30, 1948, *AEC.*
41. Establishment of Unclassified Areas of Research, July 21, 1948, and a revised version, Aug. 11, 1948, CM 188, July 27, 1948, *AEC.*
42. Wilson and Littauer, *Accelerators,* pp. 123–25; C. F. Powell *et al., The Study of Elementary Particles by the Photographic Method* (New York, 1959), pp. 7–36, 212–24.
43. Gardner recorded his activities in a series of notebooks entitled, Photographic Films for Detecting Charged Particles, Job No. 124–2, *LRL.* See entries for Oct. 13, 1948, VIII, 120, and Oct. 26, 1948, VIII, 185. (Hereafter cited as *Gardner Notebooks.*)
44. Powell to Gardner, Nov. 24, 1947, in *Gardner Notebooks,* X, 188, *LRL.*
45. Lattes to Lawrence, Jan. 2, 1948, Gardner to Lattes, Jan. 15, 1948, *Gardner Notebooks,* IX, 144, and XII, 13–15, 26–34, 51, Log entries, Feb. 15, 22, 24–26, 29, *LRL.* Gardner and Lattes, "Production of Mesons by the 184-Inch Berkeley Cyclotron," *Science 107* (1948), 270–71; AEC Press Release 93, Mar. 9, 1948, *AEC;* Lawrence to Strauss, Feb. 25, 1948, Lawrence to L. A. DuBridge, Mar. 5, 1948, *LRL.*
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47. Summary on High-Energy Proton Accelerator for GAC, Feb. 4, 1948, GAC 8, Feb. 6–8, 1948, *AEC;* Lawrence to A. P. Pollman, Feb. 5, 1948, *LRL.*
48. R. P. Johnson, Memo for Record on Berkeley Meeting, Mar. 22, 1948, *AEC.*
49. Johnson to Fisk, Apr. 3, 1948, Fisk, Construction of Two Bevatrons, Apr. 9, 1948, CM 165, Apr. 14, 1948, *AEC.*
50. On the discussion over the names "bevatron" and "cosmotron," see M. S. Livingston to Johnson, Mar. 31, 1948, Johnson to Lawrence, Apr. 8, 1948, Lawrence to Johnson, Apr. 15, 1948, *LRL.* For a comprehensive description of cosmotron design, see M. Hildred Blewett, "The Cosmotron—A Review," *Review of Scientific Instruments 24* (1953), 725–37; J. P. Blewett *et al.,* "Magnet. Part I—Design," *Review of Scientific Instruments 24,* 737–42; G. K. Green *et al.,* "Magnet. Part II—Magnetic Measurements," *Review of Scientific Instruments 24,* 743–54. Brookhaven Progress Report, July 1–Dec. 31, 1949, BNL 39 (AS-3), *BNL.*
51. For Warren's own summary of the early program in biology and medicine see his article, "The Medical Program of the Atomic Energy Commission," *Bulletin of the Atomic Scientists 4* (Aug. 1948), 233–34.
52. University of Chicago Roundtable, *World Progress in Cancer Research,* Aug. 31, 1947 (Chicago, 1947), p. 1.
53. P. C. Aebersold, Isotopes and Their Application to Peacetime Uses of Atomic Energy, Speech Before the AAAS, Dec. 29, 1947, *AEC.* For a general summary, see the Commission's *Fourth Semiannual Report* (Washington, 1948).
54. S. Warren, Cancer Research Program for the AEC, Jan. 30, 1948, CM 147, Feb. 3, 1948, J. C. Franklin, Study of Wider Use of Isotopes, encl., Franklin to C. L. Wilson, June 22, 1948, *AEC.*
55. Minutes, Interim Medical Committee, Jan. 23–24, 1947, Report, Medical Board of Review, June 20, 1947, Min-

utes, Advisory Committee for Biology and Medicine (hereafter cited as ACBM), Nov. 7, 1947, S. Warren and J. B. Fisk, Training Program for Sciences Related to Atomic Energy, Jan. 2, 1948, S. Warren, Training Program for Physicians in Medical Aspects of Atomic Energy, Jan. 16, 1948, CM 143, Jan. 21, 1948, *AEC.*

56. Minutes, ACBM, Mar. 13, 1948, AEC Press Release 85, Jan. 28, 1948, AEC Press Release 86, Feb. 3, 1948, AEC Press Release 89, Feb. 26, 1948, J. B. Fisk, Fellowship Program for Training in Physical Sciences Related to Atomic Energy, Jan. 26, 1948, Minutes, ACBM, May 8, 1948, *AEC.* For subsequent development on fellowships, see Chap. 11, pp. 340–42.
57. CM 147, Feb. 3, 1948, Minutes, ACBM, Feb. 14, 1948, S. Warren, Argonne Cancer Research Hospital, July 1, 1948, CM 181, June 24, 1948, *AEC.*
58. Minutes, ACBM, Oct. 8–9, 1948, AEC Press Release 129, Sept. 20, 1948, *AEC;* Neal O. Hines, *Proving Ground: An Account of the Radiobiological Studies in the Pacific, 1946–1961* (Seattle, 1962), pp. 50–111.
59. H. M. MacNeille, Report to Interdepartmental Committee for Research and Development, Aug. 30, 1948, Statement Furnished by AEC Summarizing Contract Provisions, encl., Wilson to Hickenlooper, Mar. 18, 1948, J. R. Loofbourow *et al.*, Report of the Advisory Board on Relationships of the AEC with Its Contractors, Nov. 30, 1947, *AEC.*
60. W. E. Kelley to Wilson, Aug. 13, 1948, *AEC.*
61. AEC Press Release 122, Aug. 5, 1948, Wilson, Organization of the Washington Headquarters and Field Operations Offices, and the Appointment of Certain Key Personnel, Aug. 31, 1948, Wilson to R. B. Snapp, Sept. 10, 1948, Revision of Reorganization Plan, Sept. 13, 1948, with drafts of GM Bulletins 21 and 32, Functions and Delegations, Division of Research and Biology and Medicine, *AEC.*
62. *Public Papers of Harry S. Truman, 1948* (Washington, 1964), pp. 482–85. Truman's speech was also reprinted in *Bulletin of the Atomic Scientists 4* (Oct., 1948), 291–93. CM 212, Oct. 27, 1948, Lilienthal to R. G. Sproul, Nov. 16, 1948, Sproul to Lilienthal, Nov. 22, 1948, AEC Press Release 146, Dec. 5, 1948, *AEC.*
63. Minutes, ACBM, Oct. 8–9, 1948, AEC Press Release 138, Oct. 20, 1948, C. L. Wilson to Managers of Operations, Jan. 27, 1949, *AEC.*
64. GAC 12, Feb. 3–5, 1949, *AEC.*
65. Warren, Research by Direct Contracts in the Fields of Biology, Medicine, and Biophysics, Mar. 10, 1949, Pitzer, Administration of Basic Research Program in Physical Sciences by Direct Contract, Mar. 11, 1949, CM 252, Mar. 14, 1949, AEC Press Release 164, Apr. 5, 1949, *AEC.*
66. C. Shugg, Argonne National Laboratory Facilities, Feb. 7, 1949, CM 243, Feb. 10, 1949, GAC 12, Feb. 3, 1949, Pitzer, Permanent Construction Program for the Oak Ridge National Laboratory, May 9, 1949, CM 270, May 12, 1949, Oak Ridge AEC Press Release, May 20, 1949, *AEC.*
67. Minutes, Argonne Board of Governors, Dec. 6, 1949, *ANL.* R. P. Johnson summarized the situation at Oak Ridge at CM 235, Jan. 19, 1949, *AEC.* Weinberg, "Oak Ridge National Laboratory," *Science 109* (Mar. 1949), 245–48; GAC 13, Apr. 5, 1949, *AEC;* Weinberg, Research Program at ORNL, Mar. 22, 1949, *ORNL;* Oppenheimer to Lilienthal, Apr. 7, 1949, *AEC.*

CHAPTER 9

1. *Congressional Record*, 80 Cong., 1 sess., pp. 1932–81; *Time*, Mar. 24, 1947; *Newsweek*, Mar. 24, 1947; Washington *Evening Star*, Mar. 12, 1947; Washington *Post*, Mar. 13, 1947.
2. A proposal by Byrnes to aid Greece and Turkey was favorably considered by Forrestal and Patterson at a State, War, Navy Coordinating Committee meeting of Sept. 25, 1946; Walter Millis, ed., *The Forrestal Diaries* (New York, 1951), p. 210. Truman's account of the crisis is in his *Memoirs*, Vol. II, *Years of Trial and Hope* (Garden City, N. Y., 1956), pp. 97–109. Vandenberg's role is described in Arthur H. Vandenberg, Jr., ed., *The Private Papers of Senator Vandenberg* (Boston, 1952), pp. 338–52. Marshall's interview with reporters is in the Washington *Post*, Mar. 5, 1947.
3. For the Quebec meeting and postwar Anglo-American relations on atomic energy through 1946, see R. G. Hewlett and O. E. Anderson, Jr., *The New World, 1939–1946*, Vol. I of *A History of the U. S. Atomic Energy Commission* (University Park, Pa., 1962), pp. 277–80, 455–81. Accounts differ as to when various people learned of the agreements. Lilienthal to the Commissioners, Apr. 23, 1947, *AEC*, described a meeting with Truman, Patterson, Forrestal, and Leahy during which the agreements were mentioned. The description leaves some doubt whether implications of the agreements were understood. According to *The Private Papers of Senator Vandenberg*, p. 359, Vandenberg and Hickenlooper learned of the agreements in the late spring or early summer of 1947. Hickenlooper wrote to Marshall on Aug. 29, 1947, that he had learned of the agreements only a short time before. The letter is one of several documents in a binder: U.S.–U.K.–Canada Negotiations, Book 1, Oct. 31, 1947, *WNRC*. Lilienthal, *Journals*, Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), pp. 175–76, 182, states that on May 5, 1947, he informed the Joint Committee of the existence of the agreements but that details should come from the State Department. Acheson spoke at an executive session of the Joint Committee on May 12, 1947. Little more than a reference to the meeting is in Joint Committee, *Summary of Proceedings on JCAE Meetings, May 5, 1947, through May 28, 1948, AEC*. Acheson's prepared statement is in U. S.-U. K.-Canada Negotiations, Book 1, Oct. 31, 1947, *WNRC*. Although Minutes, American Members, CPC, Nov. 26, 1947, *AEC*, contains a reference to a meeting informing the Joint Committee on Mar. 12, 1947, nothing has been found to substantiate that date. The evidence indicates that Truman, Forrestal, and Patterson had a general idea of the agreements, but the Congressional leaders did not learn of them until May 12, 1947.
4. Lilienthal to Byrnes, Dec. 30, 1946, Lilienthal to Commissioners, Jan. 31, 1947, *AEC*.
5. Expressions of concern about the U.N. role in Greece were voiced by Marquis Childs and Walter Lippmann, Mar. 17, 1947, Washington *Post*. Lippmann's condemnation of containment is in his *The Cold War: A Study in U. S. Foreign Policy* (New York, 1947). Vandenberg's concern can be noted in *The Private Papers of Senator Vandenberg*, pp. 340–51. Connally was also worried. Tom Connally with Alfred Steinberg, *My Name Is Tom Connally* (New York, 1954), pp. 317–18.
6. Background information on international control is in Hewlett and Anderson, *New World*, Chaps. 15 and 16, and United Nations, Department of Public Information, *Yearbook of the United Nations, 1946–47*, (New York, 1947), pp. 444–47.
7. U. S. Department of State, *International Control of Atomic Energy, The First Report of the United Nations Atomic Energy Commission to the Security Council* (Washington, 1947).

For Baruch and the veto see Hewlett and Anderson, *New World*, pp. 562–63; Truman, *Years of Trial and Hope*, p. 10; Bernard M. Baruch, *Baruch, the Public Years* (New York, 1960), pp. 366–67; Lilienthal, *Atomic Energy Years*, p. 60 n. Lilienthal records Acheson's and Trygve Lie's misgivings on the veto in *Atomic Energy Years*, pp. 131, 401. Baruch to Lilienthal, Apr. 28, 1947, *AEC*.

8. On the Baruch relations see *Baruch, the Public Years*, pp. 316–63, 367–68; Truman, *Years of Trial and Hope*, pp. 8–10; Lilienthal, *Atomic Energy Years*, pp. 130–31.
9. Harry S. Truman, *Memoirs*, Vol. I, *Year of Decisions* (Garden City, N. Y., 1955), pp. 145, 156; U. S. Department of State, *International Control of Atomic Energy—Policy at the Crossroads* (Washington, 1948), pp. 34–63; *Yearbook of the United Nations, 1946–47*, pp. 139–43.
10. On Jan. 8, 1947, the Commission authorized Lilienthal to offer its technical assistance to State in providing guidance for the U. S. representatives on the UNAEC. See CM 19, Jan. 8, 1947, *AEC*. Earlier at CM 9, Dec. 11, 1946, and at CM 18, Jan. 2, 1947, *AEC*, the Commission approved Richard C. Tolman as consultant for the UNAEC. Lilienthal describes the meeting with Acheson in *Atomic Energy Years*, p. 132. An account of Marshall's meeting with Patterson and Forrestal is in Millis, *Forrestal Diaries*, p. 241, and Forrestal Diary, *JFP*.
11. *Yearbook of the United Nations, 1946–47*, pp. 377–78.
12. Voting on the resolution was not completed until Feb. 13, 1947. *Yearbook of the United Nations, 1946–47*, pp. 377–81.
13. Commission consultation on Austin's instruction was perfunctory. "The Statement of Position of the United States" was sent to Herbert Marks on Feb. 14, 1947, by J. E. Johnson of the State Department, with the remark that the pace of events left little time for consideration. Feb. 14 was a Friday, and Marks could not contact the Commissioners. However, Marks was familiar with Commission views and thought the position was acceptable. Marks to Commission, Feb. 17, 1947, *AEC*. The position did not differ greatly from one sent by Gullion to Marks, Jan. 14, 1947, *AEC*.
14. *Yearbook of the United Nations, 1946–47*, p. 448. Text of the Soviet draft amendments and additions to the first UNAEC report, and the Mar. 5 speech of Gromyko are in U. S. Department of State, *Documents on Disarmament 1945–1959*, Vol. I, *1945–1956* (Washington, 1960), pp. 61–82. See also *Policy at the Crossroads*, pp. 72–77; New York *Times*, Mar. 6, 1947.
15. *Yearbook of the United Nations, 1946–47*, p. 448. The State Department proposed an executive committee on the regulation of armaments on Feb. 20, 1947, and it became effective Mar. 3, 1947, Acheson to Lilienthal, Feb. 20, 1947, Marshall to Lilienthal, Mar. 3, 1947, *AEC*. Lilienthal, *Atomic Energy Years*, pp. 158–60.
16. Osborn to Oppenheimer, Mar. 13, 1947, Box 194, *JRO;* U. S. Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer* (Washington, 1954), pp. 342–46.
17. Osborn met with Bacher on Mar. 24, 1947, and with Bacher and Oppenheimer on Mar. 29, 1947. See Bacher's memorandums to files, Mar. 25 and Mar. 29, 1947, *AEC*. Forrestal's and Lilienthal's opinions were given in meetings of the executive committee on the regulation of armaments and are described in Lilienthal, *Atomic Energy Years*, pp. 166–67, and Millis, *Forrestal Diaries*, pp. 258–60. Guidance to Austin and Osborn is in John C. Elliott, Memorandum to the Secretaries of State, War, and Navy, Apr. 2, 1947, and encl., United States Policy in the United Nations Atomic Energy Commission, *AEC*.
18. *Yearbook of the United Nations, 1946–47*, pp. 448–49; *Policy at the Crossroads*, pp. 85–88; Frederick Osborn, "Negotiating on Atomic Energy," in Raymond Dennet and Joseph C. Johnson, eds., *Negotiating with the Russians* (World Peace Foundation, 1951), pp. 222, 229.
19. Lilienthal, *Atomic Energy Years*, pp 213–16; Gullion to Rusk and Johnson, July 9, 1947, *DS*.
20. Osborn to Bacher, Aug. 5, 1947, Op-

penheimer to Bacher, Aug. 6, 1947, *AEC.* Reference to Conant's ideas are in Lilienthal, *Atomic Energy Years,* p. 216. Conant made them the subject of his Oct. 2, 1947, lecture to the War College, "The Atomic Age: A Preview —1947 Edition," *DS.* Others had similar ideas, as Cuthbert Daniel and Arthur M. Squires, "The International Control of Safe Atomic Energy," *Bulletin of the Atomic Scientists 3* (1947), 111–16, 135.

21. Kennan to Lovett, Aug. 21, 1947, and encl., General United States Policy with Respect to International Control of Atomic Energy, *AEC;* Rusk, Memorandum for the Record, Sept. 9, 1947, *DS.*
22. Minutes, Meeting of the Secretaries of State, War, and Navy, Sept. 8, 1947, *AEC.*
23. *Ibid.,* Sept. 11, 1947.
24. Department of State, *The Second Report of the United Nations Atomic Energy Commission to the Security Council, Sept. 11, 1947* (Washington, 1947).
25. *Department of State Bulletin,* Sept. 28, 1947.
26. *The Third Report of the United Nations Atomic Energy Commission to the Security Council, May 17, 1948* (Washington, 1948), p. 61. Truman to Lilienthal, Sept. 22, 1947, *AEC.*
27. Lilienthal to Commissioners, Jan. 29, 1947, *AEC.*
28. Acheson, British Request for Cooperation in the Field of Atomic Energy, Feb. 1, 1947, Acheson to Lilienthal, Feb. 3, 1947, *AEC;* Acheson to Marshall, Feb. 3, 1947, *DS.*
29. Marshall to Forrestal, Feb. 11, 1947, Marshall to Patterson, Feb. 11, 1947, Patterson to Marshall, n.d., from a collection of documents in U.S.–U.K.–Canada Negotiations, Book 1, Oct. 31, 1947, *WNRC.*
30. The account of this meeting is based mainly on Lilienthal, *Atomic Energy Years,* pp. 175–76. A very brief summary is in Joint Committee, *Summary of Proceedings,* May 5, 1947, *AEC.*
31. No detailed accounts of the May 12, 1947, meeting have been found. Acheson's prepared statement and Hickenlooper's letter to Marshall are in U.S.–U.K.–Canada Negotiations, Book 1, Oct. 31, 1947, *WNRC.* The Hickenlooper letter refers to a move by Vandenberg to take up the matter with Truman or Marshall. *The Private Papers of Senator Vandenberg,* pp. 359–60, states that both senators in late spring or early summer contacted Truman, Marshall, and Forrestal.
32. Meeting of the Secretaries of State, War, and Navy, Sept. 11, 1947, *AEC.* In Forrestal's opinion, Roosevelt had exceeded his authority. See Forrestal Diary, Sept. 11, 1947, *JFP.*
33. CM 98, Sept. 18, 1947, CM 101, Sept. 25, 1947, Wilson to Commissioners, Sept. 25, 1947, Lilienthal to Marshall, Oct. 1, 1947, *AEC.*
34. Recommendations Concerning a Program of Negotiations with the British and Canadian Governments, Oct. 24, 1947, *AEC.*
35. Minutes, American Members, CPC, Nov. 5, 1947, *AEC.*
36. Lilienthal, *Atomic Energy Years,* p. 259; Lewis L. Strauss, *Men and Decisions* (Garden City, N. Y., 1962), pp. 255–56, stresses the ambiguity of Section 10.
37. Wilson explored in July the legal basis for a meeting on classification with the British and Canadians. Marks to Wilson, July 3, 1947, Wilson to the Commissioners, July 14, 1947, *AEC.* Those attending the November, 1947, meeting are listed in AEC Press Release 68, Nov. 14, 1947, *AEC.* Wilson referred to the conversations in the Minutes, American Members, CPC, Nov. 24, 1947 and Nov. 26, 1947, *AEC.*
38. Minutes, American Members, CPC, Nov. 24, 1947, *AEC.*
39. Forrestal Diary, Sept. 26, 1947, *JFP.* Forrestal, Meeting with Lovett, Vandenberg, and Hickenlooper, Nov. 16, 1947, *AEC;* Vandenberg, ed., *The Private Papers of Senator Vandenberg,* p. 360.
40. Forrestal, Meeting with Lovett, Vandenberg, and Hickenlooper, Nov. 16, 1947, *AEC,* mentions Lovett's plan on informing Congress. Lilienthal refers to Hickenlooper's reasons for confining the discussion to himself and Vandenberg during Commission consideration of the negotiating position, CM 125, Nov. 25, 1947, *AEC.* For the Nov. 26, 1947, meeting see Minutes, Ameri-

can Members, CPC, Nov. 26, 1947, *AEC.*

41. Lilienthal, *Atomic Energy Years,* pp. 260, 265; Joint Committee, *Summary of Proceedings,* Dec. 5, 1947, *AEC;* Forrestal Diary, Dec. 5, 1947.
42. Minutes, CPC, Dec. 10, 1947, *AEC.* When the State Department informed the British and Canadians of the proposed negotiations is not clear. Forrestal records Lovett as saying on Nov. 16, 1947, to Vandenberg and Hickenlooper that the British and Canadians were prepared to negotiate. Forrestal, Meeting with Lovett, Vandenberg, and Hickenlooper, Nov. 16, 1947, *AEC.*
43. Summary of Discussion of U.K.–Canada–U. S. Sub-group on Technical Cooperation, Dec. 12, 1947, *AEC.*
44. Memoranda to the CPC, Dec. 12, 15, 1947, *AEC.*
45. Minutes, CPC, Dec. 15, 1947, *AEC.*
46. Memorandum of Discussion Within the Group Designated by CPC To Work out Allocation Arrangements, Dec. 18, 1947, *AEC.*
47. Conference between Mr. Bohlen and Mr. Kennan, Dec. 17, 1947, *DS;* Gullion, U. S.–U. K.–Canada Negotiations on Atomic Energy, Dec. 20, 1947, *AEC.*
48. The terms of agreement are taken from Allocations, Jan. 7, 1948, and appended to the Minutes, CPC, Jan. 7, 1948, *AEC.*
49. Memorandum of Conversation, Jan. 7, 1948, *AEC.*
50. CM 139, Jan. 7, 1948, Farley, Notes on Commission Meeting of Jan. 7, 1948, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 281–82.
51. Minutes, CPC, Jan. 7, 1948, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 281–82; Millis, ed., *Forrestal Diaries,* pp. 338–39.
52. The full Joint Committee was briefed on the conclusions of the negotiations on Jan. 21, 1948. Unsigned memorandum, Outcome of CPC Negotiations and an Explanation of the Eniwetok Test, Jan. 21, 1948, *AEC.*

CHAPTER 10

1. Lilienthal, *Journals,* Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), p. 282; Minutes, CDA, Jan. 29, 1948, *AEC.*
2. CM 152, Feb. 19, 1948, Provisional Minutes of First Meeting of the CPC Subgroup of Scientific Advisors, Feb. 21, 1948, *AEC.*
3. Gullion, Memorandum of Conversation, Mar. 19, 1948, *AEC.*
4. Walter Millis, ed., *The Forrestal Diaries* (New York, 1951), pp. 406–407.
5. *Parliamentary Debates,* Commons, May 12, 1948, Vol. 450, 2128–29.
6. Weil, Wende, and Zinn, Report of Visit to Harwell and Risley, May 28–June 4, 1948, *AEC.*
7. CM 183, June 30, 1948, *AEC.*
8. Lilienthal to Marshall, July 2, 1948, Minutes, American Members, CPC, July 6, 1948, *AEC;* Carpenter, Memorandum of Discussion, July 9, 1948, *WNRC;* Lilienthal, *Atomic Energy Years,* pp. 380–81.
9. Forrestal Diary, July 8, 1948, *JFP.*
10. CM 184, July 8, 1948, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 382–83.
11. Lilienthal, *Atomic Energy Years,* pp. 384–85; Strauss, Memorandum to the Commissioners, July 15, 1948, Bacher, Pike, Waymack, Lilienthal, Memorandum, July 23, 1948, Strauss, Memorandum for the Commission, July 29, 1948, *AEC.*
12. Lilienthal, *Atomic Energy Years,* pp. 399–401; Lilienthal, Human Relations and the Atom, Aug. 21, 1948, *AEC;* New York *Times,* Aug. 22, 1948; New York *Journal American,* Aug. 22, 1948; Strauss and Hickenlooper thought the speech implied too much cooperation. Golden, Rough Notes of Telephone Comments by Mr. Strauss, Aug. 19, 1948, Henderson to Golden, Aug. 25, 1948, *AEC.*
13. CM 177, June 9, 1948, Office of Special Projects, Technical Cooperation on Fundamental Properties of Reactor Materials, June 7, 1948, *AEC.* For Lilienthal's and Marks's views on legality of cooperation see Minutes,

American Members, CPC, Nov. 5, 1947, *AEC*. The query to Bush and the reply are in Fisk to Bush, June 11, 1948, Carpenter to Fisk, June 15, 1948, *AEC*. Efforts of the Commission to reach an understanding with the Department of Defense on technical cooperation are referred to in CM 180, June 17, 1948, CM 183, June 30, 1948, Wells to Snapp, June 30, 1948, Fisk to Carpenter, July 8, 1948, *AEC*.

14. Longair to Hobbs, June 22, 1948, CM 183, June 30, 1948, CM 184, July 8, 1948, Fisk to Smith, July 26, 1948, *AEC*.
15. Carpenter to Forrestal, Lilienthal, Lovett, Fisk, Webster, Aug. 3, 1948, *AEC*.
16. Carpenter, Memorandum of Conversation with Senator Hickenlooper at 4:00 P.M., 4 Aug. 1948, Aug. 6, 1948, *WNRC*; Wilson and Lilienthal had spent about three hours with Hickenlooper on July 29, 1948, discussing many of the topics which Carpenter states Hickenlooper mentioned on Aug. 4, 1948. Lilienthal, Memo for Commissioners, Aug. 2, 1948, *AEC*, summarizes the July 29 meeting with Hickenlooper, but does not indicate that technical cooperation was discussed.
17. Carpenter to the Commission, Aug. 9, 1948, *AEC*.
18. Pike to Hickenlooper, Aug. 9, 1948, Strauss to Hickenlooper, Aug. 11, 1948, Carpenter, Memorandum of Meeting at 11:00 A.M. . . . , Aug. 12, 1948, *AEC*; Bush to Forrestal, Aug. 12, 1948, *WNRC*; Forrestal Diary, Aug. 12, 1948, *JFP*.
19. Cable, Pike to Smith, Aug. 12, 1948, Pike to Commissioners, Aug. 13, 1948, *AEC*; Carpenter, Memorandum of Conversation with Mr. Sumner Pike, Aug. 13, 1948, *WNRC*; Smith to Pike, Aug. 14, 1948, Smith to Lilienthal, Sept. 8, 1948, *AEC*. The Pike and Strauss versions are in *Congressional Record*, 81 Cong., 2 sess., pp. 9755–73.
20. Carpenter, Memorandum of Conversation with Dr. F. N. Woodward . . . , Aug. 16, 1948, *AEC*.
21. *Ibid*., Sept. 16, 1948, *AEC*.
22. Millis, ed., *The Forrestal Diaries*, pp. 483–91; Forrestal Diary, *JFP*. Eisenhower to Forrestal, Sept. 27, 1948, Forrestal Papers, *JFP*.
23. Carpenter to Joint Chiefs of Staff, Sept. 14, 1948, William C. Lalor, Memorandum for the MLC, Sept. 29, 1948, *WNRC*.
24. Memorandum of Conversation, Sept. 30, 1948, *WNRC*.
25. *Ibid*., Nov. 16, 1948, *AEC*.
26. CM 207, Oct. 15, 1948, *AEC*. The subgroup meeting was scheduled for Oct. 21, 1948. The meeting was held; it was agreed to consider four new areas of cooperation. Minutes of Third Meeting of CPC Sub-Group of Scientific Advisers . . . , Oct. 21, 1948, *WNRC*.
27. Summary Log of Atomic Energy Work in Office of the Under Secretary, Nov. 1948, *DS*; CM 223, Dec. 9, 1948, Volpe to Snapp, Dec. 31, 1948, *AEC*. According to a State Department draft of Dec. 16, 1948, possible candidates for a four- or six-man advisory panel were: Acheson, A. W. Barkley, C. I. Barnard, B. M. Baruch, W. Batt, O. Bradley, Bush, Byrnes, Karl Compton, Conant, Elmer Davis, D. D. Eisenhower, John Hancock, George Harrison, and Oppenheimer. The study was to provide a policy which would cover the gamut of foreign relations and atomic energy, not just the relations with Britain and Canada. See Atomic Energy Policy, Dec. 16, 1948, *AEC*.
28. Wilson Diary, Jan. 4, 1949, *AEC*.
29. Notes re Princeton Meeting, Jan. 28, 1949, *AEC*; Arneson, Memorandum for the Secretary, the Under Secretary, Feb. 3, 1949, *DS*.
30. CM 240, Feb. 3, 1949, *AEC*; Lilienthal, *Atomic Energy Years*, p. 457; D. E. L[ilienthal], Resolved that as a Member of the CPC . . . , Feb. 5, 1949, CM 242, Feb. 5, 1949, Strauss, Memorandum Read to a Meeting of the Atomic Energy Commission . . . , Feb. 5, 1949, *AEC*.
31. Dean G. Acheson, "The President and the Secretary of State," Don K. Price, ed., *The Secretary of State* (Englewood Cliffs, N. J., 1960), p. 34.
32. The special subcommittee of the NSC was approved by Truman on Feb. 10, 1949, see Acheson, Memorandum for the President, Feb. 10, 1949, *AEC*. For Lilienthal's doubts on the proce-

dures see Lilienthal, *Atomic Energy Years*, pp. 462, 467. Truman's preliminary ideas were that atomic weapons in Britain were liable to capture, see Lilienthal, *Atomic Energy Years*, p. 465. The Commission considered the special subcommittee report at CM 247, Feb. 28, 1949, *AEC*. For the meeting of the special subcommittee see Arneson, Minutes of Meeting, the Special Committee of the NSC on Atomic Energy Policy with Respect to United Kingdom and Canada, Mar. 2, 1949, *AEC*. The report was transmitted to the President on Mar. 2, 1949. A brief account is contained in Truman, *Memoirs*, Vol. II, *Years of Trial and Hope* (Garden City, N. Y., 1956), pp. 302–03.

33. CM 250, Mar. 2, 1949, *AEC*.
34. Lilienthal, *Atomic Energy Years*, pp. 511, 520.
35. Arneson, Memorandum of Conversation, Mar. 9, Apr. 28, 1949, Arneson, Memorandum for the Files, June 2, 1949, Arneson to Webb, June 2, 1949, *DS*.
36. Acheson, Memorandum of Conversation with the President, June 24, 1949, Arneson, Memorandum of Conversation, June 30, 1949, *DS;* Memorandum of Conversation: Tripartite Atomic Energy Negotiations, July 6, 1949, *AEC*. At the July 6 meeting, Pike was present instead of Lilienthal.
37. President's News Conference of July 14, 1949, *Public Papers of Harry S. Truman, 1949* (Washington, 1964), pp. 375–80.
38. New York *Times*, Baltimore *Evening Sun*, Washington *Post*, Washington *Star*, July 15, 1949.
39. Arneson, Suggested Statement To Be Made by the President, July 13, 1949, Arneson, Memorandum for the File, Subject: Blair House Meeting, July 14, 1949, CM 291, July 15, 1949, *AEC*. The most colorful account is in Lilienthal, *Atomic Energy Years*, pp. 543–45, 547–48. A photocopy of Truman's remarks on White House stationery and presumably in Truman's handwriting is in *DS*.
40. Acheson, Memo of Telephone Conversation, July 18, 1949, Arneson, Memorandum for the Secretary, July 20, 1949, *DS*.
41. Arneson, Memorandum for the Files, July 20, 1949, *WNRC;* Lilienthal, *Atomic Energy Years*, pp. 545–52.
42. The President's News Conference, July 28, 1949, *Public Papers of Harry S. Truman, 1949*, pp. 402–05; Lilienthal, *Atomic Energy Years*, pp. 555, 557–59; Johnson, Memorandum for the President, July 25, 1949, *WNRC;* Acheson, Memorandum of Conversation with the President, July 25, 1949, *DS;* Proposed Statement for the Secretary of State to the JCAE, July 27, 1949, *AEC;* Press Release from the Office of Senator Brien McMahon, July 27, 1949, *WNRC*.
43. Zinn to Hilberry, July 26, 1949, quoted in Flaherty to Stirewalt, Aug. 9, 1949, *AEC*. For Volpe and Dean interpretations see CM 268, May 11, 1949, CM 287, July 5, 1949, Dean to Lilienthal *et al.*, July 21, 1949, Volpe to Commission, Sept. 13, 1949, Dean, Memorandum to the Commission, Oct. 20, 1949, *AEC*.
44. Lilienthal, *Atomic Energy Years*, p. 565.
45. Minutes, American side, CPC, Sept. 13, 1949, *AEC*.
46. Minutes, CPC, Sept. 20, 1949, *AEC*.
47. Draft, Minutes, Sub-Committee III, Sept. 21, 1949, Meeting of Drafting Group, Sub-Committee III, Sept. 22, 1949, *AEC*.
48. Meeting of Drafting Group, Sub-Committee III, Sept. 24, 1949, *AEC*.
49. Lilienthal, *Atomic Energy Years*, pp. 574–77.
50. Minutes, CPC, Sept. 30, 1949, *AEC*.
51. Transcript of Joint Committee Hearings, Oct. 13, 1949, *AEC*.
52. Acheson, Memorandum of Conversation with the President, July 21, 1949, Webb, Meeting with the President, Monday, September 26, dated Oct. 1, 1949, Webb, Meeting with the President, Saturday, October 1, 1949, dated Oct. 1, 1949, Webb, Meeting with the President, Monday, October 3, 1949, dated Oct. 3, 1949, Acheson, 12:30 Meeting with the President, Oct. 13, 1949, *DS*.
53. Arneson, Memorandum for the American Members of the CPC, Nov. 21, 1949, *AEC;* Seaborg to Wilson, Nov. 16, 1949, *WNRC*.
54. Draft Notes on Meeting of American

Working Group, CPC . . . , Nov. 22, 1949, *AEC.*

55. Hall, Draft Notes on Meeting of Sub-Group I, CPC . . . , at 10:30 A.M., Nov. 28, 1949, *AEC.*
56. Hall, Draft Notes on Meeting of the American Side, CPC Sub-Group I, at 3:00 P.M., R. Gordon Arneson's Office . . . , Nov. 28, 1949, *AEC.* Wilson met with the British and Canadians later that afternoon, but no accounts of the meeting have been found.
57. Arrangements with United Kingdom and Canada on Atomic Energy, n.d., *AEC.* Although undated, the draft memorandum was composed between Nov. 29 and Dec. 2, 1949.
58. CM 339, Dec. 2, 1949, *AEC.*
59. Remarks by C. L. Wilson in the Steering Group Meeting on Dec. 2, at 10:00 A.M., Notes on Meeting of Sub-Group I (Steering Committee) of the CPC, 10:00 A.M., Dec. 2, 1949, Notes on Informal Exploratory Technical Discussion Held in the Department of State on Dec. 2, 1949 at 11 A.M., *AEC.*
60. Notes on an Informal Exploratory Meeting Held in Carroll L. Wilson's Office at 4:55 P.M., Dec. 2, 1949, *AEC.*
61. Franks to Acheson, Dec. 29, 1949 and encl., CM 351, Jan. 5, 1950, *AEC.*
62. Fisher and Arneson to Johnson, Jan. 18, 1950, *AEC.*
63. The British proposal on allocation was accepted in Acheson to Franks, Jan. 26, 1950, *AEC.*
64. Wilson Diary, Feb. 2, 3, 1950, CM 363, Feb. 2, 1950, CM 364, Feb. 3, 1950, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 634–35; Joint Committee, Minutes of an Executive Meeting, Feb. 3, 1950, *AEC.* Several accounts of uneven quality have been written about Fuchs. Probably the best are Alan Moorehead, *The Traitors* (New York, 1952), pp. 44–164, and Rebecca West, *The New Meaning of Treason* (New York, 1964), pp. 174–97.

CHAPTER 11

1. For a good summary of the Commission organization in early 1948 see Richard O. Niehoff, "Organization and Administration of the United States Atomic Energy Commission," *Public Administration Review* 8 (Spring, 1948), 91–102.
2. The account of this meeting is based on Part II, Conference of Managers and Principal Washington Personnel, Dec. 4–6, 1947, *AEC.* The transcript of the discussion of program goals has not been found.
3. Wilson to Principal Washington Staff, Oct. 21, 1947, Snapp to Principal Washington Staff, Nov. 12, 1947, AEC Press Release 78, Dec. 30, 1947, *AEC.*
4. Part II, Conference of Managers and Principal Washington Personnel, Dec. 4–6, 1947, *AEC;* Lilienthal, *Journals,* Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), p. 89.
5. Sec. 19, The Atomic Energy Act of 1946 (P.L. 585, 79 Cong., 60 *Stat.,* 755–75; 42 U.S.C., 1801–19).
6. Committee on Appropriations, *Hearings before the Subcommittee of the Committee on Appropriations House of Representatives . . . on the Independent Offices Appropriations Bill for 1948, Part I* (Washington, 1947), pp. 1470–1531; "Independent Offices Appropriation Bill, 1948," *House Report,* 80 Cong., 1 sess., no. 589 (Apr. 13, 1947); *Congressional Record,* 80 Cong., 1 sess., p. 7231; P.L. 269, 80 Cong., 1 sess., July 30, 1947.
7. Lilienthal, *Atomic Energy Years,* pp. 181, 204–07.
8. Lilienthal to Commissioners, Nov. 26, 1947, *AEC.*
9. "The Budget of the United States Government for the Fiscal Year Ending June 30, 1949," *House Document,* 80 Cong., 2 sess., no. 456 (1948), pp. M6, M39.
10. Lilienthal to Hickenlooper, Jan. 26, 1948, Lilienthal to Bridges, Jan. 26, 1948, *AEC.*
11. Committee on Appropriations, *Hearings before the Subcommittee of the Committee on Appropriations, House of Representatives . . . on the First*

Deficiency Appropriations Bill for 1948 (Washington, 1948), pp. 861–972. There are references to a closed hearing in the subcommittee hearing, Lilienthal, *Atomic Energy Years*, pp. 299–302; Wilson Diary, Feb. 26, 1948, *AEC*.

12. Summary of Proceedings, Executive Meeting, JCAE, May 27, 28, 1948, *AEC*.
13. Committee on Appropriations, *Hearings before the Subcommittee of the Committee on Appropriations, House of Representatives . . . on the Supplemental Independent Offices Appropriation Bill for 1949* (Washington, 1948), pp. 747–873.
14. Lilienthal, *Atomic Energy Years*, p. 352.
15. "Supplemental Independent Offices Appropriation Bill, 1949," *House Report*, 80 Cong., 2 sess., no. 2455 (June 8, 1948); *Congressional Record*, 80 Cong., 2 sess., p. 7629.
16. *Congressional Record*, 80 Cong., 2 sess., pp. 7612–14, 7714–15.
17. A good study of the Joint Committee is in Harold P. Green and Alan Rosenthal, *Government of the Atom, The Integration of Powers* (New York, 1963), pp. 25–30.
18. "Development and Control of Atomic Energy," *Senate Report*, 80 Cong., 2 sess., no. 850 (Jan. 30, 1948).
19. Summary of Proceedings, Executive Meeting, JCAE, Nov. 28, 1947, *AEC*.
20. CM 127, Dec. 4, 1947, AEC Press Release No. 82, Jan. 20, 1948, *AEC*; Lilienthal, *Atomic Energy Years*, p. 267.
21. "Directing the Secretary of Commerce to Transmit . . . a Certain Letter with Respect to Dr. Edward U. Condon," *House Report*, 80 Cong., 2 sess., no. 1753 (Apr. 19, 1948).
22. Summary of Proceedings, Executive Meeting, JCAE, Mar. 2, 1948, *AEC*.
23. *Ibid.*, Apr. 1, 1948, *AEC*; New York *Times*, Mar. 5, 1948; "Directive on the Need for Maintaining the Confidential Status of Employee Loyalty Records," Mar. 13, 1948, *Public Papers of Harry S. Truman, 1948* (Washington, 1964), pp. 181–82; Harry S. Truman, *Memoirs*, Vol. II, *Years of Trial and Hope* (Garden City, New York, 1956), pp. 269–93.
24. Lilienthal, *Atomic Energy Years*, p. 312; Fisher to Files, Apr. 8, 1948, *AEC*.
25. Lilienthal, *Atomic Energy Years*, pp. 296–97.
26. *Ibid.*, pp. 286, 296, 304–07, 314.
27. Walter Millis, ed., *The Forrestal Diaries* (New York, 1951), pp. 379–80.
28. Lilienthal, *Atomic Energy Years*, pp. 319–25; Lilienthal, Memo of Conversation with Senator Hickenlooper . . . , Apr. 21, 1948, *AEC*; New York *Times*, Washington *Post*, Apr. 21, 1948.
29. Excerpts from telephone conversation between . . . Forrestal . . . and . . . Hickenlooper . . . , Apr. 19, 1948, *JFP*.
30. New York *Times*, Apr. 21, 1948; Lilienthal, *Atomic Energy Years*, pp. 319–25; Memorandum from the President to Secretary of Defense, Apr. 22, 1948, *JFP*.
31. Lilienthal, *Atomic Energy Years*, pp. 320–25.
32. New York *Times*, Apr. 24, 1948; Waymack to R. J. Blakely, Apr. 26, 1948, *AEC*.
33. Washington *Post*, Apr. 28, 1948; Lilienthal, *Atomic Energy Years*, pp. 326–31.
34. "Providing for Extension of the Terms of Office of the Present Members of the Atomic Energy Commission—Minority Views," *Senate Report*, 80 Cong., 2 sess., no. 1342, part 2 (May 24, 1948), contains the letters from Oppenheimer, DuBridge, and Rabi to Hickenlooper. Lilienthal, *Atomic Energy Years*, p. 328; Oppenheimer to Lilienthal, May 1, 1948, *DEL*.
35. News Conference of Apr. 29, 1948, *Public Papers of Harry S. Truman, 1948*, pp. 236–39.
36. Waymack to Commission, Apr. 30, 1948, *AEC*.
37. "Providing for Extension of the Terms of Office . . . ," *Senate Report*, 80 Cong., 2 sess., no. 1342 (May 17, 1948); "Providing for Extension of the Terms of Office . . . Minority Views," *Senate Report*, 80 Cong., 2 sess., no. 1342, part 2 (May 24, 1948); *Congressional Record*, 80 Cong., 2 sess., pp. 8614, 8953–54, 9060–67, 9070–73; Lilienthal, *Atomic*

Energy Years, pp. 341, 345, 362–63.

38. Report of the Office of Security and Intelligence to the General Manager for the Period January 1–April 1, 1948, *AEC.*
39. Development of AEC Security Program, appendix to Memorandum to the Commission from the General Manager, July 20, 1949, Bulletin GM-80, Mar. 30, 1948, *AEC.*
40. Interim Procedure, Apr. 15, 1948, Wilson to Managers of Directed Operations, May 29, 1948; James S. Stewart to Commission, May 20, 1948, Wilson to Stewart, June 16, 1948, *AEC.* Similar procedures governed clearance requests originating in headquarters. Comparison of AEC procedures with those of other agencies can be found in Walter Gellhorn, *Security, Loyalty, and Science* (Ithaca, New York, 1950); Eleanor Bontecou, *The Federal Loyalty-Security Program* (Ithaca, New York, 1953); New York City Bar Association, *The Federal Loyalty-Security Program* (New York, 1956).
41. Chairman, Personnel Security Review Board to General Manager, June 7, 1948, Wilson to Cunningham, June 17, 1948, CM 185, July 15, 1948, Lilienthal to Files, July 15, 1948, Lilienthal, Memorandum for Information of Commissioners, July 15, 1948, *AEC.*
42. Roberts to Commission, June 30, 1948, *AEC.*
43. Director of Security and Intelligence, Decentralization to Managers of Directed Operations of Authority To Grant Emergency Clearance, July 20, 1948, CM 187, July 22, 1948, *AEC.*
44. D. F. Carpenter, Memorandum of Conversation with Senator Hickenlooper . . . Aug. 4, 1948, *WNRC;* Millis, ed., *The Forrestal Diaries,* p. 380.
45. Wilson to Hickenlooper, Mar. 13, 1947, *AEC.*
46. CM 70, July 1, 1947, CM 85, July 24, 1947, Green to Wilson, July 9, 1947, *AEC.*
47. Statement by Paul M. Green . . . Prepared in Answer to . . . Letter . . . from the Comptroller General . . . , Dec. 15, 1947, *AEC.*
48. Green, AEC Finance and Accounting, Apr. 1948, *AEC.*

49. Summary of Proceedings, Executive Meeting, JCAE, May 11, 1948, Warren to Lilienthal, June 15, 1948, *AEC.* An account of financial and contract procedures is in the *Ninth Semiannual Report of The Atomic Energy Commission* (Washington, January, 1951). Useful and brief is John P. Abbadessa, "Financial Management in the Atomic Energy Commission," *The Federal Accountant 14* (Spring, 1965).
50. R. M. Underhill, Memorandum, Sept. 10, 1947, Lawrence Papers, *LRL;* Lilienthal, *Atomic Energy Years,* pp. 242, 245–46, 354; AEC Press Release 59, Oct. 6, 1947, Preliminary Draft of Report of the United States Atomic Energy Commission by the Industrial Advisory Group, May 29, 1948, Wilson Diary, June 3, 1948, *AEC.*
51. GAC 10, June 4–6, 1948, *AEC.*
52. Lilienthal, *Atomic Energy Years,* pp. 354, 367–68. Oppenheimer to Lilienthal, June 18, 1948, *DEL;* Terry, Memorandum for the Secretary, Aug. 27, 1948, *WNRC.*
53. Wilson to Parker, July 28, 1948, Manley to Fisk, July 22, 1948, Lilienthal to Commissioners, Aug. 2, 1948, *AEC;* Carpenter, Memorandum of Conversation with Senator Hickenlooper . . . , Aug. 4, 1948, *WNRC.*
54. Wilson, Memorandum for Managers of Directed Operations and Principal Washington Staff, Aug. 5, 1948, *AEC.*
55. GAC 10, June 4–6, 1948, *AEC.*
56. Lilienthal, *Atomic Energy Years,* pp. 360–62; CM 180, June 17, 1948, Strauss to Secretary, July 2, 1948, Hickenlooper to Lilienthal, July 30, 1948, *AEC.*
57. CM 186, July 21, 1948, Director of Biology and Medicine, Security Clearance of Fellows Participating in the AEC Fellowship Programs, Sept. 10, 1948, *AEC.*
58. The text of the two speeches is in *Bulletin of the Atomic Scientists 4* (Oct., 1948), 291–94.
59. Lilienthal to Hickenlooper, Oct. 11, 1948, *AEC.*
60. The chronology and complications of the Oak Ridge situation are set forth in Lilienthal to Hickenlooper, Jan. 6, 1948, and annexes, and Lilienthal to Hickenlooper, Jan. 16, 1948, encl., Report on Labor Problems Relating to

Continuity of Production in the Atomic Energy Program, included in Joint Committee, *Hearings . . . on Labor Policy in Atomic Energy Plants, Part 1, March 9, 10, 12, 15, and 16, 1948* (Washington, 1948), pp. 7–15, 117–138. Two helpful unpublished studies are David B. Johnson, "Labor-Management Relations in the Atomic Energy Program," a doctoral dissertation completed at the University of Wisconsin, 1955, and Joan M. Silver, "Labor-Management Relations in the Atomic Energy Program 1946–1952: Variations on a Theme," 1967, *AEC.*

61. Director of Labor Relations, Conference with the Federal Mediation and Conciliation Service, Jan. 13, 1948, *AEC.*
62. Lilienthal to Hickenlooper, Jan. 16, 1948, encl., Report on Labor Relations Relating to Continuity of Production in the Atomic Energy Program in Joint Committee, *Hearings on Labor Policy*, pp. 117–38.
63. Director of Labor Relations, Reported Communist Domination of Unions at AEC Installations in Schenectady and Chicago, Sept. 9, 1948, *AEC.*
64. Smith to Files, Jan. 30, 1948, Smith to Files, June 18, 1948, *AEC.* The Commission position on the UEW is in Report of Senate Subcommittee on Labor and Labor-Management Relations of the Committee on Labor and Public Welfare, *Communist Domination of Certain Unions—Part II—Atomic Energy Commission Reply to Subcommittee Questionnaire*, 82 Cong., 2 sess. (Washington, 1954).
65. Summary of Proceedings, Executive Meeting, JCAE, Mar. 2, 1948, *AEC;* Joint Committee, *Hearings on Labor Policy.*
66. Director of Labor Relations, A Program for Assuring Continuity of Production within the Atomic Energy Industry, Apr. 16, Apr. 19, 1948, CM 168, Apr. 22, 1948, Summary of Proceedings, Executive Meeting, JCAE, May 6, 1948, *AEC.*
67. Lilienthal, *Atomic Energy Years*, p. 354. Useful accounts of the Oak Ridge dispute are in Donald B. Straus, *The Development of a Policy for Industrial Peace in Atomic Energy* (Washington, 1950), and David B. Johnson, "Labor-Management Relations in the Atomic Energy Program."
68. Special Message to the Congress on the Labor Dispute at Oak Ridge, June 18, 1948, *Public Papers of Harry S. Truman, 1948*, pp. 379–381.
69. Report of Senate Subcommittee on Labor and Labor-Management Relations, *Communist Domination of Certain Unions—Part II—Atomic Energy Commission Reply to Subcommittee Questionnaire*, p. 4; Director of Labor Relations, Reported Communist Domination of Unions at AEC Installations in Schenectady and Chicago, Sept. 9, 1948, *AEC.*
70. Smith, Memorandum to the Files, June 18, 1948, *AEC.*
71. CM 197, Sept. 21, 1948, *AEC;* Lilienthal, *Atomic Energy Years*, pp. 411–12. Lilienthal's journal incorrectly gives the date as Sept. 22.
72. CM 198, Sept. 23, 1948, Boulware to Lilienthal, Sept. 28, 1948, Smith to Files, Oct. 1, 1948, Smith to Snapp, Oct. 1, 1948, *AEC;* Lilienthal, *Atomic Energy Years*, p. 413.
73. Fitzgerald to Lilienthal, Sept. 30, 1948, Memorandum of Conference of Mr. Oscar Smith with Mr. Philip Murray, Oct. 1, 1948, *AEC.*
74. See Report of Senate Subcommittee on Labor and Labor Management Relations, *Communist Domination of Certain Unions.*
75. The President's Commission on Labor Relations in Atomic Energy Installations, Memorandum . . . Regarding . . . the Relation of the Commission to Contractors and Labor Organizations, Apr. 9, 1949, Interim Statement of the AEC in Respect to Its Role in Labor Management Relations in Atomic Energy Installations, Apr. 29, 1949, GM Bulletin No. 44, Rev., *AEC;* Report of the President's Commission on Labor Relations in the Atomic Energy Installations (Washington, 1949).
76. Dewey, "The Challenge of the Atomic Age," *Bulletin of the Atomic Scientists 4* (Oct. 1948), 296–97; Lilienthal, *Atomic Energy Years*, p. 412.
77. The McMahon draft was enclosed in Borden to Hopkins, Sept. 27, 1948, *HST.* As an article it appeared in *Bulletin of the Atomic Scientists 4* (Oct. 1948), 298–99. The Milwaukee

speech is in *The Public Papers of Harry S. Truman, 1948,* pp. 787–92.
78. Lilienthal, *Atomic Energy Years,* pp. 431–33, 440.
79. A discussion of the AEC contract policy is in the *Ninth Semiannual Report of the Atomic Energy Commission* (Washington, 1951), pp. 57–72, and Richard A. Tybout, *Government Contracting in Atomic Energy* (Ann Arbor, Michigan, 1956).
80. CM 227, Dec. 21, 1948, Lilienthal to Pike *et al.*, Dec. 27, 1948, Lilienthal to Pike *et al.*, Dec. 31, 1948, *AEC.*
81. Lilienthal to Commissioners, Jan. 1, 1949, *AEC.*
82. Lilienthal, *Atomic Energy Years,* pp. 441–42; Shugg Diary, Jan. 4, 1949, AEC Press Release No. 151, "Criteria for Determining Eligibility for Personnel Security Clearance," Jan. 5, 1949, *AEC.*
83. Comments of Fulton Lewis, Jr., Jan. 11, 12, 1949, *AEC.* The Commission unanimously approved the Graham clearance against the recommendations of Gingrich and the Roberts board. CM 217, Nov. 17, 1948, *AEC.* The Commission had informed Hickenlooper of the action in Lilienthal to Hickenlooper, Dec. 1, 1948, *AEC.*
84. Hickenlooper to Lilienthal, Jan. 12, 1949, quoted in Joint Committee, *Atomic Energy Fellowship Program* (Washington, 1949), p. 6; Bacher to Hickenlooper, Jan. 31, 1949, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 360–61, 528–29.
85. *Fifth Semiannual Report of the Atomic Energy Commission* (Washington, 1948); Press Conference . . . Jan. 28, 1949, CM 243, Feb. 10, 1949, *AEC;* Joint Committee, *Atomic Energy Report to Congress, Feb. 2, 1949* (Washington, 1949); News Conference, Feb. 10, 1949, *Public Papers of Harry S. Truman, 1949* (Washington, 1964), pp. 132–33; Lilienthal, *Atomic Energy Years,* pp. 453, 461–62, 468.
86. Lilienthal, *Atomic Energy Years,* pp. 444, 459–67; Wilson Diary, Feb. 9, 1949, *AEC.*
87. CM 250, Mar. 2, 1949, Williams Diary, Mar. 7, 8, 14, 1949, *AEC.* The reference to the Feb. 19, 1949, meeting is in CM 250. Lilienthal, *Atomic Energy Years,* pp. 484–85, 488, 489–90.
88. Lilienthal to Commissioners, Mar. 14, 1949, *AEC.*
89. Joint Committee, Executive Meeting, Mar. 16, 1949, *AEC.*
90. Joint Committee, Executive Meeting, Mar. 17, 1949, *AEC.*
91. Joint Committee, Executive Meeting, Apr. 6, 1949, *AEC.*
92. Joint Committee, Executive Meeting, May 18, 1949, Lilienthal to Elston, May 30, 1949, *AEC;* Joint Committee, *Investigation into the United States Atomic Energy Project, Part 9, June 16, 1949* (Washington, 1949).
93. The transcript of the May 16 hearings has not been found; references to it are in Lilienthal, *Atomic Energy Years,* pp. 528–30, and in Wilson Diary, May 4, 5, 6, 1949, *AEC.* Partial texts of the Lewis broadcasts are in Senate Subcommittee on Appropriations, *Independent Offices Appropriation Bill for 1950* (Washington, 1949), pp. 622–34. The Lilienthal letter and Hoey's remarks are in *Congressional Record,* 81 Cong., 1 sess., p. 6081.
94 Joint Committee, *Confirmation of Gordon E. Dean and Henry DeWolf Smyth . . . May 12 and 18, 1949* (Washington, 1949).
95. Lilienthal, *Atomic Energy Years,* pp. 528–29.
96. Joint Committee, *Atomic Energy Commission Fellowship Program, May 16, 17, 18, 19, 1949* (Washington, 1949); Lilienthal, *Atomic Energy Years,* pp. 530–31.
97. New York *Daily News,* May 18, 1949; Lilienthal, *Atomic Energy Years,* pp. 530–31; Williams Diary, May 18, 1949, Wilson Diary, May 18, 1949, Shugg Diary, May 18, 1949, Joint Committee Executive Session, May 18, 1949, *AEC.*
98. Senate Subcommittee of the Committee on Appropriations, *Independent Offices Appropriation Bill for 1950* (Washington, 1949). Hearings were held on May 19, 20, 24, and June 7, 1949. P. L. 266, approved Aug. 24, 1949, provided that no part of any appropriation for the Commission could be used to confer a fellowship on an individual who is a member of an organization advocating overthrow of the Government.
99. The text of the Hickenlooper charges

are in *Bulletin of the Atomic Scientists* 5 (June–July, 1949), 182. Lilienthal, *Atomic Energy Years*, pp. 532–34; Arthur H. Vandenberg, Jr., ed., *The Private Papers of Senator Vandenberg* (Boston, 1952), pp. 357–58.

100. Lilienthal, *Atomic Energy Years*, pp. 535–36; Lilienthal to McMahon, May 25, 1949, reprinted in Joint Committee, *Investigation into the United States Atomic Energy Project* (Washington, 1949), pp. 7–8.
101. Joint Committee, *Investigation into the United States Atomic Energy Project;* Joint Committee, Executive Meetings, June 2, 10, 13, 17, July 26, Aug. 1, 11, 23, 1949, *AEC.*
102. Minutes, Laboratory Executive Committee, May 25, June 14, 1949, *ANL;* K. Kraus to J. Swartout, July 15, 1949, Swartout to Kraus, July 20, 1949, *ORNL.*
103. Joint Committee, Executive Meeting, Aug. 25, 1949, *AEC.*
104. The reports are in Joint Committee, Hearings on *Investigation into the United States Atomic Energy Project.*

CHAPTER 12

1. Washington *Evening Star,* New York *Times,* Sept. 4, 1949; *Congressional Record,* 81 Cong., 1 sess., p. 12600.
2. U. S. Air Force, Detection of the First Soviet Nuclear Test on August 29, 1949, dated Feb. 6, 1962, pp. 1–2, 7–11, *AEC* (hereafter cited as "Detection Report"). Strauss, *Men and Decisions* (Garden City, N. Y., 1962), pp. 204–05.
3. Wilson Diary, Sept. 8, 1949, *AEC.*
4. Wilson Diary, Sept. 9, 1949, Detection Report, pp. 11–12, *AEC.*
5. Pike to File, Sept. 14, 1949, Wilson Diary, Sept. 14, 1949, *AEC;* Webster to Johnson, Sept. 14, 1949, *WNRC;* Arneson wrote to Acheson on Sept. 12, 1949, that Truman had been informed. Arneson to Acheson, Sept. 12, 1949, *DS.*
6. Draft Report to the President on the Proposed Acceleration of the Atomic Energy Program, Sept. 13, 1949, CM 304, Sept. 14, 1949, *AEC.*
7. U. S. Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer* (Washington, 1954), pp. 615, 801, 910–11 (hereafter cited as *Oppenheimer Hearings*); Detection Report, pp. 13–16, Wilson Diary, Sept. 19, 1949, *AEC.*
8. Wilson Diary, Sept. 19, 1949, Lilienthal Appointment Book, Sept. 19–20, 1949; Lilienthal, *Journals,* Vol. II, *The Atomic Energy Years, 1945–1950* (New York, 1964), pp. 569–72.
9. Lilienthal to Oppenheimer, Sept. 23, 1949, Box 46, *JRO;* Notes on Conversation Between Pike and Souers, Sept. 21, 1949, *AEC.* Persistent rumors of devaluation of the pound sterling were part of the growing financial crisis in September. News of the devaluation broke in American newspapers on Sept. 19. New York *Times,* Sept. 12–19, 1949.
10. Truman, *Memoirs,* Vol. II, *Years of Trial and Hope* (Garden City, N. Y., 1956), pp. 306–08.
11. New York *Times,* Sept. 24, 1949; *Public Papers of Harry S. Truman, 1949* (Washington, 1964), p. 485.
12. GAC 16, Sept. 22–23, 1949, *AEC.*
13. *Oppenheimer Hearings,* p. 714; Teller to Bradbury, Aug. 23, 1949, encl., Teller to von Neumann, Aug. 23, 1949, Bradbury to McCormack, Aug. 30, 1949, encl., Bradbury to von Neumann, Sept. 14, 1949, Dean Diary, Sept. 23, 1949, Dean to the Commissioners, Sept. 23, 1949, *AEC.*
14. The Historian's Office has an extensive file of newspaper clippings on reaction to the announcement.
15. Minutes, Program Council, Sept. 23, 26, 1949, Dean to the Commission, Sept. 23, 1949, *AEC.*
16. CM 308, Sept. 27, 1949, Suggested Revisions in Draft Report to the President, Sept. 27, 1949, *AEC;* J. H. Ohly to Johnson, Sept. 30, 1949, *WNRC.*
17. JCAE, Transcript of Hearing, Sept. 28, 1949, *AEC.* The rider appears in the Appropriation Act for Fiscal Year 1950, P.L. 266, 81 Cong., 63 *Stat.* 634.

18. MLC 37, Sept. 28, 1949, *AEC.*
19. JCAE, Transcript of Hearing, Sept. 29, 1949, *AEC.*
20. Lilienthal, *Atomic Energy Years,* pp. 574–77; Lilienthal Appointment Book, Sept. 29, 1949, *AEC.* For details, see Chap. 10.
21. CM 309, Sept. 29, 1949, Strauss to the Commission, Oct. 5, 1949, with covering note, Strauss to Lilienthal, Oct. 5, 1949, *AEC.* The text of the letter is in Strauss, *Men and Decisions,* pp. 216–17.
22. CM 310, Oct. 5, 1949, Strauss to Lilienthal, covering note on Oct. 5 memorandum, *AEC.*
23. CM 311, Oct. 6, 1949, CM 312, Oct. 7, 1949, Lilienthal Appointment Book, Oct. 7, 1949, *AEC.*
24. *Oppenheimer Hearings,* pp. 659, 773–75. An account of Lawrence's activities differing in some of the details is found in Herbert Childs, *An American Genius: The Life of Ernest Orlando Lawrence* (New York, 1968), pp. 413–16. Research on the thermonuclear reaction is described in the following Los Alamos reports: LAMS-724, 743, 753, 761, 781, 791, 804, 811, 830, 868, 893, 930, and 944, *AEC.* A study paper on this subject is in the files of the Historian's Office, *AEC.* For Bradbury's views on the status of thermonuclear research, see *Oppenheimer Hearings,* pp. 478–79, 485–86. See also Ulam, "Computers," *Scientific American 211* (Sept. 1964), 203–07.
25. *Oppenheimer Hearings,* pp. 776–77; CM 313, Oct. 10, 1949, *AEC.*
26. CM 313, Oct. 10, 1949, *AEC;* Lilienthal to Pace, Oct. 10, 1949, Report to the President by the Special Committee of the National Security Council, Oct. 10, 1949, *AEC.*
27. *Oppenheimer Hearings,* pp. 243–44, 460–61, 777–78.
28. Teller to Bradbury, Oct. 10, 1949, McCormack to Bradbury, Oct. 13, 1949, *LASL;* Lilienthal Appointment Book, Oct. 11, 1949, Lilienthal to Oppenheimer, Oct. 11, 1949, M. J. Brown to the Commissioners, Oct. 13, 1949, Oppenheimer to Lilienthal, Oct. 14, 1949, CM 316, Oct. 12, 1949, Dean Diary, Oct. 13, 1949, *AEC.*
29. Oppenheimer Appointment Books, Oct. 17, 20–22, 1949, Box 2, *JRO;* Bradbury's and Manley's position is based on Manley to Los Alamos Technical Council, Oct. 13, 1949, *LASL; Oppenheimer Hearings,* p. 231.
30. Oppenheimer to Conant, Oct. 21, 1949, *AEC; Oppenheimer Hearings,* pp. 242–43.
31. LeBaron to Oppenheimer, Oct. 31, 1949, Box 45, *JRO; Oppenheimer Hearings,* pp. 328, 386, 715.
32. Seaborg to Oppenheimer, Oct. 14, 1949, *AEC; Oppenheimer Hearings,* p. 715.
33. *Oppenheimer Hearings,* pp. 778–83.
34. McMahon to Lilienthal, Oct. 17, 1949, CM 317, Oct. 17, 1949, Pace to Lilienthal, Oct. 17, 1949, Truman to Lilienthal, Oct. 19, 1949, Dean Diary, Oct. 19, 1949, Pike to Oppenheimer, Oct. 21, 1949, *AEC.*
35. *Oppenheimer Hearings,* pp. 782–84; T. O. Jones to the Commissioners, Oct. 25, 1949, *AEC.* Serber saw Oppenheimer on Oct. 27, 1949. See Oppenheimer Appointment Book, Oct. 27, 1949, Box 2, *JRO.*
36. CM 325, Oct. 27, 1949, GAC Secretariat to Members, Oct. 28, 1949, Williams to Oppenheimer, Oct. 28, 1949, *AEC.*
37. GAC 17, Oct. 28, 1949, *AEC; Oppenheimer Hearings,* p. 359.
38. GAC 17, Oct. 28–29, 1949, *AEC; Oppenheimer Hearings,* p. 328.
39. GAC 17, Oct. 29, 1949, Lilienthal, Opening Remarks for GAC Meeting, Oct. 29, 1949, *AEC; Oppenheimer Hearings,* pp. 407, 785; Lilienthal, *Atomic Energy Years,* p. 581.
40. *Oppenheimer Hearings,* pp. 247, 785.
41. GAC 17, Oct. 30, 1949, *AEC.*
42. Oppenheimer to Lilienthal, Oct. 30, 1949, transmitting report on 17th GAC Meeting, with two attachments, *AEC.*
43. Evidence on this point is contradictory. Oppenheimer did not recall the existence of the letter until it was read to him during his security hearing on April 16, 1954. See *Oppenheimer Hearings,* pp. 237–39. In 1957 Oppenheimer told an interviewer that he did present the letter to the committee and that the members decided not to include the letter in the report "because it contained nothing new." See Warner R. Schilling, Transcript of Interview with J. R. Oppenheimer,

June 11, 1957, Box 65, *JRO*. Neither Rabi nor Fermi recalled in 1954 any discussion of the Seaborg letter. See *Oppenheimer Hearings*, pp. 395, 462. Cyril S. Smith in 1967 had "a definite recollection of the small group discussing Seaborg's opinion as expressed in a physically-present letter." See Smith to R. G. Hewlett, Apr. 27, May 5, 1967, *AEC*. Seaborg, who did not attend the meeting, assumed that the letter had not been discussed because none of the members ever referred to it in later meetings. Seaborg concluded that Oppenheimer had either forgotten about the letter by the time of the meeting or had decided it was not important.

44. Lilienthal Appointment Book, Oct. 30, 1949, *AEC*. J. H. Manley kindly provided a copy of his personal diary kept from Oct. 30 to Nov. 15, 1949. See entry for Oct. 30, 1949. For direct evidence of Oppenheimer's concern about Lilienthal, see Oppenheimer to Felix Frankfurter, Dec. 9, 1949, Box 34, *JRO*.
45. Lilienthal Appointment Book, Oct. 31, 1949, Dean Diary, Oct. 31, 1949, *AEC*; Lilienthal, *Atomic Energy Years*, pp. 582–85.
46. Manley Diary, Oct. 31, 1949, *AEC*.
47. Lilienthal, *Atomic Energy Years*, pp. 585–90.
48. CM 328, Nov. 3, 1949, *AEC*. The minutes state that each Commissioner summarized his tentative conclusions. For the substance of the discussion we have used for Lilienthal the material cited in Note 44 and for Smyth his formal statement of Nov. 9, 1949, *AEC*.
49. Dean, Outline of Views, Nov. 3, 1949, *AEC*.
50. Strauss to R. B. Snapp, Nov. 3, 1949, *AEC*.
51. Teller and Manley gave strikingly different versions of their telephone conversation in *Oppenheimer Hearings*, pp. 717–18, and in Manley Diary, Nov. 1, 1949, *AEC*. Teller's appointment with McMahon is discussed in Hafstad to Principal Staff, Oct. 21, 1949, *AEC*.
52. Lilienthal, *Atomic Energy Years*, pp. 590–91; Lilienthal Appointment Book, Nov. 4, 1949, *AEC*. Acheson reported a meeting with Truman on this subject on Nov. 7, 1949. Acheson, Meeting with the President, Nov. 7, 1949, *DS*.
53. CM 329, Nov. 4, 1949, *AEC*.
54. Lilienthal, *Atomic Energy Years*, pp. 591–94.
55. CM 330, Nov. 7, 1949, Manley to Snapp, Nov. 9, 1949, Dean, Sequence of Events Leading to the Decision on the "Super" Bomb, Jan. 27, 1950, *AEC*. Neither Manley's summary nor the minutes of the meeting refer to Dean. According to Dean, overcoming his disagreement with the GAC position was the purpose and subject of the meeting.
56. CM 331, Nov. 9, 1949, Dean Diary, Nov. 8, 1949, *AEC*; Strauss, *Men and Decisions*, p. 222.
57. Memorandum for the President, Development of a "Super" Bomb, encl., Lilienthal to Truman, Nov. 9, 1949, *AEC*.
58. Lilienthal, *Atomic Energy Years*, pp. 594–96.
59. Strauss, *Men and Decisions*, pp. 222–23; McMahon to Truman, Nov. 1, 1949, Manley Diary, Nov. 2, 1949, *AEC*. Dean saw Borden and talked with Strauss by telephone on Nov. 8. See Dean Diary, Nov. 8, 1949, *AEC*.
60. Manley Diary, Nov. 10–13, 1949, H. A. Fidler to R. B. Snapp, Nov. 17, 1949, *AEC*; *Oppenheimer Hearings*, pp. 90–91, 716–17.
61. Ulam to von Neumann, Nov. 15, 1949, *AEC*.
62. Manley Diary, Nov. 14–15, 1949, *AEC*.
63. Teller recorded his comments at the Nov. 15 meeting in a memorandum to Manley on Dec. 13, 1949, *LASL*.
64. McMahon to Truman, Nov. 21, 1949, *AEC*.
65. Transcript of Nov. 1, 1949, Dumont Television Network Program, Nov. 21, 1949, *AEC*; Washington *Post*, Nov. 18, 21, 26–28, 1949; New York *Times*, Nov. 24, 26, 1949; New York *Sun*, Nov. 30, 1949; E. C. Johnson to Truman, Dec. 13, 1949, Truman to Johnson, Dec. 17, 1949, *HST*; Lilienthal, *Atomic Energy Years*, pp. 601–02.
66. Lilienthal, *Atomic Energy Years*, pp. 597–98; Truman to Souers, Nov. 19, 1949, *AEC*. Truman quotes the memorandum in part in *Years of Trial and Hope*, pp. 308–09, but the document is incorrectly dated Nov. 10.

67. AEC Press Release 222, Nov. 25, 1949, AEC Press Release 225, Nov. 29, 1949, Transcript of Press Conference, Nov. 28, 1949, *AEC.*
68. Pike to the Commission, Nov. 28, 1949, Strauss to Truman, Nov. 25, 1949, *AEC.* Strauss's letter is printed in full in Strauss, *Men and Decisions,* pp. 219–22.
69. Bradley to Louis Johnson, Nov. 23, 1949, *AEC.*
70. CM 337, Nov. 30, 1949, CM 338, Nov. 30, 1949, CM 339, Dec. 2, 1949, *AEC.*
71. GAC 18, Dec. 2–3, 1949, Report on 18th GAC Meeting, encl., Oppenheimer to Lilienthal, Dec. 3, 1949, with the following attachments: Rowe to Oppenheimer, Dec. 3, 1949, Manley, Working Memorandum, Dec. 3, 1949, Fermi to Oppenheimer, Dec. 3, 1949, Buckley to Oppenheimer, Dec. 3, 1949, DuBridge to Lilienthal, Dec. 5, 1949, *AEC; Oppenheimer Hearings,* pp. 395, 604–05, 703, 707.
72. E. Teller and F. de Hoffmann to Bradbury, Dec. 5, 1949, Fine, The Super, Dec. 8, 1949, CM 344, Dec. 9, 1949, *AEC.*
73. Manley to Lilienthal, Dec. 12, 13, 1949, Lilienthal to Manley, Dec. 16, 1949, Dean Diary, Dec. 15, 1949, Manley, Military Worth, Dec. 15, 1949, encl., Manley to Lilienthal, Dec. 16, 1949, *AEC.*
74. Lilienthal, *Atomic Energy Years,* pp. 610–12; Dean Diary, Dec. 19, 1949, Lilienthal to Truman, Dec. 21, 1949, Truman to Lilienthal, Dec. 22, 1949, *AEC.* Oppenheimer had discussed the issue with Kennan on Nov. 16, 1949. See Oppenheimer to Kennan, Nov. 17, 1949, and Kennan draft statement, Nov. 18, 1949, Box 43, *JRO.*
75. Lilienthal, *Atomic Energy Years,* pp. 613–14.
76. Military Implications of Thermonuclear Weapons, n.d., encl., Smyth to the Commissioners, Dec. 22, 1949, *AEC;* K. T. Compton to Truman, Nov. 9, 1949, *WNRC;* Compton's letter is reproduced in Strauss, *Men and Decisions,* p. 440.
77. Lilienthal Appointment Book, Jan. 4–7, 1950, *AEC;* Lilienthal, *Atomic Energy Years,* pp. 615–17, 618–20.
78. Dean Diary, Jan. 10, 1950, McMahon to Lilienthal, Jan. 9, 1950, *AEC;* McMahon to Johnson, Jan. 9, 1950, *WNRC.*
79. LeBaron to the Record, Jan. 11, 1950, *WNRC.*
80. Bradley to Johnson, Jan. 13, 1950, *AEC.*
81. Transcript of Drew Pearson Broadcast, Jan. 15, 1950, *AEC;* New York *Times,* Jan. 17, 1950; DuBridge to Lilienthal, Dec. 5, 1949, Dean, Analysis of DuBridge's Letter, Jan. 16, 1950, F. Henderson to Lilienthal, Urgent Telegram, Jan. 17, 1950, Dean Diary, Jan. 17, 1950, *AEC.*
82. Dean Diary, Jan. 16, 1950, JCAE, Transcript of Hearing, Jan. 18, 1950, CM 356, Jan. 19, 1950, *AEC.*
83. JCAE, Transcript of Hearing, Jan. 20, 1950, *WNRC.*
84. Washington *Daily News,* Jan. 20, 1950; Washington *Evening Star,* Jan. 20, 1950; New York *Times,* Jan. 21, 1950.
85. Lay to Lilienthal, Jan. 19, 1950, Lilienthal to the Commissioners, Jan. 27, 1950, *AEC.*
86. Arneson, State Department Working Paper, Jan. 24, 1950, *AEC.* Kennan had prepared a paper urging that the Government "reexamine once more, in the most solemn and serious way, the whole principle of 'first use' of atomic weapons or any other weapons of mass destruction," and urged a public statement renouncing first use of such weapons. Kennan does not recall the fate of his paper, but apparently it did not receive serious consideration in the State Department. G. F. Kennan, *Memoirs, 1925–1950* (Boston, 1967), pp. 471–76.
87. Lilienthal, *Atomic Energy Years,* pp. 620–21.
88. JCAE, Transcript of Hearing, Jan. 27, 1950, *AEC.* Dean's interpretation of the hearing in his paper, Sequence of Events Leading to the Decision on the "Super" Bomb, Jan. 27, 1950, *AEC,* differs substantially from the transcript.
89. Lilienthal, *Atomic Energy Years,* pp. 621–22. This entry does not make clear that the meeting with Truman was on Jan. 27. See Lilienthal Appointment Book, Jan. 27, 1950, *AEC.* Truman's remarks at the press conference are in *Public Papers of Harry S.*

Truman, 1950 (Washington, 1965), p. 134.

90. New York *Times*, Washington *Post*, and Washington *Evening Star* all carried extensive reports on Jan. 28, 1950.
91. Lilienthal, Meeting of Special NSC Committee on Super Bomb, Jan. 31, 1950, *AEC*. All but one paragraph of this document is reproduced in Lilienthal, *Atomic Energy Years*, pp. 623–32.
92. A copy of Johnson's proposed statement is attached to Arneson to Lilienthal, Feb. 8, 1950, *AEC*.
93. Lilienthal's account of the meeting with Truman is in Lilienthal, *Atomic Energy Years*, pp. 632–33. No copy of this memorandum has been found in *AEC*.
94. Lilienthal Appointment Book, Jan. 31, 1950, *AEC*.
95. The President's press statement is in *Public Papers of Harry S. Truman, 1950*, p. 138. Official notification came in Truman to Lilienthal, Jan. 31, 1950, *AEC*. Lilienthal's session with the GAC is recorded in GAC 19, Jan. 31, 1950, *AEC*, and in Lilienthal, *Atomic Energy Years*, pp. 633–34. On the Joint Committee meeting, see JCAE, Transcript of Hearing, Jan. 31, 1950, *AEC*. On instructions to Los Alamos, see McCormack to Manley, Jan. 31, 1950, *AEC*, McCormack to Tyler and Bradbury, Jan. 31, 1950, *LASL*.
96. Strauss to Truman, Jan. 31, 1950, Lilienthal Appointment Book, Feb. 1, 1950, *AEC*; Lilienthal, *Atomic Energy Years*, pp. 634–36. Lilienthal recalled the day of his departure in the first of his Stafford Little Lectures at Princeton on Feb. 12, 1963, a copy of which is in *AEC*.

CHAPTER 13

1. *Congressional Record*, 81 Cong., 2 sess., Feb. 2, 1950, pp. 1338–44.
2. Joint Committee, Transcript of Hearing, Argonne National Laboratory, Mar. 11, 1950, pp. 29–30, *AEC*.
3. MLC 41, Feb. 2, 1950, *AEC*.
4. Wilson Diary, Feb. 2, 1950, *AEC*.
5. *Ibid.*; Brig. Gen. R. C. Wilson, Memorandum for the Record, Feb. 6, 1950, *AEC*.
6. Joint Committee, Hearing on . . . Hydrogen Bomb Development, Feb. 10, 1950, *AEC*.
7. Teletypes, McCormack to Tyler, Feb. 8, 1950, Coiner to Tyler, Feb. 13, 1950, *ALOO*; Wilson to LeBaron, Feb. 13, 20, 1950, *AEC*.
8. Notes of a Briefing Held at the Los Alamos Scientific Laboratory on Feb. 23, 1950, *AEC*; P. J. Long, Memorandum for the Record, Mar. 6, 1950, *WNRC*.
9. Wilson to LeBaron, Feb. 20, 1950, *AEC*.
10. LeBaron to the Secretary of Defense, Feb. 16, 20, 1950, *WNRC*. The evidence for the analysis's having gone to the White House rests on a note from Matthew Connally to the Secretary of Defense, Feb. 24, 1950, *WNRC*; Johnson to Truman, Feb. 24, 1950, CM 376, Mar. 1, 1950, *AEC*.
11. MLC 42, Mar. 1, 1950, *AEC*.
12. CM 376, Mar. 1, 1950, CM 377, Mar. 2, 1950, Smyth to Pike *et al.*, Mar. 6, 1950, *AEC*.
13. Wilson Diary, Mar. 3, 1950, Joint Committee, Hearing on H-Bomb Personnel, Mar. 3, 1950, *AEC*.
14. Report to the President on Development of Thermonuclear Weapons, Mar. 9, 1950; Lay to Secretaries of State, Defense, and the Chairman of the Atomic Energy Commission, Mar. 10, 1950, *AEC*.
15. Joint Committee, Hearing on Development of the Hydrogen Bomb, Mar. 10, 1950, *AEC*.
16. Joint Committee, Transcript of Hearing, Argonne National Laboratory, Mar. 11, 1950, pp. 4–8, *AEC*.
17. H. Etherington, Interim Report on Water-Cooled Water-Moderated Reactor for Naval Application, Mar. 1, 1950, ANL-4393, H. Etherington, Quarterly Report, Naval Reactor Division, Dec. 1, 1949–Feb. 28, 1950, ANL-4424, Naymark, Feasibility of

Naval Reactor Fuel Elements Made of Zirconium-Uranium Alloy Clad with Zirconium, Mar. 31, 1950, ANL-4436, *AEC.*

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19. J. R. Huffman, MTR Project, Quarterly Report, Mar. 1, 1950, ANL-4439, *AEC.*
20. M. M. Mann and J. A. Lane, MTR Project, Progress Report, Nov. 30, 1949, ORNL-529, *AEC.*
21. F. W. Bruner, History and Present Status of NEPA, Feb. 23, 1950, C. B. Ellis and W. B. Thompson, ANP Project, Quarterly Progress Report, Aug. 31, 1950, ORNL-858, *AEC.* An excellent historical summary of developments from the fall of 1948 to the spring of 1950 is in Director of Reactor Development, Information on Activities in the Aircraft Nuclear Propulsion Program, May 31, 1950, *AEC.*
22. Oak Ridge News Release, Jan. 12, 1950, *AEC;* Weinberg, Memo on State of Laboratory and Reactor Projects, May 1, 1950, *ORNL.*
23. C. E. Winters, HRE Quarterly Report, Feb. 28, 1950, ORNL-630, C. E. Winters and A. M. Weinberg, HRE Feasibility Report, July 6, 1950, ORNL-730, *AEC.*
24. For earlier history, see Chap. 7. C. Shugg to H. A. Winne, Aug. 9, 1949, Winne to Shugg, Aug. 22, 1949, Shugg to Winne, Nov. 9, 1949, Technical Feasibility Report for the KAPL WMA Reactor, Feb. 14, 1950, KAPL-238, Shugg Diary, Feb. 21, 1950, *AEC.*
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26. J. C. Stewart, Conference . . . with General Electric Co., Mar. 17, 1950, Wilson to Stewart, Mar. 20, 1950, *AEC.*
27. Rickover and Hafstad, Notes of Meeting with Chairman, Joint Committee, Mar. 21, 1950, Shugg Diary, Mar. 21, 22, 1950, AEC Press Release 276, Mar. 30, 1950, GAC 20, Mar. 31–Apr. 1, 1950, Joint Committee, Transcript of Hearing, Apr. 3, 1950, D. B. Langmuir, Notes of Meeting with Philip Sporn, Apr. 5, 1950, Oppenheimer to Pike, Apr. 1, 27, 1950, CM 390, Apr. 5, 1950, Winne to Stewart, Apr. 6, 1950, CM 391, Apr. 12, 1950, Hafstad to Stewart, Apr. 12, 1950, *AEC.*
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29. Preliminary Study of P-10 Production, Mar. 20, 1950, Summary of Minutes of Staff Meetings on P-10 Production, Mar. 21–22, 1950, *AEC.*
30. Wilson Diary, Mar. 30, 31, 1950, Shugg Diary, Mar. 31, 1950, *AEC;* Zinn to Hafstad, Oct. 19, 1949, Meeting of the Laboratory Executive Committee, Apr. 18, 1950, *ANL.*
31. GAC 20, Mar. 31–Apr. 1, 1950, Oppenheimer to Pike, Apr. 1, 1950, *AEC.*
32. Lawrence to Pitzer, Jan. 5, 1950. Background material and correspondence are in Director of Research, Proposal from the Radiation Laboratory To Construct a 25 Mev High Current Linear Accelerator, Feb. 6, 1950, approved at CM 367, Feb. 8, 1950, *AEC.*
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35. Wilson Diary, May 12, 1950, CM 405, May 11, 1950, CM 407, May 15, 1950, *AEC.*
36. CM 405, May 11, 1950, CM 407, May 15, 1950, CM 410, May 18, 1950, Director of Production, Dual Temperature Process Heavy Water Facility, May 11, 1950, *AEC.*
37. Two letters from Zinn to Weil, both dated Apr. 12, 1950, Zinn to Weil, May 23, 1950, *ANL.*
38. Shugg Diary, Apr. 25, 1950, Weil to Zinn, May 11, 1950, Krisberg, Untermyer, Spinrad to Zinn, ANL-WPB-69, Apr. 6, 1950, ANL-WPB-71, Apr. 11, 1950, ANL-WHZ-245, May 23, 1950,

H. C. Ott and U. M. Staebler, Meeting To Discuss Designs of Heavy Water Moderated Neutron Production Reactors, June 2, 1950. The North American design is in NAA-SR-61, a D_2O Natural Uranium Neutron Production Reactor, Interim Report, Apr. 10, 1950, *AEC.*

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CHAPTER 15

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47. Quarterly Report, Biology Division, Aug., 1950, ORNL-807, pp. 42–43; L. B. Russell and W. L. Russell, "Radiation Hazards to the Embryo and Fetus," *Radiology 58* (Mar., 1952), 369–76. A complete report of Mrs. Russell's work is in "X-Ray Induced Developmental Abnormalities in the Mouse and Their Use in the Analysis of Embryological Patterns," *Journals of Experimental Zoology 114* (Aug., 1950), 545–601, 131 (Apr., 1956), 329–95.
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posium on Quantitative Biology (Cold Spring Harbor, N. Y., 1951) *16*, 327–36.
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53. Fechteler to Dean, Sept. 14, 1951, H. C. Ott to G. L. Weil, Sept. 28, 1951, Adm. N. N. Wallin to Dean, Oct. 4, 1951, Boyer to Murray, Oct. 4, 1951, Murray to Boyer, Oct. 26, 1951, LeBaron to Dean, Oct. 30, 1951, *AEC;* McMahon to Dean, Dec. 5, 1951, *JCAE.*
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57. Director of Reactor Development, Industrial Power Participation Program, Jan. 14, 1952, Dow-Detroit Edison Proposal for Reactor Development, Apr. 8, 1952, *AEC.*
58. Director of Reactor Development, Program for Development of Non-Mobile Reactors, Mar. 11, 1952, *AEC.*
59. CM 676, Mar. 27, 1952, *AEC.*
60. Director of Reactor Development, Program for Development of Non-Mobile Reactors, Apr. 8, 1952, CM 685, Apr. 17, 1952, *AEC.*
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CHAPTER 16

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2. CM 432, July 5, 1950, CM 433, July 6, 1950, CM 438, July 13, 1950, Smith, Military Reservists Employed as Civilians in Atomic Energy Program, July 5, 1950, *AEC.*
3. McMahon to Pike, June 26, 1950, Statement of Senator Brien McMahon, July 11, 1950, *AEC.*
4. Borden, Memorandum for Senator McMahon, July 17, 1950, with endorsement from McMahon to Dean, *AEC.*
5. Shugg Diary, July 10, 12, 1950, *AEC;* Special Message to the Congress . . . , July 19, 1950, Radio and Television Address . . . , July 19, 1950, *Public Papers of Harry S. Truman, 1950* (Washingon, 1965), pp. 527–42.
6. Monthly Status and Progress Reports, June, July, 1950, Williams Diary, July 3, 1950, Shugg Diary, July 13, 20, 1950, *AEC.*
7. Shugg Diary, July 19, 1950, Reactor Subcommittee of the Joint Committee, Heavy Water Reactors, July 19, 1950, Joint Committee, Adequacy of Production, July 21, 1950, *AEC.*
8. Dean, Memorandum for the Files, July 31, 1950, *AEC.*
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10. J. S. Lay, Memorandum for the Secretary of State *et al.,* Aug. 8, 1950; Joint Committee, Adequacy of Production, July 21, 1950, *AEC.*
11. Jackson to Johnson, Aug. 9, 1950, McMahon to Johnson, Aug. 22, 1950, McMahon to Dean, Aug. 22, 1950, *AEC.*
12. CM 454, Aug. 14, 1950, CM 460, Aug. 29, 1950, *AEC.*
13. Shugg, Memorandum for the Commission, Sept. 1, 1950, *AEC.*
14. Oppenheimer to Bradbury, July 19, 1950, *LASL;* Teller and Wheeler, Status of Thermonuclear Development, Aug. 1950, McCormack to Smyth, Sept. 6, 1950, GAC 22, Sept. 10–13, 1950, *AEC.*
15. GAC 22, Sept. 10–13, 1950, Oppenheimer to Dean, Sept. 13, 1950, *AEC;* Oppenheimer to Bradbury, Sept. 15, 1950, *LASL.*
16. Report of Atomic Energy Commission-Department of Defense Working Group on the Expansion of the Fissionable Material Production Capacity, Sept. 8, 1950, *AEC.*
17. CM 468, Sept. 13, 1950, CM 475, Sept. 26, 1950, Dean to Johnson, Sept. 15, 1950, F. W. Timberlake, Expansion of Atomic Energy Field, Sept. 21, 1950, Shugg Diary, Sept. 28, 1950, J. S. Lay to Secretaries of State, Defense, and Chairman of the Atomic Energy Commission, Oct. 9, 1950, *AEC;* Secretaries of Army, Navy, and Air Force, Memorandum for the Secretary of Defense, Sept. 18, 1950, *WNRC.*
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25. *Public Papers of Harry S. Truman, 1950,* Joint Statement Following Discussions with the Prime Minister of Great Britain, Dec. 8, 1950, pp. 738–40; *Newsweek,* Dec. 11, 1950, pp. 22, 36–46, Dec. 18, 1950, pp. 17, 30–34; Harry S. Truman, *Memoirs,* Vol. II, *Years of Trial and Hope* (Garden City, N. Y., 1956), pp. 394–413.
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28. GAC 24, Jan. 4–6, 1951, Williams Diary, Jan. 9, 18, 1951, Teletype, Shaw to Williams, Jan. 12, 1951, CM 519, Jan. 22, 1951, Teletype, Williams to Shaw, Jan. 23, 1951, *AEC.*
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31. Dean Diary, Feb. 9, 1951, Dean, Memorandum of Conversation with Lewis Strauss, Feb. 12, 1951, *AEC.*
32. Ulam to von Neumann, Feb. 23, 1950, *AEC.*
33. LAMS-1225, Mar. 9, 1951, *AEC.*
34. GAC 25, Mar. 15–17, 1951, *AEC.*
35. Director of Military Application, Transfer of Custody of Stockpiled Non-Nuclear Components to the Department of Defense, Mar. 17, 1950, CM 384, Mar. 20, 1950, Dean Diary, May 19, 1950, *AEC.*
36. Dean, *Ad Hoc* Committee . . . on Procedures for Authorizing Use of Atomic Weapons, Nov. 10, 1950, filed in Dean Diary, *AEC.*
37. Marshall to Truman, Dec. 16, 1950, Dean Diary, Apr. 5, 1951, Dean, Memorandum to the Commissioners, Apr. 5, 1951, *AEC.*
38. Dean Diary, Apr. 5, 6, 1951, Dean to Truman, Apr. 11, 1951, *AEC.*
39. Dean Diary, Apr. 16, 1951, T. K. Glennan, Memorandum for the Files, May 2, 1951, Lay, Memorandum for the Secretaries of State, Defense, Chairman of the Atomic Energy Commission, Apr. 27, 1951, encl., Procedures with Respect to a Presidential Decision To Use Atomic Weapons, *AEC.*
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Mar. 15, 1951, Froman, The Need and Philosophy of Fixing upon a Thermonuclear Development Program, Mar. 15, 1951, Ulam, Notes for Darol Froman, Mar. 15, 1951, *LASL.*

42. Froman, A Separate Thermonuclear Division, Mar. 20, 1951, Nordheim to Bradbury, Mar. 23, 1951, Teller to Bradbury, Mar. 24, 1951, Froman, "Examples of the rules or agreements under which Darol Froman thinks he can operate . . . ," Mar. 28, 1951, *LASL.*
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44. Dean Diary, Apr. 4, 16, 1951, *AEC.*
45. *Ibid.*, Apr. 20, 1951, *AEC;* Teller to Dean, Apr. 20, 1951, *LASL.*
46. *Joint Task Force 3 History of Operation Greenhouse,* Vol. I, pp. 35–140. Dean recorded his impressions in a separate note filed in his diary, *AEC;* Teller to Los Alamos, Reines to Bradbury, both in the spring of 1951, *LASL.*
47. Teller to Smyth, spring, 1951, *AEC.*
48. Froman to Those Listed Below, Bethe to Froman, E. R. Jette to Froman, all in the spring of 1951, *LASL.*
49. ADWD-272—Rough Draft—Los Alamos Laboratory Proposed Thermonuclear Program, June 7, 1951, TAD 262, Some Ideas about the LASL Thermonuclear Program, pencil-dated June 12, 1951, *LASL.*
50. Bradbury to Oppenheimer, June 1, 1951, Bradbury to Froman and Mark, June 6, 1951, *LASL.* Teller was listed to receive a copy of the June 6 memorandum which contained Bradbury's ideas on the laboratory presentation.
51. Information on the various projects comes from the AEC Monthly Status and Progress Reports for the period.
52. Partial Statement Made by Hans Bethe at Princeton Meeting, June 16–17, 1951, Los Alamos Scientific Laboratory Thermonuclear Program, June 22, 1951, Bradbury to Tyler, July 13, 1951, *LASL.* References to Teller's misunderstanding of the test philosophy are in Teller to Bradbury, June 21, 1951, and Bradbury to Teller, June 23, 1951, *LASL.* A more dramatic account of the Princeton meeting is in Teller's *The Legacy of Hiroshima,* pp. 51–53. See also *Oppenheimer Hearings,* pp. 84, 251, 305, 320, 430, 456, 462, 488, 520–21, 645, 720.

CHAPTER 17

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2. CM 572, June 20, 1951, Dean to McMahon, June 22, 1951, Dean Diary, June 22, 1951, Dean to LeBaron, June 25, 1951, *AEC.*
3. Glennan to Boyer, June 14, 1951, CM 572, June 20, 1951, Murray to Dean, June 21, 1951, Murray to Boyer, June 26, 1951, Murray to Glennan, June 28, 1951, Murray to Boyer, June 28, 1951, Glennan to Murray, July 5, 1951, Boyer to Murray, July 18, 1951, *AEC.*
4. Dean Diary, June 21, 1951, Borden to Smyth, July 10, 1951, encl., McMahon to Dean, Aug. 15, 1951, Joint Committee, Transcript of Hearing Before Subcommittee on Raw Materials, July 18, 1951, Joint Committee, The Scale and Scope of Atomic Production: A Chronology of Leading Events, Jan. 30, 1952, *AEC* (hereafter cited as Joint Committee Chronology). The Joint Committee Chronology consists mainly of excerpts from hearings and documents, and is cited when those hearings and documents are not available.
5. Joint Committee, Transcript of Hearing, Aug. 16, 1951, AEC Press Release 394, Aug. 21, 1951, *AEC.*
6. Joint Committee, Transcript of Hearing on General Legislative Problems, Aug. 21, 1951, *AEC.*
7. E. I. du Pont de Nemours & Co., Inc., Survey of the Plutonium Project, Mar. 25, 1949, *AEC.*

8. G. R. Prout to Schlemmer, Mar. 22, 1949, Schlemmer to Prout, May 12, 1949, refers to the May 2, 1949 authorization. Williams Diary, May 9-12, 1949, CM 267, May 11, 1949, CM 346, Dec. 21, 1949, *AEC.* A good summary of the history of Redox in 1949 is in Director of Production, Status of Hanford Chemical Separation Problems, Jan. 27, 1950, *AEC.*
9. AEC Monthly Status and Progress Reports for Sept. 1950, Aug. 1951, *AEC.*
10. Joint Committee, Transcript of Hearing Before Subcommittee on Raw Materials, July 18, 1951, AEC Press Release 347, Feb. 27, 1951, Monthly Status and Progress Reports for 1949, 1950, 1951, *AEC.*
11. J. B. Hamilton, Memorandum for the Files, Aug. 8, 1951, *DS;* CM 579, July 16, 1951, McQuiston, Progress Report on South African Uranium Project, Aug. 8, 1951, *AEC.*
12. Office of Special Projects, Report on the Visit of Mr. Playford, Premier of South Australia, Sept. 12, 1951, Joint Committee, Hearing Before the Subcommittee on Raw Materials, July 18, 1951, Dean to McMahon, Sept. 6, 1951, *AEC.* On the Section 10a amendment, see Chap. 11.
13. Zinn to McLain, Oct. 10, 1950, Conference, Sept. 27, 1950, ANL-SM-734, *ANL;* Monthly Status and Progress Report, Aug. 1951, *AEC.* A series of periodic technical progress letters and reports prepared by McLain's group is on file in *AEC.*
14. Cook to Boyer, Aug. 14, 1951, Director of Production, Comparative Costs of Heavy Water Production at Dana and Savannah River, Aug. 16, 1951, Monthly Status and Progress Report, Aug. 1951, Cook to Boyer, July 24, 1951, *AEC.*
15. For early development of the gaseous-diffusion process, see R. G. Hewlett and O. E. Anderson, Jr., *The New World, 1939–1946,* Vol. I of *A History of the U. S. Atomic Energy Commission* (University Park, Pa., 1962), pp. 97–101, 120–41. The Commission has recently published a technical analysis of the process in *AEC Gaseous Diffusion Plant Operation,* ORO-658 (Washington, 1968).
16. For earlier description, see Chap. 16, p. 532. On construction status, see Oak Ridge Monthly Status and Progress Reports, 1951–1952, *AEC.*
17. Murray to Dean, July 10, 1951, CM 582, July 26, 1951, Smyth, Murray, Glennan to Dean, Aug. 15, 1951, Murray to Dean, Aug. 16, 1951, Dean to Snapp, Aug. 28, 1951, Dean Diary, Aug. 27, Sept. 11, 1951, Boyer Diary, Sept. 11, 1951, *AEC;* McMahon to Teller, Aug. 31, 1951, *JCAE.*
18. Dean Diary, Sept. 12, 13, 1951, Notes on Informal AEC-MLC Conference, Sept. 13, 1951, R. T. Coiner, Memorandum for the Record, Sept. 19, 1951, R. G. Butler to Smyth, Sept. 25, 1951, *AEC.* There are no records of the discussion on Sept. 11 and 12 of Teller's resignation.
19. Boyer Diary, Sept. 17, 1951, Dean Diary, Sept. 20, 24, 25, 27, 28, 1951, Teletype, Bradbury to Dean, Sept. 26, 1951, *AEC.* Dean's remarks on the Sept. 28 meeting with Teller are in Joint Committee, Transcript of Hearing on H-Bomb Status Report, Sept. 28, 1951, *AEC.*
20. The study was in the form of a letter from Dean to McMahon, Aug. 31, 1951, *AEC.*
21. *Congressional Record,* 82 Cong., 1 sess., pp. 11496–11501. Representative Carl T. Durham introduced the resolution in the House. In all probability Dean had seen the speech several days earlier; see Dean Diary, Sept. 13, 1951, *AEC.*
22. McMahon to Dean, Aug. 15, 1951, Dean Diary, Aug. 27, Sept. 12, 14, 17, 19, 1951, Joint Committee, Transcript of Hearing on H-Bomb Status Report, Sept. 28, 1951, *AEC.* The opinions of the service secretaries are based on fragments of testimony included in the Joint Committee Chronology, *AEC.*
23. Dean Diary, Sept. 28, Oct. 1–4, 1951, McMahon to Dean, Oct. 5, 1951, *AEC;* Statement by Direction of the President . . . , Oct. 3, 1951, *Public Papers of Harry S. Truman, 1951* (Washington, 1965), p. 553.
24. Dean to LeBaron, Oct. 1, 1951, LeBaron to Dean, July 5, 1951, Dean to LeBaron, Aug. 2, 1951, General Manager, Report on Expansion of Fissionable Materials Production, Sept. 25,

1951, CM 586, Aug. 1, 1951, CM 608, Sept. 26, 1951, *AEC.*
25. Dean to LeBaron, Oct. 1, 1951, Dean Diary, Oct. 3, 1951, LeBaron to Dean, Oct. 4, 1951, MLC 60, Oct. 5, 1951, *AEC.*
26. LeBaron to Dean, July 18, 1951, CM 587, Aug. 7, 1951, CM 600, Aug. 29, 1951, Dean to LeBaron, Sept. 12, 1951, Director of Military Application, Relations of the Atomic Energy Commission with the Military Liaison Committee, Sept. 25, 1951, *AEC.*
27. Memorandum by General Manager, Oct. 26, Nov. 6, 1951, CM 610, Oct. 2, 1951, Smyth to Lovett, Oct. 8, 1951, *AEC.*
28. Joint Committee, Transcript of Hearing on Analysis of the Expansion Program with the Commission, Oct. 8, 1951, *AEC; Congressional Record,* 82 Cong., 1 sess., pp. 12866–12873.
29. Glennan to Commissioners and General Manager, Oct. 10, 1951, *AEC.*
30. GAC 27, Oct. 11–13, 1951, Oppenheimer to Dean, Oct. 13, 1951, *AEC.* Bradbury's views are in his letter to Fields, Oct. 9, 1951, *AEC,* which was read by the GAC. Libby's views are in Libby to Dean, Oct. 13, 1951, *AEC.*
31. McMahon to Dean, Oct. 17, 1951, *AEC.*
32. Dean Diary, Oct. 18, 1951, Chronology of Expansion Program incorporated in CM 618, Oct. 19, 1951, Lovett to Dean, Oct. 19, 1951, *AEC.*
33. LeBaron to Dean, Oct. 19, 1951, CM 618, Oct. 19, 1951, Dean to the Commissioners, Oct. 19, 1951, *AEC.*
34. Dean Diary, Oct. 19, 21, 1951, Tyler to Dean, Dec. 19, 1951, *AEC.*
35. Dean Diary, Oct. 24, 1951, LeBaron to Dean, Oct. 25, 1951, CM 620, Oct. 25, 1951, Murray, Memorandum, undated but discussed at CM 620, *AEC.*
36. Dean Diary, Oct. 25, 1951, Williams Diary, Oct. 25, 1951, T. F. Farrell, Notes on Meeting with Mr. Charles E. Wilson, Oct. 26, 1951, *AEC.*
37. CM 621, Oct. 31, 1951, Murray to NSC, Nov. 2, 1951, *AEC.*
38. Smyth to Lovett, Nov. 2, 1951, Murray to NSC, Nov. 2, 1951, with copy for Lovett, Lovett to Smyth, Nov. 6, 1951, *AEC.* On Lilienthal's earlier position, see Chap. 6, pp. 180–84.
39. AEC Press Release 392, Aug. 2, 1951, *AEC.*
40. CM 627, Nov. 14, 1951, *AEC.*
41. Smyth to Files, Nov. 16, 1951, Williams Diary, Nov. 16, 1951, *AEC.*
42. MLC 62, Nov. 20, 1951, *AEC.*
43. Dean Diary, Nov. 26, 27, 1951, CM 629, Nov. 26, 1951, CM 630, Nov. 27, 1951, Draft Report on Expansion of Fissionable Materials Production, Nov. 21, 1951, *AEC.*
44. CM 630, Nov. 27, 1951, Expansion of Fissionable Materials Production, encl., Dean to Lay, Nov. 30, 1951, *AEC.*
45. Smyth, Memorandum on Expansion of Fissionable Materials Production, Nov. 27, 1951, *AEC.*
46. Murray, Memorandum on Expansion of Fissionable Materials Production, Nov. 26, 1951, CM 632, Nov. 30, 1951, Smyth, Factors Relevant to Proposed Expansion of the Atomic Energy Program, encl., Smyth to Lay, Nov. 30, 1951, *AEC.* Smyth actually delivered the paper on Dec. 3, 1951. CM 633, Dec. 4, 1951, *AEC.*
47. GAC 28, Dec. 12–14, 1951, *AEC.*
48. Bradbury to Fields, Oct. 16, 1951, *AEC.*
49. Oppenheimer to Dean, Nov. 14, 1951, Murray to Oppenheimer, Dec. 12, 1951, encl., Thermonuclear Weapons Development Laboratory, *AEC.*
50. Teller, Statement to the General Advisory Committee on the Need of Second Weapons Laboratory, Dec. 7, 1951, GAC 28, Dec. 12–14, 1951, *AEC.*
51. CM 639, Dec. 19, 1951, Director of Military Application, Preliminary Examination of the Workload at Santa Fe Operations, Dec. 7, 1951, *AEC.*
52. Bradbury to Tyler, Dec. 26, 1951, *AEC.*
53. Dean to Lovett, Dec. 10, 1951, Lovett, Memorandum for the Executive Secretary, NSC, Dec. 11, 1951, CM 640, Dec. 20, 1951; CM 641, Dec. 21, 1951, MLC 63, Dec. 20, 1951; Lovett to Dean, Dec. 20, 1951, Smyth to Commissioners, Dec. 20, 1951, Smyth to Dean, Dec. 21, 1951, Smyth, Memorandum on the Expansion Program, Dec.

21, 1951, Glennan, Draft Memorandum for the Files, Dec. 21, 1951, *AEC*. There is no evidence that the Commissioners saw Glennan's draft at this time; however, it is indicative of his thought.

CHAPTER 18

1. J. K. Penfield to Arneson, Nov. 16, 1951, Note by Secretary, U. S. Position in Discussions with Prime Minister Churchill, Jan. 2, 1952, CM 642, Jan. 2, 1952, Hall to Arneson, Jan. 2, 1952, *AEC;* Bradley, Memorandum for the Secretary of Defense, Jan. 2, 1952, *WNRC; Newsweek 39* (1952), 19–20, 25–26. Remarks of Welcome to Prime Minister Churchill . . . , *Public Papers of Harry S. Truman, 1952–1953* (Washington, 1966), p. 9.
2. Acheson, Memorandum of Conversation at Dinner at British Embassy, Sunday, Jan. 6, 1952, *WNRC.*
3. Extract from Minutes of Truman-Churchill Talks Pertaining to . . . Atomic Energy . . . , January 7–9, 1952, *AEC.*
4. Dean Diary, Jan. 9, 10, 1952, Dean, Lord Cherwell's Visit, dated Jan. 9, 1952, filed in Dean Diary, Chief of Special Projects, Notes on Meeting with Lord Cherwell, Jan. 21, 1952, *AEC.*
5. Dean Diary, Jan. 2, 7, 1952, Acheson, Memorandum for Executive Secretary, NSC, Dec. 21, 1951, Wilson, Memorandum for Executive Secretary, NSC, Jan. 7, 1952, *AEC.*
6. LeBaron to Lovett, Jan. 7, 11, 1952, *WNRC.*
7. CM 648, Jan. 14, 1952, *AEC.*
8. Dean Diary, Jan. 16, 1952. The account of this meeting is based entirely on Dean's Memorandum for Files, Jan. 17, 1952, and his Statement to the NSC re Expansion Program, Jan. 16, 1952, *AEC.* In the memorandum he stated that he used the arguments in his statement except for data on manpower.
9. Dean Diary, Jan. 17, 1952, *AEC.*
10. Dean Diary, Jan. 17, 1952, CM 650, Jan. 17, 1952, Dean and Lovett to Chairman, Joint Committee, Jan. 17, 1952, encl., A Response to the Resolution of the Joint Committee . . . by the Department of Defense and the Atomic Energy Commission, Murray to McMahon, Jan. 22, 1952, *AEC.*
11. Joint Committee, Hearing on Expansion Program, Jan. 22, 1952, Hearing on Status of Atomic Energy Program, Feb. 6, 1952, *AEC.*
12. Dean Diary, Feb. 4, 8, 1952, S. Everett Gleason to the Secretary of State, Chairman of Atomic Energy Commission, Feb. 8, 1952, *AEC.* The only reference to the Commission meeting of Feb. 8 is in the Dean Diary.
13. Dean Diary, Feb. 8, 1952, Dean to Snapp, Feb. 12, 1952, Note by Secretary, Background Material on Custody and Use of Atomic Weapons, Feb. 18, 1952, Oppenheimer to Dean, Feb. 17, 18, 1952, *AEC.*
14. Snapp to Those Listed, May 29, 1952, *AEC;* U. S. Atomic Energy Commission, *In the Matter of J. Robert Oppenheimer* (Washington, 1954), pp. 446, 496–98, 503–05, 521, 524–25, 583–85, 616–17, 746, 748, 759, 762–73 (hereafter referred to as *Oppenheimer Hearings*).
15. CM 660, Feb. 12, 1952, Cook to Shaw, Feb. 20, 1952, Dean to Lovett, Feb. 20, 1952, *AEC.*
16. McMahon to Dean, Feb. 11, 1952, Joint Committee, Hearing on Status of Hydrogen Project, Feb. 21, 1952, *AEC.*
17. Borden to McMahon, Oct. 2, 1951, *JCAE;* Lovett to McMahon, Mar. 9, 1952, *AEC.* The chronology of these events is difficult to reconstruct and rests upon Teller and Allen Brown, *The Legacy of Hiroshima* (Garden City, N. Y., 1952) and *Oppenheimer Hearings*, pp. 744–58; Herbert Childs, *An American Genius: The Life of Ernest Orlando Lawrence* (New York,

1968), pp. 438–42, states that Dean asked Lawrence in November, 1951, about Livermore as the site for a second weapon laboratory. No records the Authors have seen mention Livermore for this purpose at this time, although other sites were under consideration.

18. *Oppenheimer Hearings*, pp. 757–58; Teller and Brown, *Legacy of Hiroshima*, pp. 61–62; A. S. Alexander, F. P. Whitehair, and T. K. Finletter to the Secretary of Defense, Mar. 27, 1952, Dean to Teller, Apr. 8, 1952, Dean to Snapp, May 29, 1952, *AEC*.
19. Status Report on Mark I Tests, Apr. 15, 1952, Smyth to Lawrence, Apr. 3, 1952, Benedict *et al*., Evaluation of the MTA Program by the Operations Analysis Staff, Apr. 10, 1952, Director of Production, Future Course of the MTA Program, June 12, 1952, CM 717, June 30, 1952, CM 729, Aug. 7, 1952, *AEC*.
20. CM 744, Sept. 8, 1952, *AEC*.
21. Dean Diary, July 28, 1952, *AEC*. Filed in the diary are Dean's statement and that of the Commission. Statement by the President on the Death of Brien McMahon, *Public Papers of Harry S. Truman, 1952–1953*, p. 509; *Newsweek 39* (June, 1952), 27.
22. Lovett to Executive Secretary, NSC, Feb. 6, 1952, encl., Glennan to Dean *et al*., Mar. 3, 1952. Dean, Memorandum to the Commissioners, Mar. 10, 1952, Director of Military Application, Joint Chiefs of Staff Views on Department of Defense Interest in the Use of Atomic Weapons, Apr. 18, 1952 and revision of June 3, 1952, CM 690, May 7, 1952, Dean to NSC, May 27, 1952, Department of State Comments on JCS paper, Statement of the Views of the Joint Chiefs of Staff . . . , June 11, 1952, *AEC*. Dean in his memorandum of Mar. 10, 1952, refers to Murray's comments. These have not been found.
23. Lay to Secretary of State, Secretary of Defense, Chairman, AEC, Sept. 10, 1952, encl., Agreed Concepts Regarding Atomic Weapons, *AEC*.
24. Fleischmann to Lovett, Jan. 30, 1952, Foster to Fleischmann, Mar. 5, 1952, Dean to Lovett, June 17, 1952, Foster to Dean, July 7, 1952, Foster to Steelman, July 7, 1952, Steelman to Foster, July 8, 1952, *AEC*. The bewildering personnel changes in the production agencies can be found in U. S. Department of Commerce, National Production Authority, "Historical Reports on Defense Production, Report No. 1, Organization for Defense Production" (Washington, 1953).
25. Monthly Status and Progress Report, Aug. 1952, Director of Production, Characteristics of the Jumbo Reactors, Aug. 19, 1952, AEC Press Release 441, Aug. 12, 1952, *AEC*. The operating contractor for Portsmouth was discussed at CM 739, Aug. 28, 1952, and at several later meetings before the announcement in AEC Press Release 449, Sept. 18, 1952, *AEC*.
26. Douglas Larsen in an interview with Boyer, Augusta *Chronicle*, Jan. 31, 1951; Dean Diary, Nov. 6, Dec. 4, 5, 1950, June 1, 1951, *AEC*.
27. Dean Diary, Nov. 19, Dec. 14, 1951, Jan. 8, 24, 1952, *AEC*; Joint Committee, *Hearing on the Nomination of Eugene M. Zuckert To Be a Member of the Atomic Energy Commission, January 29, 1952* (Washington, 1952).
28. Glennan to the Commissioners, May 9, 1952, *AEC*.
29. CM 680, Apr. 4, 1952, *AEC*.
30. Policy Analysis Staff, Policy Studies, Aug. 25, 1952, CM 737, Aug. 26, 1952, *AEC*.
31. Policy Analysis Staff, Preparation for Commission Review, Sept. 15, 1952, Memorandum for Mr. Dean, Sept. 19, 1952, Draft Memorandum to the President, Sept. 25, 1952, Snapp to the Commissioners, Sept. 23, 1952, *AEC*.
32. *Topnotch* Conference, Oct. 22, 1952, Dean to Files, Oct. 7, 1952, *AEC*.
33. Dean Diary, June 30, 1952, *AEC*.
34. Bradbury to Oppenheimer, June 11, 1952, *AEC*, refers to Bethe, who expressed these doubts again in Bethe to Dean, Sept. 9, 1952, *AEC*.
35. Dean Diary, Aug. 8, 11, 12, 1952, *AEC*.
36. Dean, Memorandum for the Special Committee of the NSC, Aug. 15, 1952,

Dean Diary, Aug. 19, 27, 28, Sept. 9, 1952, AEC Press Release 445, Sept. 9, 1952, Fields to Tyler, Sept. 26, 1952, *AEC.*

37. Dean Diary, Oct. 15, 1952, Dean, Memorandum to the Files, in Dean Diary, *AEC;* Truman's account of these events is in his *Memoirs,* Vol. II, *Years of Trial and Hope* (Garden City, N. Y., 1956), pp. 313–14. Zuckert carried a letter to Dean. The letter has not been found, but is referred to in Dean to Clarkson, Oct. 15, 1952, *AEC.*
38. Dean Diary, Oct. 27, 28, 29, 30, 1952, *AEC.* The itinerary is in the Dean Diary, *AEC.*
39. Dean Diary, Oct. 31, 1952, *AEC.*
40. Dean Diary, Nov. 6, 7, 1952, Dean to Eisenhower, Nov. 7, 1952, *AEC.*

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