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## Part VII

# Department of Energy

**Record of Decision; Tritium Supply and Recycling Programmatic Environmental Impact Statement; Notice**

## DEPARTMENT OF ENERGY

### Record of Decision: Tritium Supply and Recycling Programmatic Environmental Impact Statement

**AGENCY:** Department of Energy.

**ACTION:** Record of Decision: Selection of Tritium Supply Technology and Siting of Tritium Supply and Recycling Facilities.

**SUMMARY:** The Department of Energy (DOE) is issuing this Record of Decision regarding DOE's proposal for Tritium Supply and Recycling Facilities. The Department is making three simultaneous decisions. First, the Department will pursue a dual track on the two most promising tritium supply alternatives: to initiate purchase of an existing commercial reactor (operating or partially complete) or irradiation services with an option to purchase the reactor for conversion to a defense facility; and to design, build, and test critical components of an accelerator system for tritium production. Within a three-year period, the Department would select one of the tracks to serve as the primary source of tritium. The other alternative, if feasible, would be developed as a back-up tritium source. Second, the Savannah River Site is selected as the location for an accelerator, should one be built. Third, the tritium recycling facilities at the Savannah River Site will be upgraded and consolidated to support both of the dual track options. If the commercial reactor alternative is selected as the primary source, a tritium extraction facility will also be constructed at the Savannah River Site. The environmental analysis to support this decision was issued by the Department in the Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling (PEIS) DOE/EIS–0161 (October 1995). The PEIS identified the dual-track strategy described above as the preferred technology alternative. The Savannah River Site was identified as the preferred site for an accelerator, and the site for the upgrade and consolidation of existing recycling facilities. The Department has decided to implement the preferred alternatives.

**FOR FURTHER INFORMATION CONTACT:** Further information on the Final Programmatic Environmental Impact Statement can be obtained by calling 800–776–2765, or writing to: Stephen M. Sohinki, Director, Office of Reconfiguration, DP–25, U.S. Department of Energy, P.O. Box 3417, Alexandria, VA 22302.

Information on the Department of Energy National Environmental Policy Act process can be obtained by contacting: Carol M. Borgstrom, Director, Office of NEPA Policy and Assistance, EH–42, U.S. Department of Energy, 1000 Independence Ave. SW., Washington DC 20585, Telephone: (202) 586–4600 or (800) 472–2756.

**SUPPLEMENTARY INFORMATION:** The Department of Energy has prepared this Record of Decision pursuant to the Council on Environmental Quality (CEQ) Regulations for implementing the procedural provisions of the National Environmental Policy Act (NEPA) (40 CFR Parts 1500–1508) and the Department of Energy regulations implementing the National Environmental Policy Act (10 CFR Part 1021). This Record of Decision is based on the Final Programmatic Environmental Impact Statement for Tritium Supply and Recycling (DOE/EIS–0161, October 1995) and the Technical Reference Report for Tritium Supply and Recycling (DOE/DP–0134, October 1995). The Technical Reference Report summarizes schedule, production assurance and cost data and presents the results of the uncertainty analysis. Several comments and a report from Congress were received after the documents listed above were published. This additional information was taken into consideration in preparing this Record of Decision.

In January 1991, the Department announced it would prepare a Programmatic Environmental Impact Statement (PEIS) examining alternatives for the reconfiguration of the Department's nuclear weapons complex. The framework for the Reconfiguration PEIS was described in the Nuclear Weapons Complex Reconfiguration Study (DOE/DP–0083), issued in January 1991. A Notice of Intent to prepare the PEIS was published in the Federal Register on February 11, 1991 (56 FR 5590). The purpose of the PEIS was to establish the locations for future weapons complex missions. The missions to be analyzed included plutonium and uranium component fabrication and processing, weapons assembly and disassembly, high explosive production, tritium recycling, and nonnuclear component fabrication.

At the time the Reconfiguration PEIS was begun, technology and siting alternatives for a new tritium supply facility were being examined in a separate New Production Reactor Capacity Environmental Impact Statement. On September 27, 1991, President Bush announced an initiative to reduce the Nation's nuclear weapons stockpile. In response to this initiative, the need for new facilities was delayed and the Department announced, on November 1, 1991, that it would delay decisions on the new production reactor technology and siting and include the environmental analysis for a new tritium production source in the Reconfiguration PEIS. The Department's intent to incorporate the New Production Reactor capacity analysis into the Reconfiguration PEIS was published in the Federal Register on November 29, 1991 (56 FR 60985).

In June 1992, the United States and Russia announced an arms reduction agreement which was signed in January 1993 as the START II Protocol. This agreement caused the most significant reductions to date in planned future weapons stockpiles of both nations. It also provided the Department with the opportunity to consider a much smaller weapons complex than previously envisioned. Therefore, the Department determined that it was necessary to reevaluate the Reconfiguration Program to insure that alternatives which reflected requirements of a greatly downsized nuclear weapons stockpile would be assessed in the PEIS. On July 23, 1993, a revised Notice of Intent was published in the Federal Register (58 FR 39528) which described a smaller, more integrated nuclear weapons complex. Additionally, long-term storage alternatives for plutonium and uranium were added to the analysis. As a result of this reevaluation and public comment, the Department published a notice in the October 28, 1994, Federal Register (59 FR 54175), that would separate the Reconfiguration PEIS into two separate analyses: the Tritium Supply and Recycling PEIS and Stockpile Stewardship and Management PEIS.

On March 1, 1995 the Department issued a Draft Programmatic Environmental Impact Statement for Tritium Supply and Recycling (DOE/EIS–0161) which presented an analysis of the environmental impacts of the proposed action and alternatives. In the Draft PEIS, the Department indicated that the use of a commercial reactor was not a reasonable long-term tritium supply alternative due to concerns about the use of civilian reactors for military purposes. However, the Draft PEIS evaluated the impacts associated with the use of a commercial reactor to make tritium, whether such a reactor were used as a contingency source of tritium in the event of a national emergency, or the Department chose to purchase an existing reactor and convert it to a defense facility for long-term tritium supply. Comments received during the agency and public review of the Draft PEIS asserted that the use of an existing commercial reactor had the potential to be the lowest cost option and indicated confusion as to whether purchase of a commercial reactor or irradiation services from a privately owned reactor were treated as reasonable alternatives capable of meeting long-term tritium requirements. These comments and concerns prompted the Department to issue a Federal Register announcement on August 25, 1995 (60 FR 44327) in which the Department reopened the comment period for 21 days regarding its intention to treat both the purchase of irradiation services and the purchase of an existing or partially completed reactor as reasonable alternatives for long-term tritium supply. The Department summarized all comments received from both comment periods, prepared responses to the summaries, made revisions to the PEIS based on the comments, and identified its preferred alternative. The Notice of Availability of the Final Programmatic Environmental Impact Statement was published in the Federal Register on October 27, 1995 (60 FR 55021).

Comments have been received since the Notice of Availability was published asserting that there are errors in the analysis of cost, schedule and production assurance, especially regarding a new large Advanced Light Water Reactor. Comments were also received regarding the multipurpose reactor concept, and the use of the Fast Flux Test Facility at the Department's Hanford site to produce tritium. These comments are addressed in a subsequent section of this Record of Decision.

## Alternatives Considered

*Proposed Action:* The Department of Energy proposes to provide tritium supply and recycling facilities for the Nation's Nuclear Weapons Complex. Tritium, a radioactive isotope of hydrogen, is produced in nature, but in very small amounts. Therefore, since it is an essential component of every warhead in the current and projected U.S. nuclear weapons stockpile, the amounts required must be man-made. Tritium decays at a rate of approximately 5.5 percent per year and must be replaced periodically as long as the Nation relies on a nuclear deterrent. Currently, the Department does not have the capability to produce the required amounts of tritium. The Department needs a capability that can produce tritium to meet the requirements set forth in the 1994 Nuclear Weapons Stockpile Plan, the latest official guidance. These requirements have been defined as a steady-state mode of 3/16 of the goal amount previously established for a nuclear reactor under the Department's New Production Reactors (NPR) program. The tritium supply source should also be capable of producing 3/8 of NPR goal amount if necessary either to eliminate inventory shortfalls or to support a larger stockpile size. The Department is currently meeting tritium requirements for the stockpile by utilizing tritium recycled from dismantled weapons. Ratification of the START II Protocol would mean that new tritium would be required by approximately 2011. The ability to meet an earlier date, if stockpile requirements should change, was also analyzed.

New tritium would be supplied, in either a reactor or accelerator, by irradiating target materials with neutrons and subsequently extracting the tritium in pure form for its use in nuclear weapons. The tritium recycling process consists of recovering residual tritium from weapons components, purifying it, and refilling weapons components with pure tritium. The Department's tritium recycle facilities are located at the Savannah River Site (SRS) near Aiken, SC.

Four technology alternatives were evaluated for a new supply facility—a heavy water reactor, an advanced light water reactor—both large (1,300 MWe) and small (600 MWe); a modular high temperature gas-cooled reactor; and a linear accelerator. Emerging design options for the heavy water reactor and the modular high temperature gas-cooled reactor were also reviewed. The advanced light water reactor and modular high temperature gas-cooled reactor alternatives were also evaluated as to the potential use of fuel fabricated from plutonium excess to weapons program requirements while simultaneously producing tritium and electricity (the so-called ''multipurpose reactor''). Five sites were evaluated for a new facility—the Idaho National Engineering Laboratory (INEL), near Idaho Falls, ID; the Nevada Test Site (NTS), near Las Vegas, NV; the Oak Ridge Reservation (ORR), Oak Ridge, TN; the Pantex Plant (Pantex), Amarillo, TX; and SRS. The Department also evaluated the use of existing commercial light water reactors, either through purchase of an existing or partially completed reactor that would be converted for the production of tritium or through purchase of irradiation services from a privately owned reactor. The purchase of an existing or partially completed reactor would allow the Department, should it choose to do so, to implement the multipurpose reactor concept. Such use is evaluated in the Final PEIS and the Technical Reference Report. Additionally, in accordance with CEQ regulations, the no action alternative (not providing a new supply of tritium) was evaluated.

Tritium recycling alternatives evaluated included no action (utilizing existing facilities at the Savannah River Site with no upgrades or consolidation), consolidation and upgrading of the existing facilities, or construction of new recycling facilities to be collocated with a new tritium supply facility if the Savannah River Site were not chosen as the site for a new tritium supply facility. The consolidation and upgrading of the Savannah River Site recycling facilities would support either a new tritium supply facility (if constructed at the Savannah River Site) or the use of an existing commercial reactor (if a commercial reactor were ultimately selected as a long-term tritium supply source or became necessary as a contingency source of tritium). In addition, a new tritium extraction facility would be constructed at the Savannah River Site.

## Tritium Supply Technology Alternatives

This section describes each of the alternatives. The size of the facilities, land area requirements, and construction and operation workforces are presented.

1. *No Action:* No Action is presented for comparison with the action alternatives. Under No Action, the Department would not establish a new tritium supply capability, the current inventory of tritium would decay, and the Department would eventually not meet stockpile requirements for tritium.

### *Construct and Operate New Facilities*

2. *Accelerator Production of Tritium (APT):* An APT would accelerate a proton beam in a long tunnel toward one of two target/blanket assemblies located in separate target stations. Such an accelerator would be approximately 4,000 feet in length and would be housed in a concrete tunnel buried 40 to 50 feet underground. It would require approximately 550 MWe of electricity during peak production periods (to meet the 3/8 requirement) and 355 MWe to produce the steady-state requirement (to meet the 3/16 requirement) of tritium. In addition to the accelerator, the facility would include a klystron manufacturing and remanufacturing building as well as waste treatment, maintenance, operation, and administrative buildings, and a security infrastructure. Two target types are being analyzed, a helium-3 target which uses helium-3 gas to make tritium or a spallation-induced lithium

conversion (SILC) target which uses lithium-6 to make tritium. The facilities required for the helium-3 target include target fabrication and target processing (including extraction) buildings. Facilities for the SILC target include target fabrication, target processing, and tritium extraction buildings. The APT complex would cover approximately 173 acres. Construction would take approximately 5 years and require approximately 2,760 workers during the peak construction year. Operation of the APT would require approximately 624 workers.

3. *Advanced Light Water Reactor (ALWR):* The ALWR would be a high temperature, high pressure reactor whose primary purpose would be to produce tritium, but which would also generate substantial amounts of electricity. There are two options for the ALWR technology: A large ALWR (1,300 MWe) and a small ALWR (600 MWe). Both options use light (regular) water as the reactor coolant and moderator, and include a power conversion facility as an integral part of the design. The design of the ALWR complex would include an interim spent fuel storage building, a waste treatment facility, a tritium target processing facility, warehouses, and security infrastructure. Fuel rods would be purchased from commercial suppliers.

*Large ALWR:* The large ALWR complex would require approximately 350 acres. Construction would take approximately 6 years and approximately 3,500 workers during the peak construction year. Operation would require approximately 830 workers.

*Small ALWR:* The small ALWR complex would also require approximately 350 acres. Construction would take approximately 5 years and require approximately 2,200 workers during the peak construction year. Operation would require approximately 500 workers.

4. *Heavy Water Reactor (HWR):* The HWR would be a low pressure, low temperature reactor whose sole purpose would be to produce tritium. The HWR uses heavy water (i.e. deuterium oxide) as the reactor coolant and moderator. Because of the low temperature of the exit coolant, a power conversion system designed to produce electrical power as an option would not be feasible. The conceptual design of the HWR complex includes a fuel and target fabrication facility, a tritium target processing building, an interim spent fuel storage building, a general services building, and security infrastructure. The HWR complex would cover approximately 260 acres. Construction would take somewhat less than 8 years and require approximately 2,320 workers during the peak construction year. Operation would require approximately 930 workers.

*Small Advanced HWR:* The small advanced HWR is an emerging design variation of the HWR. The design output of the small advanced HWR would be 470 MWt compared to 990 MWt for the HWR. It would have the same configuration of support buildings although they would be somewhat smaller. The design could be developed to produce tritium to meet steady-state tritium requirements, or modified to meet peak capacity requirements. The total area required for the complex would be 150 to 170 acres. Construction would take approximately 5 years and require approximately 1,800 workers during the peak year of construction. An operational workforce has not been estimated.

5. *Modular High Temperature Gas-Cooled Reactor (MHTGR):* The MHTGR would be a high temperature, moderate pressure reactor whose primary purpose would be to produce tritium, but which would also generate substantial amounts of electricity. The MHTGR would use helium gas as a core coolant and graphite as a moderator. A steam cycle MHTGR would use a heat converter to transfer the heat from the helium coolant to feedwater producing super-heated steam which is then used to drive a turbine in the production of electricity.

The steam cycle MHTGR requires three 350 MWt reactors to produce the maximum (3/8) requirement of tritium. Because of the high temperature of the exit coolant, a power conversion facility designed to produce electricity is an integral part of the design. The design of the MHTGR complex, in addition to the three reactors, includes a fuel and target fabrication facility, a tritium target processing facility, helium storage buildings, waste treatment facilities, interim spent fuel storage facility, general services building, security infrastructure, and power conversion facility. The MHTGR complex would cover approximately 360 acres. Construction of the MHTGR would take about 9 years and require approximately 2,210 workers during the peak construction period. Operation would require approximately 910 workers.

*Direct Cycle MHTGR:* A direct cycle MHTGR is an emerging design variation of the steam cycle MHTGR. In this design the primary helium coolant drives a turbine generator through a gas-compression/gas-expansion, heating/cooling cycle. Two 600 MWt direct cycle reactors would be needed to produce the maximum (3/8) requirement of tritium. The support facilities, resource requirements, and environmental impacts of the direct cycle MHTGR are similar to the steam cycle MHTGR. A two reactor direct cycle MHTGR would require fewer operating personnel than the three module steam cycle MHTGR.

Use Existing Reactors

6. *Existing Commercial Reactors:* The purchase by the Department of an existing operating reactor, the purchase of a partially completed reactor, or the purchase of irradiation services from a commercial power reactor(s)(with an option to purchase the reactor) are the three options evaluated which utilize existing facilities. Commercial light water reactors use both pressurized water and boiling water technologies. The Department has conducted significant development work on tritium targets for pressurized water reactors. Significant additional development work would likely be required to develop a target for a boiling water reactor. The Department plans to proceed with development of the target for the pressurized water reactor, but has not ruled out the use of boiling water reactors if industry demonstrates an advantage to the Department in developing such a target.

Commercial pressurized water reactors are high-temperature, high pressure reactors that use ordinary light water as the coolant and moderator and are capable of generating large amounts of electricity through a steam turbine generator. A typical commercial light water reactor facility includes the reactor building, turbine generator building, auxiliary buildings, interim spent fuel storage facilities, cooling towers, a switchyard for the transmission of electricity, maintenance buildings, administrative buildings, and security facilities.

*Purchase of an Operating Commercial Light Water Reactor or Purchase of Irradiation Services:* Approximately 72 to 127 workers (depending upon the number of reactors utilized) would be added to the work force because of the tritium activities. New fencing and security buildings may be required to support additional security requirements. Road access restrictions or construction of new roads may also be required.

*Purchase of a Partially Constructed Commercial Light Water Reactor:* The number of construction workers and the length of the construction period would vary depending on the percentage of completion of the plant. Data were available for a two-unit reactor plant with one unit 45 percent complete and the second unit 85 percent complete. The schedule data estimated completing the 45 percent complete unit in 5 years or both units simultaneously in 7 years. Since the Department is only interested in one unit, the 5 year estimate was selected. It is possible that the 85 percent unit could be completed in a shorter time. For the 45 percent complete unit, peak year workers were estimated to be approximately 2,065. The 85 percent complete unit would require a peak work force of approximately 1,525. Operations would require approximately 830 workers.

*Other Missions Beyond Tritium Production*

*Multi-Purpose Reactor Concept:* The ALWR, MHTGR, and the purchase options of the commercial reactor alternative would also be capable of utilizing fuel fabricated from excess plutonium to make tritium and generate electricity. To ''burn'' plutonium in an ALWR or a commercial light water reactor, a plutonium Pit Disassembly, Conversion, and Fuel Fabrication Facility would be needed to fabricate the plutonium and uranium (mixed oxide) fuel rods. For the MHTGR, only a plutonium Pit Disassembly and Conversion Facility would be needed, because the MHTGR design already includes a fuel fabrication facility. The MHTGR, if used to ''burn'' plutonium, would utilize fuel fabricated solely from plutonium without blending it with uranium. However, because tritium production declines significantly in a plutonium-fueled MHTGR, twice as many reactors would be necessary in order to produce the steady-state (3/16) tritium requirements. The need to include a plutonium Pit Disassembly, Conversion, and Fuel Fabrication facility for the ALWR and commercial reactor options, and the need for plutonium Pit Disassembly and Conversion Facility and more reactors for the MHTGR, would be major contributors to potential direct environmental impacts.

If an ALWR or commercial light water reactor were used as multi-purpose facilities, the new plutonium Pit Disassembly, Conversion, and Fuel Fabrication Facility would cover up to 129 acres and require a peak construction work force of approximately 745 during the 6-year construction period. Operation would require approximately 650 workers. If an MHTGR were used as a multi-purpose reactor, the new plutonium Pit Disassembly and Conversion Facility would cover up to 30 acres and require a peak construction work force of approximately 125 during the 6-year construction period. Operation would require approximately 520 workers.

Recycling Facilities

The tritium recycling facility processes and recycles tritium for use in nuclear weapons. This includes emptying reservoirs returned from weapons in the stockpile, recovering and purifying the tritium, reclaiming reusable reservoirs, providing new gas mixtures, and refilling reservoirs. The facility also tests reservoirs and provides appropriate waste management activities.

1. *No Action:* The Department currently operates tritium recycling facilities at the Savannah River Site. These facilities would continue to operate without modifications or consolidation to meet environmental, health, and safety requirements, or to maximize efficiencies. Environmental impacts would not change from those experienced today.

2. *Construct New Facilities:* If the tritium supply and recycling facilities were to be located at any site other than the Savannah River Site, new recycling facilities could be collocated with the supply facilities. The tritium recycling activities would be housed in two buildings for operations and several support facilities. All tritium handling activities would be completed in the tritium processing building, which would be designed to contain tritium releases should they occur. An auxiliary building would house non-tritium activities and extremely small amounts of working tritium. The recycling facilities would cover approximately 196 acres. Construction would take approximately 4 years and require approximately 335 workers during the peak year of construction. Operation of the recycling facilities would require approximately 910 workers.

3. *Upgrade Existing Facilities at Savannah River Site:* There are two options for the upgrade of recycling facilities at the Savannah River Site. The first, the unconsolidated upgrade, would result in the continued use of all existing facilities and thus no consolidation of tritium handling activities. Five buildings would be upgraded in order to meet environmental, health, and safety requirements. No additional land area would be required. Construction of the upgrades would take approximately 3 years and require approximately 26 workers during the peak construction year. Operations would require approximately 970 workers.

The second option, the consolidated upgrade, would result in closing one building and transferring its functions to two existing buildings. Four buildings would be upgraded to meet environmental, health, and safety requirements and one to accept the transferred activities. The land area required for the facilities would not change. Construction would take approximately 3 years and require approximately 36 workers during the peak construction year. Operations would require approximately 910 workers.

Siting of New Tritium Supply Facilities

New tritium supply facilities, if constructed, would be located at one of five sites currently owned by the Department. These five sites are:

1. *Idaho National Engineering Laboratory:* The INEL is situated on approximately 570,000 acres, approximately 50 miles west of Idaho Falls and presently employs approximately 10,100 workers. The site has been used to test, build, and operate nuclear facilities. Research and development activities include reactor performance studies, materials testing, environmental monitoring, waste processing, breeder reactor development, and naval reactor operator training. Currently, there are four operational reactors. In addition to nuclear research, INEL supports processing and/or storage of high-level, low-level, and transuranic radioactive wastes.

2. *Nevada Test Site:* The NTS is situated on approximately 854,000 acres, 65 miles northwest of Las Vegas. Approximately 6,850 workers are presently employed at the site. The site is a remote secure facility for conducting underground testing of nuclear weapons and evaluating the effects of nuclear detonations on military communications, electronics, satellites, sensors, and other materials. NTS is also the location of a low level radioactive waste management facility.

3. *Oak Ridge Reservation:* The ORR is located on approximately 35,000 acres, 20 miles west of Knoxville, TN. Approximately 15,000 workers are presently employed at the site. It includes three major facilities: the Oak Ridge National Laboratory; Y–12 Plant, and the K–25 site. The Oak Ridge National Laboratory conducts basic and applied scientific research and technology development. The K–25 site is the location of the former Oak Ridge Gaseous Diffusion Plant. It currently serves as an operations center for environmental restoration and waste management programs. Y–12 is the primary location for nuclear weapons activities at Oak Ridge. These include

the dismantling of nuclear weapons components, maintaining uranium and lithium component fabrication capabilities, and storing special nuclear materials.

4. *Pantex Plant:* The Pantex Plant is located on 10,000 acres, 17 miles northeast of Amarillo, TX. Approximately 3,400 workers are presently employed at the site. Activities at Pantex include fabrication of chemical explosives, nuclear weapons assembly and disassembly, testing, repair and disposal of nonnuclear components, and development activities in support of the national laboratories. Pantex also is the interim storage site for sealed plutonium components from dismantled weapons.

5. *Savannah River Site:* The SRS is situated on approximately 198,000 acres, 12 miles south of Aiken, SC. Approximately 20,300 workers are presently employed at the site. Currently, tritium recycling operations to support nuclear weapons activities are conducted at the SRS. Other activities include interim storage of plutonium, waste management, and environmental monitoring and restoration. Past activities at SRS have included nuclear fuel and tritium target fabrication, operation of reactors for nuclear material production, chemical separation for recovery of plutonium and plutonium isotopes, tritium extraction, and uranium fuel reprocessing. The facilities that supported these past activities are currently supporting waste management and environmental cleanup activities and will ultimately be decommissioned and decontaminated.

*Commercial Reactor Site:* The commercial light water analysis does not evaluate a specific site. Currently, commercial light water reactors are operating on 59 sites in 32 states. Approximately one-half of these sites contain two or three nuclear units. The sites range in size from 84 to 30,000 acres. The largest use of the sites is for cooling systems, including reservoirs and artificial lakes, and safety buffer areas. Analysis of specific candidate reactors would be conducted in a separate NEPA document.

## Preferred Alternative

Based on the analysis presented in the PEIS and Technical Reference Report, the Department announced a preferred alternative in the FINAL PEIS. The preferred alternative is a acquisition strategy that assures tritium production for the nuclear weapons stockpile rapidly, cost effectively, and safely. The preferred strategy is to begin work on the most promising production alternatives of purchasing an existing commercial light water reactor or irradiation services with an option to purchase the reactor for conversion to a defense facility, and to design, build, and test critical components of an accelerator system for tritium production.

The Savannah River Site was designated as the preferred site for an accelerator, should one be built. The preferred alternative for tritium recycling and extraction activities was to remain at the Savannah River Site with appropriate consolidation and upgrading of current facilities, and construction of a new extraction facility.

## Tritium Supply Evaluation

This section describes the results of the Department's evaluation of each of the alternatives. It summarizes their environmental impacts, costs, and schedule and production assurance risks. The evaluation of schedule, production assurance and costs were completed by developing base estimates and then conducting a formal assessment by experts to determine the risk. The risk is presented as the probability of achieving a specific objective. Base cases were developed for six schedule components, production capacity and availability, and five cost components. The estimates were normalized to insure consistency across all tritium supply alternatives. Technical experts (different groups for schedule, production assurance, and cost) were asked to provide judgments of the probability of success of the base estimates for each of the schedule components, capacity and availability, and each of the cost components. In addition, potential technical, regulatory, or institutional problems were identified for each tritium supply alternative and their probability for causing schedule delay, production assurance uncertainty or cost uncertainty were assessed. The impacts of the problems on schedule, capacity and availability, and cost were assessed. This information was combined through multiple simulations to develop probabilities of meeting various schedule, production assurance and cost objectives. The environmental impacts reported in the PEIS were evaluated for discriminators among tritium supply technologies and among sites.

The schedule, production assurance, and waste factors which discriminate among tritium supply technology alternatives are summarized in Table 1. These are: (1) The capability of meeting a schedule supporting a START II Protocol stockpile size; (2) the likelihood of producing the amount of tritium necessary to meet maximum (3/8) tritium requirements; (3) amount of additional spent fuel generated; and (4) amount of additional solid low level radioactive waste generated. Costs are presented in Table 2. They are divided into: (a) Total life cycle cost with revenue; (b) total life cycle cost without revenue; (c) total project cost; (d) operations and maintenance cost; and (e) revenue.

Additional environmental discriminators are the need for or generation of electricity, and cancer risk from a severe accident. The APT and HWR are users of electricity while the ALWR(s), MHTGR(s), and purchase of a partially completed or existing commercial reactor will result in the generation of additional electricity. The range between the potential amount of electricity used (550 MWe for the APT) and the potential amount of electricity generated (1,300 MWe for the large ALWR) is 1,850 MWe. The amount of electricity used was evaluated for each candidate site against the capability of the power pool to supply electricity. No significant impacts on the pool or the ability to supply the required amounts were identified. A separate evaluation of the option of the construction and operation of a dedicated 550 MWe coal or gas-fired electrical generating plant was completed for the APT. The potential impacts of a gas-fired electrical generating plant were incorporated into the environmental analysis for each of the sites. The cancer risks attributable to a severe accident are, in absolute terms, very low for each alternative. However, in comparative terms, the APT clearly has a significantly lower cancer risk than any of the new facility reactor alternatives. Therefore, cancer risk is considered a discriminator between the APT and new reactor alternatives for the purposes of this decision. The results of the evaluations are described below.

TABLE 1.—SCHEDULE, PRODUCTION ASSURANCE, AND WASTE DISCRIMINATORS

| Alternatives | Probability of delivering first gas in 2011[a] | Probability of producing START I amounts in any one year | Additional spent fuel generated per year ($yd^3$/yr) | Additional solid low level waste generated ($yd^3$/yr) |
|---|---|---|---|---|
| No Action | 0 | 0 | 0 | 0 |
| APT | 0.76 | 0.77 | 0 | 57[e] |
| Large ALWR | 0.78 | 0.96 | 55 | 710 |
| Small ALWR | 0.78 | 0.89 | 36 | 660 |
| HWR | 0.40 | 0.93 | 7 | 5,200 |
| Small Advanced HWR | <0.40[b] | 0.79 | <7[f] | <5,200[f] |
| Steam Cycle MHTGR | 0.22 | 0.86 | 80 | 1,300 |
| Direct Cycle MHTGR | <0.14[c] | 0.49 | 82 | ~1,300[g] |
| Purchase Existing CLWR | >0.99[d] | >0.96 | 40 | 160 |
| Purchase Partially Complete CLWR | >0.99[d] | >0.96 | Similar to Large ALWR | Similar to Large ALWR |
| Purchase Irradiation Services | >0.99[d] | >0.96 | 0 to 40 depending on number of reactors used. | 160 |

[a] Includes technical, regulatory, and institutional delays.
[b] Due to emerging state of technology longer delays than HWR assumed.
[c] Probability without any delays is 0.14. Delay would reduce this probability.
[d] Assumes institutional questions are resolved.
[e] For Helium-3 target; 544 $yd^3$/yr for SILC target.
[f] No analysis completed, however, expected to be the same or less than the HWR.
[g] No analysis completed, however, expected to be approximately the same as the steam cycle MHTGR.

*1. Ability to meet required schedules.* To meet projected stockpile requirements for tritium, new tritium gas is required by 2011. This date is based on a stockpile consistent with the START II Protocol. Maintaining a stockpile consistent with the START I Treaty would require new tritium gas by 2005. The schedule analyses assumed a requirement to deliver tritium in 2011. A sensitivity analysis assessed the ability of the alternatives to deliver new tritium gas in 2005.

TABLE 2.—COST EVALUATION DATA AT SAVANNAH RIVER SITE

[In Billions of 1995 Dollars]

| Alternatives | Total life cycle cost w/o revenue [a] | | | Total life cycle cost w/o revenue [a] | | | Total project cost [a] | | | Operations and maintenance [b] costs [a] | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Low | Mean | High | Low | Mean | High | Low | Mean | High | Low | Mean | High |
| No Action | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| APT | 3.6 | 5.1 | 7.8 | 3.6 | 5.1 | 7.8 | 2.0 | 3.0 | 5.5 | 1.4 | 2.1 | 2.9 |
| Large ALWR | 1.3 | 3.7 | 7.6 | 4.8 | 6.5 | 10.2 | 2.4 | 4.0 | 7.2 | 1.9 | 2.5 | 3.3 |
| Small ALWR | 1.5 | 2.7 | 4.5 | 3.2 | 4.2 | 5.8 | 1.6 | 2.3 | 3.9 | 1.4 | 1.8 | 2.5 |
| HWR | 4.3 | 5.8 | 8.1 | 4.3 | 5.8 | 8.1 | 2.6 | 3.8 | 6.4 | 1.4 | 2.0 | 2.9 |
| Small Advanced HWR | 2.9 | 4.2 | 5.7 | 2.9 | 4.2 | 5.7 | 1.8 | 2.7 | 4.1 | 0.9 | 1.5 | 2.1 |
| Steam Cycle MHTGR | 4.1 | 6.3 | 9.9 | 5.0 | 7.1 | 10.7 | 3.0 | 4.5 | 7.8 | 1.8 | 2.6 | 3.7 |
| Direct Cycle MHTGR | 3.0 | 5.0 | 8.3 | 4.2 | 6.0 | 9.5 | 2.5 | 4.1 | 7.4 | 1.4 | 1.9 | 2.6 |
| Purchase existing CLWR | 0.8 | 1.4 | 3.8 | 2.8 | 4.1 | 5.2 | 1.0 | 1.7 | 2.8 | 1.7 | 2.4 | 3.2 |
| Purchase partially complete CLWR | 0.1 | 2.0 | 4.4 | 2.9 | 4.4 | 6.6 | 1.1 | 1.9 | 3.4 | 1.7 | 2.5 | 3.8 |
| Purchase Irradiation Services | 0.8 | 1.2 | 1.7 | 0.8 | 1.2 | 1.7 | 0.3 | 0.5 | 0.7 | 0.5 | 0.7 | 1.1 |

[a] The costs are for steady-state production, discounted at 4.9% per year at SRS for new facilities. The low estimate corresponds to the 5th percentile of the cost probability distribution. The high estimate corresponds to the 95th percentile of the cost probability distribution.

[b] Operations and maintenance costs include decontamination and decommissioning costs.

The potential for technical or regulatory delays in the baseline schedule was also considered in assessing schedule uncertainties for each of the technologies. Technical delays relate to issues such as the maturity of the facility design, operational experience associated with the technology and maturity of the target design. Regulatory delays relate to the potential that independent reviews by organizations external to the Department could take longer than anticipated, either due to administrative licensing proceedings or to resolution of technical issues that delays design acceptance by the reviewing organization. By the end of 1995, a Task Force on External Regulation established by the Department is scheduled to present its recommendations whether the Department's nuclear facilities should be externally regulated, and if so, by what entity. While a number of different outcomes are possible as a result of the Task Force efforts, the Nation's commercial nuclear reactors are now regulated by the Nuclear Regulatory Commission (NRC). Therefore, in considering scenarios that involved regulatory delay, the Department used the NRC regulatory process and structure as the basis for this consideration, and assumed that an NRC license would be obtained for construction and operation of the reactor technologies.

Since the NRC has the greatest amount of experience with regulation of light water reactors, the potential regulatory delays associated with the light water options, either the new ALWR designs or the existing commercial reactor options, were assumed to be the shortest among the reactor technologies. Potential regulatory delays associated with the MHTGR and the HWR would be greater than for the light water candidates because changes to the NRC's regulatory structure would be required to license these technologies. While there will be technical and potential regulatory reviews associated with the APT design, the safety issues associated with this technology are not nearly as complex as those associated with any of the reactor technologies. Therefore, the potential for regulatory delays was assessed to be minimal. The purchase of an existing or partially complete commercial reactor would also require the transfer of a license to the Department, which would require a change to the Atomic Energy Act and corresponding changes to the NRC regulations.

While issues related to the new facility technologies are primarily technical and regulatory, existing commercial reactors are subject to an additional set of institutional issues that must be resolved before this option could be implemented to meet long-term tritium requirements. These center around concerns about the use of civilian commercial reactors for purposes which support military requirements. Such issues have been raised in the past predominantly in conjunction with the use of civilian reactors to produce special nuclear materials (highly enriched uranium and plutonium) which would, in turn, be used to make nuclear weapons. Any concerns will have to be addressed and resolved over the course of the next several years if the commercial reactor alternative options are to be utilized as the primary long-term source of tritium.

The no action alternative would not be able to produce new tritium. Therefore, it could not meet the schedule requirements.

Of the action alternatives, the commercial reactor options have the highest probability of meeting the 2011 start date, if there are no technical or institutional delays. However, as noted above, there are institutional issues related to their implementation. If these issues cannot be resolved, the commercial reactor alternative would remain only as a contingency source of tritium in the event of an emergency.

Even when delays or major issues are taken into account, the ALWRs, among the new facility alternatives, have a high probability of meeting the required 2011 start date. The base case construction schedule of the small ALWR is one year shorter than that of the large ALWR. However, the small ALWR has a higher risk of technical delays due to the uncertainties surrounding its passive safety system and potential regulatory delays, due to the fact that it has not yet received NRC design certification. The APT has only a slightly smaller probability of meeting the 2011 date compared to the ALWRs, and it is expected to have very few technical or regulatory delay problems. The HWR and the MHTGR would have difficulty in meeting the 2011 date.

The sensitivity analysis on producing tritium as early as 2005 assumed that the base schedules could be compressed by 2 years, and that no technical or regulatory delays would occur. It showed that the commercial options have a high probability (0.80 to 0.99) of meeting the 2005 date. The APT and the small ALWR have a small (0.20) probability of producing tritium by 2005 if no delays are experienced. None of the other alternatives could produce tritium by 2005.

The assessment also showed that the schedule for completing all activities to develop a multipurpose reactor would be similar or identical to that of the MHTGR, ALWRs, and purchase of a commercial reactor options if they are used for tritium production alone, as long as the tritium mission is given priority over the plutonium burning and electricity production missions.

In summary, the no action alternative is not able to meet tritium schedule requirements. The HWR and MHTGR have the potential for major technical or institutional delays; thus, there is a low probability of their making tritium by the 2011 start date. The ALWRs and the APT have a very high probability of delivering tritium by 2011. The commercial options have the highest potential for delivering tritium by 2011, if the institutional issues associated with the defense use of such facilities can be resolved. Only the commercial options have a high probability of delivering tritium by 2005, if that becomes a requirement.

*2. Ability to produce the required amounts of tritium.* Production assurance refers to the ability of the tritium supply alternatives to meet the annual production requirements for maintaining the tritium inventory. The steady-state (3/16) and maximum (3/8) production rates were used in the production assurance analysis.

The second column of Table 1 summarizes the results of the production assurance analysis in terms of the probability that a tritium supply option can meet the maximum rate in any given year. Since the facility is designed to operate for 40 years, a technology that produced at more than the maximum rate in any given year would produce excess tritium. If such a year is followed by a year that the technology produced at less than the maximum rate, the combination of years would still produce roughly the desired overall quantity of tritium over the 40-year lifetime of the facility. Thus, a production rate with a 0.50 probability of a rate meeting or exceeding the maximum rate in any given year provides a reasonable degree of production assurance. A 0.75 probability of meeting or exceeding the maximum rate every year is a high degree of production assurance, since it means that roughly during 30 years of the 40 years of production the maximum rate will be exceeded.

For all tritium supply alternatives, with the exception of the direct cycle MHTGR, there is a high probability of producing the required amounts of tritium (0.77 or higher). The direct cycle

MHTGR has a moderate probability of production assurance (0.49).

The production assurance of a multipurpose reactor would not change from that of the MHTGR, ALWR, and commercial reactor purchase options, as long as tritium production is the primary mission of the facility. National security requirements mandate that tritium supply remain the primary mission of a multipurpose reactor.

In summary, the no action alternative has no chance of meeting the tritium production requirements. With the exception of the direct cycle MHTGR, all other alternatives have very high probabilities of meeting the steady-state and maximum production requirements.

*3. Environmental Impacts.* The Final PEIS presents numerous environmental impacts for a variety of resource areas for each of the new tritium supply facility alternatives at each of the five sites, and generic impacts for the commercial reactor options. The analysis was completed for meeting the maximum (3/8) goal requirement of tritium. Many of these impacts are very small. For example, the air quality impacts of all technological alternatives at all sites are very low. Most other impacts show little or no differentiation among alternatives. The evaluation of the tritium supply alternatives focuses, therefore, on the three environmental impacts that differentiate among the tritium supply alternatives: spent fuel generation, low level radioactive waste generation and risks from severe accidents. For all three of these area of environmental impact, the no action alternative would not change the status quo, i.e., no tritium would be produced. Therefore, it has the lowest environmental impact. This section presents the evaluation of tritium supply technology alternatives which are not site dependent. The following section presents the evaluation of the sites.

*3.1 Spent fuel.* Spent fuel is measured by the cubic yards of radioactive spent fuel rods produced during reactor operations in one year. The third column of Table 1 shows the annual amounts of spent fuel generated by the reactor supply alternatives. The new reactors generate spent fuel amounts ranging from 7 cubic yards to 80 cubic yards. The options to purchase an operating reactor or to purchase irradiation services would create up to 40 cubic yards of additional spent fuel (if only one reactor were utilized) due to shorter refueling cycles. If there were no change to the refueling cycles, no additional spent fuel would be generated. The option to purchase an incomplete reactor would create amounts of spent fuel comparable to those of the large ALWR. The APT does not generate any spent fuel. No additional spent fuel would be produced by virtue of the use of fuel fabricated from excess plutonium for the ALWR, MHTGR, or purchase commercial reactors options.

*3.2 Low level radioactive waste.* The fourth column of Table 1 shows the annual amounts of low level radioactive waste produced by the supply alternatives. For the new facility alternatives the HWR creates by far the most low level radioactive waste (5,200 cubic yards), followed by the other new rectors. The APT generates the least amount of low level radioactive waste (57 cubic yards) when using the helium-3 target, and 544 cubic yards when using the SILC target. The options to purchase an operating commercial reactor or to purchase irradiation services would create 160 cubic yards of additional low level radioactive waste due to the use of additional fuel rods and to handling additional radioactive materials. The option of purchasing an incomplete reactor would produce amounts of low level radioactive wastes that are similar to those of the large ALWR. A multipurpose reactor would generate about the same amount of low level radioactive waste as the reactor when used for tritium production alone. However, the plutonium Pit Disassembly and Conversion and Mixed-Oxide Fuel Fabrication Facility for the ALWR and commercial reactor options would generate approximately 540 cubic yards of low level radioactive waste annually. The plutonium Pit Disassembly and Conversion Facility for the MHTGR would generate approximately 10 cubic yards of low level radioactive waste per year.

*3.3 Severe accidents.* Risk is the probability of an accident occurring times the consequences of the accident if it occurred. Cancer risk to a population within a 50-mile radius of a facility is influenced by the size of the population within the radius. However, technologies can be compared if the same 50 mile radius is used for the analysis. For the purposes of comparison the SRS is used. The annual cancer risk from a severe accident to the population within 50 miles of the facility for the new reactor technologies is very low, ranging from $5.1 \times 10^{-5}$ to $2.6 \times 10^{-7}$ at the SRS. The APT would have the lowest annual cancer risk ($2.8 \times 10^{-11}$) for all the new facility alternatives. The options to purchase an operating reactor or to purchase irradiation services would pose no significant additional severe accident risks because of adding tritium production. The option to purchase an incomplete commercial reactor would have severe accident risks that are comparable to that of a large ALWR.

The use of plutonium as mixed oxide fuel in an ALWR or the purchase of commercial reactor options would not significantly affect the consequences of radioactivity releases from severe accidents though there would be some small changes in the source term release spectrum and frequency. The MHTGR would have twice as many reactors when operated in the multipurpose mode, and therefore, while extremely small, the accident risk for the MHTGR would double if used in this mode compared to the risk if used for tritium production alone.

An accident at a plutonium Pit Disassembly and Conversion and Mixed-Oxide Fuel Fabrication Facility for the ALWR and purchase of commercial reactor options would result in a small additional cancer risk from a severe accident if located at the SRS. A severe accident at the plutonium Pit Disassembly and Conversion facility for the MHTGR would also result in a small additional cancer risk.

In summary, the no action alternative has no additional environmental impacts. The APT and the commercial options to purchase an operating reactor or to purchase irradiation services, if the fuel cycle is not changed, generate no additional spent fuel, and have the lowest amounts of additional low level radioactive waste and cancer risks from a severe accident. The new reactor alternatives and the completion of a partially complete commercial reactor produce spent fuel and low level radioactive waste, and they present a very small additional cancer risk from a severe accident.

*4. Affordability (Cost).* For each action alternative, a range of costs, and the probability distributions over the range, were developed for Total Life Cycle Cost (TLCC), Total Project Cost (TPC), and Operation and Maintenance (O&M). The O&M costs included decontamination and decommissioning. No costs were developed for the no action alternative. For the action alternatives, results were calculated for both undiscounted and discounted cost. The discount rate used was 4.9% per year in accordance with Office of Management and Budget guidance. The ALWR, MHTGR, and purchase commercial reactor options can produce revenues through electricity generation. The TLCC was calculated with and without revenues for these alternatives. Costs were estimated both for steady-state and maximum production rates.

The results of the cost ranges for steady-state production using discounted 1995 dollars are shown in Table 2. For each alternative a low, mean and high cost estimate is presented for TLCC with revenue, TLCC without revenue, TPC and O&M. The low estimate is the 5th percentile of the cost probability distribution, i.e., there is a 5% chance that the true cost will fall below the low estimate. The mean estimate is the average of the cost probability distribution. The high estimate is the 95th percentile of the cost probability distribution, i.e., there is a 95% chance that the true cost will fall below it.

The TLCC with revenue represents the estimated cumulative discounted net cost to the government or the taxpayers for each of the alternatives, since revenues from electricity sales would come to the government, not the Department. The Department must budget for all costs; therefore, the TLCC without revenue shows the estimated cumulative discounted cost to the Department. TPC represents the discounted capital cost estimates to develop, construct and make operational each alternative. The O&M costs are the discounted costs after the facility would become operational.

For TLCC with revenues (first column of Table 2), the option to purchase irradiation services has the lowest mean estimated cost (1.2 billion dollars) with uncertainty adding approximately 500 million dollars (95th percentile above the mean). The option to purchase an existing reactor has a mean cost of 1.4 billion dollars (17 percent higher than purchasing irradiation services) with uncertainty adding approximately 2.4 billion dollars. The option to purchase a partially complete commercial reactor has a mean cost of 2.0 billion dollars (67 percent higher than purchasing irradiation services) with uncertainty adding 2.4 billion dollars. The new reactor technology alternatives have mean costs that range from 2.7 billion dollars for the small ALWR (125 percent higher than purchasing irradiation services) to 6.3 billion dollars for the steam cycle MHTGR (425 percent higher than purchasing irradiation services). All new reactor alternatives have significant cost uncertainties, which add from 1.5 billion dollars (small advanced HWR) to 3.9 billion dollars (large ALWR). The APT has a mean cost of 5.1 billion dollars (325 percent higher than purchasing irradiation services) with uncertainty adding approximately 2.7 billion dollars. The large uncertainties create a substantial overlap in the cost distributions of the alternatives, except for the purchase of irradiation services.

For TLCC without revenues (second column of Table 2), the option to purchase irradiation services has the lowest mean estimated cost (1.2 billion dollars) with uncertainty adding approximately 500 million dollars (95th percentile above the mean). The option to purchase an existing reactor has a mean cost of 4.1 billion dollars (242 percent higher than purchasing irradiation services) with uncertainty adding approximately 1.1 billion dollars. The option to purchase a partially complete commercial reactor has a mean cost of 4.4 billion dollars (267 percent higher than purchasing irradiation services) with uncertainty adding approximately 2.2 billion dollars. The new reactor technology alternatives have mean costs that range from 4.2 billion dollars for the small ALWR and small advanced HWR (250 percent higher than purchasing irradiation services) to 7.1 billion dollars for the steam cycle MHTGR (492 percent higher than purchasing irradiation services). All new reactor alternatives have significant cost uncertainties, which add from 1.5 billion dollars (small advanced HWR) to 3.7 billion dollars (large ALWR). The APT has a mean cost of 5.1 billion dollars (325 percent higher than purchasing irradiation services) with uncertainty adding approximately 2.7 billion dollars. The large uncertainties create a substantial overlap in the cost distributions of the alternatives, except for the purchase of irradiation services.

For TPC (third column of Table 2), the option to purchase irradiation services has the lowest mean estimated TPC (0.5 billion dollars) with uncertainty adding approximately 200 million dollars (95th percentile above the mean). The option to purchase an existing reactor has a mean TPC of 1.7 billion dollars (240 percent higher than purchasing irradiation services) with uncertainty adding approximately 1.1 billion dollars. The option to purchase a partially complete commercial reactor has a mean TPC of 1.9 billion dollars (280 percent higher than purchasing irradiation services) with uncertainty adding 1.5 billion dollars. The new reactor technology alternatives have mean TPCs that range from 2.3 billion dollars for the small ALWR (360 percent higher than purchasing irradiation services) to 4.5 billion dollars for the steam cycle MHTGR (800 percent higher than purchasing irradiation services). All new reactor alternatives have significant cost uncertainties, that add from 1.4 billion dollars (small advanced HWR) to 3.3 billion dollars (Direct Cycle MHTGR). The APT has a mean TPC of 3.0 billion dollars (500 percent higher than purchasing irradiation services) with uncertainty adding approximately 2.5 billion dollars. The large uncertainties create a substantial overlap in the TPC distributions of the alternatives, except for the purchase of irradiation services.

The O&M costs make up the fourth cost item (fourth column of Table 2). The option to purchase irradiation services has the lowest mean estimated O&M cost (700 million dollars) with uncertainty adding approximately 400 million dollars (95th percentile above the mean). The option to purchase an existing reactor has a mean O&M cost of 2.4 billion dollars (243 percent higher than purchasing irradiation services) with uncertainty adding approximately 800 million dollars. The option to purchase a partially complete commercial reactor has a mean O&M cost of 2.5 billion dollars (257 percent higher than purchasing irradiation services) with uncertainty adding 1.3 billion dollars. The new reactor technology alternatives have mean O&M costs that range from 1.5 billion dollars for the small advanced HWR (114 percent higher than purchasing irradiation services) to 2.6 billion dollars for the steam cycle MHTGR (271 percent higher than purchasing irradiation services). All new reactor alternatives have significant O&M cost uncertainties, that add from 600 million dollars (small Advance HWR) to 1.1 billion dollars (steam cycle MHTGR). The APT has a mean O&M cost of 2.1 billion dollars (200 percent higher than purchasing irradiation services) with uncertainty adding approximately 800 million dollars. The large uncertainties create a substantial overlap in the cost distributions of the alternatives, except for the purchase of irradiation services.

The costs of a multipurpose reactor were analyzed separately from the tritium supply alternatives. The Department's Fissile Materials Disposition Office and an independent contractor prepared separate estimates. Different discount rates were used in the reports, which also only identified the minimum and maximum cost range. The results of the independent analysis, in discounted 1995 dollars are: (1) $4.5 billion to $14 billion for a government-owned large ALWR, $2.9 billion to 8.6 billion for a small ALWR, and $2.7 billion to $9.9 billion for a commercial reactor option; (2) $5.2 billion to $25.4 billion for a privatized large ALWR, $3.1 billion to $14 billion for a small ALWR, and $1.9 billion to $11.3 billion for a commercial reactor option. The result of the Department's analysis, in discounted 1993 dollars, is: (1) For a government-owned large ALWR costs would range from $1.5 billion to $3.5 billion, and 2) for a privately financed large ALWR costs would range from $0.7 billion to $5.0 billion. These amounts include revenue from electricity sales.

In summary, the purchase of irradiation services is the lowest cost in all categories and has the lowest uncertainty. The other commercial options have the lowest cost estimates for TLCC both with and without revenues, and for TPC but with a higher degree of uncertainty. The APT, small ALWR, and small advanced HWR make up a middle group with approximately similar discounted mean costs for TLCC without revenue, and TPC. The small ALWR and small Advanced HWR have smaller uncertainties than the APT in both these categories. TLCC with revenue shows the small ALWR to have a lower mean cost than the APT or the small advanced HWR and adds the large ALWR to this middle group. The large ALWR is in the higher mean cost group for TLCC without revenue and for TPC, along with the MHTGRs and HWR, which also have higher uncertainties. The O&M analysis shows that the purchase of irradiation services has clearly the lowest mean cost, with all other alternatives grouped together. The uncertainties for all the alternatives generally have a substantial overlap in their cost distributions.

Evaluation of Site Alternatives

The five sites for new tritium supply and recycling facilities were evaluated with respect to environmental impacts and cost. Two criteria emerged as discriminators: (1) Ability to handle low-level radioactive waste; and (2) cost. No siting analysis was needed for the commercial reactor options, since they all currently exist, and any reactor ultimately selected would have to undergo a separate NEPA review.

Numerous environmental impacts were examined in the Final PEIS. The analysis either showed very small or no impacts, or the impacts did not differentiate among sites including cancer risks from a severe accident. Impact differences are primarily due to the differences in the size of the population within 50 miles of the site. Because cancer risk is low for all sites, it is not a discriminator between sites. The cost estimates for site alternatives are published in the Technical Reference Report.

The results of the evaluations are summarized in Table 3 and described below.

TABLE 3.—SITE EVALUATION

| Criterion site | Ability to dispose of wastes on site | Cost of adding non-evaporative cooling (reactors only)[a] | Percent adjustment to base cost site (INEL) due to site differences | |
|---|---|---|---|---|
| | | | Construction (percent) | Operation & maintenance (percent) |
| INEL | Yes | $86 to $208 | 0 | 0 |
| NTS | Yes | 99 to 239 | 5 | 15 |
| ORR | Yes | 0 | 5 | 0 |
| PANTEX | No | 98 to 239 | −10 | 15 |
| SRS | Yes | 0 | 0 | 10 |

[a] Mean discounted cost in millions of 1995 dollars, using a 4.9% annual discount rate.

1. *Ability to Handle Wastes.* As shown in column 2 of Table 3, with the exception of Pantex, all sites can dispose of low level radioactive waste on site. The wastes from Pantex would be shipped to an approved off site low level radioactive waste disposal facility.

2. *Cost.* The results of the cost comparisons are shown in Table 3. Cost differences among sites are determined by three major factors:

(1) The cost for the non-evaporative cooling system needed at sites which do not have ample water availability (this does not apply to the APT, which is not designed to use non-evaporative cooling),

(2) The percentage differential in construction costs (primarily because of labor rates), and

(3) The percentage differential in operation and maintenance costs (primarily because of labor and electricity rates).

The third column of Table 3 shows the range of additional costs due to the need for non-evaporative dry cooling for reactors at INEL, NTS, and Pantex. The high end of these costs would occur for the large ALWR.

The fourth and fifth columns of Table 3 show the percent increases in cost of construction, and operation and maintenance over the least expensive site (INEL). For construction, Pantex shows a decrease, SRS shows no change, and NTS and ORR show small increases. Operation and maintenance costs are higher at NTS and Pantex than INEL, with SRS higher than INEL but less than NTS and Pantex. ORR shows the same cost to INEL. These differences are fairly small compared to the large uncertainties in the actual costs of the facilities.

Evaluation of Tritium Recycling Alternatives

If a new supply facility is chosen at INEL, NTS, ORR, or Pantex, the alternatives are to build a new recycling facility collocated with the supply facility or to upgrade the SRS facility. Constructing a new tritium recycling facility (1.9 to 2.1 billion dollars) is more expensive (between $500 million and $750 million) than upgrading existing tritium recycling facilities (1.3 billion) at SRS. The operational environmental impacts would be similar.

If a new supply facility is chosen at SRS or if a commercial reactor option is chosen, upgrading the existing tritium recycling facility is the only option considered, since building a new recycling facility at another site is more expensive and has no other advantages.

Cumulative Impacts

Impacts from the siting, construction, and operation of new tritium supply and recycling facilities would be cumulative with impacts from existing and planned facilities and actions at the five candidate sites. The consequences of each new tritium supply alternative and recycling alternatives include the cumulative effect of tritium supply and recycling impacts and impacts from existing, planned, and reasonably foreseeable operations. Other more long-term impacts associated with the Department's proposed Environmental

Management Program and the Storage and Disposition of Weapons-Usable Fissile Materials Program are speculative at this time but could increase or decrease cumulative impacts, depending on the decisions resulting from the PEISs being prepared for these programs and the time frame of site-specific projects. Information on potential waste management activities at the candidate sites was included as appropriate in the assessment of waste management impacts in the Tritium Supply and Recycling PEIS.

The Storage and Disposition PEIS alternative of burning plutonium in a reactor could result in increased cumulative impacts at the candidate sites if this Record of Decision selected a new facility, and the Record of Decision for the Storage and Disposition PEIS selected a separate new reactor. The impacts of combining tritium production and plutonium disposition in a single reactor, the multipurpose reactor, were evaluated in the Tritium Supply and Recycle PEIS. Cumulative impacts from constructing two separate reactors would approximately double those presented for a single reactor in the Tritium Supply and Recycling PEIS. Cumulative impacts from construction of a APT for tritium production and a new reactor for plutonium disposition would be represented by adding together the APT and ALWR or MHTGR impacts evaluated in the Tritium Supply and Recycling PEIS. Cumulative impacts would be minimized if tritium production and plutonium disposition were to take place in a single reactor.

The Environmentally Preferable Alternative

The environmentally preferable alternative is the alternative that would cause the least impact to the physical environment, and best protect worker and public health.

With respect to all three decisions, the no action alternative is the environmentally preferable alternative. Under the no action alternative, tritium requirements to support the nuclear weapons stockpile would continue to be met by recovering residual tritium from weapons components, purifying it, and refilling weapons components. These activities would be performed at the Savannah River Site, the current location of this function. However, under the no action alternative, the Department would not establish a new tritium supply capability and the Department would not meet future stockpile requirements of tritium. This would be contrary to the Department's mission as specified by the Atomic Energy Act of 1954, as amended. Thus, no action is not a reasonable alternative.

Of the alternatives that would satisfy the Department's mission, the potential environmental impacts are generally small and, except for the commercial reactor options to purchase an existing reactor or irradiation services, the impacts are within the same range. The Department considers the commercial reactor options of purchasing an existing reactor or irradiation services to be the environmentally preferred alternative.

Implementation of either of these options would result in certain environmental impacts. The environmental impacts of construction activities would be limited to any support facilities that would be required. Operation of the commercial reactor options would have few potential environmental impacts. No additional spent fuel over and above what the reactor(s) would otherwise generate during their planned lifetime would be generated, assuming that operating scenarios do not change fuel cycles. If fuel cycles were changed, additional spent fuel would be generated.

There are no environmental grounds for discrimination among sites for the tritium supply alternatives. Therefore, the SRS is the environmentally preferred site since impacts from upgrading tritium recycling facilities are less than building new facilities at any of the other sites. Resource areas where no major differences exist, or where potential environmental impacts are small are: land resources, air quality, water resources, geology and soils, biotic resources, socioeconomics, and site infrastructure.

Comments on the PEIS and Related Documents

Several comments were received on the Final PEIS during the 30-day period following the filing of the Final PEIS with the Environmental Protection Agency (EPA). The EPA stated that all of its specific comments on the Draft PEIS had been adequately addressed in the Final PEIS. A vendor for one of the ALWRs commented that on the Final PEIS did not adequately reflect the fact that the electricity-producing reactor options have an environmental benefit. That is, construction of such a reactor would offset the need to build and operate an equivalent capacity of fossil-fueled power plants, whereas the accelerator would have an additional environmental impact from a power plant needed to provide electricity for operating the accelerator.

The Final PEIS assessed the environmental impacts associated with providing power to the APT. Two methods were assessed: (1) Purchasing electricity from regional power pool grids; and (2) building and operating a dedicated power plant. If a new dedicated power supply were constructed, impacts would occur to air resources, land use, soils, biotic resources, and socioeconomics at the construction site. Operation of a dedicated power supply, or increased electrical demand on the power pool would result in increased impacts to air resources, water resources, waste management systems, and local traffic. Impacts to land use, soils, waste management systems, and biotic resources could occur at the plant location and along the transportation system supplying the coal or gas to the power plant. While these environmental impacts were assessed, no decision regarding a preferred source of power is appropriate at this time. If an accelerator were eventually built, the site-specific NEPA review would more fully explore the options of providing power to the accelerator, and the appropriate decision would be made at that time. The environmental impacts that could be avoided through the use of a multipurpose reactor are discussed qualitatively in the Final PEIS for both the ALWR, MHTGR, and commercial reactor alternatives. These impacts are presented as part of the cumulative impacts discussion in the previous section.

Additional comments on the Technical Reference Report and cost analysis were also received from the vendor for one of the ALWRs. The vendor questioned the basis of the cost estimate and the judgments used in developing the uncertainties related to schedule, production assurance, and cost as presented in the Technical Reference Report. The commentor presented a revised set of assumptions resulting in modifications to the cost ranges for the large and small ALWRs, APT and commercial reactor options. The Department does not agree with these assumptions. However, if these assumptions were accepted hypothetically, and applied consistently and appropriately to each of the ALWR, APT, and commercial reactor options, the result would be to increase the cost range of the purchase of irradiation services and lower the cost ranges of all other light water alternatives. Thus, there still would be significant overlap in the cost of these alternatives, and there would be no effect on the decisions presented in this Record of

Decision. The Department selected experts knowledgeable in schedule, cost or production assurance for the assessment panels who did not stand to gain from the results of the assessment. In addition, each panel included experts knowledgeable in the different technologies and the mean results of their combined judgments were used in the uncertainty analysis.

The Department received on October 11, 1995, a Congressional report: ‘‘Getting On With Tritium Production: A Report to Speaker Newt Gingrich’’. The primary recommendation of the report is that the Department base its selection of a tritium production source on two objectives: Maximizing the assurance that tritium sources will be available when needed and minimizing costs to the taxpayers. The Department's acquisition strategy described in this Record of Decision implements this recommendation of the Congressional report. Additional recommendations related to insuring that the plutonium disposition mission and the tritium production mission be reviewed for combining efforts to save money, and the new reactor option must be evaluated to the same level of detail as the commercial reactor options. The responsibility for tritium production and fissile material disposition rests with two separate offices in the Department, the preparation of the Tritium Supply and Recycle PEIS and Technical Reference Report was closely coordinated with the Office of Fissile Materials Disposition. Therefore, the option of using a reactor in a multipurpose mode is analyzed in these two documents and the factors relevant to decision making are presented in this Record of Decision. Due to the rapid decay of tritium, and the long lead time required to bring a new tritium source on line, even supplies of tritium from retired weapons are not sufficient to postpone the need for a tritium supply facility to the point where decisions concerning technology and site selection can be deferred. With regard to equal evaluation, the Department believes that the analysis completed to date accomplishes this recommendation. Cost considerations associated with the reactor alternatives point the decision toward existing commercial reactors. Moreover, a new reactor has no major schedule or production advantage over an existing reactor that would justify incurring the additional cost and environmental impacts associated with a new reactor.

A private group has recently suggested that it purchase the Fast Flux Test Facility (FFTF) from the Department and that the Department then contract with the private group to make tritium at that facility. In the PEIS, the use of FFTF was considered and dismissed as a long-term tritium supply option because the amount of tritium that it could produce would only meet a percentage of the steady state tritium requirements, and it was not reasonable to rely on operating the facility far beyond the end of its design life. However, the Department will evaluate the presentation made by the private group to determine whether the operation of the FFTF might be able to play any role in meeting future tritium requirements. If any changes are warranted to this Record of Decision following that review, or further NEPA documentation is required, the Department will take appropriate action.

## Decision

The Department is making three simultaneous decisions regarding tritium supply and recycling. First, the Department will pursue a dual track on the two most promising tritium supply alternatives: (1) To initiate the purchase of an existing commercial reactor (operating or partially complete) or irradiation services with an option to purchase the reactor for conversion to a defense facility; and (2) to design, build, and test critical components of an accelerator system for tritium production. Within a three-year period, the Department would select one of the tracks to serve as the primary source of tritium. The other alternative, if feasible, would be developed as a back-up tritium source. Second, the Savannah River Site is selected as the location for an accelerator, should one be built. Third, the tritium recycling facilities at Savannah River Site will be upgraded and consolidated to support both of the dual track options. A tritium extraction facility will be constructed at Savannah River Site. The basis for these decisions is as follows.

*Tritium Supply Decision:* The options of the commercial reactor alternative are the best in terms of schedule, production assurance and cost. However, there are institutional issues with these options that must be resolved, or else the alternative can only be used as a contingency.

Institutional issues regarding the use of a commercial reactor(s) must be resolved. Since commercial reactors are already constructed and operating, adding the tritium mission to an existing reactor does not significantly increase any existing environmental impact. Using existing commercial reactors offers the least expensive approach. The purchase of irradiation services presents the lowest cost and has the lowest uncertainty. The purchase of an existing or partially completed commercial reactor has the lowest capital and life cycle costs but a greater degree of uncertainty than the purchase of irradiation services.

Among the new facility alternatives, the accelerator has the highest probability to meet earlier production requirements because of less regulatory uncertainty. Among the new facility alternatives, the accelerator also has the least environmental impact because it does not use fissile material, generates no high-level wastes, and while the risk from a severe accident is very small for all of the alternatives, the risk for the accelerator is the smallest. While all of the components of the accelerator have been proven, the entire system needs to be demonstrated to assure the components work together as a complete system. From a cost perspective, the APT is grouped with the small ALWR and small advanced HWR in a middle range of costs if revenue is not taken into consideration. There is significant overlap among the alternatives, however. The two reactor alternatives have a smaller uncertainty than the APT. If revenue is included, the small ALWR has a lower mean cost than the APT and small advanced HWR. Also the large ALWR is added to this middle group. The Department has confidence that as we optimize the accelerator design over the next several years, the resulting costs will fall within the lower end of the cost range presented in the Technical Reference Report.

Based on the these considerations, the Department will implement a dual acquisition strategy that assures tritium production for the nuclear stockpile rapidly, cost-effectively, and safely. This dual-track strategy for meeting tritium supply requirements provides the following advantages:

- Resolves major uncertainties over the next three years, before selection of the primary alternative;
- Selects the new facility that has the lowest estimated environmental impacts, an accelerator, and the environmentally preferred alternative, purchase of a existing commercial reactor or irradiation services;
- Lessens programmatic risk because it: 1) pursues two technically different and independent approaches which provide fall back in the event either approach develops significant problems; 2) provides proven independent capability to increase production; 3) develops and protects contingency capability to support requirements in the event of a national emergency; 4) selects a strategy that has the greatest

flexibility to meet production requirements earlier than 2011, if necessary, and 5) includes the least cost option (irradiation services); and

• Preserves an option for simultaneous reactor ''burning'' of excess weapons plutonium, if the Storage and Disposition of Weapons—Usable Fissile Materials Record of Decision selects reactor burning of that material.

*Site Decision:* For the commercial options, the potential sites are where existing facilities are located. Selection will be subject to a separate NEPA analysis. For the APT, environmental impacts and costs are not significant discriminators. The Savannah River Site will be the site for the APT, if one is constructed, because it has the only existing tritium recycling capability and infrastructure of the candidate sites.

*Tritium Recycling Decision:* Upgrading and consolidating the tritium recycling facilities at the Savannah River Site is the least expensive option and avoids additional transportation of tritium between sites if the APT is constructed. Therefore, if the APT is the primary source of tritium, the existing tritium recycling facilities at Savannah River Site will be consolidated and upgraded. If one of the commercial reactor options becomes the primary source of tritium, the existing recycling facilities at Savannah River Site will be consolidated and upgraded, and a new extraction facility will be constructed.

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Hazel R. O'Leary,

*Secretary.*

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