INTERIM REPORT OF THE

NATIONAL PETROLEUM COUNCIL'S

COMMITTEE ON SYNTHETIC LIQUID

FUELS PRODUCTION COSTS

January 29, 1952

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INTERIM REPORT OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON SYNTHETIC LIQUID FUELS PRODUCTION COSTS

As instructed by the National Petroleum Council at its October 31, 1951 meeting, the Committee on Synthetic Liquid Fuels Production Costs is proceeding to complete the study requested by the Secretary of the Interior. This involves a review of certain alternate procedures submitted by the Bureau of Mines on the coal hydrogenation and shale oil process. It also includes a complete estimate of the cost of producing synthetic liquid fuels by the coal gasification and Fischer-Tropsch process.

I am pleased to advise that satisfactory progress is being made by the various subcommittees on these studies. It has been necessary that members of the subcommittees hold several meetings with Bureau of Mines personnel and visit various demonstration plants to develop satisfactory process design data so that the subcommittees' cost estimates could be prepared. Additional meetings for this purpose will be required, particularly with respect to the coal gasification and Fischer-Tropsch process. Employees of some companies that heretofore have not participated in this investigation are being contacted in order to secure additional assistance to complete the assignment.

All of the studies are proceeding smoothly and relations between the Subcommittee and Bureau of Mines personnel at all levels continue to be harmonious.

At the October 31, 1951 meeting of the National Petroleum

Council, immediately following the presentation of this Committee's report, the Bureau of Mines presented a report on Coal Hydrogenation. The Subcommittee has made a complete and comprehensive analysis of the latest report of the Bureau of Mines dated November 19, 1951.

The Subcommittee has submitted a summary letter with an attached memorandum concerning the results of its analysis and comparison of the Bureau of Mines' report with the National Petroleum Council's study. This letter and memorandum are included as a part of this Interim Report. I will read the summary letter and urge you, at your convenience, to study the attached memorandum.

January 29, 1952

New York 17, N. Y., January 21, 1952

NATIONAL PETROLEUM COUNCIL COMMITTEE ON
SYNTHETIC LIQUID FUELS PRODUCTION COSTS

Mr. W. S. S. Rodgers, Chairman
135 East 42nd Street
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Dear Sir:

Following your presentation of the report of the National Petroleum Council Committee on Synthetic Liquid Fuels Production Costs at the Council meeting on October 31, 1951, the Bureau of Mines distributed a new report entitled "Cost Estimate for Coal Hydrogenation", dated October 25, 1951. At the same time Dr. Schroeder, Assistant Director of the Bureau of Mines made certain comments to the Council concerning the differences between the National Petroleum Council and the Bureau of Mines estimates of the cost of producing synthetic fuels. The Bureau of Mines report of October 25, 1951 was later superseded by a report dated November 19, 1951 titled "Cost Estimate for 30,000 B/CD Rock Springs, Wyoming Coal Hydrogenation Plant".

The attached memorandum discusses in some detail the differences which exist between the National Petroleum Council and the new Bureau of Mines estimates. It should be emphasized that the National Petroleum Council estimate is a result of the most intensive and detailed evaluation of synthetic fuels that has ever been made. The National Petroleum Council utilized personnel available in the industry with a tremendous amount of experience in the fields of research,

development, engineering design, construction, operation, economic and cost analysis. Assistance was obtained from experts in many other industries, particularly the Coal Industry. It is unlikely that any figures developed in a sound evaluation would deviate significantly from those presented in the National Petroleum Council report.

The new Bureau of Mines report states that gasoline can be produced by the hydrogenation of coal for 12¢/gallon. This is to be compared with a National Petroleum Council figure of approximately 41¢/gallon. The differences in costs result from the factors which are discussed below.

(1) Investment Cost:

The difference of 121.5 million dollars in investment cost is principally a result of the following. . .

(a) The Bureau of Mines estimated the cost of the plant facilities to be 47.5 million dollars less than the National Petroleum Council even though the Bureau of Mines plant had 11% more capacity and included aromatic extraction facilities.

(b) The Bureau of Mines allowed 55 million dollars less for housing than did the National Petroleum Council.

(c) Allowance for working capital, start-up expense, and other capital charges was 19 million dollars less in the Bureau of Mines estimate.

The Subcommittee has reviewed these differences in as much detail as possible from the scant information in the new Bureau of Mines report and is convinced that the National Petroleum Council estimates are realistic and represent values which would be involved in the actual construction of a commercial unit.

The Bureau of Mines questioned the validity of the National Petroleum Council assumption that the plant owners should be responsible for the housing investment. When considering the resk involved in the coal hydrogenation process, considerable independent authority has concurred in the National Petroleum Council view that housing at Rock Springs would be a responsibility of the plant owner. It should be borne in mind that while the National Petroleum Council estimate called for the industry to assume the investment responsibility initially, it was, perhaps optimistically, assumed that the rental income would provide for maintenance of the housing and would recover 90% of the initial investment for employee housing. The overall effect of the housing charges on gasoline cost amounts to less than 10% of the difference between the two estimates.

(2) Operating Labor and Maintenance Costs:

Dr. Schroeder commented at the Council meeting on the differences in the estimates of the operating personnel. Although the Bureau of Mines estimate was 60% of the National Petroleum Council estimate, these differences in operating labor costs amounted to a difference in gasoline costs of less than 1/2¢ per gallon or less than 2% of the difference between the two estimates. The National Petroleum Council estimate of operating labor was derived from a detailed study of commercial operations of as nearly the same nature as those involved in the coal hydrogenation operation as were available. The basis for the Bureau of Mines estimate of operating labor requirements

is not in accord with comparable Industry experience.

However, the largest error in operating costs made by the Bureau of Mines was its attempt to estimate maintenance labor as a ratio to operating labor. This correlation is basically unsound and has led the Bureau of Mines to seriously underestimate maintenance labor. The Bureau of Mines total maintenance, which it calculates to be equivalent to only 1.7% on total investment, compares to the National Petroleum Council estimate of 3.9% and is far below that found in commercial experience on comparable facilities.

(3) By-Product Credits:

The plant proposed in the latest Bureau of Mines report cannot be classified as a liquid fuels venture because the chemicals produced account for more than half of the total revenue. If this operation is to be justified on chemicals it must be evaluated versus alternate methods available for producing these chemicals.

Although the Committee has not had the opportunity to review the basis of the higher chemical yields used in the latest report, the Committee feels that the values assigned to the chemicals are high because of present prices in a defense-inflated market and insufficient freight allowance.

(4) Return on Investment:

The Bureau of Mines representatives have been very critical of the method of financing used by the National Petroleum Council to establish a cost of gasoline. It should be sharply

emphasized that manufacturing costs alone amount to 20¢/gallon after full credit for by-products but without allowance for interest, income taxes, and return on investment. Since the value of gasoline is now about 12¢ per gallon, obviously there will be no profit to be applied to any capital, borrowed or equity. Accordingly, neither type of capital could be attracted to the venture. The calculation of financing costs by the Committee, based on the extremely low return of 6% after taxes on total investment, is included only to establish a minimum selling price for comparison with the present price of gasoline.

It should be noted that, although the Committee estimate of the cost of gasoline produced by coal hydrogenation is much higher than that from shale, the same group, following the same estimating policies, produced both figures.

Conclusion:

In conclusion the subcommittee is of the opinion that the revised report of the Bureau of Mines of November 19, 1951 has contributed nothing to indicate that cost of gasoline from coal hydrogenation should be lowered from 41¢/gallon as reported by your committee. It appears that the Bureau of Mines greatly understated its operating, investment, and capital costs and at the same time overstated its product revenue, resulting in a fictitious and misleading cost of gasoline.

It is again recommended that Bureau of Mines personnel use the procedure and factors developed in the National Petroleum Council studies as a basis for their calculations.

Respectfully submitted,

SUBCOMMITTEE ON SYNTHETIC LIQUID FUELS PRODUCTION COSTS

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By: /s/ L. C. KEMP, JR.
L. C. Kemp, Jr., Chairman

SUBCOMMITTEE OF THE
NATIONAL PETROLEUM COUNCIL
COMMITTEE ON
SYNTHETIC LIQUID FUELS PRODUCTION COSTS

COMMENTS ON THE BUREAU OF MINES REPORT,
"COST ESTIMATE FOR 30,000 B/CD, ROCK
SPRINGS, WYOMING, COAL HYDROGENATION
PLANT," DATED NOVEMBER 19, 1951

At the time of the issuance of the report of the National Petroleum Council's Committee on Synthetic Liquid Fuels Production Costs on October 31, 1951, the Bureau of Mines presented a new report entitled "Cost Estimate for Coal Hydrogenation," dated October 25, 1951. A revised report was issued November 19, 1951. In addition, Dr. Schroeder of the U. S. Bureau of Mines made certain comments to the council concerning synthetic fuels and the main points of difference between the estimates made by the National Petroleum Council and the Bureau of Mines. The Bureau of Mines essentially agreed with the estimates on liquid fuels from shale except for the handling of capital and the inclusion of housing. On coal hydrogenation, Dr. Schroeder reported a required selling price for gasoline of 12¢/gallon as compared with the National Petroleum Council figure of 41-42¢/gallon.

The processes employed by the Bureau of Mines in the revised report of November 19, 1951 are, with the exception of additional aromatic extraction facilities, the same as those previously submitted and upon which the National Petroleum Council based its extensive investigation. Basically, the coal hydrogenation process is still the same one which was developed and utilized in Germany, and no material improvements over German technology have been made. Certain mechanical improvements have been incorporated in the process but many of these improvements were recognized and in some cases utilized in German practice.

With regard to oil shale, the process accepted by the Bureau of Mines involved the retorting of oil shale via a process developed by the Union Oil Company. The refining of the crude shale oil was likewise accomplished by procedures developed by the Industry. The only developments contributed by the Bureau of Mines were those involved in mining operations where novel application of equipment being used in other type mining was accomplished.

The National Petroleum Council utilized the best technical personnel available within the Industry in its study, and assistance was obtained from experts in other industries where needed. Never before has such a thoroughgoing evaluation

of synthetic liquid fuels been made. It is unlikely that any figures developed in a sound evaluation by another group would deviate significantly from these. Nevertheless, the estimate of the investment cost by the Bureau of Mines is materially less than the National Petroleum Council estimate even though the plant proposed by the Bureau of Mines has an 11% greater capacity and includes facilities for the separation and purification of aromatic hydrocarbons. At the same time, the operating costs estimated by the Bureau of Mines are substantially less even in proportion to investment, than those determined by the National Petroleum Council. The value of by-products estimated by the Bureau of Mines is also materially greater than the value determined by the National Petroleum Council.

A tabulation comparing the revised Bureau of Mines estimate with the National Petroleum Council values is attached.

INVESTMENTS

Plant Investment

With regard to investment costs for coal hydrogenation the following comparison is significant:

	USBM Study 11-19-51	NPC Study 10-15-51	Ratio USBM to NPC
Plant Capacity, BPD	30,000	27,000	-
Total Investment	$411,440,000	$532,900,000	-
$/B/CD	13,700	19,700	0.70

The difference in the total investment cost amounting to 121.5 million dollars can be broken down as follows:

Total Plant Investment	$47,500,000
Housing	55,000,000
Working Capital and Start-Up Expense, etc.	19,000,000

As mentioned above the smaller investment cost of the Bureau of Mines was estimated for a plant having 11% more capacity and an additional process unit for separation of aromatic chemicals.

The information presented in the latest U. S. Bureau of Mines report is so meager that it is impossible to reconcile the current investment estimate with that summarized in the Bureau of Mines Report R.I. 4564 and which was reviewed in detail by the National Petroleum Council. The "conventional" plant investment estimate given in R.I. 4564 was $306,748,000. The latest estimate indicates that modifications have been

made to three major units in the "conventional" plant. Correcting this investment for these three units brings the revised estimate to $288,419,000. The U. S. Bureau of Mines' current estimate of these same facilities (excluding separation of aromatic hydrocarbons and water facilities which were not in the preceding number) is $332,783,000, or an increase of 15.4%. This increase is supposed to provide for the rise in construction costs from 1948 to January 1, 1951, as well as to provide for an 11% increase in the capacity so as to permit a throughput of 30,000 B/CD.

The increase in the construction index over this period was 14%. It has been estimated by the National Petroleum Council committee that the cost of increasing the capacity of this plant to 30,000 B/CD would add 6%. In addition, the steam and power requirements for the coal hydrogenation facilities were incorrectly determined by the U. S. Bureau of Mines on their latest report and would account for an additional increase of 7%. Summing up these various increases, the original $288,419,000 should have been increased by at least 28%, making a total adjusted investment of about $370,000,000, instead of $332,783,000 as reported by the Bureau of Mines. The above adjustments do not correct for the inadequacies of the original Bureau of Mines estimate which the National Petroleum Council estimated would add 60 to 70 million dollars to the $370,000,000 mentioned above.

Housing

The second item of investment on which the National Petroleum Council and the U. S. Bureau of Mines differed was that for housing. Although investment for housing accounted for about half of the difference in investment between the studies, there were rental payments as an offset so that the actual effect on gasoline cost amounted to only 2.3¢/gallon.

With regard to housing, a difference in philosophy seems to exist. Before the National Petroleum Council developed their recommendations on housing, this matter was discussed with institutional and governmental agencies directly concerned with the financing of housing projects. The information obtained was presented in the National Petroleum Council subcommittee report of October 15, 1951, and the subject is further discussed in the following paragraphs.

The subcommittee agrees with the Bureau of Mines on the desirability of minimizing the plant owners financial and associated obligations for employee housing. As noted by the Bureau of Mines, this effort should be through maximum encouragement of private enterprise (by others than plant owners) to provide the needed facilities, utilizing any available help from public agencies. National Petroleum Council estimates for Rock Springs assume adherence to these methods but anticipate

little success; first, because of almost complete lack of housing and related services in this area; and, second, because value of housing at the time of construction would appear so dependent on continued operation of this one plant that the plant owner would be unable to get others to assume the risk.

Housing for the Rock Springs hydrogenation plant requires a substantial amount of skilled manpower, steel, and materials. The Bureau of Mines reports it to be a "fallacious conception" that these items should be a burden on a new project such as a synthetic fuel plant. Those responsible for defense production do not share the Bureau of Mines' view. In connection with priorities assistance for the Petroleum and Gas Industries, NPA Order M-46B lists material for residences on a par with that for other operations peculiar to the industries. In the case of requests for Certificates of Necessity, the Department of Interior, Petroleum Administration for Defense, requires a special Form 1-701 "Identification of Facilities to be Certified (Alternate to Appendix A-NSRB Form 140)" on all petroleum and gas projects over which they have jurisdiction. This form tabulates housing, including employee housing, in the same category as all process and manufacturing facilities.

At Eastern hydrogenation sites studied by the National Petroleum Council, the need for new housing and facilities is minimized, but not eliminated, by existing housing since the selected sites are in less populated areas of the states involved. The terrain and other features of coal areas do not attract population, and manufacturing plants generally are not immediately adjacent to the mines. As a result, the sites chosen for the study are not near large towns. It was assumed many people would drive considerable distances to continue living in existing homes, but in view of the large overall housing requirements generated by such a project, a housing development adjacent to the plants would be required.

Such housing as is required still rates as an extremely poor risk from the point of view of lenders or guarantors of loans who apply the following tests: (1) Are there nearby industries which would create a demand for this housing if the hydrogenation plant should not continue to operate? (2) Has this hydrogenation project adequate assurance of long range satisfactory earnings considered both from the point of view of proved processing and competition with flush crude oil production or other developments in the energy supply field?

In view of these unfavorable circumstances, the requisite housing and facilities represent an initial investment burden on the plant builder.

Dr. Schroeder has questioned the depreciation rate of 5% on housing investment. The Committee used a depreciation or amortization rate of 5% per year on housing because the housing built in connection with hydrogenation plants is so located that its value depends entirely on the success of the hydrogenation plant. The field of operation of the petroleum industry, including refining, has been one of such rapid change that those familiar with the industry would consider it unwise to establish a depreciation rate based on a period of longer than twenty years for any petroleum operation. Such reasoning would also apply to coal hydrogenation since these plants might have to be abandoned within twenty years from start of operations because of process obsolescence as well as competition from discoveries of other energy sources.

Other Capital Investments

There are several miscellaneous items of capital expenditure or requirement which introduce further differences between the U. S. Bureau of Mines and the National Petroleum Council estimates. Included are working capital, start-up expense, process royalties, and interest during construction. Although these cannot be determined in an exact manner, the general allowance for such capital requirements can be derived from the experience of U. S. industry in general.

Although the National Petroleum Council's estimate of the combined sum for these items exceeded the Bureau of Mines' estimate by about twenty million dollars, the individual differences are much more pronounced. For instance, the Bureau of Mines provides $20,000,000 for working capital vs. the National Petroleum Council's $37,400,000. The National Petroleum Council figure is slightly less than 10% on plant investment. For comparison working capital of thirty oil companies compared by Pogue and Coqueron averaged 19% on gross property, plant and equipment in 1950. The National Petroleum Council estimate was carefully developed by considering every factor, such as product inventory, accounts receivable, operating and maintenance supplies inventories, etc., which require capital expenditures prior to the point at which daily income exceeds expenses. The Bureau of Mines' smaller figure, however, is unexplained and perhaps is also intended to cover start-up expense as well. For this latter expense, the National Petroleum Council estimated that $18,500,000, amounting to only four months "out of pocket" operating costs, represents a reasonable allowance, and thus for the two items combined, the actual difference is about $36,000,000. The Bureau of Mines only reference to start-up expense implies that this is included in the investment cost for each individual unit of the plant. If such is the case, it is not apparent and would further invalidate their estimate of equipment and construction cost.

Process royalties are, to date, only a matter of conjecture and the U. S. Bureau of Mines was more conservative than

the National Petroleum Council $2,000,000 vs. $1,000,000. The Bureau of Mines included an expense of $15,657,000 for interest during construction, but the National Petroleum Council estimate included no allowance for this expense.

OPERATING COSTS

In comparing the operating costs, the following basic comparisons are significant:

	USBM Study 11-19-51	NPC Study 10-15-51	Ratio USBM to NPC
Direct Operating Cost Excluding Depreciation, $/Bbl.	$3.18	$5.44	0.58
Major Operating Factors (Incl. in above)			
Operating Labor, Man Hours/Barrel	.125	.211	0.59
Total Maintenance, % per year on investment	1.7	3.9	0.45

The preceding table indicates that there is a wide deviation between the two studies with regard to operating labor and maintenance. These items deserve a critical review to determine the merits of both estimates.

At the time the Bureau of Mines estimates were released in Washington on October 31, 1951, Dr. Schroeder made certain verbal comments with respect to differences on manpower and he was quite critical with respect to the National Petroleum Council estimate. The National Petroleum Council estimate reflects experience in designing and operating similar type equipment in the petroleum industry, and was made only after detailed examination of the facts available.

With respect to operating labor, the National Petroleum Council estimate required 238 men per shift whereas the Bureau of Mines estimated 156 men per shift. The National Petroleum Council requirements were the composite views of process people charged with the responsibility for the design of the equipment, and due consideration was given to any peculiarities of construction and operation inherent in the coal hydrogenation plant. The National Petroleum Council Committee realizes that its estimate of operating labor for this project is unusually low when compared with the labor force required in a petroleum refining unit. It is believed that the low figure might be justified on the basis of the economies achieved by reason of effective design and a high level of instrumentation for unit control.

Dr. Schroeder in his criticisms pointed particularly to the differences in manpower with respect to the power plant, the water system, the oxygen plant, and tankage and loading.

In the National Petroleum Council estimate of the number of operators (29) required for the steam power plant, due consideration was given to the fact that it was a coal-fired installation presenting problems with respect to coal handling and ash disposal. This estimate also included a sufficient number of operating personnel to provide for efficient distribution of the steam and power load throughout the plant. Dr. Schroeder quoted the number of operators for a similar size power plant to be between 10 and 18 on the basis of data submitted in the "Electrical World." An examination of the data published in the "Electrical World," August 27, 1951, indicates that, in five plants of approximately one-half the electrical generating capacity of that required for the coal hydrogenation plant, the number of operators varied from 7 to 25. These plants were balanced with respect to generating steam sufficient to produce power load and would not meet the requirement with respect to generating process steam above this quantity. These plants also did not include any operating personnel for steam and power distribution.

The National Petroleum Council estimate of operators required for the water system allowed for operators to man the pumping stations and pipe line outside the plant proper, for the necessary pumpers within the plant, and for the cooling-tower operators. Apparently the Bureau of Mines estimate ignored at least the operating personnel required outside the plant. Moreover, there is a fundamental difference in the water supply systems which partially account for the personnel discrepancies. In this connection, it might be stated that the Bureau of Mines report contemplates an 18-million dollar water line from a lake about 100 miles north of the plant site. The National Petroleum Council, after close inspection, decided to install a much shorter line (32 miles) at a cost of $7,200,000. Pumping requirements were greater on the shorter line because the longer line was primarily a gravity feed. However, an economic appraisal indicates the line used in the Bureau of Mines report never could be justified.

The National Petroleum Council estimated the labor force on the basis of several large oxygen plants now operating in the U. S. and on the Brownsville, Texas, oxygen plant experience with one unit in operation and with consideration given to the anticipated labor force when both units are in operation. The Bureau of Mines estimate as stated was given on the basis of their experience in operating an oxygen plant. It should be realized that the Bureau of Mines experience is

with one 24-ton-a-day pilot plant and the design for the coal hydrogenation plant provided for four 450-ton-per-day oxygen plants. If consideration is given to the size of these oxygen plants, the amount of mechanical equipment involved, and the necessity for providing for a safe-operating margin under all contingencies, we believe that it will be realized that the Bureau of Mines figure of two men per shift is utterly fantastic.

Dr. Schroeder spoke of the discrepancy in the number of men required for tankage and loading, giving as his estimate six to seven men and reporting that his estimate was in agreement with petroleum experience. Again, we believe the Bureau of Mines has not studied the problem completely and has misinterpreted the facts, for the basis used by the National Petroleum Council was completely backed up by data on actual practices. The National Petroleum Council estimate of 13 men was for tankage and loading and covered the pumpers, gaugers, and loaders required to handle the products from this plant. From the context of Dr. Schroeder's remark, it would appear he has not given consideration to the pumpers and gaugers required. The National Petroleum Council estimate of the men required for this operation gave consideration to the facts that all shipments would be made overland by tankcar and tanktruck and that, in addition to normal petroleum product handling, there are relatively large quantities of phenols and cresols which have toxic properties and must be handled under special safety conditions.

Maintenance

If the discrepancy between direct operating labor costs were the only one in the report, it would not be too serious because the difference in operating labor and supervision amounts to only $1.5 million dollars per year, or about 1/2¢ gallon on gasoline. The major differences in operating costs arise because there is a significant difference in the method of estimating maintenance labor and material costs. The National Petroleum Council estimated maintenance on the basis of the relationship to investment whereas the Bureau of Mines based maintenance on a ratio to operating labor. It was assumed that the maintenance-operating labor ratio for the coal hydrogenation project would be the same as that prevailing in certain operations in the petroleum industry. This assumed correlation of maintenance to operating labor represents highly fallacious reasoning. As a rather simple example we may take the operating costs of a half-ton panel delivery truck against a heavy-duty construction truck. One man can operate both units but to assume that the maintenance would be the same on these two types of equipment represents an error which is readily apparent. To further confuse the issue, the ratio of maintenance to operating personnel quoted by the Bureau of Mines as petroleum industry practice is low.

Maintenance is, in part, repairing and replacing items that have become worn as a result of operations. These parts were originally placed in position by the construction effort. The repair is repetitive effort employing the same type of labor and the same type of material as originally expended in erection and therefore it is closely related to the construction cost. The reduction in operating labor by reason of a high level of instrumentation or mechanization acts to increase the maintenance-operating labor ratio and also the maintenance costs. Maintenance also represents the use of mechanical craftsmen in the servicing and inspection of operating equipment such as instruments, compressors, pumps and automatic valves, and the more of this type of equipment in any given plant, the higher the maintenance cost. Maintenance also represents periodic inspection and turn-around costs required for continuously operating equipment. The higher the operating pressures and temperatures, the more detailed and exact these inspections and turn-around activities become and, consequently, the maintenance costs increase. The coal hydrogenation plant was rather heavily weighted with the type of equipment referred to above, and the National Petroleum Council used as a guide the petroleum industry's experience in maintenance costs as related to investment cost. The maintenance costs as estimated by the National Petroleum Council are deemed to be a well-studied and reasonable evaluation of the costs which would be incurred when operating such a plant.

The Bureau of Mines, having based their maintenance on a false maintenance-operating labor relation referred to above, calculated maintenance equivalent to 1.7 per cent of plant erection costs, or approximately six million dollars per year. This compares to the National Petroleum Council estimate of 3.9% or 15 1/2 million dollars per year. In justifying their maintenance estimate, the Bureau of Mines assigned arbitrary percentages against the various units and arrived at a check weighted average of 1.78 per cent. Individual percentages ranged from five down to one per cent. Significantly, the National Petroleum Council and Bureau of Mines estimates agree with respect to the percentage of maintenance cost assigned against the product distillation unit and tankage. In the following table, a few of the various plant sections are grouped to accent the comparison between the Bureau of Mines and National Petroleum Council studies.

Group	Plant Section	Annual Maintenance, % of Investment USBM	NPC
A	Product Distillation	3.0	3.0
	Low Temperature Separation and Oxygen Plants	1.3	4.0
B	Product Distillation	3.0	3.0
	Vapor-and Liquid-Phase Hydrogenation	2.3	4.0
C	Tankage	2.0	2.0
	Power Plant	1.0	3.0

In group A, the product distillation section (on which both organizations agree as to maintenance cost) is compared to the low temperature separation unit and oxygen plants. These latter sections, operating at extremely low temperatures and requiring compression facilities, would require higher maintenance percentagewise than ordinary distillation equipment. The Bureau of Mines, however, reports maintenance costs on these two sections as less than half that required for ordinary distillation equipment.

In group B, the comparision is made between the same product distillation section and the hydrogenation sections. The hydrogenation sections, besides operating at high pressure and temperatures, require a high proportion of pumps, compressors, and heat exchangers. But again the Bureau of Mines believes that the maintenance on the hydrogenation sections would be less than that required for the product distillation section.

Group C compares the tankage section with the power plant. Both the Bureau of Mines and the National Petroleum Council agree on the maintenance percentage for tankage, which normally requires the least maintenance of any section in a refinery. The Bureau of Mines, however, believes that the steam and power generation facilities will require only half as much maintenance.

These few examples illustrate how such a large discrepancy was created between the two estimates. The Bureau of Mines attempt to validate their maintenance costs by preparing the sectional breakdown does not, in any manner, justify their original assumption with regard to a fixed ratio between maintenance and operating labor.

Other Operating Costs

The Bureau of Mines report includes an overhead item of 16% on payroll for labor benefits, which include vacations, social security, sick leave, workmen's compensation, etc. It is stated that this is believed to be somewhat higher than the present average for industrial workers. Actually, the benefits being paid by integrated companies in the petroleum industry rank among the highest in the nation and average about 20%.

Most of the remaining plant operating costs, including operating supervision, operating supplies, and general and administrative overhead, are based on the costs developed for direct operating labor and maintenance. This method of deriving total operating costs cannot provide a reasonable estimate when the basic factors of direct operating labor and maintenance costs are invalid.

CHEMICALS BY-PRODUCTS EVALUATION

With respect to tar acids two areas of difference are involved. First, the Bureau of Mines quantities are greater* than were used by the National Petroleum Council and second, the Bureau of Mines realizations are greater. As to the first of these, National Petroleum Council used the figures supplied by the Bureau of Mines at the time the National Petroleum Council review was started. A set of revised yield figures is employed in the Bureau of Mines latest report. The Bureau of Mines could not provide related yield, quality, and materials balances to the committee to establish their reliability. It is not clear that gasoline quality would be the same with the new and higher phenols yields.

As to the realization, National Petroleum Council figures were based on current prices, but took into account the effect on market of the relatively large supplies made available by the hydrogenation plant. This was expected to have no effect on phenol realization; while all cresols and xylenols could probably be disposed of, successively greater discounts for the heavier materials would be required. On this the Bureau of Mines differed considerably, taking current prices and assuming that market at these prices could be developed by the time a hydro plant was installed. This conclusion was based on an extrapolation of trends in the tar acids market. No information on the Bureau of Mines extrapolation was available to the committee. It is probable that the Bureau of Mines extrapolation is in error by reason of recent abnormal rises in demand connected with unsettled world conditions. In determining realizations used by the National Petroleum Council, a number of manufacturers, dealers, and consumers were approached, and the services of a consultant in the field were obtained. All sources agreed as to the necessity for discounts of the order used.

In addition to the differences in basic realization, difference in transportation allowance shows up. National Petroleum Council assumed that all products but phenol would have to be transported to the equivalent of Pittsburgh; phenol was expected to be marketable in the East St. Louis-Chicago area. This seems a reasonable basis since most consumers are located in an area centering on Pittsburgh, and only the phenol production from one hydro plant is small enough to allow its absorption closer to Rock Springs. The Bureau of Mines, on the other hand, allowed for a smaller transportation cost for all tar acids, sufficient to carry the products from Rock Springs only part of the way to East St. Louis or Chicago.

* Except for O-cresol and xylenols, the sales of which were limited to approximately the 1950 import rate.

The Bureau of Mines assumptions with regard to product prices are, in general, optimistic. Motor gasoline, for instance, is currently being sold at the refineries at an average price of about 11 cents per gallon. The Rocky Mountain region, however, has crude producing and refining capacity in excess of current consumption. A new source of supply would therefore find stiff competition if it attempted to market in this region. If the products were marketed elsewhere, such as in the Middle West or Pacific Coast regions, the plant realization would be reduced by the extra cost of transportation.

For LPG, the situation is similar. A new source of supply, particularly with a volume which, for this product, is exceptionally large, would have considerable difficulty in initially marketing all of the product at four cents per gallon. It is probably optimistic to assume that even three cents per gallon could be obtained during the first few years of plant operation.

As to aromatics (benzene, toluene and xylenes), the Bureau of Mines memorandum provides for their extraction, a step not included in the original design provided National Petroleum Council for review. It is questionable whether in a large-scale synthetic fuels study the extraction of aromatics should be considered. However, assuming that this is within the province of the review the following points are pertinent.

The original Bureau of Mines figures contemplated 40-45% aromatics in the gasoline. The benzene, toluene and xylene extracted in the revised report amount to 15% of the total gasoline components. This difference implies that the clear octane as well as the maximum leaded octane numbers of the total gasoline would be considerably lower than had been estimated for the original Bureau of Mines design. It should also be noted that the discussion is based on having only one hydrogenation plant in operation. The situation with respect to disposal of chemicals by-products in the multi-plant case is even more complicated.

At this point it should be stressed that the plant proposed by the latest Bureau of Mines report cannot be classified as a liquid fuels venture. The chemicals (phenols and aromatic hydrocarbons) which are produced account for more than half of the total product income. If several coal hydrogenation plants were to be built, competition would reduce prices of these materials to a value approaching that of liquid fuels. If the yields and prices used by the Bureau of Mines were adjusted to reflect this situation, the total product income would be reduced by about one-third.

CAPITAL CHARGES

One of the points upon which the Bureau of Mines has laid great weight is the handling of capital charges. In the preparation of the economics reports of the National Petroleum Council Subcommittee Report on Synthetic Liquid Fuels Production Costs, it was decided to present the economics based on 100% equity financing (no borrowed capital) with an allowance after income taxes of a 6% annual return on the total capital invested or retained in the business. Since Federal income taxes were included at a rate of 50%, the "effective" capital charges for this case (excluding consideration of depreciation charges) amount to 12% per year.

The question of equity versus borrowed capital and rate of return was considered and discussed in some detail in the Economics Subcommittee Report. It was the Committee's considered opinion that presentation of figures using 100% equity capital and 6% return on the total investment, after income taxes, represented a minimum financing basis, and the cost developed in this manner would cover any conceivable ratio of equity versus borrowed capital. Some of the reasoning behind this conclusion is presented in the following paragraphs.

The variation of "effective" capital charges (defined as interest on borrowed capital plus return on equity capital plus income taxes) by borrowing capital and thereby reducing the equity capital is shown in the following table:

	% Equity Capital					
	100	80	60	50	40	30
"Effective" Capital Charges, % per Year on Total Invested Capital						
Interest on Borrowed Capital at 4%	-	0.8	1.6	2.0	2.4	2.8
Return on Equity Capital at 6%	6.0	4.8	3.6	3.0	2.4	1.8
Allowance for Federal Income Taxes	6.0	4.8	3.6	3.0	2.4	1.8
Total "Effective" Capital Charges, %	12.0	10.4	8.8	8.0	7.2	6.4

The above table probably covers the entire range of financing schemes in which the equity capital is limited to a 6% return, since even utilities, a very stable and well protected industry, are seldom financed with less than 40% equity capital. Utilities, in fact, have much lower "effective" capital charges than manufacturing industries in general.

The preceding table is not meant to imply that each level of percent of equity capital, carrying a 6% return, is equally attractive to the equity investor. If this were true, it is apparent that the "effective" capital charges could be reduced from 12% to a level such as 7.2% (at 40% equity capital), thereby improving the competitive prospects of the venture. This is the device employed by the Bureau of Mines to reduce total capital charges while still providing an annual return of about 6% to the equity investor. Actually, as the per cent of equity capital is reduced, the equity investor requires a larger return due to the greater risk involved on his part. The risk is created by the fact that if the project should fail, the total assets of the company must first be used to retire the borrowed capital, after which the equity investor is entitled to whatever is left. Ordinarily the value of plant facilities of a project that has failed are worth only a fraction of their original cost. Thus, the equity investor demands a return commensurate with the risk of losing his capital.

A more reasonable approach to determining how the equity investor should fare is to allow the "effective" capital charges to remain at some level such as 12% and calculate the return to the equity investor at various levels of per cent of equity capital. The following table presents such a computation:

	% Equity Capital					
	100	80	60	50	40	30
"Effective" Capital Charges, % Per Year on Total Invested Capital						
Total "Effective" Capital Charge	12.0	12.0	12.0	12.0	12.0	12.0
Interest on Borrowed Capital (@4%)	-	0.8	1.6	2.0	2.4	2.8
Net for Income Taxes and Return on Equity Capital	12.0	11.2	10.4	10.0	9.6	9.2
Income Taxes (@50%)	6.0	5.6	5.2	5.0	4.8	4.6
Net for Return on Equity Capital	6.0	5.6	5.2	5.0	4.8	4.6
Return on Equity Capital, % Per Year on Equity Capital Only	6.0	7.0	8.7	10.0	12.0	15.3

Thus it is shown that, by holding the total "effective" capital charges constant and reducing the per cent equity capital, the return on equity capital is increased. It is not implied that the equity investor would be equally satisfied with each scheme in the above table; it is merely the purpose to show that, by holding the total "effective" capital charges at a constant value, the equity investor is offered better return to compensate for the increased risk resulting from the borrowing of a part of the capital.

At this point, it is emphasized that the preceding table illustrates what the Economics Subcommittee had in mind when an annual return of 6% on total invested capital was used. Although it was not explicitly stated in the summary report that a portion of the total invested capital could be borrowed and the balance obtained in the form of equity capital, this matter was considered and discussed in the Subcommittee report. It was realized that the total "effective" capital charge of 12% per year (including the income taxes) could be split up in numerous ways. Thus, the "effective" capital charge of 12% was intended to cover all ratios of equity to borrowed capital and not specifically the one case in which all invested capital is equity capital.

The National Petroleum Council, in estimating an annual return of 6%, wished to emphasize the effect of this minimum return on the cost of gasoline. It did not mean to imply that it was of the opinion that capital could be secured at this low cost. Financial consultants and other authorities have indicated that for a venture such as a synthetic liquid fuel project an annual return in the order of 15% (after income taxes and depreciation) on total invested capital would be required to attract equity capital. On this basis the total "effective" capital charge would be 30% per year for all ratios of equity to borrowed capital as compared to the 12% used by the National Petroleum Council.

If synthetic fuel plants are to be built by the petroleum industry without government subsidy, the financing scheme considered by the Bureau of Mines (60% borrowed capital, 40% equity capital) is exceedingly unrealistic. Inasmuch as the per cent of borrowed capital in the petroleum industry is in the neighborhood of 20% or less, an unproved operation such as a synthetic fuels plant could not expect a large proportion of borrowed funds without the guarantee of a financially responsible third party. The low per cent of borrowed capital in the petroleum industry is due to the speculative nature of the business. Borrowed money must be paid back. Equity money is risked on the hope of success.

The Bureau of Mines argues that the coal hydrogenation process is not speculative because the coal reserves have been proven to exist in ample quantities. Finding crude oil, however, is only one of the many speculations in the liquid fuels industry. Obsolescence of techniques and facilities is a factor of great risk in the oil business, contrary to what the Bureau of Mines states. A project costing approximately $500,000,000 and subject to being outmoded by improved techniques in other parts of the petroleum industry certainly has more elements of risk in it than is envisioned by the Bureau of Mines. Not only must the plant provide funds to repay the borrowed capital, it must also keep abreast of competitive technological advancements.

The average experience of the War Assets Administration in disposing of various plants after World War II was that about 25% of the initial cost of the physical assets were recovered. If a loan from a government agency is obtained for, say, half of the cost of the plant, then in effect 25% of the cost of the plant is a government subsidy. Banks and insurance companies who cannot subsidize or speculate with the funds entrusted to them would not permit the borrowed capital to exceed 20% of the total capital required to finance a synthetic fuels project unless some sort of guarantee was arranged.

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It would be well to review the basis upon which this work was undertaken by National Petroleum Council. Secretary of the Interior, Honorable Oscar L. Chapman, in his letter of April 21, 1950, to Mr. Walter S. Hallanan, Chairman of the National Petroleum Council, requested that the National Petroleum Council create a committee to:

(1) Review estimates made by the Bureau of Mines of the cost of producing synthetic liquid fuels, and its estimates of comparative costs of producing liquid fuels from crude oil.

(2) Prepare independent cost estimates.

(3) Make recommendations as to ways and means, if any, for improvement of future cost estimates by the Bureau of Mines.

On the investigations completed to date, it would appear that the National Petroleum Council has accomplished items (1) and (2) above. With regard to item (3), it would appear from the recent reports issued by the Bureau of Mines that no progress has been made. Considerable effort was taken to inform the Bureau of Mines continually as to the methods being used in the development of these cost estimates. These methods were in conformance with petroleum industry practice and have proved to be correct over many years of experience. All of this information has been offered to the Bureau of Mines and is available at any time for their inspection. It is unfortunate that the Bureau of Mines has not availed itself of the factual information put at its disposal.

1-21-52

N A T I O N A L P E T R O L E U M C O U N C I L

COMPARISON OF NATIONAL PETROLEUM COUNCIL COSTS
WITH BUREAU OF MINES COSTS

	National Petroleum Council (Oct. 31, 1951)			Bureau of Mines (Nov. 19, 1951)			
	Per calendar day	Per year	Cents per gallon of gasoline (298,781,700 gallons)	Per calendar day	Per year	Cents per gallon of gasoline (284,500,000 gallons)	NPC Excess over USBM cents per gallon. (Negative numbers in parenthesis.)
Raw materials:-							
Coal:							
Expenses	$ 26,593	$ 9,707,000	3.25	$ 33,425	$ 12,200,000	4.29	(1.04)
Depreciation	1,740	635,000	.21				.21
	28,333	10,342,000	3.46	33,425	12,200,000	4.29	(.83)
Catalyst and chemicals	6,507	2,375,000	.79	4,904	1,790,000	.63	.16
T.E.L.	209	76,000	.03	2,268	828,000	.29	(.26)
Total raw materials	35,049	12,793,000	4.28	40,597	14,818,000	5.21	(.93)
Operating costs:-							
Operating:							
Labor	11,424	4,170,000	1.40	7,479	2,730,000	.96	.44
Supervision	1,714	626,000	.21	1,123	410,000	.14	.07
Material	2,964	1,082,000	.36	3,384	1,235,000	.43	(.08)
Maintenance:							
Labor	27,651	10,093,000	3.38	11,277	4,116,000	1.45	1.93
Material	14,819	5,409,000	1.81	5,638	2,058,000	.72	1.09
Payroll extras	8,158	2,978,000	1.00	3,181	1,161,000	.41	.59
Utilities credit	(1,218)	(445,000)	(.15)				(.15)
Overhead	29,271	10,684,000	3.58	14,452	5,275,000	1.85	1.73
Research and development	2,740	1,000,000	.34				.34
Local taxes and insurance	16,290	5,946,000	1.99	9,748	3,558,000	1.25	.74
Depreciation	55,246	20,164,000	6.75	40,707	14,858,000	5.22	1.53
Amortization of process royalties and start-up expense	2,671	975,000	.33				.33
Housing and community facilities - net	21,461	7,833,000	2.62				2.62
Total operating costs	193,191	70,515,000	23.62	96,989	35,401,000	12.43	11.19
Total costs	228,240	83,308,000	27.90	137,586	50,219,000	17.64	10.26
Interest, federal income taxes and return:							
Interest expense				23,672	8,640,000	3.04	(3.04)
Interest income				(11,836)	(4,320,000	(1.52)	1.52
Federal income taxes	77,737	28,374,000	9.50	24,112	8,801,000	3.09	6.41
Return	77,737	28,374,000	9.50	28,123	10,265,000	3.61	5.89
Total interest, federal income taxes and return	155,474	56,748,000	19.00	64,071	23,386,000	8.22	10.78
Total cost and return	383,714	140,056,000	46.90	201,657	73,605,000	25.86	21.04
Less - Sales of by-products	45,171	16,488,000	5.52	115,905	42,305,000	14.87	(9.35)
Gasoline	$338,543	$123,568,000	41.38	$ 85,753	$ 31,300,000	10.99	30.39