. . . . . Petroleum Storage for National Security. . . . August 1975

A Report of the National Petroleum Council . . . . .

National Petroleum Council
(Established by the Secretary of the Interior)

August 6, 1975

My dear Mr. Secretary:

On behalf of the members of the National Petroleum Council, I am pleased to transmit to you herewith the National Petroleum Council report *Petroleum Storage for National Security*, approved by the Council at its meeting on August 6, 1975. The attached study, which is in response to a December 31, 1974 request from Assistant Secretary of the Interior, Jack W. Carlson, stresses the urgency of creating a crude oil national security storage system and recommends a plan for establishing a sound program. The recommended program includes a 500 million barrel crude oil reserve held in U.S. Gulf Coast salt domes and connected to the existing and planned petroleum logistical system. The Federal government's share of production from the Naval Petroleum Reserve at Elk Hills, California is recommended to form the basis of fill.

Although determination of the optimum amount of crude oil that should be placed in the security storage system is based on numerous subjective decisions, the National Petroleum Council believes that a 500 million barrel program is a sound objective. A substantially smaller volume would provide little ability to withstand an import interruption, whereas a much larger effort would be excessively costly in terms of direct investment and diversion of manpower and materials from other needed areas. A much larger petroleum storage system would encounter diminishing added security benefits; and as the size of the program increases, costs of oil placed in storage may well rise. Moreover, over the longer term, genuine security of supply can be obtained only by sharply reducing the Nation's dependence on imported fuel supplies.

Based on refinery/logistical analyses, the NPC recommends that a crude oil security storage system be developed. If a future interruption were all crude oil, only minor, readily covered product shortfalls would occur. In a 3 million barrel per day interruption of 60% crude oil and 40% refined products, most product requirements could be met. The only potentially significant product shortfall calculated was on the order of 400 to 600 thousand barrels per day of residual fuel oil on the U.S. East Coast. A number of options, such as refinery yield flexibility, distillate blending, reduced demand and fuel conversions, were analyzed and considered probably adequate to cover such a shortfall. However, specific further steps are recommended to verify this conclusion.

I would like to express the Council's concern over proposals which appear to provide quick security storage solutions, for the Nation must realize that no practical quick solutions exist and begin now on a comprehensive program such as the one proposed in this report. Attempts to implement near-term, temporary security storage could seriously dilute efforts to achieve the more meaningful ultimate program by providing a false sense of security, misdirecting resources and confusing program priorities. In short, a make-shift program may be of less value than no program at all.

It is imperative to underscore the urgency of the Federal government's proceeding immediately with a crude oil security storage program. The time

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for studies is over and we must now proceed with specific impelmentation planning. This phase can be best expedited with least risk of costly mistakes and needless delays if major decisions are made with access to the knowledge of experienced industry personnel. Sound professional advice will be required on siting of storage and terminal facilities, sizing of storage pumps, pipelines and a host of related matters in order to assure the optimum integration of the security storage system into the U.S. petroleum logistical system. Provisions must be made for formal access to the expertise of the petroleum industry: The National Petroleum Council and the industry stand ready to provide whatever assistance possible.

I call your attention to the recommendation of the Council that the Federal government own and control the entire crude oil security storage capability. Because the Council believes strongly that the free market system will provide the greatest degree of long-term energy security, the decision that the Federal government should own and control the entire security storage capability was a difficult recommendation to make. This recommendation reflects the fact that a national security petroleum storage program is designed to provide insurance against a threat to the Nation's economic well-being and to its military security. The beneficiaries of a security storage program are the Nation as a whole, its economy, and all its people in their roles as producers and consumers. Further, this recommendation reflects the very large financial burden of the program, the ownership of crude by the government through production of Elk Hills, and the necessity of the private sector to devote its resources to the very formidable task of increasing domestic energy supplies. There simply is not enough money for the petroleum industry to undertake both efforts simultaneously. In the next several years, when a security storage system would be implemented, industry's capital requirement will double or triple. In fact, serious concern exists over the industry's ability to generate the required capital for needed energy resource development.

In the design and implementation of a security storage program, we must also not lose sight of the real keys to long-term security of supply--the strenuous implementation of fuel conservation measures and a greatly expanded effort to increase production of domestic oil, gas, and other forms of energy. If we are able to take effective steps to reduce our dependency upon foreign energy supplies, we will most certainly minimize the danger of the crippling effects of import interruptions upon the U.S. economy and effectively reduce our future investment requirements in security storage.

The National Petroleum Council sincerely hopes that this study will be of benefit to you and the Federal government in the difficult decision-making process that lies ahead.

Respectfully submitted,

John E. Swearingen

John E. Swearingen
Chairman

Honorable Stanley K. Hathaway
Secretary of the Interior
Washington, D. C.

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A Report of the National Petroleum Council . . . . .

. . . . . . Prepared by the National Petroleum Council's Committee on Emergency Preparedness . . . . Carrol M. Bennett, Chairman . . . . with the Assistance of the Coordinating Subcommittee . . . . Edward T. DiCorcia, Chairman. . . . . . .

NATIONAL PETROLEUM COUNCIL

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Industry Advisory Council

to the

U.S. DEPARTMENT OF THE INTERIOR

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PETROLEUM STORAGE FOR NATIONAL SECURITY

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INTRODUCTION

PURPOSE

Pursuant to the December 31, 1974 request from Assistant Secretary of the Interior, Honorable Jack W. Carlson, the National Petroleum Council (NPC) presents herein its study of the major factors involved in the implementation of a security storage system similar to that recommended in the NPC report of September 10, 1974 entitled, Emergency Preparedness for Interruption of Petroleum Imports into the United States. In addition to developing a more in-depth analysis than was presented in the material previously submitted to the Secretary of the Interior on this subject, this report focuses on the logistical, economic and environmental considerations of the program.

This report first analyzes the NPC's recommended crude oil storage system from the standpoint of logistical and refining capabilities. The ability of such a system to cover specific regional product shortages which might occur as a result of an interruption of crude imports or a combination of crude and product imports is evaluated to determine the need for supplementary product storage programs. Based on the conclusions of this analysis, which show that the security storage system should be filled predominantly with crude oil, the possible alternative sources of fill are then discussed. The physical storage facilities and their associated costs have been discussed in previous NPC reports(1) and are updated in light of current technological and economic conditions with emphasis on environmental protection. A storage program of the magnitude envisioned by the NPC could have an initial cost in excess of $7 billion. The financing problems of such a system are analyzed and various alternatives are suggested. Since the Federal Government will be involved throughout the development and operation of a petroleum security storage system, a number of actions that the government could take to expedite implementation are identified as well as some of the effects of governmental inaction. Finally, the recommended security storage system is compared with that maintained by other nations and with that suggested by international agreement.

It is intended that this report present pertinent policy options and their implications to assist the Secretary of the Interior in his deliberations regarding the implementation of a security storage system. The options are numerous and the costs in absolute terms are high. By design this report has not addressed all conceivable options, but is focused on those options the Council believes would offer the Nation the lowest cost and greatest overall benefit.

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(1) Underground Petroleum Storage Facilities, 1952. Emergency Preparedness for Interruption of Petroleum Imports into the United States, Interim Report, July, 1973, and Final Report, September, 1974.

BACKGROUND

NPC Reports

On September 10, 1974, the National Petroleum Council approved and transmitted to the Secretary of the Interior a report entitled, Emergency Preparedness for Interruption of Petroleum Imports in the United States. That report was made pursuant to requests from the Secretary of the Interior in December, 1972, and January, 1973, asking the Council to examine options that may be available to the United States in the event that supplies of imported petroleum--up to 3 million barrels per day (MMB/D)--were interrupted for a period of up to 6 months. The September Report outlined a number of options for an overall program of emergency preparedness which would include measures for energy consumption reduction, conversion to alternate fuels, additional oil and gas production, and maintenance of emergency standby petroleum supplies. The Council concluded that while all four avenues should be pursued vigorously, a standby petroleum reserve would be the major factor in compensating for a future embargo or supply interruption.

In the September Report, the Council stated:

> It is clear that a substantial volume of petroleum security storage is needed within the United States and that efforts to implement such a program should begin immediately because of the long construction lead time involved.

Further, the Council stated that its study "indicates that 500 MMB of crude storage in combination with normally available inventories will provide 90 to 180 days of supply for a large percentage range of crude imports presently foreseen."

In a letter dated December 31, 1974, the Assistant Secretary of the Interior, Honorable Jack W. Carlson, cited the recommendation of the Council for a security storage reserve and requested the Council to:

> ...undertake as a matter of urgency a study of the major factors involved in the implementation of a security storage system....Your analysis should include, but not necessarily be limited to, discussions of; the optimum size of the security storage system in terms of total volume and deliverability; the alternatives available for providing this storage as expeditiously as possible; the financing problems which could be expected to arise; the sources and types of fill for the storage; and Federal actions that could assist in expediting the development of the security storage system as well as Federal actions that might deter development. In addition your analysis should include discussions of the relative needs for crude versus product storage and any specific geographical, logistical or environmental problems which you would anticipate to be encountered were the Nation to be confronted with another energy emergency. (See Appendix A for Request Letters.)

The Committee on Emergency Preparedness of the National Petroleum Council was reactivated and charged with preparing for the Council's consideration a report in response to the Secretary of Interior's request. The Committee was chaired by Carrol M. Bennett, Chairman of the Board, Texas Pacific Oil Company, and assisted by the Coordinating Subcommittee, chaired by Edward T. DiCorcia, Assistant General Manager, Supply Department, Exxon Company, U.S.A. (See Appendix B Committee Rosters.)

Embargo Experiences and Long-Term Supply/Demand Outlook

From mid-October, 1973, to mid-March, 1974, the United States experienced an embargo of oil shipments by a number of exporting countries, the fourth sudden oil import stoppage of political origin in the past 25 years. This was the first time the country found itself without spare domestic producing capacity to offset such interruptions, and shortage conditions resulted. The embargo sharply reduced the amount of oil exported to the United States and other countries and, at the same time, world prices for crude oil and petroleum products escalated. However, the effects of the embargo on the United States supply situation were not felt immediately. The long supply lines from the Middle East to the United States provided considerable lag time, but, by mid-December reduced receipts of petroleum became apparent, with the full impact of the embargo--about 2.2 MMB/D--occurring during January, February, and March of 1974.

It has been estimated that the cutback in petroleum consumption during the first quarter of 1974 was accompanied by a 7 percent decrease in real Gross National Product (GNP); whereas, a modest increase had been expected prior to the embargo. Unemployment also increased during the embargo. There was substantial disruption of petroleum markets and considerable inconvenience and apprehension was caused for various segments of the consuming public. The situation might have been worse were it not for conservation efforts and for the occurrence of unusually mild winter weather. If the United States were to have available, at the time of a potential future import interruption, a petroleum reserve system of sufficient deliverability and capacity to compensate for the majority of supplies denied, effects such as those experienced during the 1973-1974 interruption could be mitigated or perhaps prevented entirely.

In order to evaluate the Nation's future import dependency, the Council in its previous Emergency Preparedness Study found it necessary to have an updated longer term supply/demand outlook. The staff of the National Petroleum Council was requested to poll several private sources of then current United States energy supply/demand projections and developed an average or "medium" case to reflect the consensus of data received. The data in that survey were based on knowledge and conditions that existed in the summer of 1974. Implicit in the survey's medium case is a relatively stable but high level of imports in the period 1978 to 1990. These import projections, as shown in Table 1, average 8 MMB/D.

TABLE 1

SURVEY OF PROJECTIONS OF TOTAL U.S. PETROLEUM IMPORTS
(Million Barrels Per Day)

	1978	1980	1985	1990
High Range of Data Received	9.4	10.2	12.5	12.0
Low Range of Data Received	5.2	5.3	5.4	4.0
Calculated Medium Case	7.8	7.8	8.4	8.1

Source: NPC, Emergency Preparedness for Interruption of Petroleum Imports into the United States, September, 1974, Table 17, Page 54.

The medium case projection of about 8 MMB/D total crude and products imports through 1990 might be reduced by approximately 1 MMB/D through various conservation measures, leaving a possible 7 MMB/D import rate to be protected by security storage in the 1980's. It is unlikely that there would be a total denial of such imports, and to provide long-term insurance against the risk of loss of all imports does not appear to be cost-effective. The most effective protection against an interruption of imported oil is to achieve the highest practical level of domestic energy self-sufficiency through maximum development of domestic energy resources. Nevertheless, effective emergency preparedness plans which include security petroleum storage can provide the United States with substantial protection against the effects of a future import interruption, such as one which might result from an embargo imposed by exporting nations or from natural or man-made damage to critical producing or transportation facilities.

SUMMARY OF OVERALL EMERGENCY PREPAREDNESS CONSIDERATIONS

This report differs from previous NPC Emergency Preparedness reports in that it deals with just one facet of overall emergency preparedness planning--security storage. For reference, the Council's prior conclusions regarding other available alternatives for response to import denials are summarized below.

Conversion to Alternate Fuels

Potential petroleum savings from conversion of gas and oil burning industrial and utility boilers to coal during the first 90 days of an interruption were estimated to physically total 250 thousand barrels per day (MB/D) (23 million tons[MMT] of coal), but actual savings were estimated to be more likely within a range of 40 to 120 MB/D, recognizing the constraints involved in coal production, transportation, and environmental standards. Actual savings achieved during the first quarter of 1974 were 61 MB/D. The Energy Supply and Environmental Coordination Act of 1974 provides the authority to require oil and gas burning power plants to switch to coal, and also permits the Federal Government to direct that new power plants use coal as the primary energy source. It is anticipated that much of the additional potential for conversion to coal will be realized over the next several years on a non-emergency basis; therefore, there will be little future emergency coal substitutability for oil and gas in industrial or utility plants by the 1980's.

Emergency Production

Legal, physical and economic problems precluded temporarily increasing oil and gas production from private fields during the 1973-1974 embargo. There are several oil fields in Texas which, on a temporary basis, have producing capability above their long-term maximum efficient rate (MER);(2) however, the potential from currently producing fields will decline over time. Thus, this source could provide only a small amount (about 100 MB/D in 1978) of the required volume of emergency supplies in the event of an import curtailment even if the many problems could be overcome. The primary known untapped source of temporary additional production is the Naval Petroleum Reserves(NPR).

Reduction of Consumption

Consumption reduction is a fast and effective response in an energy emergency. In many cases, consumption can be curtailed promptly and with little or no capital investment. In other instances, reductions require investments and time to produce results. A review of each of the major energy-use sectors indicated potential emergency consumption reductions totalling approximately 1 MMB/D in 1980 and 1985 as still being available (above base case on-going conservation) to utilize in response to an imports denial.

Emergency Standby Petroleum Supplies

Three basic alternatives for providing standby supplies to offset a sudden loss of imports were considered:

- Shut-in or reduce production from domestic oil fields,
- Store refined petroleum products, and
- Store crude oil after production.

(2) MER is defined as the highest rate of production that can be sustained over a long period of time without reservoir damage and significant loss of ultimate oil and gas recovery. Production in excess of MER for sustained periods may result in both loss of recovery and premature loss of producing capacity.

Shutting-in or reducing production from domestic fields would reduce the supply of indigenous oil and gas available to the United States economy. In order to maintain consumption, a corresponding increase in imports would occur with attendant adverse affects on the U.S. economy and balance of payments. Additionally, maintaining a security storage system in natural reservoirs is highly inefficient when compared to maintaining readily deliverable petroleum reserves after production. It was therefore the conclusion of the September, 1974 report that the Nation should maintain a strategic reserve of produced petroleum. Further, the Council recommended that first consideration should be given to providing crude oil storage to protect domestic refinery runs. The NPC study indicated that 500 MMB, together with normally available inventories, would provide 90 to 180 days of a large percentage range of crude imports foreseen.

FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

The Nation has become increasingly dependent on oil imports, which currently constitute 35-40 percent of United States oil consumption and about 20 percent of total energy consumption. The purpose of national security petroleum storage is to reduce the Nation's vulnerability to possible future denials of imported oil which might occur for political reasons to bring pressure for changes in United States foreign (or even domestic) policies, or as a result of armed conflict in foreign producing areas. Based on previous NPC estimates, a future embargo or similar event which resulted in the loss of 3 MMB/D of United States oil supplies for an extended period of time could cause a reduction in real gross national product of such magnitude that, translated into human terms, could result in more than two million workers losing their jobs. Economic effects of this magnitude could not be confined to any one industry, any one group of consumers, or any one geographic area, but would affect the entire Nation. The Council believes that it is incorrect to assume that only selected industries (such as the petroleum industry), selected consumers (such as automobile owners), or selected areas of the country (such as the Atlantic coastal states), primarily benefit from insurance against a future interruption of oil imports. A national security petroleum storage program is designed to protect the Nation against a threat to its economic well-being and to its military security. The beneficiaries of a security storage program are the Nation as a whole: its economy, and all its people in their roles of producers and consumers.

The nature and purpose of petroleum security stocks needs to be clearly distinguished from the substantial working stocks of crude and products maintained by industry. These stocks are owned and financed by the many private companies that make up the petroleum industry for the purpose of operating efficient supply systems in every region of the country. In order to furnish this highly complex service reliably, highly fragmented and widely dispersed increments of working stocks are used by the many individual competing companies to assist in preventing interruption to their customers' supplies, which might result from a wide variety of daily operating contingencies (such as tanker and barge delays, refinery equipment shutdowns, pipeline outages, etc., as well as for seasonal demand variations). National security petroleum stocks on the other hand are intended to provide insurance against an entirely different contingency, and would be used and controlled under entirely different circumstances.

The goals of an effective petroleum security storage program include:

- Security storage facilities built with sufficient capacity to insure against a reasonable range of anticipated risk.

- Facilities designed and located for quick and efficient movement of security stocks into the U.S. supply system to replace lost imports.

- An expeditious construction schedule (as import levels and vulnerability are already significant and growing).

- Petroleum security stocks that are clearly distinguished from working stocks of crude and product maintained by industry.

- Minimum program cost distributed equitably to beneficiaries.

- Tight control of system operation to ensure that the security stocks are actually on hand in the event of an emergency.

- Avoidance of undue complexity in ownership, financing and administrative requirements.

- Provide the benefits of petroleum security storage without reducing energy resource development.

The summary findings, conclusions and recommendations of this report are listed below, and are intended to respond to the questions directed to the Council in Assistant Secretary Carlson's letter of December 31, 1974.

I. OPTIMUM SIZE OF STORAGE SYSTEM AND RELATIVE NEEDS FOR CRUDE VERSUS PRODUCT STORAGE

Total petroleum imports in the United States in 1978 to 1990 are estimated in this report to average approximately 8.1 MMB/D, or 1.2 MMB/D higher than immediately prior to the 1973-1974 Arab oil embargo. Crude oil imports have been estimated to increase to approximately 5.5 MMB/D, or 2 MMB/D more than in November, 1973. In the 1980's, emergency energy conservation measures are estimated to be available to reduce total petroleum demand in the U.S. by about 1.0 MMB/D, leaving a net shortfall of about 4.5 MMB/D if there were a total crude oil denial, or about 7 MMB/D in the unlikely event of a total petroleum imports denial. Therefore, 500 MMB of security storage might cover a total imports denial of 70 days and a total denial of crude oil for 110 days. In addition to the protection offered by such volumes in security storage, protection (time to implement emergency preparedness plans) would be provided by volumes of crude and product in transit at the time of an interruption and that in usable United States working inventories. Further, import interruptions of total imports are considered highly unlikely. Thus, actual supply coverage afforded by a 500 MMB program in response to a more likely 3 MMB/D denial, in conjunction with other emergency measures, should exceed 6 months.

While it cannot be predicted what proportion of crude imports denied would be low-sulfur content crude, currently about one-third of foreign crude imports can be classified as low-sulfur content. It is, therefore, reasonable that security storage facilities be designed for segregated storage such that at least one-third of the crude fill be low- to medium-sulfur content crude oil.

In order to answer the question of crude versus product storage, projected petroleum supply and demand patterns were examined to assess the probable impact of a future petroleum import denial. Feasible refining and logistical responses were explored, specific product shortfalls were estimated, and appropriate emergency steps were developed for relieving the indicated shortfalls. Two 3 MMB/D import denial cases were examined: the first was a loss of only crude; the second was a combination of 60 percent crude and 40 percent product denial. An assessment was made as to where a future embargo would likely impact geographically. The petroleum industry response to the estimated product shortfalls was based on the historical incremental U.S. refining yield patterns for 1969 through 1973 (as reported by the Bureau of Mines), and was determined for three types of security storage crude in order to test for crude quality characteristics. In the crude denial case, only minor product shortfalls were calculated; however, these were shown to be readily covered within the capabilities of demonstrated refinery flexibility. Therefore, a crude denial alone appears manageable with security crude storage.

It should be noted, however, that processing of crude does not significantly affect liquified petroleum gas (LPG) production. Therefore, any future requirement for imported LPG should not depend on crude oil security storage for import denial protection.

The logistics analysis suggests that security crude stocks could be run in offshore (Caribbean) refineries based on the expected spare capacity of these refineries during a combined crude and product embargo situation. This expected spare capacity is based on the assumption that a product import denial resulting from a crude supply denial will be distributed in historical proportions among the normal United States sources. The United States has traditionally relied on Caribbean refiners to supply a high percentage of total United States residual fuel oil demand. The Caribbean refineries are located in areas that have historically been friendly to the United States and are an integral part of the refining capacity normally serving the United States market and should, therefore, be utilized in an embargo situation. The security storage crude delivery logistics of supplying these refineries are similar to those for delivering crude out of Gulf Coast security storage to East Coast refineries.

The expected overall response to a crude and product denial indicates that most product requirements could be met. The only potentially significant product shortfall after processing security storage crude is a possible 400 to 600 MB/D residual fuel oil shortfall for PAD I's requirement. A number of alternative steps, such as demonstrated refinery yield flexibility, distillate blending, reduced demand, and fuel conversion, were considered to cover this shortfall and are estimated to result in a range of additional residual fuel oil available of 460 to 830 MB/D. In addition, the non-quantified effects of implementing extraordinary refinery yield flexibility steps and storing higher residual yield crudes might be available. Furthermore, in an emergency petroleum supply interruption under the provisions of the International Energy Program (IEP) Agreement, fuel oil could be allocated to the United States in lieu of crude. Therefore, it would appear that covering a 400 to 600 MB/D shortfall might be achieved although there is some uncertainty in this analysis.

Thus, refining/logistical analyses indicate that with the possible exception of residual fuel oil on the East Coast, a substantial denial of crude oil and/or refined petroleum products could be covered with a crude storage program. To confirm the extent of a potential residual fuel oil shortfall resulting from interruption of imported products, an independent and detailed survey is needed of individual refineries located in PAD Districts I and III (and possibly the other districts) to determine their physical capability and flexibility to produce and ship residual fuel oil in an emergency. It is believed that these refiners can respond by a rapid change in product mix, although this may require non-optimum operating steps such as by-passing or shutting down refinery units and/or diverting asphalt or other products. The extent to which refineries, logistically connected to the Northeastern states, can increase fuel oil availability is highly dependent on the individual refinery's processing and shipping facilities and has not previously been documented. Pending results of such a survey, together with a further assessment of other potential residual fuel emergency steps, final decision as to the need, if any, for high cost fuel oil security storage should be deferred.

I. *Based on the above findings and conclusions, the National Petroleum Council recommends: The first objective of the national security storage program should be to store approximately 500 million barrels of produced crude oil of which at least one-third is low in sulfur content.*

II. SOURCES AND ECONOMICS OF CRUDE FILL FOR SECURITY STORAGE

The four principal sources of crude oil which have been considered for security storage fill are:

- Domestic crude oil;
- Foreign crude oil purchased and transported to storage;
- Federal royalty oil; and
- Crude oil from Naval Petroleum Reserve No. 1(NPR-1).

Security storage crude oil ideally should be of a composition to facilitate ready substitution in the refining capacity denied imports with minimal shift in desired product yield and quality; and deterioration to processing and handling equipment. In addition to using conventional crude oil, synthetic oil derived from a source such as shale was considered, but its cost was found to be substantially higher, and its availability more distant by several years.

With the exception of oil obtained from the Naval Petroleum Reserve, the other sources are already being utilized to meet base domestic consumption and their diversion to security storage would require a net increase in foreign imports. Increasing the national requirement for foreign imports is in conflict with current federal energy policy objectives. Cost of the fill to the Nation would be effectively the cost of the foreign crude used for replacement, including tanker transportation. Payment in dollars to the foreign producer would be in the direction of adversely affecting the balance of trade.

Purchased Foreign Crude

Security stocks for use in future import supply interruptions could be obtained by the purchase of foreign production rather than domestic production. Host governments, from which the crude would be supplied, might consider the use of oil produced in their countries directly for this purpose, contrary to their national interest. However, the International Energy Program (IEP) Agreement and the United States' intentions to create a national security reserve, are matters of public record. It is not possible to predict what adverse actions, if any, might be taken against the United States if it chose to acquire foreign crude for security storage fill.

Federal Royalty Crude

The amount of federal royalty oil production reached a peak volume of 88 MMB for the year 1971. The year-to-year volume has trended slightly downward since then and totalled 80 MMB in 1974. Federal royalty oil has been set aside in the past for sale to small refiners who qualify under the rules of the Small Business Administration. In 1974, 53 percent of the federal royalty oil was supplied to this group. Royalty oil remaining after meeting the demand of eligible refiners -- 38 MMB in 1974 -- is sold to the lessee or to the operator of the lease. As is the situation with regard to purchased domestic crude, since federal royalty oil is now a portion of base domestic supply to United States refineries, its diversion to security storage would require replacement with imports to balance the Nation's current needs.

Elk Hills Crude

The NPR-1 (Elk Hills field) situated in Kern County near Bakersfield, California is reserved by law for use in a national emergency and requires authorization by the President with the approval of Congress for production in excess of the minimum required to maintain the field in a state of readiness and to prevent drainage from adjacent commercial wells. Average current production from this field is about 3 MB/D.

The field is reported to have total proven reserves in excess of 1 billion barrels with possible additional reserves estimated at 0.5 billion barrels as exploration proceeds.

The shallow zone crude, which represents approximately one-third of the Elk Hills reserves, as typified by an October, 1974 sample, had a 20° API gravity and a sulfur content of 0.9 weight percent. The gravity of Stevens zone crude, comprising about two-thirds of the Elk Hills reserves, ranges from 28° API to 38° API. Sulfur content ranges from 0.3 to 1.5 weight percent. A sample of Stevens zone crude taken in December, 1973, which might be indicative of the average quality of this zone, had a gravity of 31.5° API and a sulfur content of 0.65 weight percent. Based on these characteristics Elk Hills crude is ideally suited for use in a national security storage system.

Given the necessary legislative approval and funds, a production rate of 130 MB/D could be possible within several months and, with continued development, an ultimate short-term production rate of 400 MB/D might be achieved by 1980. Maximum ultimate recovery of hydrocarbons from the field can be achieved by limiting production to the long-term maximum efficient rate (MER) of the field. The MER currently reported to be 267 MB/D may be revised after completion of the current drilling program. If a sustained rate of 267 MB/D could be maintained, the Navy's share of the production (80 percent) would completely fill a 500 MMB produced crude security storage system in 6 to 7 years. Production and transfer to storage could continue after 500 MMB should a larger storage system be desired.

Sale or Exchange of Federally-Owned Crude Oil

If federally-owned crude oil (royalty or NPR-1) were to be the basis of a national petroleum security storage program, public sales and/or place and time exchanges might be made to deliver security crude oil into Gulf Coast storage at lower transportation cost. In the case of NPR-1 crude, there could be a transportation advantage for delivery of that crude to West Coast refiners in exchange for comparable crude oil delivered to security storage locations in the Gulf Coast.

Funds generated by domestic sale of federally-owned crude oil might be used to purchase other crude which would incrementally be foreign oil. If it is assumed, as it has been throughout this study, that NPR-1 crude oil would not otherwise be produced for inclusion in the domestic raw material base, funds generated from the sale of NPR-1 crude oil could be used to offset the purchase cost of foreign oil with little, if any, effect on the level of imports or balance of payments. However, the possibility of sale and/or exchange for NPR-1 crude oil in PAD District V to accomplish equivalent security storage fill in PAD District III may become less likely as Pacific Outer Continental Shelf (OCS) resources are developed and as North Slope oil becomes available in District V.

During the 1980's, there will be a significant westward shift in the center of domestic petroleum supply, moving directionally away from the consuming regions most vulnerable to an interruption of imports. National emergency preparedness would be served if the heretofore largely independent crude oil and product logistical systems of PADs I-IV and PAD V were connected, as has been advanced in several proposals. West Coast to Texas pipeline systems may be built sometime in the future. The likelihood of construction might be improved if a program is instituted to move NPR-1 produced crude oil, or equivalent by sale or exchange in PAD V, to security storage in the Gulf Coast.

Economics of Security Crude Fill

Since both purchased domestic crude and federal royalty crude must be replaced by imports, cost of these sources is effectively the same as that of purchased replacement foreign oil or about $6.5 billion for 500 MMB (1975 dollars).

Under the assumption that NPR-1 crude would not be produced except as a national security resource, cost of fill from this source would be equivalent to the out-of-pocket production costs for development and operation of the field, or about $1.50 to $2.00 per barrel. Transportation to the Gulf Coast in an assumed pipeline is estimated to cost $1.15 to $1.35 per barrel, resulting in a total expenditure cost to the government of approximately $1.5 billion for 500 MMB (1975 dollars). The costs of the four alternative sources of fill are summarized below:

SOURCES AND ECONOMICS OF CRUDE FILL

Source	Delivered Cost ($/B)
Purchase Foreign Crude	12.00 to 14.00
Domestic Crude	Equivalent to Foreign
Federal Royalty Crude	Equivalent to Foreign
Elk Hills Crude	2.65 to 3.35

If, however, the assumption were made that legislation is passed to permit the Naval Petroleum Reserves to be produced and sold into the domestic economy, diversion in that instance to security storage would result in foregoing a potential decrease in imports. Under this assumption, the cost of fill would be the same as the other sources which is effectively the cost of replacement foreign crude oil, or $12.00 to $14.00 per barrel (1975 dollars).

Thus, the Council concludes that Elk Hills crude in NPR-1 is the logical choice as a basis of security storage fill since it is the only source of fill which would probably not increase foreign imports and is the lowest expenditure cost alternative. Assuming the Naval Petroleum Reserve would not otherwise be produced, the cost to the Nation would be the out-of-pocket production costs plus transportation to the storage site, either physically or by exchange. NPR-1 should be developed to produce at its maximum efficient rate on a sustained basis and pipeline capacity out of the reserve should be increased. These measures could be completed by the time Gulf Coast salt dome storage projects could be ready to accept fill in 1979. The value of NPR-1 to the Nation as a strategic reserve would, thereby, be greatly enhanced as its deliverability in time of need would, in effect, be increased from its current 3 MB/D to over 3 MMB/D.

II. *Based on the above findings and conclusions, the National Petroleum Council recommends: The Naval Petroleum Reserve at Elk Hills should be developed and produced. The Federal Government's share should form the basis of crude security stocks.*

III. STORAGE FACILITIES: CONSTRUCTION, COST, LOCATION DESIGN, AND ENVIRONMENTAL CONSIDERATIONS

Construction and Cost Considerations

Security storage of crude or refined products can be located aboveground in steel tanks or underground in caverns leached in salt or mined in hard rock. The primary advantage of steel tank storage is locational flexibility and the ease with which supplies can be integrated into the existing petroleum logistical system. The major disadvantage is cost which is estimated to range from $6.00 to $12.50 per barrel (1975 dollars), depending on tank size, location, and local conditions.

There are three proven methods of storing crude after production and refined petroleum products underground: (1) abandoned underground mines that have been specially adapted for storage, (2) new cavities mined in hard impermeable rock formations such as granite, shale, or limestone, and (3) existing or new cavities leached in salt domes or salt beds.

Storage of crude in specially converted abandoned mines is a proven technique. Under ideal conditions, costs for this type of storage can be competitive with salt dome storage. However, the potential for use of abandoned mines for United States storage purposes does not appear promising. It would likely be more practical to mine new caverns in suitable rock formations than to try to utilize abandoned mines. The cost of new mined storage caverns would be competitive with the cost of steel tanks for storage volumes in excess of 1 MMB.

A salt dome is a massive column of rock salt, typically 0.5 or more miles wide, thrusting upward from many miles below the earth's surface and topped by a caprock. There are more than 350 known salt domes within a 50,000 square mile area along the Gulf Coast. Many of these salt domes are located near: the major Gulf Coast refining centers (Houston, Beaumont/Port Arthur, and New Orleans/Baton Rouge), and the Gulf of Mexico and major inland waterways (Houston Ship Channel, Port Arthur [Sabine] Ship Channel, and the Mississippi River). Underground petroleum storage projects have an excellent record of safety and reliability based on more than 20 years of experience. Individual storage caverns of more than 5 MMB capacity, each, can be constructed with existing technology.

Based on a study of several Gulf Coast salt domes, underground storage in leached salt dome cavities can be provided at an initial cost of $0.70 to $1.15 per barrel (1975 dollars), depending upon the cost of pipelines required to connect the storage to distribution facilities and the distance from suitable water sources and brine disposal areas. This estimate applies to large volume projects (250 MMB) with individual caverns of 7 MMB. The low end of the cost range will be typical of a project located on dry land near the Gulf and major crude trunk lines. The high end of the cost range will be typical of a project located up to 50 miles from the Gulf with a somewhat longer crude delivery line. Facilities to permit tanker loading during an emergency will add an additional 15¢ to 40¢ per barrel to this cost. Thus, the likely storage facility cost range appears to be from $0.85 to $1.55 per barrel (1975 dollars). Combined with the expenditure costs of Elk Hills production, the total recommended program would cost $3.50 to $4.85 per barrel, or $1.8 to $2.4 billion for a 500 MMB program, as shown below:

SECURITY STORAGE COSTS

Facilities	($/B)	MM$ for 500 MMB
Salt Dome Storage (250 MMB Projects)	0.70-1.15	350- 575
Tanker Loading	0.15-0.40	75- 200
Total Cost of Facilities	0.85-1.55	425- 775
Fill		
Elk Hills Production Costs	1.50-2.00	750-1,000
Pipeline Transportation to Gulf Coast	1.15-1.35	575- 675
Total Cost of Fill	2.65-3.35	1,325-1,675
Total Cost for Recommended Program	3.50-4.85	1,750-2,425

If environmental studies begin promptly and engineering design starts in January, 1976, storage fill could begin in 1979. The leaching phase for a 250 MMB facility could be reduced from 3 to 1-1/2 years, at an additional cost of 10¢ to 35¢ per barrel (1975 dollars), which might enable completion of the fill perhaps a year or so earlier than with the normal schedule. However, this could be justified only if crude can be made available at a rate sufficient to accelerate storage fill.

There are certain domes where a number of very large cavities already exist as a result of salt mining operations. While such cavities may be suitable for crude storage, detailed studies have to be made to ensure structural integrity and to determine which cavities could be safely utilized. In addition, facilities such as pipelines and tanker docks have to be constructed to permit delivery of crude into or out of storage, and this would likely require several years. Thus, while some storage in existing domes might be made available prior to 1979, additional information will be required to determine the practicality of such projects.

Storage leached in salt beds is also a proven technique; however, the potential utility of such beds for security storage projects is limited. Most salt beds are located inland where fresh water costs are relatively high and where subsurface brine disposal would be required with attendant environmental problems. Further, placement of the security storage program in these locations would be logistically less efficient than in the Gulf Coast.

Location and Design Considerations

If the Gulf Coast offshore terminals, LOOP and Seadock, are constructed, the most efficient and lowest cost system would be one 250 MMB storage facility integrated with each terminal. If more than 500 MMB of storage capacity is to be provided in the program, additional 250 MMB units could be leached. Upon completion of the deepwater port facilities, imported crude could flow to most of the refining capacity in PAD Districts II, III and IV. It is also feasible to design deepwater terminals so that tankers can load crude for shipment to other United States ports, if such a need is incorporated in the initial deepwater terminal design. Thus, with proper location of salt dome storage projects, a large percentage of refining capacity east of the Rockies can effectively be supplied with crude out of Gulf Coast salt dome storage during an emergency. Caribbean refineries could also be supplied if necessary.

If Gulf Coast deepwater terminals are not available in time to meet the desired program completion schedule, a different set of salt domes might be selected for storage. In this case, it is likely that at least three salt dome projects would be required for optimum logistical efficiency: one near the Houston Ship Channel refining center; one near the Beaumont/Port Arthur (Sabine) Ship Channel refining center; and one near the Capline terminal on the Mississippi River. These inland waterways could be utilized to transport imported crude to major refining centers in the absence of deepwater terminals. The absence of deepwater terminals would add about 20¢ to 40¢ per barrel to the initial storage cost of $0.70 to $1.15 per barrel, depending on the percentage of crude delivered to adjacent crude pipelines.

The required delivery rate of crude out of storage is difficult to define because it depends on both the future level of imports and the rate at which imports are interrupted. Consideration should be given to a high design delivery rate out of storage, perhaps as much as the total United States crude and product import rate less emergency curtailment volume. Even though a total import denial appears unlikely, the cost of providing such a delivery rate capability should be a small percentage of total crude storage system costs. Spare delivery rate capacity would provide flexibility to offset possible downtime for facility maintenance, bad weather, sabotage, etc., at one or more sites. On this basis, if two 250 MMB projects are to constitute the security storage program, each project should be designed to deliver crude out of storage at a rate equal to at least the design throughput capacity of the adjacent deepwater terminal (i.e., about 2 MMB/D). In addition, allowance should be made for deliveries to other locations by tanker such as the East

Coast, the Caribbean, or non-pipeline connected Gulf Coast locations. This suggests a design rate of between 2 and 3 MMB/D at each location or up to 6 MMB/D of total delivery capacity. If more than two storage projects are provided, because deepwater terminals are not available or a system larger than 500 MMB is constructed, a design delivery rate as high as 2 to 3 MMB/D for each project might not be necessary.

Environmental Considerations

The leaching of salt dome caverns, while a fairly simple process, needs to be carried out carefully to protect the environment. A well is drilled into the top of the salt formation and several steel casing strings are set and cemented to protect fresh water beds and to seal off intervening formations. Fresh water (or sea water) is then pumped down an inner string of tubing. The salt is dissolved, and the resulting brine solution is circulated back to the surface for disposal.

It is recognized that storage area surface requirements, subsurface fresh water protection, brine disposal pipeline right-of-way requirements from the storage area to the offshore outfall, fresh water requirements, and brine disposal considerations associated with large volume storage projects raise questions concerning impact on the environment. These questions should be addressed concurrently with the site selection as a first order of priority after project authorization. Of particular importance is optimization of the brine disposal system design to minimize the environmental impact on marine life offshore and in nearby bays, marshes, and estuaries, and protection of onshore wildlife and human amenities. Environmental studies should include pipeline right-of-way routing and design to minimize disturbance, and offshore outfall location and distance to produce adequate dispersion of brine discharged at sea. Development of such plans and the necessary Environmental Impact Statements will require ecological studies of the pipeline route and the outfall area, including biological, chemical, botanical, and oceanographic studies. However, if storage projects are located near LOOP and Seadock as recommended, the extensive ecological surveys conducted for these projects over the past 2 years will be of significant benefit. The Environmental Protection Agency should be consulted at an early date in anticipation of securing a discharge permit under the National Pollutant Discharge Elimination System. While leaching and filling are under way, the system should be monitored to assure proper operation and compliance with discharge permit requirements.

Thus, it is concluded that storage in large caverns leached in Gulf Coast salt domes is the lowest cost system currently available. Individual salt dome storage facilities of 250 MMB (e.g., 36 caverns of 7 MMB capacity) could provide substantial economy of scale and can be installed on the Gulf Coast for $0.85 to $1.55 per barrel (1975 dollars), including tanker loading facilities. Crude security storage must be effectively integrated into existing and planned United States crude logistical systems, including direct access to tanker loading facilities as well as major trunk pipelines. A design delivery rate out of storage as high as the total United

States crude and product import rate less emergency curtailment volume should be considered. Even though a total import denial appears unlikely, the cost of providing such a high delivery rate capability could be a small percentage of total crude storage system costs, and spare delivery rate capacity would provide flexibility to offset inevitable facility outages.

III. *Based on the above findings and conclusions, the National Petroleum Council recommends: National security crude oil storage should be in caverns leached in Gulf Coast salt domes and connected to existing and planned U.S. petroleum industry logistical systems.*

IV. FINANCING, OWNERSHIP, AND CONTROL OF SECURITY STORAGE

Two basic options exist for the financing and/or ownership of a crude security storage program: government financing and ownership, or private financing and ownership. In addition to these two basic options, a number of hybrid government/private financing and/or ownership alternatives were examined. There is only one suitable option for control of national security storage: government control.

Private Ownership Alternatives

All Refiners and Importers

All refiners and all importers of crude and/or products could be required to expand their working stocks to provide a prescribed level of national security storage. Presumably, this approach could place the burden of security storage equitably on all refiners and all importers and would result in wide physical dispersion of stocks. However, this approach would require a massive administrative system to prescribe storage requirements for each participant and an extensive reporting and monitoring system to confirm the continued physical existence of the prescribed emergency stocks. Because the storage would be dispersed and stored primarily in aboveground steel tanks, economy of scale would be lost, and would be much more costly than large volume salt dome storage. Because of the varying impact on private participants, applications for relief from hardship and requests for exceptions are anticipated, resulting in delays and considerable practical difficulties.

Crude and Product Importers Only

Only importers of crude and/or products could each be required to provide a prescribed level of security storage. This approach places the burden of insurance directly on those who import the supplies which are insecure. However, placing the burden of national security storage on only the crude and product importers could place these operators at a substantial competitive disadvantage with all other industry operators. Pressures could arise to "equalize" cost disparities through further regulatory machinery. This approach also might not take advantage of the economy of scale of a salt dome program. Furthermore, this alternative might tend to result in fuel oil security storage by individual importers. This would be highly inefficient because of its relatively high cost and because fuel oil denials could probably be handled by other more cost-effective emergency steps.

Industry Consortiums

Privately-owned national security storage could be achieved through formation of industry consortiums to own, develop and operate large volume, centrally located salt dome storage. This method would be applicable whether the storage obligation applied to all refiners and all importers or only to importers. This approach could achieve economy of scale and would avoid a few of the problems of administration caused by widely diverse storage locations. A consortium could provide storage on an equity participation basis or for a fee. Among the many disadvantages of this approach is the fact that considerable time would be required to organize the consortiums and to negotiate equitable participation and operating agreements. Further, enabling federal legislation may be required with specific antitrust provisions if this kind of national security storage venture is to be workable.

Private Financing Alternatives

Several options for financing a privately-owned national security storage system were examined, including:

- Complete private financing with recovery of capital and operating costs in a free marketplace.
- Industry financing with government loan guarantees.
- Industry financing with cost recovery provided by the government by means of tax credits, import fee or tariff rebates, or even direct grants.
- Note that while the last two options maintain private ownership, they amount to indirect government financing to the extent costs are recovered through government sources.

While in theory industry should simply recover the costs of security storage in a free marketplace by increasing product prices, in practice this option is very uncertain. Should price controls exist, as they do now, any time during the life of the security storage project, recovery of the cost would be placed in substantial jeopardy. Since there is no profit incentive for a private investor to build, fill, and own national security storage, it will be accomplished only in the interest of national security. Because there is no reasonable way for a private investor to earn a return on his security storage investment, he must ultimately seek to recover its cost from the government.

The problem of sharply increased petroleum industry capital needs has a significant bearing on security storage financing options. During the next several years, when a security storage system would be implemented, industry's capital requirements will double or triple. In fact, serious concerns exist over the industry's ability to generate the required capital for needed energy resource development. A number of financing alternatives can be constructed whereby the government, by means of loan guarantees, loans and grants, tax credits, rebates on import fees, etc., provides a direct means of cost recovery. These systems are in reality an indirect means of government financing with the attendant administrative complexities and problems of equitable treatment.

Hybrid Ownership

Combined government/private ownership possibilities exist, such as private industry financing and owning storage facilities, and government financing and owning the stored oil, and vice versa. In the former case, private owners could anticipate a return on investment by renting the storage to government through operating fees. Additionally, such a system might encourage use of industry expertise in the design, construction and operation of the facilities. In the alternative, government might provide the storage facility for industry participants to store their oil in. Hybrid ownership involves inevitable complexities in relationships among the parties and could be difficult if not impractical to administer.

Government Ownership and Financing

While at first glance it may appear counter-intuitive, the concept of government ownership of national security storage should be much more straightforward than any alternative considered. The factors supporting government ownership and financing include:

- The basic purpose of a national security storage system is to reduce the risk of external threats to the well-being of the Nation, a role analogous to that of a major weapons system.
- The benefits of having petroleum security stocks available, in the event of an imports denial, accrue to the entire Nation rather than just a specific industry, group of consumers, or region.
- The nature and requirements of a security storage system are such that they cannot be undertaken and financed by private industry as a normal business investment.
- Public policies will determine the level of security storage and control the access to and disposition of national security stocks in the event of an emergency.
- Government already maintains ownership of security reserves of petroleum at NPR-1.

- Substantial legal and historical precedent exists for government ownership and financing of emergency stockpiles of critical materials.

Government ownership and control of security storage crude and facilities should not preclude involvement of the private sector in design, construction, management, and operation. This expertise can readily be obtained by the government through use of private contractors, which is common practice in a wide range of government procurement programs.

The government could finance the security storage system from general revenue funds or from a dedication of existing energy-related revenues, such as fees on imports, excise taxes on products, etc. In effect, all taxpayers would pay for the security storage under either alternative unless incremental energy-related taxes or fees were imposed, in which case a more direct burden would be placed on certain energy consumers.

In summary, the Council reiterates that the basic purpose of the national security crude storage system is to protect the physical and economic security of the entire Nation. A number of alternative financing and ownership plans were analyzed in an effort to develop a program which would achieve the above purpose, attain equitable participation, and be consistent with the Nation's goal of increased energy self-sufficiency. The only financing alternatives found to meet these criteria involve direct or indirect government financing. The Federal Government should continue to own crude from NPR-1 (or its exchange equivalent) when transferred to and stored in Gulf Coast salt domes. Government is also in the best position to own and control these crude security storage facilities. Design, construction, management, and operation of the system should be contracted on a competitive basis to qualified private companies under the supervision of the appropriate government agency. This agency should not itself attempt to duplicate or overlap existing private industry capability.

IV. *Based on the above findings and conclusions, the National Petroleum Council recommends: The Federal Government should finance, own and control the crude oil security storage system utilizing private industry expertise in design, construction, management, and operation.*

V. FEDERAL ACTIONS THAT MIGHT ASSIST OR DETER PROMPT IMPLEMENTATION

An early and definitive resolution on the part of the Federal Government that a security storage petroleum reserve is a matter of high national priority is essential to the expeditious completion of the program. Since conditions constantly change, attempts to answer all questions regarding the ultimate extent of the program can only delay the attainment of an initial degree of security against petroleum import denials.

One federal department or agency should be designated to direct the petroleum security storage program. If one federal department or agency is not clearly designated, competition among the many federal departments and agencies that could have partial jurisdiction over individual facets of a storage program could substantially delay completion and increase costs.

Completion of environmental studies and preparation of Environmental Impact Statements, as required by the National Environmental Policy Act, is a first and most important step for the responsible department or agency. Brine discharge plans should be discussed with the Environmental Protection Agency (EPA) as early as possible, and the EPA should be requested by the responsible department or agency to expedite action on the application for a discharge permit.

Authority under the Defense Production Act should be used if necessary to expedite delivery of materials or equipment that threaten to delay the security storage program. The responsible department or agency should be empowered to exercise the right of eminent domain should it become necessary in securing the needed surface sites and pipeline right-of-ways. Because NPR-1 reserves in the Elk Hills field should be used as the basis for security storage fill, enabling legislation must be passed to allow development for this purpose.

To minimize uncertainty in responding to an emergency denial of petroleum imports, legislation should provide an operational definition of an energy emergency, require conservation measures prerequisite to withdrawals from security storage, and empower the President to activate withdrawal mechanisms after energy emergency guidelines are met. Since expeditious movement of oil out of security storage will be necessary in an energy emergency, the President should be authorized to engage vessels not normally permitted in the coastwise trade to transport oil cargoes between U.S. ports, if required.

Finally, legislation should provide for easing conflict-of-interest and antitrust restrictions to permit knowledgeable industry people to assist the Federal Government in implementing any phase of the security storage program.

It should be noted that positive action by the United States to develop a significant petroleum security storage system would fulfill our obligation under the International Energy Program (IEP) Agreement, would help to accomplish the IEP objectives, and could result in more favorable resolution of other IEP/International Energy Agency (IEA) related matters. The U.S. obligation for emergency reserves under the IEP is to maintain emergency reserves sufficient to sustain consumption for at least 60 days with no net oil imports based on the average daily consumption level of the previous calendar year. The governing board will determine the date at which emergency reserve requirements will be raised to 90 days. Security storage requirements for emergency petroleum reserves in the United States are not fully comparable with most European requirements or the IEP definitions. In 1974, the U.S. indigenous crude oil and natural gas production supplied almost 63 percent of petroleum requirements. The United States is also much larger geographically than other IEP countries and requires a much higher level of working stocks just to maintain an operable supply and distribution system. When minimum operating inventory levels for crude oil and refined products in the United States are considered, an adjustment of over 800 MMB is required in the IEA formula. At the current level of imports and stocks, as well as at the projected 1985 level, about 500 MMB of additional storage is required to provide for protection against a total crude and product import interruption for 90 days. Since an interruption of total imports is believed highly unlikely, a 500 MMB reserve, in conjunction with other emergency measures, would protect against a probable denial substantially longer than 90 days.

V. *Based on the above findings and conclusions, the National Petroleum Council recommends: Federal legislative and administrative action should be taken promptly to authorize and expedite a petroleum security storage program if it is to be available for fill by 1979. These actions should specify:*

- *A single federal department or agency to oversee the program;*
- *The target volumes and time schedule for security petroleum stocks to be in storage;*
- *Early initiation and completion of environmental studies;*
- *The authority to develop and produce NPR-1 as the basis of storage fill;*
- *The method of government financing;*
- *Guidelines under which the President may initiate emergency withdrawal and transportation; and*
- *Easing of restrictions on industry personnel to permit them to assist the government in implementing any phase of the security storage program.*

CHAPTER I

CRUDE AND PRODUCT STORAGE REFINING/LOGISTICS ANALYSES

INTRODUCTION

The September, 1974, NPC Emergency Preparedness Report concluded that the United States should create a petroleum security storage system that, in combination with other available measures, will provide adequate time to react positively to a substantial, sudden interruption in petroleum supplies. It was suggested that 500 MMB of crude oil located in caverns leached in Gulf Coast salt domes, in combination with normally available inventories, would provide supply protection for a large range of projected petroleum imports.

Although the exact level of security storage required is difficult to define, it appears that 500 MMB of crude storage is a reasonable initial approach and represents an ambitious undertaking. The factors difficult to assess in arriving at a reasonable level are future levels of demand, level of United States energy self-sufficiency, level and source of imports, and the timing and duration of the denial.

During the first quarter of 1974, while the 1973-1974 embargo was in maximum effect, imports averaged 2.2 MMB/D less than earlier projections and 1.6 MMB/D less than November, 1973, total imports of about 6.9 MMB/D; 3.5 MMB/D being crude oil. As shown in Table 1, projected average medium case total crude and product imports, for the 1980-1990 period, are 8.1 MMB/D, an increase of 1.2 MMB/D over November, 1973. However, the projected crude oil imports increase to an average of 5.5 MMB/D, or 2 MMB/D more than November, 1973. It is estimated that in the 1980's emergency conservation measures could reduce petroleum demand in the United States by about 1.0 MMB/D, leaving a net shortfall of about 4.5 MMB/D if there were a total crude oil denial, and about 7.1 MMB/D in the unlikely event of a total petroleum imports denial. A 500 MMB security storage system could, therefore, by itself protect against a total imports denial of 70 days, and a crude oil only total denial of 110 days. In addition to the protection offered by such volumes in security storage, protection (time to implement emergency preparedness plans) would be provided by volumes of imported crude in transit at the time of an interruption and that in usable United States working inventories.

European countries, which are much more dependent on imports than the United States, provide an example. These countries generally require security storage equivalent to 90 days of prior year imports, and they permit a portion of industry working stocks to be counted against such requirements. The level of protection provided by a 500 MMB security petroleum storage system for the United States brackets the 90-day protection level planned by the other consuming countries. If authorized in 1975, and expeditiously implemented starting early in 1976, fill could start in 1979 with significant storage available in the early 1980's. The need for a larger volume is doubtful and the costs so great that any decision should be deferred at least until initial steps are taken toward implementation of a 500 MMB first phase.

The objectives of this chapter are to: (1) examine projected petroleum supply and demand patterns in the United States, (2) assess the probable impact of a future crude embargo and combination crude and product denial, (3) explore feasible U.S. refining and logistical responses to the hypothetical embargoes, and (4) estimate specific product shortfalls that cannot be reasonably covered through the processing of security crude and, for these, to suggest appropriate actions for relieving the indicated shortfalls.

BASE CASE PETROLEUM SUPPLY AND DEMAND

In order to assess the ability of the U.S. refiners to cover an embargo-induced petroleum product shortfall with security storage crude, it is necessary to first establish a base case which describes a future U.S. petroleum supply and demand situation. The NPC survey medium case projections for 1978 as reported in the NPC Emergency Preparedness Report dated September 1974 were used as the basis for the total U.S. supply situation. The data contained in the September 1974 NPC Report concerning existing and announced U.S. refining capacity with good or average probability of completion before 1978 were also used to project U.S. refining capacity for that year by Petroleum Administration for Defense (PAD) Districts. The previously documented NPC projections for 1978 were utilized to represent a base case U.S. petroleum supply and demand balance and domestic refining situation. However, it should be noted that the results of the analyses of the U.S. refining and logistical response to a future interruption of petroleum imports are relatively insensitive to the base case assuming a relatively constant ratio of crude and product imports, since spare refining capacity is the most significant variable which would affect the embargo response with security storage crude. Therefore, the conclusions and recommendations of these analyses are applicable beyond 1978 and are valid for the period after security storage is completed in the 1980's.

In order to appropriately allocate among the various PAD Districts the NPC survey projections for total U.S. petroleum supply and demand, an analysis was completed by PAD Districts of the U.S. Bureau of Mines Petroleum Statement (1) year-end summaries for 1969 through 1973 for historical trends. In this way an estimate was made of a normal 1978 supply and demand situation for each PAD District, as shown in Table 2, indicating the most probable amount of domestic crude being refined in each district, the requirements for imported crude, and the probable level of product imports.

The historical trends as determined from the 1969-1973 U.S. Bureau of Mines Reports were also used to prorate total U.S. domestic demand and exports among the PAD Districts. Domestic crude production for each PAD District was based upon U.S. Bureau of Mines data for 1973 with the following adjustments: PADS I and II were held relatively constant, PAD IV shows a slight increase of 100 MB/D, PAD V was increased by 1,400 MB/D to reflect North Slope production, and PAD III was

(1) U.S. Bureau of Mines, "Annual Petroleum Statements," Mineral Industries Survey.

TABLE 2

PROJECTED U.S. SUPPLY/DEMAND BALANCE - 1978
(Million Barrels Per Day)

	PAD DISTRICTS					U.S.
	I	II	III	IV	V	Total
Domestic Demand	7.8	5.2	3.7	0.5	2.5	19.7
Exports	0.02	-	0.11	-	0.07	0.2
TOTAL OIL DEMAND	7.82	5.2	3.81	0.5	2.57	19.9
Domestic Production						
Crude and Condensate	0.1	1.0	5.6	0.8	2.5	10.0
NGL and Other	0.02	0.3	1.2	0.04	0.04	1.6
Imports						
Crude	1.8	1.0	2.0	-	0.2	5.0
Products, Unfinished & Other	2.53	0.08	0.19	-	-	2.8
Processing Gain and Other	0.07	0.12	0.20	0.02	0.09	0.5
Interdistrict Domestic Movements						
Crude	0.1	1.8	(1.6)	(0.3)	-	-
Products, Unfinished & Other	3.2	0.9	(3.78)	(0.06)	(0.26)	-
TOTAL OIL SUPPLY	7.82	5.2	3.81	0.5	2.57	19.9

MEMO:

	I	II	III	IV	V	U.S. Total
Refining Capacity	2.2	4.2	7.1	0.5	2.9	16.9
Capacity Usable For Crude	2.0	3.8	6.5	0.5	2.7	15.5
Crude Runs	2.0	3.8	6.0	0.5	2.7	15.0

adjusted to balance on total. Total U.S. domestic production of natural gas liquids (NGL) and other was prorated for each PAD District in accordance with historical patterns. Total U.S. crude imports were allocated to the individual PAD Districts in accordance with historical trends and the refinery capacity additions indicated earlier, with the following additional considerations: PAD V crude imports were reduced to a nominal 200 MB/D to allow for specialty crude and refiners who do not plan to process North Slope crude; PAD II at 1,000 MB/D included only 300 MB/D of Canadian crude due to Canadian export curtailment (whereas in 1973 virtually all 700 MB/D of crude imports were Canadian); PAD I was set to meet projected demand requirements; PAD IV includes negligible imports; and PAD III was balanced on total. Product imports were prorated in accordance with historical trends with the majority of U.S. product imports required for PAD I. Interdistrict movements of both domestic crude and products were based upon historical data and the projected refinery capacity by PAD Districts. The applicability of historic relationships for estimating future crude and product import distributions and interdistrict movements has been assumed; however, it should be noted that these patterns could change over time.

The total projected U.S. crude runs of 15.0 MMB/D for 1978, which includes 10.0 MMB/D of domestic production and 5.0 MMB/D of imports, is distributed among the projected refining capacity for the individual PAD Districts, as shown in Table 2. Refining capacity includes existing and announced U.S. capacity with good or average probability of completion by year-end 1977. Capacity usable for crude after excluding other refinery inputs and considering historical utilization of reported capacity is approximately 92 percent of total. Thus, the projected capacity usable for crude in 1978 is assumed to be 15.5 MMB/D which would result in approximately 500 MB/D of spare crude refining capacity. This spare capacity is expected to be primarily in PAD III.

PROBABLE INITIAL EMBARGO EFFECTS

A sudden and limited duration interruption of 3 MMB/D of petroleum imports was considered which could be either all crude or a combination of 60 percent crude and 40 percent product denial. An assessment was made as to where a future embargo would likely impact geographically. Table 3 shows the denial effects on the assumed 1978 base case imports of both types of embargoes according to PAD Districts. Figures 1 and 2 show schematically the projected imports to the U.S. and the initial denial effects. In 1978, negligible imported crude and products and only imported specialty crudes will be required for PAD V. Therefore, after completion of the Trans Alaskan pipeline, PAD Districts IV and V would most probably be least affected by a future denial of crude and products. The need to provide a formal crude security storage system for West Coast refineries during the 1980's is uncertain. North Slope crude deliveries are expected to begin by 1978. However, future West Coast import volumes will depend on the growth in District V oil demand which depends in part on the level of gas supplies, the future level of production from new discoveries, including offshore and secondary/tertiary recovery, the volume of North Slope crude moved into Districts I-V, and the availability of Elk Hills crude to meet District V requirements. Some or all of these factors may be clarified within the next 2 to 3 years. In addition, it may be possible to supply District V imports by exchange during an embargo. Therefore, a decision on crude security storage for District V should be made at a later date.

TABLE 3

POTENTIAL EMBARGO EFFECTS ON U.S. IMPORTS - 1978
(Million Barrels Per Day)

	PAD DISTRICT					U.S.
3 MMB/D DENIAL (ALL CRUDE OIL)	I	II	III	IV	V	Total
Base Crude Imports	1.8	1.0	2.0	0	0.2	5.0
Deduct Canadian Crude from PAD II and Specialty Crude from PAD V		(0.3)			(0.2)	(0.5)
Sub-Total	1.8	0.7	2.0	0	0	4.5
3 MMB/D Crude Denial	(1.2)	(0.5)	(1.3)	0	0	(3.0)
Net Crude Imports	0.6	0.2	0.7	0	0	1.5
3 MMB/D DENIAL (60% CRUDE AND 40% PRODUCT)						
Crude Denial	(0.7)	(0.3)	(0.8)	0	0	(1.8)
Net Crude Imports	1.1	0.4	1.2	0	0	2.7
Base Product Imports	2.53	0.08	0.19	0	0	2.8
Product Denial	(1.09)	(0.03)	(0.08)	0	0	(1.2)
Net Product Imports	1.44	0.05	0.11	0	0	1.6

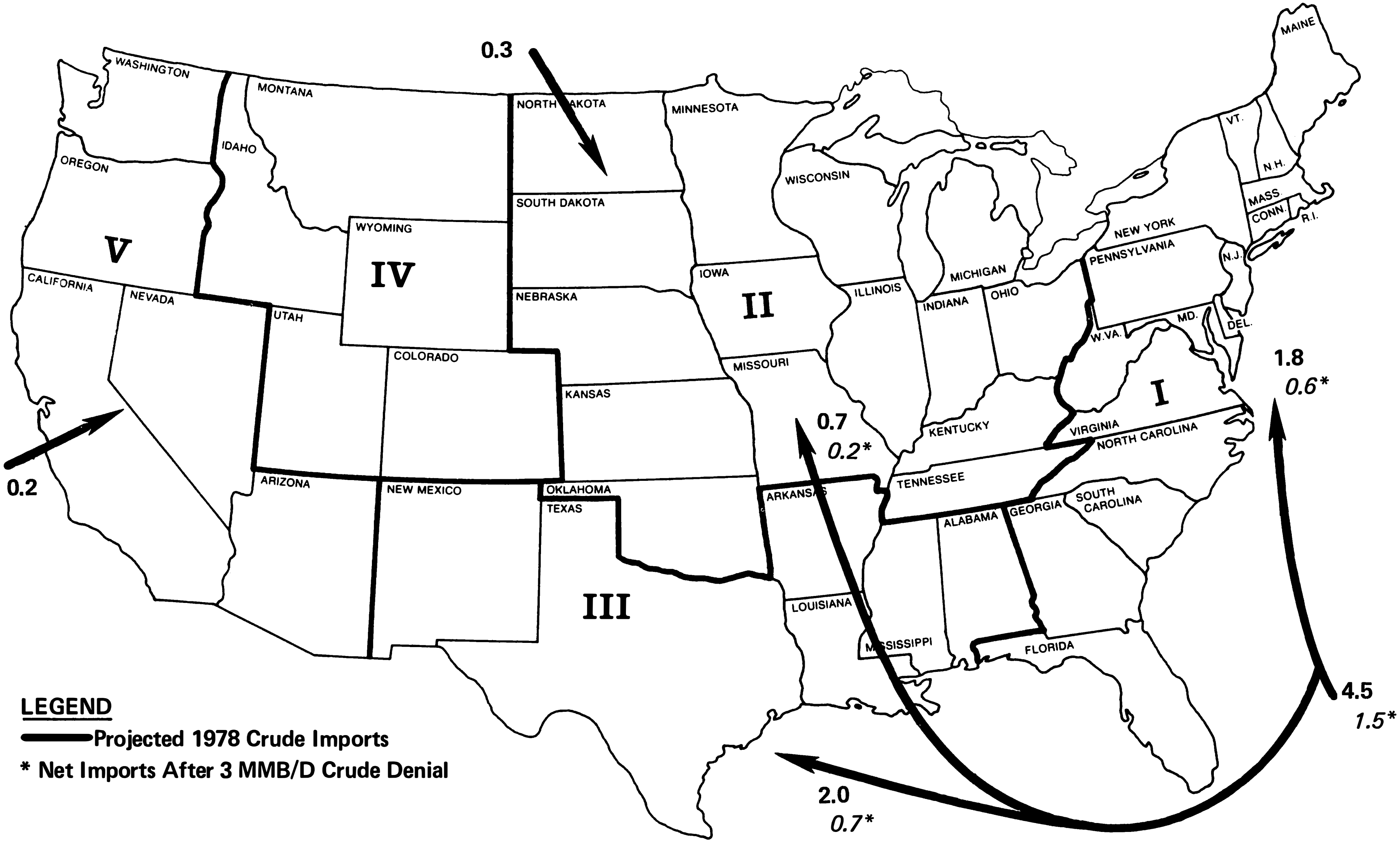

Figure 1. Potential Denial Effects on U.S. Crude Imports, MMB/D.

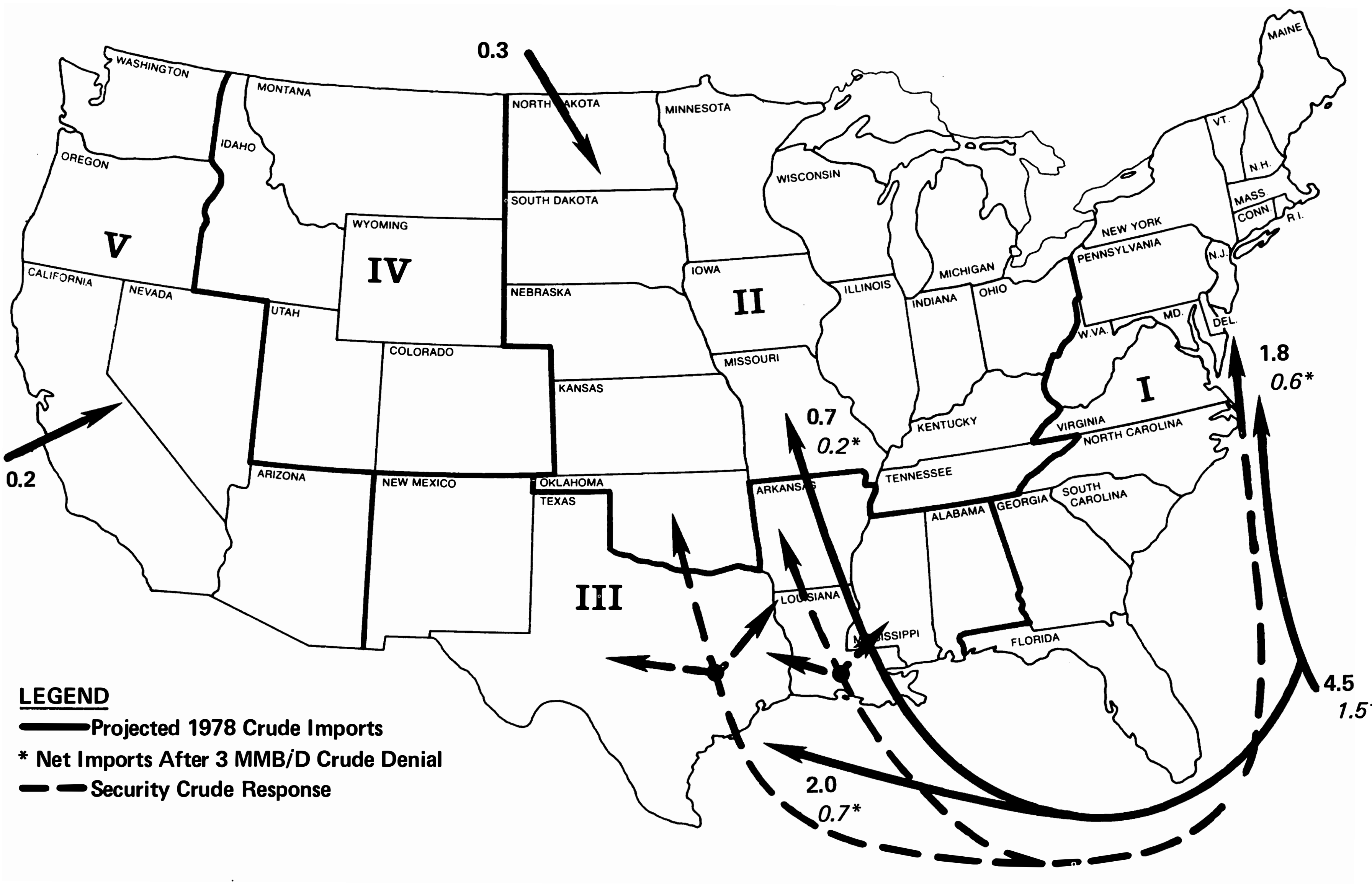

Figure 2. Security Crude Response to Potential Denial of U.S. Crude Imports, MMB/D.

Aside from the assumed continuing Canadian crude imports into PAD II at the already reduced rate of 300 MB/D, for purposes of this estimate it has been assumed that PAD Districts I, II and III would probably experience a prorata share of either a crude or combination crude and products denial. It should be noted, however, that re-optimization under embargo conditions should divert non-embargoed imports and ships at sea to PAD I from PAD III, with PAD III making up the difference with security storage crude.

In order to determine the major petroleum products effects of a future denial of imported crude or crude and products, an analysis was made of the 5-year incremental U.S. refining yield pattern for 1969 through 1973 utilizing U.S. Bureau of Mines Reports (2). Refinery output of the major products was plotted for each PAD District as a function of refinery crude throughput, as shown in Appendix C. The resultant incremental yields (slope of the plots) for PAD Districts I, II and III, as presented in Table 4, were used to estimate the product-by-product effects for both embargo situations. These initial embargo product effects are shown in Tables 5 and 6.

REFINING/LOGISTICS RESPONSE TO A POSSIBLE EMBARGO

The U.S. petroleum industry response to the product shortfalls estimated above was determined for three types of security storage crude in order to test for crude quality characteristics. These included NPR-1 Elk Hills crude (Stevens zone) and two combinations of low- and high-sulfur crudes, namely South Louisiana/West Texas Sour and Nigerian Light/Arabian Light. Average industry conversion refinery and hydroskimming refinery yields for these crudes and crude mixtures are shown in Table 7. The yields for the two low-sulfur crudes considered are quite similar as are also the yields of the two high-sulfur crudes. Thus the yields of the two crude mixtures are similar for the same proportion of low-and high-sulfur crudes. The expected refinery yields from Elk Hills crude are not significantly different from the two low- and high-sulfur crude mixtures.

For the purpose of this analysis, it has been assumed that security crude storage will be located in Gulf Coast salt domes to take advantage of significantly lower project construction costs and attractive overall economics. For projects storing approximately 250 MMB, construction costs for Gulf Coast salt domes should range from $0.85 to $1.55 per barrel (1975 dollars) including tanker loading facilities as compared to $6.00 to $12.50 per barrel for steel tank storage. Annual maintenance costs after filling and excluding ad valorem taxes are 0.5¢ per barrel for salt dome storage as compared to 2.5¢ per barrel for steel tank storage. An additional cost would be involved in transporting the crude from the Gulf Coast to the East Coast when the crude is required during an emergency. This cost could range between $0.50 and $1.00 per barrel of crude transported depending upon the size of the tanker utilized and tanker rates existing at the time.

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(2) U.S. Bureau of Mines, "Annual Petroleum Statements," Mineral Industries Survey.

TABLE 4

1969-1973 INCREMENTAL REFINERY YIELDS
(Percent of Crude Runs)

	PAD DISTRICT I	PAD DISTRICT II	PAD DISTRICT III
Motor Gasoline	44	48	44
Distillate	20	35	36
Jet & Avgas	0	4	2
Heavy Fuel Oil	30	10	17
LPG	6	3	1
TOTAL	100	100	100

TABLE 5

INITIAL EFFECT OF CRUDE EMBARGO
(Million Barrels Per Day)

	PAD DISTRICT I	PAD DISTRICT II	PAD DISTRICT III	TOTAL
CRUDE DENIAL	(1.2)	(0.5)	(1.3)	(3.0)
PRODUCT EFFECT:				
Motor Gasoline	(0.53)	(0.24)	(0.57)	(1.34)
Distillate	(0.24)	(0.18)	(0.47)	(0.89)
Jet & Avgas	-	(0.02)	(0.03)	(0.05)
Heavy Fuel Oil	(0.36)	(0.05)	(0.22)	(0.63)
LPG	(0.07)	(0.01)	(0.01)	(0.09)
TOTAL	(1.2)	(0.5)	(1.3)	(3.0)

TABLE 6

INITIAL EFFECT OF CRUDE AND PRODUCT EMBARGO
(Million Barrels Per Day)

	PAD DISTRICT I	II	III	Total
CRUDE DENIAL	(0.70)	(0.30)	(0.80)	(1.80)
PRODUCT EFFECT:				
Motor Gasoline	(0.31)	(0.15)	(0.35)	(0.81)
Distillate	(0.14)	(0.10)	(0.29)	(0.53)
Jet & Avgas	-	(0.01)	(0.01)	(0.02)
Heavy Fuel Oil	(0.21)	(0.03)	(0.14)	(0.38)
LPG	(0.04)	(0.01)	(0.01)	(0.06)
TOTAL	(0.70)	(0.30)	(0.80)	(1.80)
PRODUCT DENIAL	(1.09)	(0.03)	(0.08)	(1.20)
PRODUCT EFFECT:				
Motor Gasoline	(0.03)	-	-	0.03
Distillate	(0.10)	-	(0.02)	(0.12)
Jet & Avgas	(0.06)	-	(0.03)	(0.09)
Heavy Fuel Oil	(0.89)	(0.01)	(0.03)	(0.93)
LPG	(0.01)	(0.02)	-	(0.03)
TOTAL	(1.09)	(0.03)	(0.08)	(1.20)
TOTAL PRODUCT EFFECT				
Motor Gasoline	(0.34)	(0.15)	(0.35)	(0.84)
Distillate	(0.24)	(0.10)	(0.31)	(0.65)
Jet & Avgas	(0.06)	(0.01)	(0.04)	(0.11)
Heavy Fuel Oil	(1.10)	(0.04)	(0.17)	(1.31)
LPG	(0.05)	(0.03)	(0.01)	(0.09)
TOTAL	(1.79)	(0.33)	(0.88)	(3.00)

Furthermore, it was assumed that crude withdrawal from security storage and shipment would not be limiting factors in an emergency situation. This assumption was based on selection of specific salt dome sites being located (1) near major crude pipelines capable of delivering crude to inland (pipeline connected) refineries in PAD Districts II and III at rates compatible with normal crude import rates and (2) with access to water such that tankers can both deliver crude into storage and be loaded for delivery out of storage to U.S. refineries in PAD I who normally receive crude by water (see Figure 3 for schematic). If sufficient U.S. flag vessels are not available during an

TABLE 7

REFINERY YIELDS FROM SELECTED CRUDES
(Percent)

	Nigerian Light	Arabian Light	30/70 Mix	South La.	West Tx. Sour	30/70 Mix	Elk Hills
Gravity, °API	38	34		35	32		38
Sulfur, Wt. %	0.1	1.7		0.2	1.8		0.3
AVERAGE INDUSTRY CONVERSION REFINERY YIELD, %							
Motor Gasoline	63	57	58	58	61	60	60
Distillate	23	27	26	23	23	23	24
Jet & Avgas	11	7	8	13	6	8	8
Heavy Fuel Oil	3	8	7	6	9	8	7
LPG	0	1	1	0	1	1	1
TOTAL	100	100	100	100	100	100	100
HYDROSKIMMING REFINERY YIELD, %							
Motor Gasoline	30	25	27	24	27	26	38
Distillate	27	23	24	26	25	25	19
Jet & Avgas	11	7	8	15	8	10	8
Heavy Fuel Oil	27	40	36	30	35	34	30
LPG	2	2	2	2	2	2	2
TOTAL	97	97	97	97	97	97	97

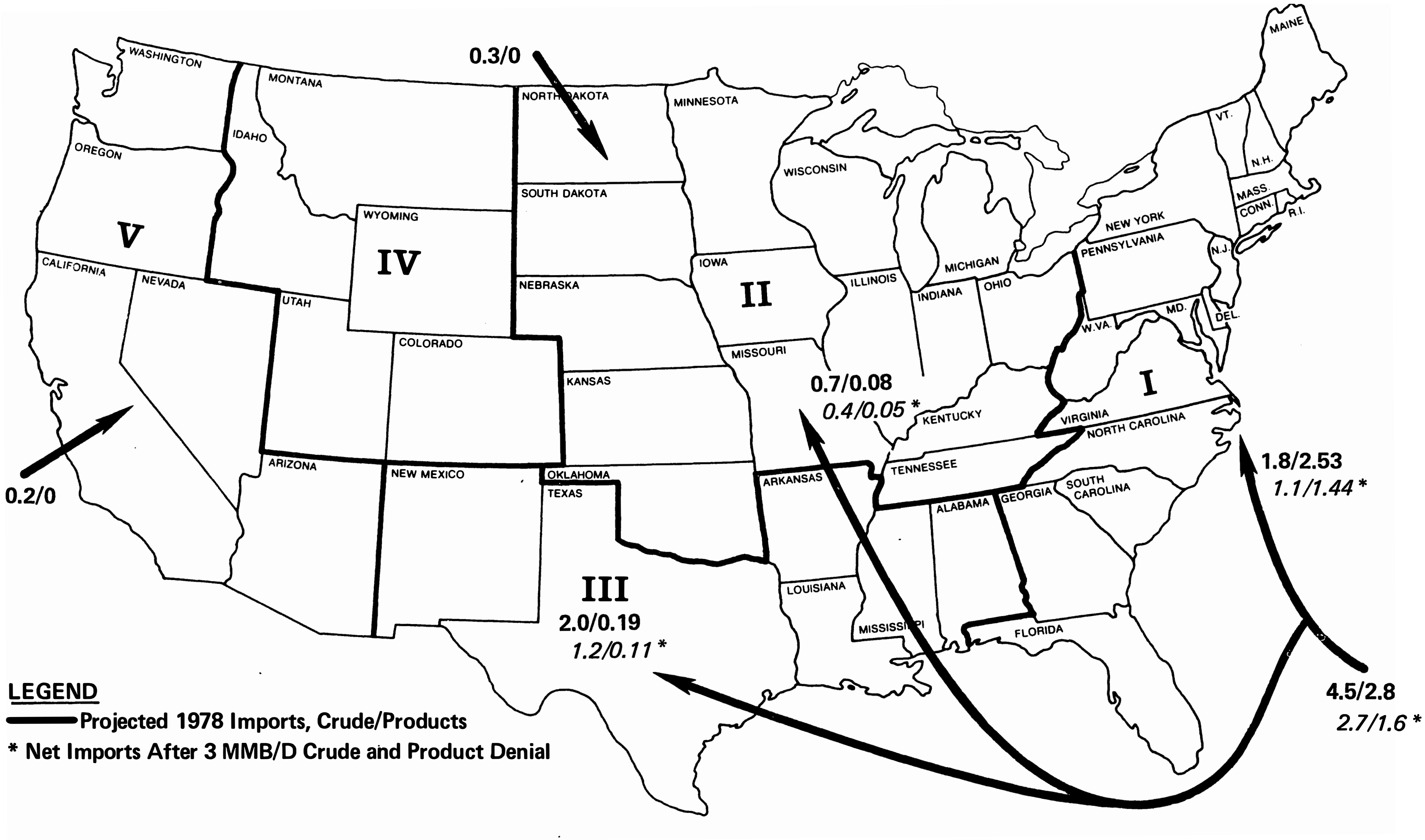

Figure 3. Potential Denial Effects on U.S. Crude and Product Imports, MMB/D.

emergency to transport the security storage crude or to distribute refined products, utilization of foreign flag vessels should be allowed. Thus, in an embargo situation, PAD Districts II and III could be supplied with security storage crude through the normal pipeline receipt system for imported crude. With proper planning, the logistical problems of delivering security storage crude out of Gulf Coast salt dome storage during an emergency to PAD I could be minimal. Furthermore, it would appear logical for the majority of the remaining crude imports during an embargo situation to be directed to PAD I with PAD Districts II and III supplied out of security storage, thus minimizing the need to ship security storage crude to PAD I.

In determining the effect of replacing the embargoed crude with security storage crude, refining yield flexibility was assumed to exist in each PAD District such that the replacement crude yields could vary between the average conversion and hydroskimming operating modes to compensate equally for the heavy fuel oil shortfall resulting from a crude denial. This is a reasonable assumption based upon the U.S. refining industry's demonstrated flexibility to vary yield patterns and heavy fuel oil producibility.

Table 8 shows the estimated response to a future crude denial by major products and PAD Districts for the three types of security crudes. Processing of crude does not significantly affect liquified petroleum gas (LPG) production and therefore any future requirement for imported LPG should not depend on security storage crude for import denial protection. A slight shortfall of motor gasoline and distillates was calculated; however, this can easily be offset by a product shift from jet and aviation fuels. Therefore a crude denial alone would appear to be manageable with crude only in security storage.

The product response to a combination imported crude and product embargo is presented in Table 9, by PAD District. The denied imported crude (1.8 MMB/D) would be replaced together with an additional 0.5 MMB/D of security storage crude to fill spare refining capacity in the United States. In the event that no spare refining capacity exists in the future, additional crude running might be achieved during an emergency situation by deferring otherwise normally planned refinery unit maintenance shutdowns and incurring other non-optimum operating steps. A 3 percent increase of usable capacity from the historic 92 percent to 95 percent of reported capacity would have an equivalent effect of filling the projected 1978 spare capacity of 500 MB/D. Of the remaining available 0.7 MMB/D of security storage crude, at least 0.6 MMB/D could be run in offshore (Caribbean) refineries based on the expected spare capacity of these refineries during an embargo situation. This expected spare capacity is based on the assumption that a product import denial resulting from a crude supply denial will be distributed in historical proportions among the normal U.S. sources (countries of import origin). Based on U.S. Bureau of Mines data for 1973 (3), product imports from Caribbean countries represented approximately 50 percent of total U.S. product imports. Thus in an embargo situation involving 1.2 MMB/D of denied product imports to the United States, at least 600 MB/D of spare refining capacity should exist in Caribbean refineries.

(3) U.S. Bureau of Mines, "Annual Petroleum Statement," Mineral Industries Survey.

TABLE 8

ESTIMATED RESPONSE TO CRUDE EMBARGO
(Million Barrels Per Day)

		PRODUCT SURPLUS/(SHORTFALL) WITH SECURITY STORAGE CRUDE SECURITY STORAGE CRUDE TYPE AND MIX		
	Initial Embargo Product Effect	Nigerian Light/ Arabian Light	So. Louisiana/ West Tx. Sour	Elk Hills
PAD I				
Motor Gasoline	(0.53)	(0.15)	(0.16)	(0.07)
Distillate	(0.24)	0.06	0.07	(0.02)
Jet & Avgas	-	0.10	0.12	0.10
HFO	(0.36)	0.02	-	-
LPG	(0.07)	(0.05)	(0.05)	(0.05)
TOTAL	(1.2)	(0.02)	(0.02)	(0.04)
PAD II				
Motor Gasoline	(0.24)	0.03	0.05	0.05
Distillate	(0.18)	(0.05)	(0.07)	(0.07)
Jet & Avgas	(0.02)	0.02	0.02	0.02
HFO	(0.05)	-	-	-
LPG	(0.01)	-	-	-
TOTAL	(0.50)	-	-	-
PAD III				
Motor Gasoline	(0.57)	0.06	0.06	0.10
Distillate	(0.47)	(0.14)	(0.16)	(0.18)
Jet & Avgas	(0.03)	0.07	0.09	0.07
HFO	(0.22)	-	-	-
LPG	(0.01)	-	-	-
TOTAL	(1.3)	(0.01)	(0.01)	(0.01)
Total U.S.				
Motor Gasoline	(1.34)	(0.06)	(0.05)	0.08
Distillate	(0.89)	(0.13)	(0.16)	(0.27)
Jet & Avgas	(0.05)	0.19	0.23	0.19
HFO	(0.63)	0.02	-	-
LPG	(0.09)	(0.05)	(0.05)	(0.05)
TOTAL	(3.0)	(0.03)	(0.03)	(0.05)

TABLE 9

ESTIMATED RESPONSE TO CRUDE AND PRODUCT EMBARGO
(Million Barrels Per Day)

		SECURITY STORAGE CRUDE TYPE AND MIX								
	Initial Embargo Product Effect	NIGERIAN LIGHT/ARABIAN LIGHT Run Crude Onshore	NIGERIAN LIGHT/ARABIAN LIGHT Run Crude Offshore	NIGERIAN LIGHT/ARABIAN LIGHT Net Surplus/ (Shortfall)	SO.LOUISIANA/WEST TEXAS SOUR Run Crude Onshore	SO.LOUISIANA/WEST TEXAS SOUR Run Crude Offshore	SO.LOUISIANA/WEST TEXAS SOUR Net Surplus/ (Shortfall)	ELK HILLS Run Crude Onshore	ELK HILLS Run Crude Offshore	ELK HILLS Net Surplus/ (Shortfall)
PAD I										
Motor Gasoline	(0.34)	0.22	0.16	0.04	0.21	0.16	0.03	0.27	0.23	0.16
Distillate	(0.24)	0.17	0.06	(0.01)	0.18	0.08	0.03	0.13	0.05	(0.06)
Jet & Avgas	(0.06)	0.06			0.07			0.06		
HFO	(1.10)	0.22	0.36	(0.52)	0.21	0.34	(0.55)	0.21	0.30	(0.59)
LPG	(0.05)	0.01	-	(0.04)	0.01		(0.04)	0.01	-	(0.04)
TOTAL	(1.79)	0.68	0.58	(0.53)	0.68	0.58	(0.53)	0.68	0.58	(0.53)
PAD II										
Motor Gasoline	(0.15)	0.16	-	0.01	0.17	-	0.02	0.17	-	0.02
Distillate	(0.10)	0.08	-	(0.02)	0.07	-	(0.03)	0.07	-	(0.03)
Jet & Avgas	(0.01)	0.02	-	0.01	0.02	-	0.01	0.02	-	0.01
HFO	(0.04)	0.03	-	(0.01)	0.03	-	(0.01)	0.03	-	(0.01)
LPG	(0.03)	0.01	-	(0.02)	0.01	-	(0.02)	0.01	-	(0.02)
TOTAL	(0.33)	0.3	-	(0.03)	0.3	-	(0.03)	0.3	-	(0.03)
PAD III										
Motor Gasoline	(0.35)	0.63	-	0.28	0.63	-	0.28	0.67	-	0.32
Distillate	(0.31)	0.33	-	0.02	0.31	-	-	0.29	-	(0.02)
Jet & Avgas	(0.04)	0.10	-	0.06	0.12	-	0.08	0.10	-	0.06
HFO	(0.17)	0.22	-	0.05	0.22	-	0.05	0.22	-	0.05
LPG	(0.01)	0.01	-	-	0.01	-	-	0.01	-	-
TOTAL	(0.88)	1.29	-	0.41	1.29	-	0.41	1.29	-	0.41
TOTAL U.S.										
Motor Gasoline	(0.84)	1.01	0.16	0.33	1.01	0.16	0.33	1.11	0.23	0.50
Distillate	(0.65)	0.58	0.06	0.06	0.56	0.08	0.09	0.49	0.05	(0.04)
Jet & Avgas	(0.11)	0.18			0.21			0.18		
HFO	(1.31)	0.47	0.36	(0.48)	0.46	0.34	(0.51)	0.46	0.30	(0.55)
LPG	(0.09)	0.03	-	(0.06)	0.03	-	(0.06)	0.03	-	(0.06)
TOTAL	(3.0)	2.27	0.58	(0.15)	2.27	0.58	(0.15)	2.27	0.58	(0.15)

The United States has traditionally relied on Caribbean refineries to consistently supply between 50 to 60 percent of total United States heavy fuel oil demand. The bulk of these imports came initially from the major refining centers in Venezuela, the Netherlands Antilles, and Trinidad. In more recent years, the Virgin Islands and the Bahamas have also become major suppliers of fuel oil to the U.S. from the Caribbean. An even more striking reliance on Caribbean imports is found on the U.S. East Coast (PAD District I) where imports have supplied 80 to 90 percent of fuel oil demand over the last decade. Here again the five major Caribbean refining centers mentioned above supply almost all of the fuel oil imports. The domestic supplies for the East Coast include shipments of fuel oil from the U.S. Gulf Coast as well as indigenous fuel oil production on the East Coast.

Total imports of approximately 1.3 MMB (4) were received in 1973 from the Netherlands Antilles, Bahamas, Trinidad, Virgin Islands and Puerto Rico which represented about 50 percent of the reported capacity for these countries.(5) These Caribbean refineries are an integral part of the refining capacity normally serving the U.S. market and should therefore be utilized in an embargo situation. The security storage crude delivery logistics of supplying these refineries are similar to those discussed previously for delivering crude to PAD I. Although these refineries would probably be supplied with the remaining crude imports, the same facilities for withdrawing security storage crude from the Gulf Coast salt dome storage and loading on tankers could supply these refineries in an embargo situation (see Figure 4).

Since a substantial shortfall of heavy fuel oil, especially in PAD I, results from the crude and product denial, security storage crude processed in offshore facilities would be run at maximum hydroskimming yields. The maximum hydroskimming yields for the crude types considered are shown in Table 10. The overall response to a crude and product denial, as presented in Table 9, indicates that most product requirements could be met with no insurmountable problems. The only potentially significant remaining product shortfall after processing security storage crude is PAD I's requirement for heavy fuel oil in the Northeastern states. Under the stated assumptions, this shortfall could be 400 to 600 MB/D, or approximately 15 percent of the total U.S. heavy fuel oil demand in 1978. Depending on the spare refining capacity available at the time of an embargo, the shortfall may be somewhat larger. Further consideration specifically aimed at this potential exposure is warranted in order to develop alternative strategies to mitigate the impact of a heavy fuel oil shortfall.

STEPS TO COVER HEAVY FUEL OIL SHORTFALL

A possible solution for responding to a heavy fuel oil shortfall is product security storage. Heavy fuel oil (or acceptable substitutes; e.g., distillates) could be stored in tanks at individual refineries, terminals, and/or at the major utilities and individual industrial plant locations in the Eastern states. However, this is

(4) Ibid.
(5) Oil & Gas Journal, December 31, 1973, Vol. 71, No. 53, Page 88.

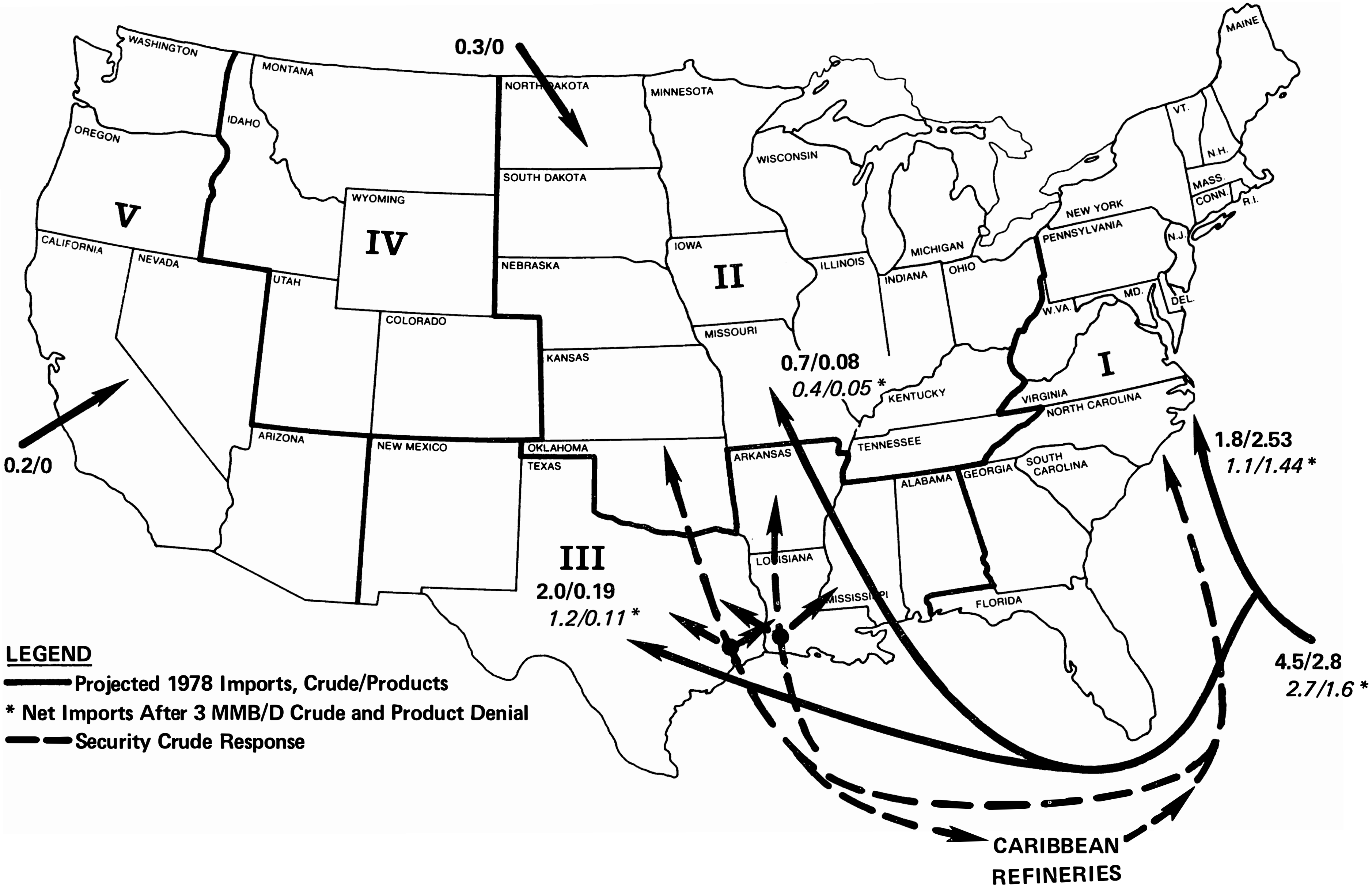

Figure 4. Security Crude Response to Potential of U.S. Crude and Product Imports, MMB/D.

TABLE 10

OFFSHORE HYDROSKIMMING REFINING YIELDS
(Percent)

	Nigerian Light	Arab. Light	30/70 Mix	South La.	West Tx. Sour	30/70 Mix	Elk Hills
Naphtha	30	25	27	24	27	26	38
Distillate	21	5	10	23	10	14	9
Heavy Fuel Oil	46	67	60	50	60	57	50
TOTAL	97	97	97	97	97	97	97

very high cost storage and there is a substantial economic incentive to develop alternative means for covering, or at least easing, heavy fuel oil shortages before initiating a costly fuel oil security storage construction program on the East Coast. This incentive, based on covering a 500 MB/D heavy fuel oil shortfall for a 180-day period, could amount to a capital investment of over $1 billion (1975 dollars) excluding the cost of fill.

Among the alternative steps to cover a heavy fuel oil shortfall which should be considered are:

- Demonstrated refinery yield flexibility
- Distillate blending to fuel oil
- Extraordinary refinery yield flexibility as a condition of security storage crude receipt
- Reduce demand through conservation
- Store heavier crude
- Conversion to coal.

The quantitative impact of these options at the time of an embargo is uncertain; however, an estimated range of the potential effect of each of these steps to mitigate a heavy fuel oil shortage is presented in Table 11. The actual magnitude achievable will depend upon several factors prevailing at the particular time on the different steps. Thus a range of the potential impact on heavy fuel oil availability is shown as a speculative estimate of what could be expected during an embargo or emergency situation. A discussion of each of these steps follows.

Demonstrated Refinery Yield Flexibility

Refinery yield variations can provide flexibility in product mix. When an emergency situation denies the United States a certain product that is normally imported, domestic refineries can partially offset the effect by increasing production of that product and, of course, decreasing production of other products. Directionally the result would be to spread the shortage, insofar as consumers are concerned, proportionately among all the products.

In order to reduce the projected heavy fuel oil shortfall during a crude and product denial, product flexibility of refineries should be directed toward increasing the supply of heavy fuel oil and distillates and reducing the supply of motor gasoline. The ability to vary production among the end-products was the subject of a survey of U.S. refineries conducted by the NPC staff in 1973 which asked respondents to indicate the range in yields possible in 1978 based on projected operable capacity. The results were presented in the NPC Emergency Preparedness Report dated September 1974. Experience indicates that a yield change of approximately 2 to 3 percentage points is feasible. This would be equal to about 170 to 250 MB/D of additional heavy fuel oil available from the 8.5 MMB/D crude processed in PAD Districts I and III to offset the heavy fuel oil shortfall in PAD I. PAD Districts II and IV could also alter their yield patterns to supply some additional volume of heavy fuel oil to PAD I.

Distillate Blending To Fuel Oil

Additional heavy fuel oil could be produced, principally at the expense of middle distillates through deconversion and blending of

TABLE 11

ESTIMATED EFFECT OF EMERGENCY STEPS TO COVER HEAVY FUEL OIL SHORTFALL

(Thousand Barrels Per Day)

Emergency Steps	Range of Additional Heavy Fuel Oil
Demonstrated Refinery Yield Flexibility	170 - 250
Distillate Blending	150 - 200
Extraordinary Refinery Yield Flexibility	Not Quantified
Reduce Demand through Conservation	140 - 280
Store Heavier Crude	Not Quantified
Conversion to Coal	0 - 100
TOTAL EMERGENCY POTENTIAL	460 - 830

distillate fuels into heavy fuel oil. In view of the estimated 350 to 450 MB/D surplus producibility of motor gasoline and distillates during an embargo situation with security storage crude, 150 to 200 MB/D of distillate blending to heavy fuel oil is considered to be potentially achievable. Depending on more rigorous determinations of (1) refinery yield flexibility, and (2) fuel oil user flexibility, this option might be significantly expandable.

Extraordinary Refinery Yield Flexibility

During future emergency situations which are so severe as to result in a heavy fuel oil shortfall after normal refinery yield adjustment steps have been implemented, extraordinary refinery yield flexibility steps could be undertaken. Non-optimum steps could be implemented such as by-passing and/or shutting down refinery units (cokers, catalytic cracking units and hydrocrackers), diverting streams normally used to produce asphalt, and adjusting base heavy fuel oil yields up to distribution system limits. In this way petroleum product components could be made available for fuel oil disposition; however, the extent to which this could be accomplished would likely be limited by the capability of the individual refinery's existing fuel oil blending equipment, storage tanks, loading facilities, pipelines, marine and terminal facilities, all of which involve millions of dollars of substantial investment. Some refineries may be less restricted than others and, therefore, have spare fuel oil producibility which could be utilized during an emergency. Other refineries have only a limited amount of flexibility to produce some fuel oil up to a facility's limit requiring major investment and high incremental costs to alleviate. Information was not readily available during the development of this report for predicting a reasonable range of the additional heavy fuel oil attainable through extraordinary refinery steps. Additional work should be completed, including a survey of individual refineries in PAD Districts I and III, in order to quantify the potential for increased heavy fuel oil production through extraordinary refinery steps.

These extraordinary refinery yield steps would probably require refinery investment to implement since traditional demand variations provided for in the typical refinery facilities design do not require this degree of flexibility.

However, investment for increased refinery heavy fuel oil yield flexibility would almost certainly be a more attractive alternative than security storage of heavy fuel oil. Means of cost recovery and motivation would be required to encourage refineries to invest and to initiate otherwise non-economic operating steps. For example, a minimum yield of heavy fuel oil could be imposed as a condition of receipt of security storage crude and/or price incentives for yield shifts could be specified.

Reduce Demand Through Conservation

The policy of the government should be to encourage the conservation of energy. However, even with conservation, a possible future denial of 3 MMB/D would require emergency energy curtailment. Voluntary measures can be expected to offset loss of only a relatively small volume of imports. Therefore, the Federal Government should have a standby mandatory allocation authority and plans available for distributing supplies in an equitable manner during an emergency.

Residual fuel oil consumption was reduced by 781 MB/D, or 22 percent of projected domestic consumption during the first quarter of 1974 as shown in the September, 1974 Emergency Preparedness Report. This reduction was considered to result from several constraining factors: lower electricity use, warmer than normal weather, 2° F thermostat setting reduction, lower refinery throughput, lower economic activity together with allocation and conservation. The extent of energy conservation achieved in the future under normal conditions will depend on prices, the rate of development of additional sources of energy, and the intersubstitutability of fuels, which in turn will depend on policies, laws, regulations, and government actions at all levels.

Also, a future embargo may occur after many price-driven efficiencies and voluntary use-curtailments have been effected, and little "slack" remains. Thus, the actual magnitude of energy conservation achievable under a future emergency situation is difficult to assess. However, during an emergency period, when governmental encouragement of conservation programs would be more emphatic, a net reduction of 4 to 8 percent of heavy fuel oil consumption may be possible considering the combined effects of conservation efforts directed toward all petroleum products. This would equate to approximately 140 to 280 MB/D of reduced heavy fuel oil consumption in 1978.

Store Heavier Crude

Another possible option for increasing heavy fuel oil production to cover a future denial is to selectively store heavier crudes with higher fuel oil yields (e.g., Elk Hills shallow zone crude). While substantial refinery flexibility exists to shift yields of various products to meet seasonal needs, the U.S. refineries do not have a large amount of flexibility with regard to crude types. Alternative crude supplies would be required which either match closely or exceed the quality of the interrupted supplies. The crude types and mixes considered in this study generally qualify as suitable substitutes. A more detailed analysis of individual refinery facilities would be required to assess the ability to utilize heavier crudes. The effect of this step to increase heavy fuel oil production in the United States over what has already been assumed is considered to be minor; however, the ability to utilize heavier crudes could exist in offshore refineries and the associated advantages should be considered further in determining specific security storage crudes.

Conversion to Coal

During an oil denial period, the ability to convert quickly from heavy fuel oil to another available fuel could mitigate the potential economic and social disruptions caused by the denial. In addition to the convertibility of the industrial sector from oil to gas discussed above, substitution of coal in electric utility boilers should be pursued. During the last emergency period, it was estimated that approximately 250 MB/D could have been converted from oil and gas to coal within a 90-day period. Actual convertibility through March, 1974 was approximately 60 MB/D. The unavailability of coal supplies of proper quality characteristics and the inability to obtain air quality variances were the principle reasons for lower conversion rates. An analysis documented in the September, 1974 NPC Report of coal convertibility by PAD Districts indicated a maximum future potential convertibility of 375 MB/D, essentially all of which is located in PAD I.

The Energy Supply and Environmental Coordination Act of 1974 (HR 14368), which was signed into law on June 22, 1974, should directionally increase the amount of coal being burned in utilities through 1980. This Act gives the Federal Energy Administration (FEA) authority to require power plants and other major users burning oil or gas to switch to coal. These conversions, to the extent possible, must comply with primary air quality standards of the Clean Air Act. The Act authorizes temporary suspension of air quality restrictions on coal burning and requires the EPA under certain conditions to grant exemption from State Secondary Standard Implementation Plan Regulations to those who convert to coal. The law also gives the FEA power to allocate low-sulfur fuels.

The FEA is also authorized to require new power plants to be built to use coal as the primary energy source if the FEA determines that (1) using coal will not impair service, and (2) a reliable source of coal is expected to be available. Under this law, as of June 1974, 42 units and 23 plants are in line for conversion to coal. Some of these conversions will take from 6 months to 3 years. By the order to convert these plants, the future conversion to coal potential of PAD District I will be reduced to approximately 90 MB/D; therefore as much as 100 MB/D is shown in Table 11 for this step. However, if coal conversions are maximized in the base, there may be no significant increment available at the time of a future embargo.

Estimated Potential Fuel Oil Flexibility

These scoping estimates indicate a total potential range of additional heavy fuel oil available through these particular emergency steps of 460 to 830 MB/D plus the non-quantified effects of implementing extraordinary refinery yield flexibility steps and possibly storing higher yielding heavy fuel oil crudes. In addition to these steps, in an emergency petroleum supply interruption under the provisions of the International Energy Program (IEP) Agreement fuel oil could be allocated to the United States in lieu of crude. Therefore, it would appear that covering a 400 to 600 MB/D shortfall could be approached and possibly achieved through some combination of emergency preparedness steps.

CONCLUSIONS AND RECOMMENDATIONS

The above analysis of the potential effects of a future interruption of imports and the ensuing refining and logistical response with security storage crude indicates that:

- A 3 MMB/D crude denial of a duration for which security crude storage has been designed and sized is manageable, and the impact on the normal U.S. petroleum supply and demand requirements could be minimized to a tolerable level.

- A 3 MMB/D crude and product denial (in a 60/40 percent ratio) could cause approximately 400 to 600 MB/D shortfall of heavy fuel oil primarily in the Northeastern states. The impact of this shortfall could be mitigated if not essentially eliminated through appropriate energy emergency action steps; however, further and more specific quantification will be required to more definitively assess this potential.

As a result of this analysis it is recommended that:

- The U.S. should expeditiously develop a security storage system to initially provide crude oil storage for the protection of domestic refinery runs during future emergencies.

- In view of the potential heavy fuel oil shortfall resulting from an interruption of crude and product imports, the U.S. Department of Interior should conduct a detailed review of the refineries located in PAD Districts I and III (and if possible the other PAD Districts, Eastern Canada and the Caribbean) to determine their yield flexibility to produce heavy fuel oil under normal conditions and in an emergency situation. (Suggested questions for such a survey are listed in Appendix D). Furthermore, PAD I fuel oil users should be studied in detail to determine their ability to use lighter oils on an emergency (albeit non-optimal) basis.

- Pending the results of more detailed refinery and fuel oil user surveys together with a further assessment of other potential heavy fuel oil emergency steps, final conclusions and recommendations regarding heavy fuel or alternative light oil (e.g., distillate) storage should be deferred, although it is anticipated that no such security storage will be required.

- Any future projects requiring imported LPG should not depend on security storage crude for protection against LPG import denial.

- The United States should have available emergency energy-use reduction programs designed for responding immediately to interruptions of oil imports.

- In selecting the crude type and mix, consideration should be given to its heavy fuel oil yield characteristics to the extent that domestic and offshore refining facilities are capable of processing the heavier crude. Moreover, the combined effects of shifting refinery yields and running stored crude may require product specification (sulfur) relaxation during an embargo.

- Standby mechanisms to prompt desired emergency actions, such as yield shifts toward fuel oil, should be formulated and included as part of emergency preparedness planning. For example, economic incentives are required to provide cost recovery of otherwise non-economical shifts and to motivate fast and widespread refiner response.

CHAPTER II

SOURCES AND ECONOMICS OF CRUDE STORAGE FILL

INTRODUCTION

The preceding chapter discussed the merits of including produced crude oil in security storage. This chapter will address the possible alternative sources for produced crude oil to be used as fill, in terms of the pertinent factors associated with each, and the relative expenditure cost to the economy for each source.

There are four principal sources of crude oil which can be considered for security storage fill. These are:

- Domestic crude oil;
- Foreign crude oil purchased and transported to storage;
- Federal royalty oil; and
- Crude oil from Naval Petroleum Reserve No. 1 (NPR-1).

In addition to these possibilities using conventional crude oil, synthetic oil derived from a source such as shale was considered, but its cost was estimated to be substantially higher, and its availability more distant by several years.

With the exception of oil obtained from the Naval Petroleum Reserve, all other sources of security storage crude would require a net increase in foreign imports. Presently, domestic production is declining even though essentially all United States oil and gas fields are being produced at their maximum efficient rates (MER's). While this trend will reverse by the early 1980's as new areas enter the production base, notably from the Alaskan North Slope, year to year declines will resume after only a brief period, as product demand growth outstrips increases in domestic crude availability. Unless new energy sources are developed beyond those presently projected, or consumption markedly curtailed, increased reliance will be placed upon imports of crude and products.

Security storage of crude oil has been recommended as a feasible means of increased preparedness to deal with the disruptions to the national security, both economic and military, occasioned by a denial of petroleum imports. Such stored crude oil, ideally, should be of a composition to facilitate ready substitution in the refining capacity denied imports with minimal shift in desired product yield and quality, and deterioration to processing and handling equipment. Analysis of projected refining capacity in 1980, in the regions most severely impacted by a denial of imported crude oil (i.e., PADS I-III), suggests 60 percent of the capacity could require low-sulfur crudes (i.e., less than 0.5 weight percent sulfur content). While it cannot be predicted what proportion of the crude imports denied would be low sulfur, currently about one-third of foreign crude imports can be classified as low sulfur. Accordingly, crude oil stored under a security storage program should be segregated into low-sulfur and high-sulfur components with one-third or more as low- to medium-sulfur crude.

With this background, each of the potential sources will be considered and evaluated.

CRUDE OIL SOURCE ALTERNATIVES

Domestic Crude Oil from Existing Production

Programs could be designed to put in storage barrels of domestic crude diverted from current production and supply to refineries. The supply and storage obligation could be accomplished as a mandated sale to the Federal Government by the private producing sector, or as an assigned responsibility to the several sectors of the petroleum producing and consuming industries, to include integrated producers and refiners, independent refiners, jobbers, brokers, marketers, terminal operators, petrochemical firms, utilities, etc. The issues, benefits, drawbacks, inequities and possible consequences of government versus private ownership, control and funding are discussed at length in Chapter IV.

The amount of domestic crude oil supply to be diverted and concurrent increases in foreign import requirement will depend upon the volume of crude oil to be stored and time period for accomplishing fill. A 500 MMB security storage system crude oil requirement, filled within 3 years, would equate to an additional daily requirement of 450 MB during the fill period. Under these circumstances, if the basic need were at the first quarter 1975 level (3.8 MMB/D) during the full fill period, the imports would be increased by approximately 12 percent. Increasing the national requirement for foreign imports is in direct conflict with the goals of Project Independence and the current action programs which seek to reduce imports dependency.

Cost of the fill to the Nation would be effectively the cost of the foreign crude used for replacement including tanker transport. Payment in dollars to the foreign producer would be in the direction of worsening the balance of trade.

From a quality standpoint, withdrawal of domestic crude from current runs for storage would require the acquisition of replacement material of equivalent gravity, content and yield characteristics. This would require careful planning, especially in terms of replacement of sweet crude sent to storage, as the world supply/demand balance returns to a situation where the Persian Gulf, with its high-sulfur crude, becomes the major incremental source.

Purchased Foreign Crude

If it were feasible and economic to use purchased foreign crude as security storage fill, the objective of protection from future import supply interruption would be achieved by the use of foreign reserves rather than domestic reserves.

An important factor to consider with the use of purchased foreign crude for storage would be the attitude of the host governments, from whom the crude would be supplied. It could be speculated that they might consider the use of oil produced in their countries directly for this purpose inimical to their national interests. However, the International Energy Program Agreement, with its proposed requirement for the establishment of strategic reserves by all members, and the U.S. intention to create a national security reserve are matters of public record. It is not possible to predict what actions, if any, might be taken against the United States, if it chose to acquire foreign crude for security storage fill.

The excess supply of foreign crude now available would suggest that quantities could be acquired for security storage purposes. However, commitment to a program of substantial volume acquisition for this purpose would maintain upward pressure on world oil prices. Any price increase that is occasioned by this increase in demand requirement has the adverse cost effect not only on the security storage volumes but on all imported barrels that are increased in price. In addition, such action would impact adversely on the energy cost of the less industrially developed nations.

Use of purchased foreign crude for fill increases total imports directly by the volumes purchased. Cost would be the price paid to the seller including transportation to the United States. Presumably, if the government were to purchase the fill, there would be no need to pay itself import tariff fees and duty. Foreign exchange balances would be adversely affected by the dollars used for payment in the foreign exchange portion of the transaction.

Federal Royalty Crude

The Federal Government has historically leased federal lands for exploration for and production of oil and gas by the United States petroleum industry. During the early years, public and acquired properties onshore were involved. In 1947, President Truman by Proclamation No. 2667 declared that "The Government of the United States regards the national resources of the subsoil and sea bed of the continental shelf beneath the high seas but contiguous to the coasts of the United States, as appertaining to the United States, subject to its jurisdiction and control." By authority of this proclamation, leases were granted by the Federal Government and petroleum development started outside the boundaries of the states in the Gulf of Mexico, off Louisiana and Texas. Subsequent additional legislation has expanded the scope of such leasing, defined procedures and conditions for such activities.

Under this program, the Federal Government receives as a condition of the lease an "owners" royalty payment. This payment which could be in oil or money payment was initially a one-eighth royalty for the onshore tracts leased. In more recent times, the size of the royalty has moved upward and is commonly one-sixth for offshore leases, though it has been as high as 32 percent for some lease sale contracts.

The amount of federal royalty oil has increased as the leasing program expanded and reached a peak volume of 88 MMB for the year 1971. The year to year volume of such oil has trended slightly downward since then and totalled 80 MMB for the year 1974.

Federal royalty oil has been set aside in the past for sale to eligible small refiners who qualify as small business enterprises under rules of the Small Business Administration. These refiners are thus guaranteed an adequate domestic supply of crude oil to meet the needs of their existing refinery capacities. In 1974, 53 percent of the federal royalty oil was supplied to this group. Royalty oil remaining after meeting the demand of eligible refiners is sold to the lessee or to the operator of the lease. During 1974, approximately 38 MMB were handled in this manner.

The prices received for royalty oil have moved upward with domestic oil prices under the price control regulations and as weighted by the proportions of new and old crude oil produced as defined by Federal Energy Administration regulations. The estimated weighted average price received in June, 1975, is in the range of $7.00 to $7.50 per barrel.

Total federal receipts for royalty oil increased in 1974 over the same period for 1973 from $494 million to $670 million, largely the result of increase in the price realized.

If the current rate of royalty oil production were to be maintained, and it were to be the sole basis directly or indirectly for fill of national petroleum security storage, over 6 years would be required for a 500 MMB system and, of course, longer if a larger volume program were instituted or the production rate continues to decline.

In addition, "eligible" refiners who now buy roughly one-half of all federal royalty oil would be required to obtain replacement volumes which would presumably be incremental foreign oil at the substantially higher prices which are required for foreign oil. About $700 million per year of government revenue would be foregone if all federal royalty oil were to fill security storage instead of being sold. This in effect becomes the a cost to the Federal Government for using this oil for storage. However, the cost to the Nation would be significantly higher, possibly on the order of $1 billion per year at current foreign oil prices.

As is the situation with regard to purchased domestic crude, since federal royalty oil is now a portion of domestic supply to United States refineries, its diversion to security storage would require replacement with imports to balance the supply. At the 1974 rate, imports would have to increase 220 MB/D. Dollars paid to foreign suppliers, insurers and tanker owners for the oil would contribute to unfavorable exchange balances, just as in the case of purchasing foreign oil directly for security storage.

Naval Petroleum Reserve Crude

The September, 1974 Report of NPC on Emergency Preparedness for Interruption of Petroleum Imports into the United States included a section entitled, "Production from Naval Petroleum Reserves"(1) which concluded that of these only NPR-1 (Elk Hills) would be capable of providing significant additional production for a number of years.

The NPR-1 reserve at Elk Hills is situated in Kern County near Bakersfield, California. The field is reserved by law for use in a national emergency and requires approval of the President and a joint resolution of Congress for production in excess of the minimum required to maintain the field in a state of readiness and to prevent drainage from adjacent commercial wells. Average current production from this field is 3 MB/D.

The field is reported to have several zones of oil and gas deposits with two principal zones--a shallow zone at about 3,000 to 4,000 feet, and the thicker Stevens zone at 5,000 to 9,000 feet. Total proved reserves are reported as 1 billion barrels with possible additional reserves estimated at 0.5 billion barrels as exploration proceeds. The Navy has an active 5-year exploration and development plan which is currently under way with five drilling rigs at work.(2)

The shallow zone crude, which represents approximately one-third of the reserves, as typified by an October, 1974 sample, had a 20° API gravity and a sulfur content of 0.9 weight percent. The gravity of Stevens zone crude, comprising about two-thirds of the reserves, ranges from 28° API to 38° API. Sulfur content ranges from 0.3 to 1.5 weight percent. A sample of Stevens zone crude taken in December, 1973, which might be indicative of the average quality of this zone, had a gravity of 31.5° API and a sulfur content of 0.65 weight percent.

A significant volume of associated gas is present in the Stevens zone and the Navy is developing plans for optimal gas handling as field development proceeds. Given the necessary legislative approval and funds, a production rate of 130 MB/D could be possible within several months and, with continued development, an ultimate production rate of 400 MB/D might be achieved by 1980.

Maximum ultimate recovery of hydrocarbons from the field can undoubtedly be achieved by limiting production to the maximum efficient

(1) Pages 87-89.
(2) Naval Petroleum and Strategic Energy Reserves Serial No. 94-13 (92-103). Statement, Jack L. Bowers, Assistant Secretary of the Navy at joint hearings before the Committees on Interior and Insular Affairs and Armed Services, United States Senate, March 11, 1975, Pages 117, 121.

rate (MER). The Office of Naval Petroleum Reserves in 1972 estimated MER at 267 MB/D.(3) The MER may be revised after completion of the current drilling program. Producing capacity decline with time must be considered since storage fill would take place over several years. If a sustained rate of 267 MB/D could be maintained, 98 MMB per year of total production would be available from NPR-1. Since the Navy's share of this is about 80 percent, approximately 80 MMB per year would be available for fill. If NPR-1 production were to be the basis for a 500 MMB crude security storage system, between 6 and 7 years would be required to accomplish the fill. However, after removal of the 500 MMB quantity significant producing capacity would still remain at NPR-1 should a larger storage system be instituted.

Production development is not the only relevant factor for providing NPR-1 produced crude on a direct or indirect basis for security storage. Currently, only 130 MB/D of pipeline transport capability exists to deliver crude from this area to refining and distribution centers at Bakersfield, San Francisco and Los Angeles. New capacity would have to be added in a timely fashion to achieve utility for the crude whether these specific volumes are transported to storage or sold or exchanged for other produced crude, either foreign or domestic, to be placed in storage. Assistant Secretary of the Navy, Bowers, has testified that total pipeline capacity could be increased from 130 to 355 MB/D within 36 months assuming adequate planning and funding.(4)

Sale or Exchange of Federally-Owned Crude Oil

If federally-owned crude oil (royalty or NPR-1)were to be the basis of a national petroleum security storage program, public sale and/or place and time exchanges might be made to deliver security crude oil into Gulf Coast storage at lower transportation cost. In the case of NPR-1 crude, there could be transportation advantage for delivery of that crude to West Coast refiners, in exchange for comparable crude oil delivered to security storage locations in the Gulf Coast.

Direct exchange to PAD V refiners could back out current foreign imports under some circumstances with attendant delivery of foreign imported barrels to the storage location, presumably the Gulf Coast area. Under such a plan, there would be effectively no net increase in the amount of foreign imports or greatly added costs to the Nation except for the investments required to bring on NPR-1 production and transport it to points of refining or exchange.

Exchanges to achieve effective transfer of federal royalty crude oil into security storage would not have the same net impact on foreign imports. Since federal royalty crude oil is now a part

(3) Capability of the Naval Petroleum and Oil Shale Reserves to Meet Emergency Oil Needs B-66927, Report to Congress by the Comptroller General of the United States, October 5, 1972, Page 16.

(4) Bowers, op. cit.

of the Nation's domestic runs base, withdrawal by direct or indirect means has the result of increased imports requirements as previously discussed.

Direct sale of owned oil from either federal royalty or NPR-1 could also be possible assuming delivery capability. Funds generated by such sale could be used to purchase other crude which would incrementally be foreign oil. In the case of federal royalty oil, this has the impact of increased imports and unfavorable balance of trade effects. If it is assumed, as it has been throughout this study, that NPR-1 crude oil would not otherwise be produced for inclusion in the domestic raw material base, funds generated from the sale of NPR-1 crude oil could be used to offset the purchased cost of foreign oil with little, if any, effect on the level of imports or balance of payments. While conceivably such a mechanism could be logistically advantageous, it could have negative political appeal because of the required valuation risk of crude value fluctuation between the time when NPR-1 crude was produced and sold, the time when imported crude is purchased, and the time when security storage crude is sold. Continuous ownership of NPR-1 barrels during transformation from unproduced to produced storage may limit exposure to political or public criticism for mismanagement.

The possibility of sale and/or exchange of NPR-1 crude oil to accomplish equivalent security storage fill in PAD District III will become less likely as additional production is made available to PAD V from Pacific OCS reserves and the North Slope operations are begun and brought to the expected level of 2 MMB/D in the early 1980's. While estimates vary, a crude oil surplus is projected in District V in the early 1980's period.[5]

During this period, there will be a significant westward shift in the center of domestic petroleum supply moving in a direction away from the consuming regions most vulnerable to an imports interruption. The national interest will be served as the largely heretofore interdependent crude oil and product logistical systems of PAD I-IV and PAD V are integrated, possibly through the use of one or more pipelines to connect the areas west of the Rockies with the extensive distribution network east of the Rockies. Several proposals have been advanced for such a linkage. The effectiveness of the national security petroleum storage system would be thereby significantly enhanced by providing increased flexibility in the Nation's ability to use its domestic reserves.

West Coast to Texas pipeline systems may be built at some time in the future. The likelihood of such construction might be improved by a program to move NPR-1 produced crude oil, or the equivalent by sale or exchange in PAD V, to security storage in the Gulf Coast.

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(5) The Trans Alaska Pipeline and West Coast Petroleum Supply--1977 - 1982, Arlon R. Tussing, Chief Economist, Committee on Interior and Insular Affairs, United States Senate, Pages 7, 14.

SYNTHETIC SOURCE MATERIAL

Synthetic crude oil could also be considered as a source of fill for a security storage system. Synthetic crude oil could be produced from shale oil from federal properties or the Naval Shale Oil reserves. Existing technology would enable the production of a premium quality, hydrotreated, low-sulfur syncrude. The total quantity would be limited for practical purposes only by the size of the venture undertaken and ecological necessities.

However, no commercial shale facilities are now in operation. Development of an oil shale industry awaits adequate incentives to cover the extremely high capital investment required and the associated risks. Heavy capital demands for other programs of energy development are another contributing obstacle. Current projected cost for delivered syncrude is estimated to be 40 percent greater than the current delivered cost of foreign crude oil. Because of this situation, it is unlikely that significant volumes of syncrude from oil shale will be available until sometime in the 1980's, if then. While government programs under the Project Independence objectives could be conceived to encourage syncrude development, it is unlikely to have any foreseeable role in security petroleum storage fill.

A more likely source of security storage barrels for a system larger than 500 MMB would be remaining NPR-1 reserves, developed NPR-4 reserves, and possibly new increments of federal royalty oil from expanded OCS producing operations.

ECONOMIC SUMMARY

Since both purchased domestic crude and federal royalty crude must be replaced by imports, the cost of these sources is effectively the same as that of the purchased replacement foreign category. As representative of imports, a long range price of $11.00 per barrel for Persian Gulf crude has been estimated by the FEA. This, plus transportation to the U.S. Gulf Coast at $1.50 per barrel, assuming a long-term tanker charter rate for very large crude carriers (VLCC'S) at Worldscale 70, results in a total cost of $12.50 per barrel excluding tariff fees or duty. This would be cost to the government for security storage crude fill derived from imports, expressed in current (1975) dollars.

Under the assumption that NPR-1 crude would not be produced, except as a national security resource, cost of fill from this source would be equivalent to out-of-pocket production costs for development and operation of the field. Order of magnitude estimate for this might be $1.50 to $2.00 per barrel. Transportation to the Gulf Coast in an assumed existing or expanded pipeline is estimated to cost $1.15 to $1.35 per barrel, resulting in a total expenditure cost to the government of approximately $3.00 per barrel in current (1975) dollars.

If, however, the assumption were made that legislation were passed to permit the Naval Petroleum Reserves to be produced and sold into the domestic economy, diversion in that instance to security storage would result in foregoing a potential decrease in imports. Under this assumption, the cost of fill from NPR crude would be the same as the other sources, which is effectively the cost of replacement foreign oil -- $12.00 to $14.00 per barrel.

Use of syncrude from federal or naval shale oil properties to supply a later portion of the fill might require a price of about $16.00 per barrel to provide the necessary incentive to produce the material. If pipeline cost of $1.00 per barrel is assumed for the necessary transportation, a total of about $17.00 per barrel is the estimated cost of fill from syncrude material. While this would be a higher cost to the government than direct purchase of foreign supplies, it would be money spent in the United States to the benefit of the United States' economy.

CONCLUSIONS AND RECOMMENDATIONS

Consideration of these factors leads to the following conclusions relative to produced crude oil fill for security storage:

- Since the United States producing industry is expected to continue operating essentially at its maximum efficient rate, the diversion of purchased domestic crude oil to security storage means that an equivalent volume must be imported to balance supply thereby resulting in increased dependence on imports.

- Use of directly purchased foreign oil, if allowed by the exporting nations, would achieve the desired objective of protection from foreign supply interruptions by the use of foreign reserves, but negatively impacts the balance of payments and greatly increases the expenditure cost for a national security petroleum storage system.

- Federal royalty oil appears at first to be a logical candidate for fill, since it is already owned by the Federal Government. However, its removal from small business refiners plus the loss of large revenues by the government, its declining volume, and the need to replace it with an equivalent volume of imports to balance supply tend to limit its desirability.

- Elk Hills crude in NPR-1 is the logical choice as a basis of security storage fill since it is the only source of fill which would not increase imports and represents the lowest expenditure cost alternative to the Nation's economy. Cost would be out-of-pocket production costs plus transportation to the storage site either physically or by exchange. Production at the estimated maximum efficient rate considering appropriate decline in capacity would require about six to seven years after the storage and delivery facilities are brought into being to receive oil at a 500 MMB level.

- Production from NPR-1 could be sold or exchanged while a crude deficit exists in PAD V. One or more interconnecting pipelines to tie PAD V with PAD I-IV appear as necessary adjuncts to the Nation's logistical network and would add flexibility to effective utilization of the Nation's crude oil reserves. Such facilities would enable more ready transport or exchange of NPR-1 and/or other PAD V crude oil surplus to the District's need to the Gulf Coast.

- Availability of significant volumes of material from synthetic type sources appears to be too far in the future and too costly to be considered as the fill for the strategic storage system.

These conclusions lead to the following recommendations:

- Enact necessary legislation to permit the use of the Federal Government's share of Elk Hills crude as the basis for direct or indirect fill for a security storage system.

- Develop specific plans for exchange or sale of NPR-1 crude and provide corresponding acquired volumes to storage sites in the United States Gulf Coast. Where cost effective, develop plans for movement of NPR-1 crude oil by pipeline into Gulf Coast salt dome storage.

- Be alert to possible opportunities to purchase, in a politically acceptable manner, significant quantities of foreign crude of satisfactory quality for security storage fill, if necessary, to supplement NPR-1 supplies.

- Consider longer range programs to permit production of high quality syncrude from oil shale located in federal or naval reserves for inclusion in an expanded level of security storage reserves if the cost/benefit ratio would justify.

CHAPTER III

TECHNOLOGY AND ECONOMICS FOR STORAGE FACILITIES

INTRODUCTION

To be fully effective, security petroleum storage must be integrated into the existing and planned U.S. petroleum logistical system, including direct access to tanker loading facilities as well as major petroleum trunk lines. The objectives of this chapter are to: (1) discuss the alternatives available for providing such storage, both underground and aboveground, as expeditiously as possible; (2) estimate and compare the costs of various storage alternatives; and (3) project the normal and accelerated project construction schedules for each of these options, assuming that a large scale security storage program will be given national defense priorities. The emphasis will be on crude storage because, as discussed in Chapter I, the need for emergency product storage appears to be non-existent with the possible exception of residual fuel oil for PAD District I.

UNDERGROUND STORAGE

There are three proven methods of storing crude after production and petroleum products underground: (1) cavities leached in salt domes or salt beds, (2) cavities mined in hard impermeable rock formations such as granite, shale, or limestone, and (3) abandoned underground mines that have been specially adapted for storage. About 255 MMB of light hydrocarbon underground storage capacity exists in the United States. Some 95 percent of this capacity is located in cavities leached either in salt domes or salt beds, and about 5 percent is in cavities mined in hard rock.

Salt Dome Storage

As illustrated by Figure 5, a salt dome is a massive column of rock salt, typically 0.5 or more miles wide, thrusting upward from many miles below the surface and topped by a thick caprock. The top of the salt may be near the surface, and in many cases, salt from such domes is mined for commercial use. There are more than 350 known salt domes within a 50,000 square mile area along the Gulf Coast (Figure 6). Many of these salt domes are located near the major Gulf Coast refining centers (Houston, Beaumont/Port Arthur, and New Orleans/ Baton Rouge), the Gulf of Mexico and the major inland waterways (Houston Ship Channel, Port Arthur [Sabine] Ship Channel, and the Mississippi River).

Underground petroleum storage projects have an excellent record of safety and reliability based on more than 20 years of experience. Because salt caverns are generally located more than

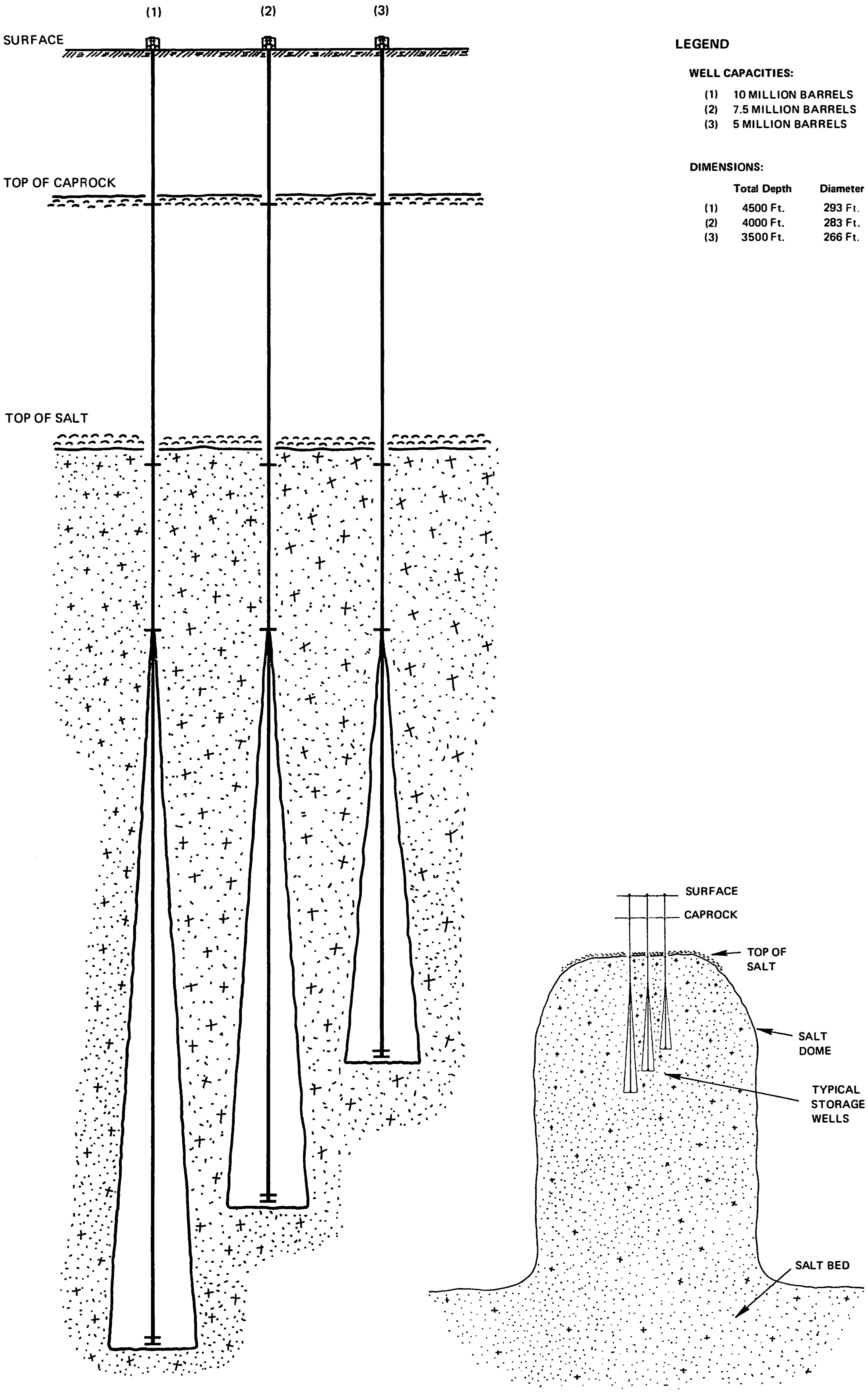
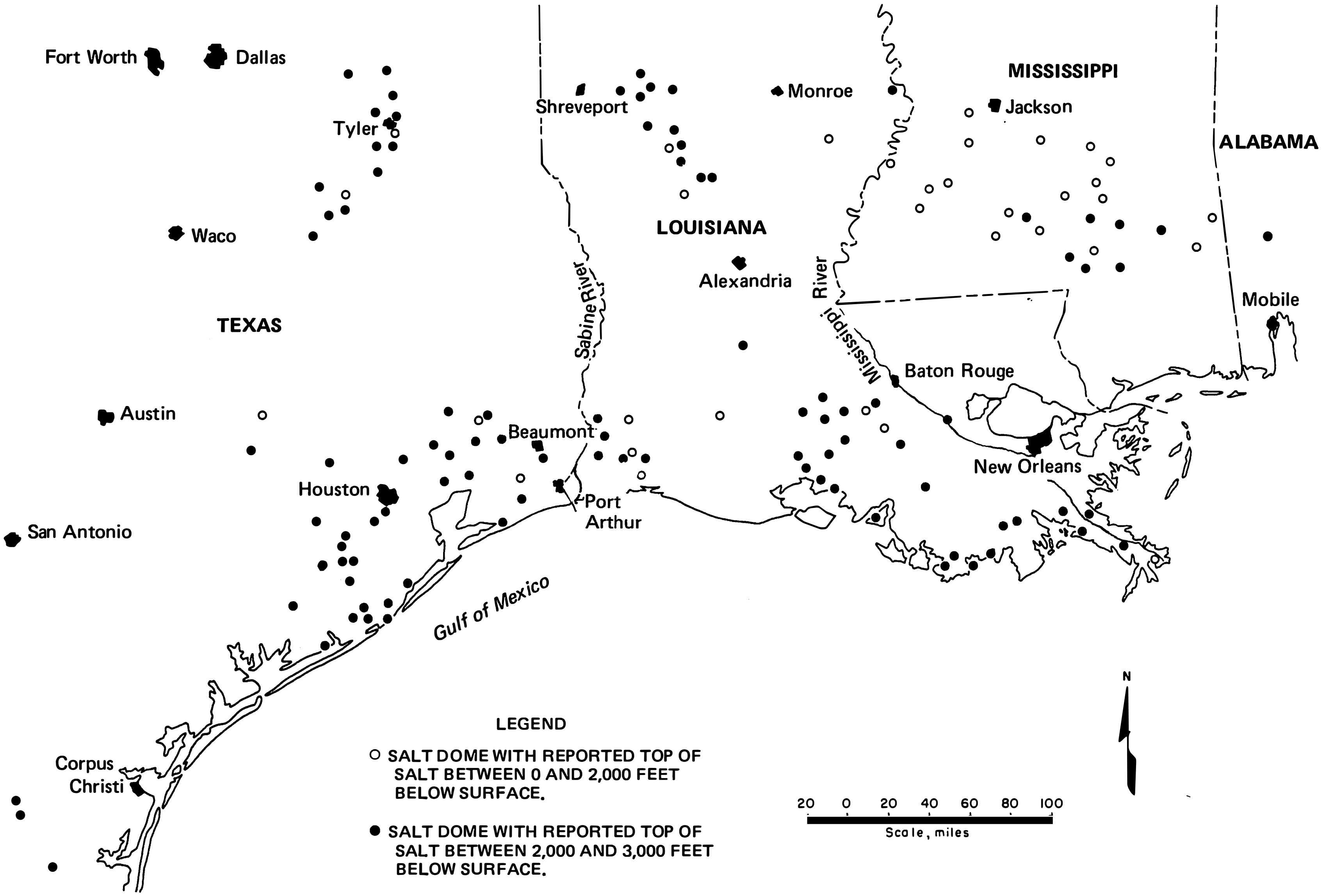


Figure 5. Typical Salt Dome Storage Wells.



Source: U. S. Department of the Interior, Bureau of Mines, Information Circular 8313, (Washington, D. C.).

Figure 6. Onshore Salt Domes That Offer Good Possibilities for Salt Extraction or Underground Storage Sites.

2,000 feet below the surface, maximum protection is provided against hazards such as fire, storm, and sabotage. Some 180 MMB of salt dome storage capacity are presently utilized for light hydrocarbon storage in the U.S. Individual storage caverns commonly range from 0.5 MMB to 2 MMB, and a number of caverns are designed to store up to 5 MMB. Even larger individual storage caverns are technically feasible.

Based on a study of several Gulf Coast salt domes, underground storage in leached salt dome cavities can be provided at an initial cost of $0.70 to $1.15 per barrel (1975 dollars), depending upon the cost of pipelines required to connect the storage to distribution facilities and the distance from a suitable brine disposal and water source area. This estimate does not include the cost of crude or product to fill such storage and is valid only for large volume projects (250 MMB) with individual caverns of 7 MMB.

Figure 7 illustrates how economy of scale affects the cost per barrel of storage for a typical salt dome project. The cost of constructing a 100 MMB project is indicated to be one unit per barrel of storage capacity. A 50 MMB project would cost about 1.3

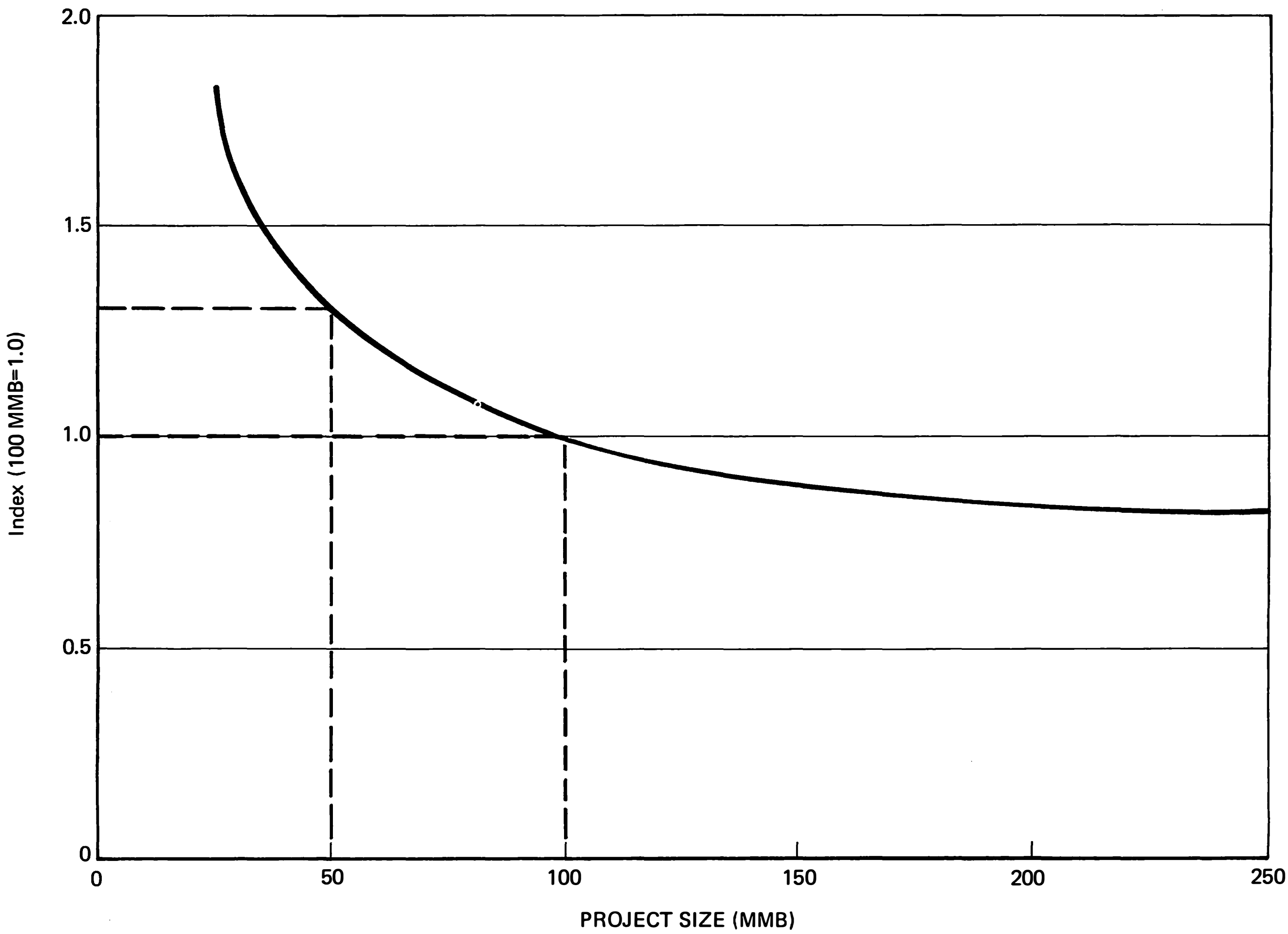


Figure 7. Salt Dome Storage--Economy of Scale Index of Relative Construction Cost per Barrel of Storage.

units per barrel or 30 percent more than the 100 MMB project. Similarly, a 20 MMB project would cost nearly twice as much per barrel as a 100 MMB project. Projects larger than 100 MMB should exhibit costs somewhat below one unit per barrel. For example, the unit cost for a 250 MMB project would be only 80 percent as much as for a 100 MMB project. Such savings are possible because after the high cost leaching and brine disposal system is installed, additional storage can be leached at low incremental cost. Thus, the cost per barrel should continue to decline for even larger volume projects. This indicates that substantial cost savings can be achieved by combining storage requirements in large caverns at a single location. Gulf Coast salt domes can be leached to provide an extremely large volume of underground storage. A few salt domes, such as Stratton Ridge, located southwest of Houston, are large enough to provide 1 billion barrels of storage capacity, and many domes are large enough to provide a storage capacity of several hundred million barrels.

The leaching of a salt dome cavern is a fairly simple process. First, a well is drilled into the top of the salt formation. Several steel casing strings are set and cemented to protect fresh water beds and to seal off intervening formations. Fresh water (or sea water) is then pumped down an inner string of tubing. The salt is dissolved, and the resulting brine solution is circulated back to the surface where it is disposed of by a method designed to fully protect the environment.

After leaching, the cavern contains salt water. As shown on Figure 8, it is then filled with oil by pumping crude down the annular space between tubing and casing and displacing clean brine through the tubing string which is set near the bottom of the cavern. The oil floats on top of the brine that remains. Because the oil is stored in a large cavern, it can be withdrawn at a very high rate by pumping water down the tubing string to displace oil up the annular space between tubing and casing. This procedure insures that only clean oil is discharged when the cavern is emptied and that only clean water is discharged when it is filled with oil. With proper casing/tubing design, a crude delivery rate on the order of 200 MB/D per well can be achieved. Thus, a 100 MMB storage project with only 10 to 20 caverns could have a combined crude delivery capacity of several million barrels per day if the capacity of crude trunk lines connecting the storage project to refining centers and tanker loading facilities is adequate. Water for future displacement of crude from such caverns need not be stored in surface pits. Rather, it would be supplied by pipeline from either a large body of fresh water, such as a river, or the Gulf of Mexico.

A typical storage system is illustrated on Figure 9. For large caverns, about 7.5 barrels of fresh water are required to leach 1 barrel of storage depending on the leaching rate utilized. Sea water can be used for leaching if adequate fresh water is not available; however, a second pipeline to the Gulf would be required. This would not add significantly to the cost per barrel of storage if the project were located near the Gulf. The assumption of

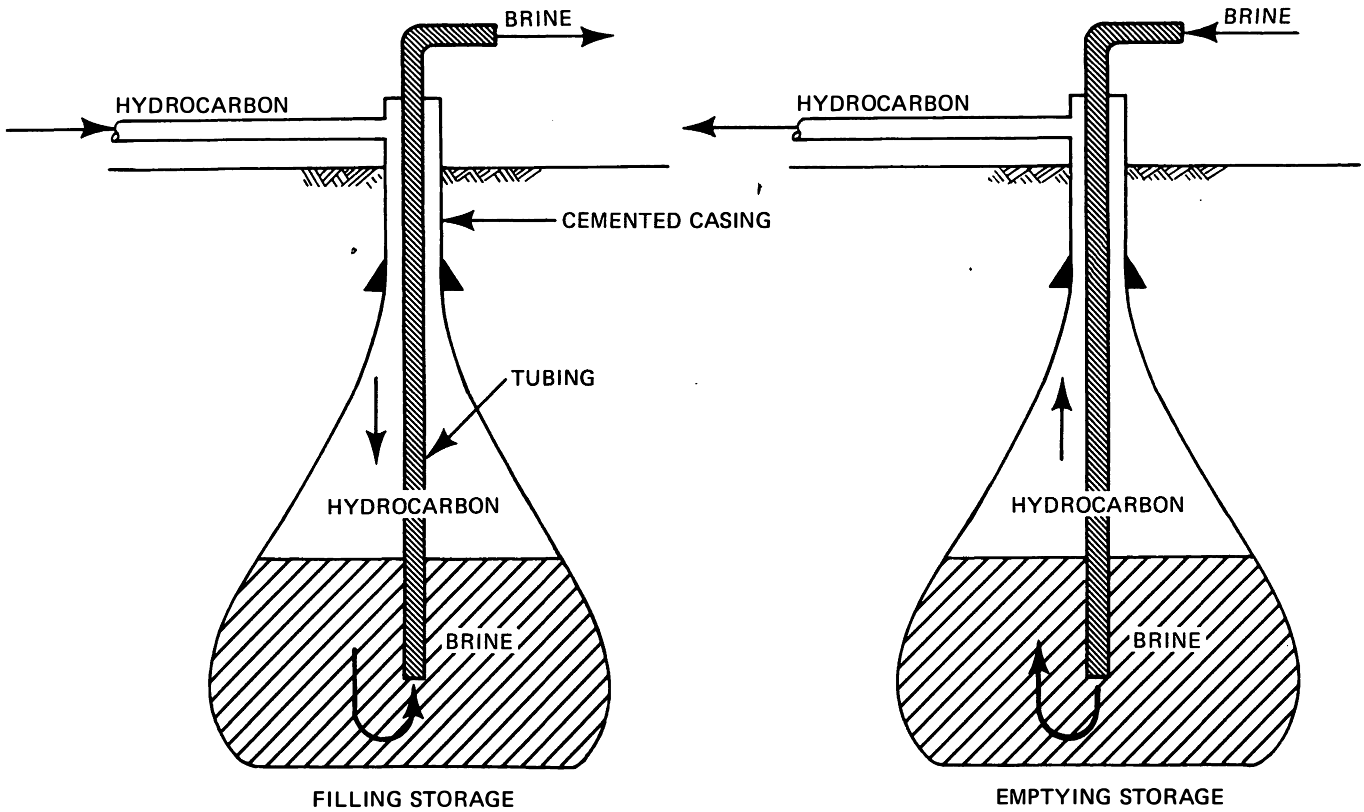


Figure 8. Filling and Emptying of Salt Dome Storage Caverns.

offshore brine disposal capability is also important. About 2 MMB/D (130 cubic feet per second) of brine would be produced from leaching of a 250 MMB storage project in 3 years. Subsurface disposal of such a volume would be physically impossible at most locations and in addition, prohibitively expensive.

It is recognized that storage area surface requirements, subsurface fresh water protection, brine disposal pipeline right-of-way requirements from the storage area to the offshore outfall, fresh water requirements, and brine disposal considerations associated with large volume storage projects raise questions concerning impact on the environment. These questions will be addressed concurrently with site selection as a first order of priority after project authorization. Of particular importance is optimization of the brine disposal system design to minimize the environmental impact on marine life offshore and in nearby bays, marshes, and estuaries, and protection of onshore wildlife and human amenities. Environmental studies will include pipeline right-of-way routing and design to minimize disturbance, and offshore outfall location and distance to produce adequate dispersion of brine discharged at sea. Development of such plans and the necessary Environmental Impact Statement will require ecological studies of the pipeline route and the outfall area, including biological, chemical, botanical, and oceanographic studies. However, if storage projects are located near LOOP and Seadock as recommended, the extensive ecological surveys conducted for these groups over the past two years will be of significant benefit. The Environmental Protection

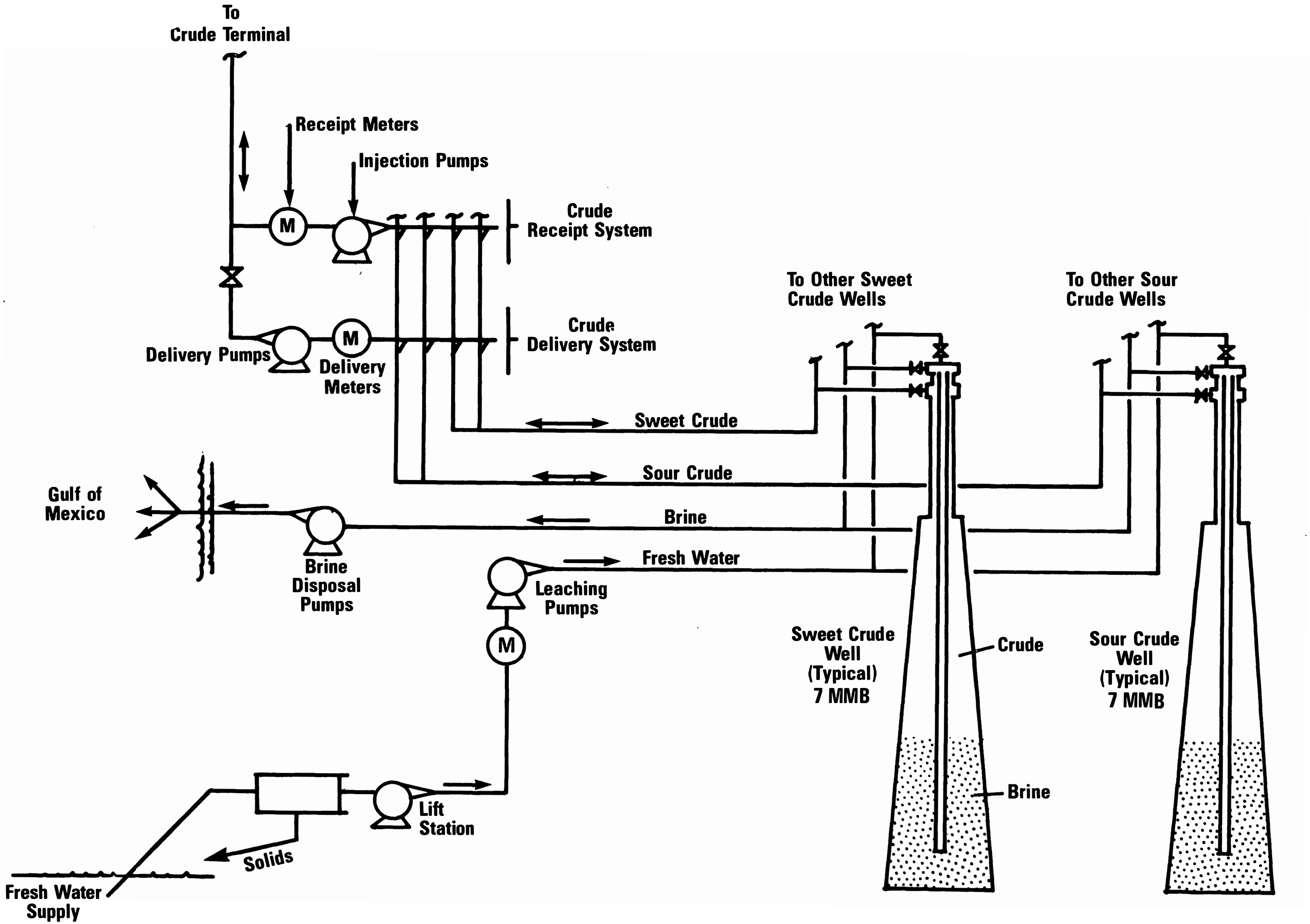


Figure 9. Crude Security Storage Facility: Schematic of Salt Dome Terminal.

Agency will be consulted at an early date in anticipation of securing a discharge permit under the National Pollutant Discharge Elimination System. While leaching and filling are in progress, the system will be monitored to assure proper operation and compliance with discharge permit requirements.

Although no specific environmental studies have been made for a very large scale salt dome crude oil storage system in the U.S., based upon past experience, it appears that for most applicable Gulf Coast locations, a suitable water supply for leaching will be available and that with proper planning and implementation the environmental effects of the storage facilities and produced brine discharges will be minimal.

Storage leached in salt beds is also a proven technique; however, the potential utility of such beds for security storage projects is limited. Most salt beds are located inland where fresh water costs are relatively high and where subsurface brine disposal would be required, thus making very large volume projects impractical.

There are also certain domes such as Stratton Ridge where a substantial volume of very large cavities already exist as a result of salt mining operations. While such cavities may be suitable for crude storage, detailed studies would have to be made to insure structural integrity and to determine the volume that could be safely utilized. In addition, facilities such as pipelines and tanker docks would likely have to be constructed to permit delivery of crude to storage, and this would require several years. Thus, while some storage of this type might be made available prior to 1979, additional information will be required to determine the practicality of such a course of action.

FACILITIES FOR FILLING STORAGE AND MOVEMENT OF CRUDE FROM GULF COAST SALT DOMES TO OTHER LOCATIONS

Total U.S. security storage crude supplies could be located in Gulf Coast salt domes to take advantage of significantly lower project construction cost compared to alternative storage facilities as will be discussed later in this chapter. However, two important factors in addition to cost must be considered during the selection of specific project sites. First, the projects should be located near major crude pipelines capable of delivering crude out of storage to inland (pipeline connected) refineries at rates compatible with normal crude import rates. Secondly, the projects must have ready access to water such that tankers can both deliver crude into storage and be loaded out of storage for delivery to (1) U.S. refineries who normally receive crude by water, (2) Caribbean refineries supplying product imports to the U.S. who are denied crude during a future embargo, and (3) East Coast refineries if total U.S. security storage crude supplies are located in Gulf Coast salt domes.

The most efficient, lowest cost salt dome storage projects will result if U.S. Gulf Coast deepwater crude unloading terminals and associated crude pipelines are constructed as planned. However, with the current uncertainties regarding government policies affecting future petroleum demand and crude imports, it is possible that these deepwater terminals may either be delayed or perhaps not constructed at all. For this reason, the factors affecting project location and cost will be described for two cases: (1) Gulf Coast deepwater terminals are operational by 1979, and (2) Gulf Coast deepwater terminals are not available in time to complete storage fill by an acceptable deadline.

Location of Projects if Gulf Coast Deepwater Terminals Are Constructed

Figure 10 shows the location of two proposed Gulf Coast deepwater crude unloading terminals, LOOP and Seadock, and the location of the major U.S. refining centers within each PAD district. Enabling federal legislation was enacted in 1975 that will permit these or similar deepwater terminals to be constructed in international waters off the U.S. coast. Both projects will apply for permits as soon as the Department of Transportation is ready to receive applications. The startup of these projects is dependent on a number of factors which are somewhat uncertain; however, under favorable conditions, startup in 1979 is feasible. At each project, deep draft very large crude carriers (VLCC's) will tie up to buoys (single point moorings) located 20 to 30 miles offshore and unload crude (neither project is being designed for finished product throughput). The crude will be pumped through buried pipelines to onshore tank farms and then to Gulf Coast and Midwest refineries.

Figure 10 also shows the proposed route of several new large diameter crude pipelines to be built for transportation of imported crude to U.S. refineries. These include pipelines to be constructed downstream of the LOOP and Seadock tank farms and the proposed Seaway and Texoma pipelines, which will run from Freeport and Beaumont, Texas, respectively, to Cushing, Oklahoma. Significant crude pipeline capacity is already in service between Cushing and the Chicago area. Capline, which currently moves crude from the Louisiana Gulf Coast to the Chicago area, can be expanded if necessary.

In addition, there is a large network of crude trunk lines from North and West Texas to the Gulf Coast. Reversal of some of these lines to handle imported crude is being considered. The crude pipelines connecting PAD Districts II and IV presently move crude from west to east because District IV has a crude surplus. However, should District IV become short of crude in the future, one or more of these pipelines could be reversed to move imported crude to District IV refineries.

Upon completion of these facilities, imported crude could flow to most of the refining capacity in PAD Districts II, III and IV. Therefore, if Gulf Coast salt domes near LOOP and Seadock are utilized for security storage, these same refineries could easily receive security storage crude during an embargo. It is also

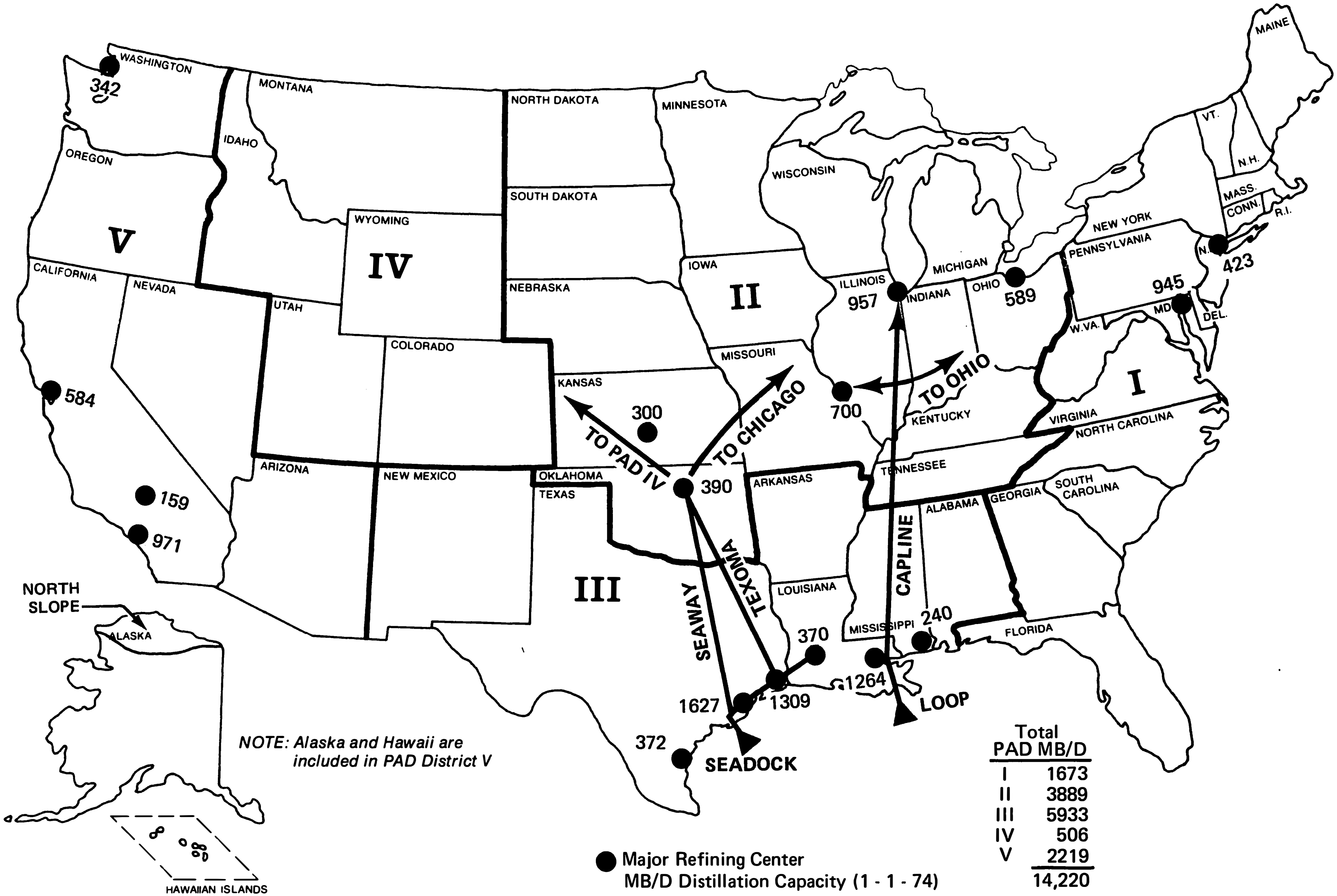


Figure 10. Major Refining Centers by Petroleum Administration for Defense (PAD) Districts and Proposed Gulf Coast Deepwater Terminal Locations.

feasible to design deepwater terminals so that tankers can load crude for shipment to other U.S. ports, particularly if such a need is considered in the initial deepwater terminal design. Such facilities (primarily pumps) would add about 15¢ to 20¢ per barrel to the cost of storage (1975 dollars). Thus, with proper location of salt dome storage projects, a large percentage of refining capacity east of the Rockies can effectively be supplied with crude out of Gulf Coast salt dome storage during an emergency. Caribbean refineries could also be supplied if necessary. The effective integration of storage projects into the U.S. crude logistics system, as described, is of major importance and must be accomplished if the United States is to have a reliable emergency crude storage system.

If a crude security storage program of 500 MMB or more is undertaken, at least two salt dome storage projects should be constructed; one near the Seadock terminal in Texas (Figure 11) and one near the proposed LOOP to St. James crude pipeline in Louisiana (Figure 12). Locating a project in both Texas and Louisiana will enable delivery of crude to a higher percentage of PAD II-IV refining capacity at a higher rate than if only one storage project is constructed because each location connects to different major crude trunk line systems.

Near the Seadock onshore terminal, the Stratton Ridge salt dome appears particularly suitable for a storage project. Stratton Ridge could easily accommodate 500 MMB of storage. Near the LOOP to St. James pipeline, the Clovelly, Chacahoula, and Napoleonville domes appear suitable for 250 MMB projects and the latter two domes could each likely accommodate 500 MMB of crude storage. There are undoubtedly other suitable domes near each location. Detailed geotechnical, engineering, and environmental studies would be required to verify the suitability of any specific salt dome for crude storage.

The required delivery rate of crude out of storage is difficult to define because this depends on both the future level of imports and the volume that is likely to be denied during an embargo. If maximum national security is to be provided, a design delivery rate out of storage to permit replacement of total U.S. crude and product imports should be considered. Even though a total import denial appears unlikely, the cost of protecting against such an eventuality could be a relatively small percentage of total crude storage costs, and spare capacity would provide flexibility to offset possible downtime for project maintenance, bad weather, sabotage, etc.

On this basis, if two 250 MMB projects are to constitute the total storage program, each project should be designed to deliver crude out of storage at a rate equal to at least the design throughput capacity of the adjacent deepwater terminal (i.e., around 2 MMB/D). In addition, allowance should be made for deliveries to other locations by tanker such as the Caribbean, East Coast or non-pipeline connected Gulf Coast locations. This suggests a design rate of be-

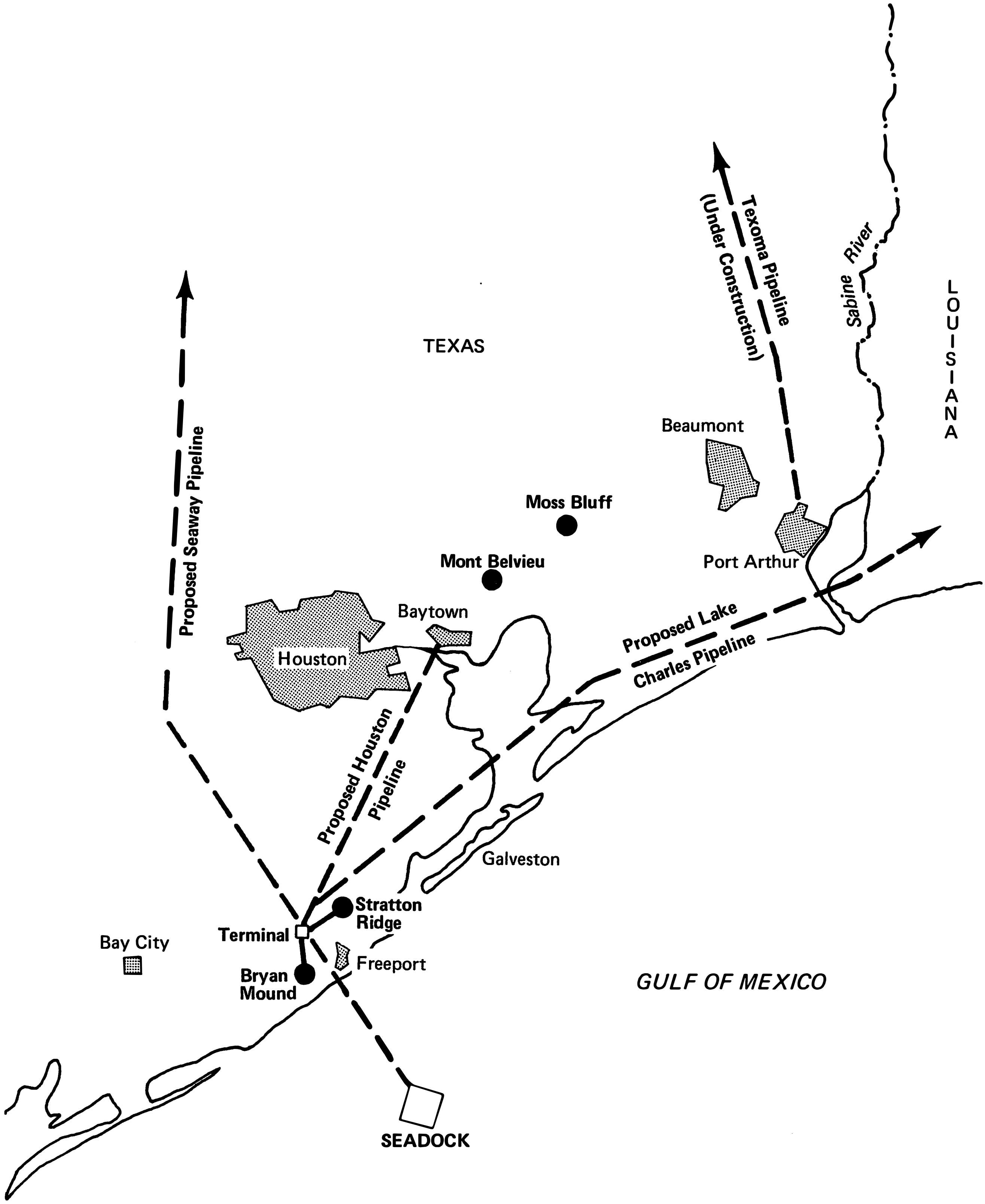


Figure 11. Texas Salt Dome Sites.

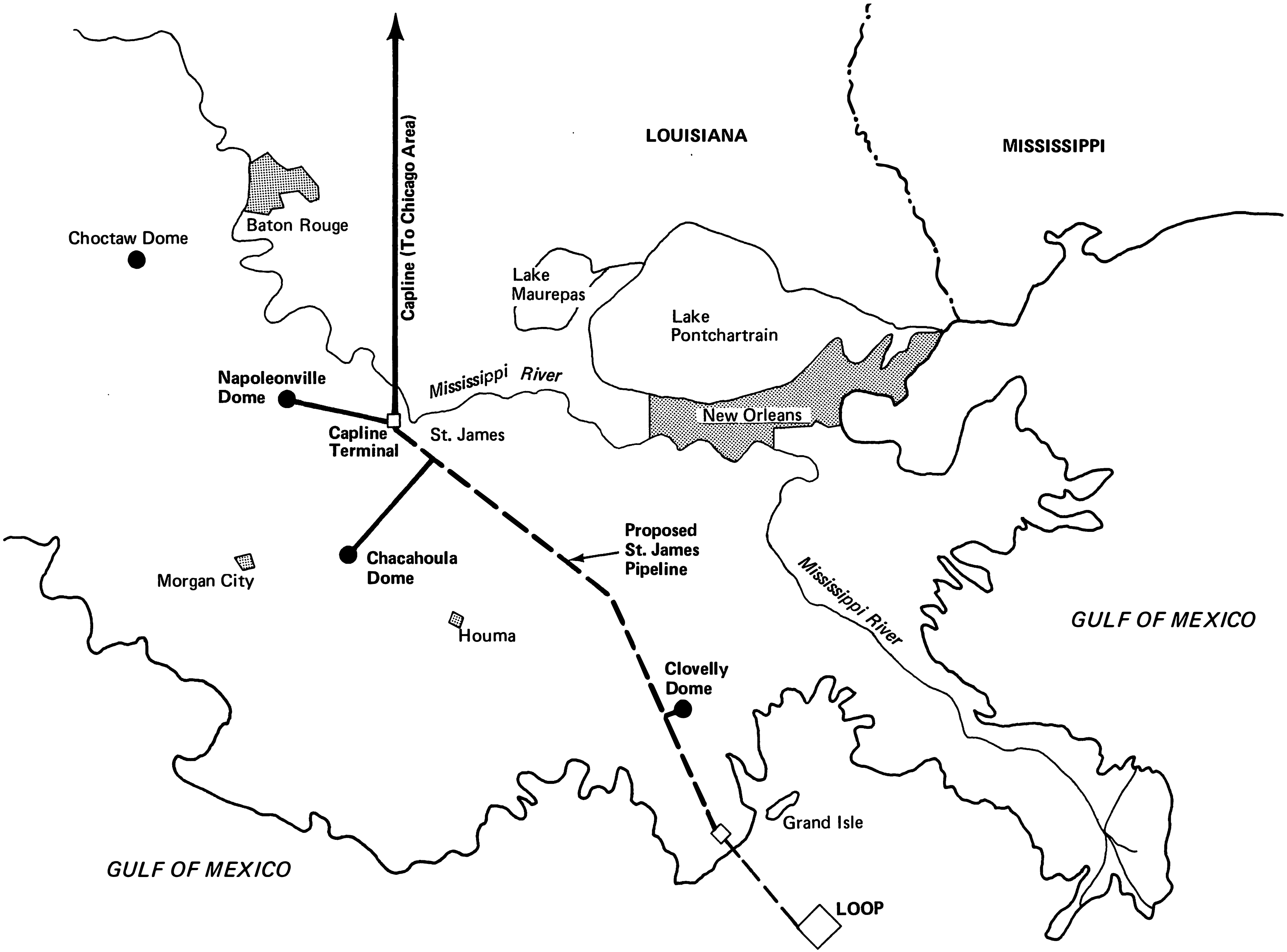


Figure 12. Louisiana Salt Dome Sites.

tween 2 and 3 MMB/D at each location or up to 6 MMB/D of total delivery capacity. On the other hand, if four 250 MMB storage projects are provided, a design delivery rate of 2 to 3 MMB/D for each project might not be necessary.

For a given storage volume, a reduction in total delivery capacity could be accomplished in several ways; for example, by utilizing a smaller number of larger caverns, by reducing individual cavern deliverability (smaller casing and tubing) and/or by installing less pump horsepower and a smaller crude delivery line. The approach utilized depends on a number of factors which would have to be evaluated for each specific site. However, it appears likely that an increase in the delivery rate of a 250 MMB project from 2 MMB/D to 3 MMB/D might be accomplished at a cost of about 5¢ to 10¢ per barrel, depending on the percentage of crude delivered to tanker loading facilities.

Location of Projects Without Gulf Coast Deepwater Terminals

If Gulf Coast deepwater terminals are not available in time to meet the desired program completion schedule, a different set of salt domes would probably be selected for storage. In this case, it is likely that at least three salt dome projects would be required for optimum efficiency: one near the Houston Ship Channel such as Mont Belvieu or Moss Bluff; one near the Beaumont/Port Arthur (Sabine) Ship Channel (there are several); and one near the Capline terminal on the Mississippi River such as Napoleonville or the Choctaw dome. These inland waterways will be utilized to import crude to major refining centers in the absence of deepwater terminals. By constructing new tanker receipt facilities and pipelines to the salt dome storage project, tankers could both unload crude to fill storage and load crude during an emergency for delivery to U.S. refineries normally importing crude, and to the Caribbean. In addition, storage could be connected to major pipelines delivering crude to the Midwest (Capline and Texoma). The absence of deepwater terminals would add about 20¢ to 40¢ per barrel to storage costs, depending on the percentage of crude delivered to adjacent crude pipelines. In addition, delivery out of storage would be much more complicated because of the higher percentage of security storage crude delivered to refineries by tanker.

BASIS FOR SALT DOME STORAGE COST ESTIMATES

To determine the probable range of salt dome storage costs, five suitable salt domes located near LOOP and Seadock were studied. The bases used in developing project costs are summarized on Table 12. It is emphasized that a much more detailed engineering, geotechnical and environmental analysis would be required before a specific site, development program, and budget quality cost estimate could be obtained. However, the cost estimates developed are believed representative of what can be accomplished in actual practice.

TABLE 12

BASIS FOR SALT DOME STORAGE COSTS

Location of Salt Dome	
a. Near deepwater terminals (LOOP/Seadock)	
b. Top of salt	Minimum 600 feet Maximum 2000 feet
c. Area	360 acres
d. Near to Gulf as possible	For brine disposal For possible ship loading
Well casing	Concentric design 20-inch product casing 13-3/8 inch brine casing 9-5/8 inch leaching string
Displacement fluid	Fresh water (no brine pit storage capacity included)
Displacement rate	165 MB/D per well 18 wells simultaneously = 3 MMB/D
Rigs required	Maximum rating - 200 tons 3 rigs per location 60-90 days per well
Well size	7 MMB initial, 10 MMB ultimate
Well spacing	575 feet, 8 acres per well
Leaching rate	1.8 MMB/D fresh water (117 cfs)
Leaching efficiency	7.5 barrels water per barrel of salt (8.5 barrels brine per barrel new storage)
Pump driver type	Electric
Brine disposal	Gulf of Mexico offshore, 2 MMB/D (130 cfs) Minimum 20 foot water depth 48-inch disposal line
Crude system	3 MMB/D delivery rate per segregation (2) 48-inch delivery line
Crude delivery point	Texas - Seadock tank farm Louisiana - LOOP and Capline tank farms

Note: Detailed engineering studies will be required before the design bases for an actual project can be determined. The general specifications listed herein are for cost estimating purposes only.

Selection of Salt Domes

Cost estimates for 250 MMB of salt dome storage are conservatively based on land requirements of 360 acres and assume construction of a single tiered, multiple cavern facility. Salt domes selected for such construction should be shallow enough to prevent excessively high drilling costs and operating pressures. A maximum top-of-salt depth of 2,000 feet appears to be a reasonable limit. A minimum depth of at least 600 feet was also specified to prevent possible structural problems that could result due to insufficient overburden.

Another important location criterion is proximity to the Gulf of Mexico. For the very high brine disposal rates required to develop large amounts of storage in a relatively short time, the Gulf provides the only feasible means of brine disposal. It was, therefore, assumed that permits to dispose of large volumes of brine into the Gulf will be obtained. Sites located near the Gulf on dry land are preferable from both development cost and environmental points of view. It appears that electric prime movers will be the lowest cost power alternative and that power availability will be an important consideration in site selection.

Well and Delivery System Design

The casing program selected for cost estimation is based on a standard size which can be handled with conventional land drilling rigs and obtained with minimum delivery time. Twenty-inch product casing with displacement fluid tubing of 13-3/8 inch would provide the required average delivery rate of 165 MB/D,using fresh water as the displacing fluid. Smaller casing and tubing might also be utilized. However, the reduced tubular goods cost would be offset to a large degree by increased pump investment and power costs during leaching. (This will be optimized during detailed engineering design.) After crude fill is completed, subsequent displacements would be with fresh or sea water; therefore, no brine surface pits are required. If surface pits were utilized, project cost would be increased substantially. To obtain a delivery rate of 3 MMB/D would require simultaneous delivery from 18 wells of the design described above.

Cavern Size

Generally, the larger the cavern size, the lower the cost per barrel of storage. For crude storage, 10 MMB is considered a reasonable ultimate cavern size which should provide good structural stability at relatively low unit cost. However, a smaller initial cavern size is appropriate to allow for future cavern enlargement in the event several displacements are required because of the need to use stored crude over the years. Therefore, this analysis is based on an initial cavern volume of 7 MMB with very conservative well spacing that would permit growth to 10 MMB or more in the future. There are any number of combinations of well size and casing design which could be utilized. Although a detailed optimization will be required in actual practice, the sizes indicated should provide a reasonable estimate of the cost of crude security storage.

Brine Disposal and Leaching Rate

As previously mentioned, brine disposal at a rate of 2 MMB/D (130 cubic feet per second) can only be accomplished into a large body of water such as the Gulf of Mexico. Preliminary studies by consultants for LOOP and others have indicated that substantial volumes of near-saturated brine can be disposed of several miles offshore without serious risk of damage to the environment. The optimum location of outfalls for brine disposal in the Gulf will be studied in detail during the design and environmental assessment phase of each individual project.

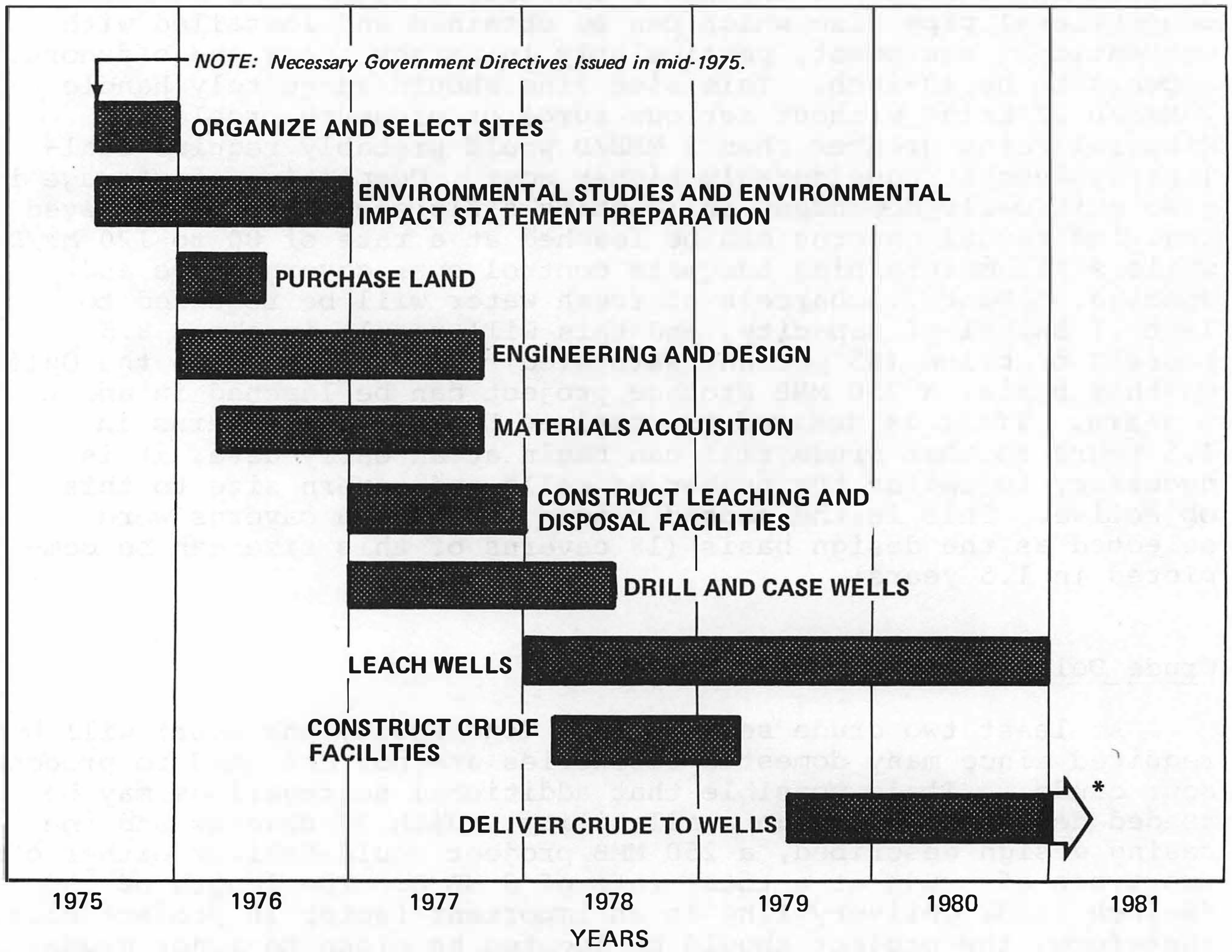
Brine will be pipelined offshore to a minimum water depth of 20 feet and discharged through a diffuser system. The maximum conventional pipe size which can be obtained and installed with conventional equipment, particularly in marshy areas and offshore, appears to be 48-inch. This size line should adequately handle 2 MMB/D of brine without serious surge or pressure problems. Disposal rates greater than 2 MMB/D would probably require dual-line systems at considerably higher cost. Completion of storage is also critically dependent on leaching efficiency. It is believed that individual caverns can be leached at a rate of 80 to 120 MB/D while still maintaining adequate control over cavern shape and spacing. About 7.5 barrels of fresh water will be required to leach 1 barrel of capacity, and this will result in about 8.5 barrels of brine (85 percent saturated) for disposal into the Gulf. On this basis, a 250 MMB storage project can be leached in about 3 years. If it is desired to complete half of the caverns in 1.5 years so that crude fill can begin at an early date, it is necessary to tailor the number of wells and cavern size to this objective. This is the second reason that 7 MMB caverns were selected as the design basis (18 caverns of this size can be completed in 1.5 years).

Crude Delivery System

At least two crude segregations (one sweet, one sour) will be required since many domestic refineries are not designed to process sour crude. It is possible that additional segregations may be needed depending on crude availability. With 36 caverns and the casing design described, a 250 MMB project could deliver either of two types of crude at a total rate of 3 MB/D. The length of the 48-inch crude delivery line is an important factor in project cost; therefore, the project should be located as close to major crude trunk lines and tanker loading facilities as possible. Delivery will be out of salt dome storage into terminal tankage (e.g., the Seadock onshore terminal) using pumps installed for construction of the storage project. Pumps on the various crude pipelines normally moving crude out of each area can be utilized to pump crude to the various refineries, thereby reducing capital required to construct the storage facility.

Project Timing (Normal Development)

Figure 13 illustrates the "normal development" schedule for a 250 MMB salt dome storage project. Completion about 5-1/2 years after an appropriate government directive is issued may be possible. However, this schedule assumes that national defense priorities are established so that critical path materials such as leaching pumps can be delivered within 18 months. It is also assumed that materials acquisition and expenditure of funds can proceed simultaneously with necessary environmental studies as opposed to the normal practice of waiting until such studies are completed and a federal permit has been issued. Necessary environmental studies should begin immediately upon issuance of a government directive. It is likely that studies relating to the selection



*Completion of fill is dependent on rate of crude availability.

Figure 13. Construction of 250 MMB of Salt Dome Storage--Normal Development Case.

of the salt dome sites themselves could be completed quickly, particularly if basically dry-land sites were involved. The more complicated site specific environmental studies relating to routing and burial of pipelines, optimization of brine disposal outfalls in the Gulf, base line and current surveys, etc., could be done simultaneously with other activities as long as such studies were satisfactorily completed and reviewed in time to make necessary adjustments in project design. Key events in the above schedule are as follows:

PROJECT TIMING

Key Events	Cumulative Time From Government Directive, Months
Begin environmental studies	0
Begin engineering design	6
Order long lead time materials	9
Delivery of well casing, begin drilling and construction	18
Delivery of all pumps, pipe, etc.	27
Begin cavern leaching	30
Complete first half of caverns	48
Complete second half of caverns	66 (5-1/2 years)

Assuming engineering design begins in January, 1976, 125 MMB of storage might be completed and ready to fill in mid-1979. This schedule fits well with the earliest probable startup date of deepwater terminals. It is also about as early as new crude delivery facilities such as a pipeline from the Elk Hills field to the Gulf Coast, or new tanker docks could be completed and placed in operation. With this schedule, leaching of 250 MMB of salt dome storage could be completed in 1980 and storage fill might be completed during the early 1980's depending on crude availability.

Project Timing (Accelerated Development)

If it appears necessary to complete construction of a 250 MMB salt dome storage project prior to 1980, this could probably be accomplished. It is doubtful that cavern leaching could begin prior to the time indicated in the normal development schedule. However, the leaching time might be cut in half by installing duplicate leaching and brine disposal facilities and leaching all 36 caverns simultaneously. This would require a disposal rate of 4 MMB/D (260 cubic feet per second) into the Gulf for a single 250 MMB project compared to 2 MMB/D in the normal development case, and well drilling would have to begin about 3 months earlier

With this approach, total project capacity might be ready to fill with crude in mid-1979. If sufficient crude is available, fill might be completed perhaps a year or so earlier than with the normal development schedule. Duplication of facilities would increase project cost by about 10 to 35¢ per barrel (1975 dollars). There would be little point in accelerating completion of storage unless it is certain that facilities required to deliver crude into storage will be in operation by 1979 and that sufficient crude will be available to accelerate storage fill.

Timing of 500 MMB and 1000 MMB Crude Programs

The timing of program completion is basically a trade-off between the desirability of minimizing cost and the need to obtain the protection afforded by security storage at an early date. This balance is also affected by the availability of crude for storage fill, environmental considerations related to leaching water availability and brine discharge rates, and the interaction between construction of security storage and the achievement of other national objectives such as energy independence.

The size (number) of individual projects is also a factor. For example, based on the normal development schedule for a 250 MMB project, a 500 MMB program with two projects might be completed in 5-1/2 years. If three projects with identical leaching and brine disposal systems were constructed (167 MMB each) completion time might be reduced to 4-1/2 years, but the cost per barrel would increase due to reduced economy of scale benefits. Similarly, the accelerated development approach with dual leaching/disposal systems could be utilized.

Recognizing that such flexibility exists, the timing of 500 MMB and 1000 MMB salt dome storage programs (normal development) might be as follows. For a 500 MMB program with deepwater terminals, construct one 250 MMB project in Texas near Seadock and one 250 MMB project in Louisiana near LOOP. Total storage could be constructed in 5-1/2 years.

For 1000 MMB, each project could continue to leach storage with its single leaching/disposal system until 500 MMB had been constructed at each location. This would require 8-1/2 years, but the average cost would be 10¢ to 20¢ per barrel lower than for a 250 MMB project. If considerations dictated that the total program be completed more rapidly, four 250 MMB projects could be started simultaneously and completed in 5-1/2 years. In either case, dual leaching/disposal systems might be utilized to reduce construction time to about 4 years. However, as mentioned earlier, the real objective, completion of storage fill, depends on crude availability.

Cost of Salt Dome Crude Storage

Using the bases previously described, it is estimated that salt dome crude storage costs (normal development basis) will range from \$0.70 to \$1.15 per barrel for a 250 MMB project (1975 dollars). The low end of the cost range will be typical of a project located on dry land near the Gulf and major crude trunk lines. The high end of the cost range will be typical of a project located up to 50 miles from the Gulf with a somewhat longer crude delivery line. The major difference in these two extremes is the cost of leaching including the brine disposal pipeline to the Gulf. Facilities to permit tanker loading during an emergency will add an additional 15¢ to 40¢ per barrel to this cost.

Thus, the likely cost range appears to be from \$0.85 to \$1.55 per barrel for normal development and from \$0.95 to \$1.80 per barrel for accelerated development (1975 dollars). If future costs escalate at a rate of 6 percent per year for materials, 7.5 percent per year for labor, and 10 percent per year for electric power, project costs on an inflated or "as expended" basis would increase by about 20 percent over the costs quoted in 1975 dollars.

OTHER UNDERGROUND STORAGE TECHNIQUES

Abandoned Mine Storage

Storage of crude in specially converted abandoned mines is a proven technique. A large project has been in operation in South Africa since 1969. No such storage exists in the United States. Under ideal conditions, costs for this type of storage can be competitive with salt dome storage. However, the potential for use of abandoned mines for United States storage purposes does not appear promising.

Such mines are usually filled with water, and many of them are interconnected with other mines through underground water systems. Only a few of these mines have isolated water systems. Most of these old mines would not be safe to enter even when pumped dry as the potential for collapsed shoring in the access tunnels would be very high. Extensive surveys would be required to insure that product would not leak out of storage. Also, it is doubtful that typical abandoned mines located in the eastern U.S. would permit development of large volume storage projects of sufficient scale to compete favorably on a cost basis with other alternatives, particularly large-scale salt dome projects. The closest abandoned mines to East Coast refineries are located near Higgins, Pennsylvania, about 100 miles west of Philadelphia.

Mined Cavern Storage

It would likely be more practical to mine new caverns in the good rock formations in the Philadelphia area, for example, than to try to utilize abandoned mines. The cost of new mined storage caverns could approach the cost of steel tanks for storage volumes in excess of one million barrels.

There are about 60 storage projects in mined caverns in hard rock in the United States. These projects vary in size up to about 800 MB capacity and are usually used to store light hydrocarbons under pressure. The potential for developing large volume storage projects of this type close to existing refineries or existing distribution systems appears limited. In addition, the cost of salt dome storage is far less.

Depleted Reservoir Storage

This type of storage is not regarded as practical for the following reasons. First, the rate at which crude can be injected into and withdrawn from porous reservoir rock is usually limited to the order of hundreds of barrels per day per well. This is a severe limitation. Second, experience indicates that crude loss from such a system would be high.

ABOVEGROUND STORAGE IN STEEL TANKS

The primary advantage of aboveground storage in tanks is locational flexibility. Such storage can be easily integrated into the existing petroleum logistical system. Crude can be stored in tanks at individual refineries, and refined products can be stored at the optimum location for rapid supply to consumers, either at refineries or product terminals. One disadvantage of tank storage is the cost per barrel of storage capacity. Such cost is a function of location, local construction requirements, and tank size.

Location plays an important role in tank cost. An obvious factor is location with respect to existing transportation facilities. A remote storage location requiring an expensive pipeline connection would add significantly to the unit cost. A second factor is the variation in material and construction cost at different locations in the U.S. For example, it is estimated that a 5 MMB crude tankage project using simple foundations at an existing Gulf Coast refinery would cost about $6.00 per barrel whereas a similar installation in the New York/Philadelphia area would cost about $9.00 per barrel. If pilings must be driven to provide an adequate foundation, the cost per barrel would increase by about 40 percent. If heated tanks were required for viscous products, costs would also be higher. It is recognized that actual estimates for a specific site may vary significantly from these values. However, the above comparison is believed to be representative of an average installation.

A third factor is the economy of scale provided by large tanks. For example, a 500 MB East Coast clean product storage facility utilizing an average 70 MB tank would cost about 1.25 times per barrel more than a 2 MMB facility utilizing an average 180 MB tank.

In summary, the cost to construct steel tank storage at sites that can be tied into existing installations with minimum additional facilities should be in the general range of $6.00 to $12.50 per barrel (1975 dollars). Higher costs would be anticipated for the following: locations near existing East Coast refineries versus Gulf Coast locations; product versus crude tankage; small versus large tanks; soil conditions requiring special foundations; heated versus non-heated tanks, and construction at locations that are a significant distance from existing terminal or refinery sites.

If a large-scale security storage program utilizing steel tankage were undertaken, the capacity to construct such tankage as rapidly as desired could become a limiting factor. About 4,300 tons of steel are required to provide 1 MMB of tank storage capacity, or 2.15 million tons for 500 MMB of steel tankage. This is comparable to the current total annual consumption of oil country tubular goods (casing, tubing, and drill pipe) used for drilling and producing oil and gas wells in the U.S.(1) If the United States is to achieve a high degree of energy independence by 1985, a staggering amount of drilling and construction of refineries and other energy related facilities will be required. For example, total tankage for the two proposed Gulf Coast deepwater terminal tank farms (LOOP and Seadock) will probably exceed 30 MMB. These projects and many other energy related facilities will be constructed during the next 5 years.

This will place an enormous load on the construction and fabrication industries, significantly increase the demand for steel and likely lengthen the interval between the time that materials are ordered and construction is completed. The quantity of steel required for salt dome storage is far less than for a comparably sized steel tank storage project. Between 8.5 and 9.0 pounds of steel are required for each barrel of steel tank storage including related facilities versus 0.25 to 0.33 pounds per barrel of salt dome storage. Thus, creation of salt dome storage would have a lesser effect on the Nation's ability to develop energy related projects requiring large quantities of steel.

Estimated East Coast Steel Tank Crude Storage Cost and Timing

If security crude storage for East Coast refineries is located in PAD I, it would likely be in steel tankage. Existing refining capacity plus additions with good or average probability of completion by year-end 1977 for PAD I were estimated to be about 2.18 MMB/D in the September, 1974 NPC Emergency Preparedness Report. Crude run in this capacity, at 92 percent utilization, would be about 2 MMB/D. A 90-day security storage program to cover total PAD I crude runs which are primarily imports would, therefore, require up to 180 MMB of storage. For comparison, the magnitude of such a storage project is over six times the total crude storage of 28 MMB which existed in PAD I in 1973.

(1) NPC, Availability of Materials, Manpower, and Equipment for the Exploration, Drilling and Production of Oil--1974-1976, 1974, Table 3, Page 14.

It is probable that such tankage would be located adjacent to each refinery rather than at one or two centralized locations. This approach would take advantage of the flexibility of location which is provided by steel tankage and would save investment in delivery systems from a centralized location to the various refineries. Such storage is not considered to be required, however, as noted in Chapter I.

Tankage Costs

The costs of steel tankage consist of the cost of the tank itself, connections to the refinery process units, pumps, land, and pilings if required by local soil conditions. It is assumed that importing facilities in normal use would be adequate to handle the additional imports required to fill security storage. The cost estimates presented below are believed to be representative of an average East Coast location. First quarter 1975 dollars are shown and would have to be adjusted upward for late 1970's construction because of inflation.

TANKAGE COSTS

Construction Requirements	$/B (1975)
Tankage (500 MB each), including foundations, firewalls, etc.	6.00
Connection to refinery, pumps, lines, etc.	2.50
Land	0.50
Total Without Pilings	9.00
Total With Pilings	12.50

Overall, the total investment required for a 90-day crude security program in steel tanks for PAD I would approximate $1.6 billion, excluding the cost of fill. For a 250 MMB project, yearly maintenance costs for steel tankage would average about 2.5¢ per barrel compared to about 1/2¢ per barrel for salt dome storage and 1.5¢ per barrel for concrete storage. These estimates apply after storage is filled and exclude ad valorem taxes.

Project Schedule

The timing for construction of a 180 MMB project would largely be influenced by the availability of steel. It is estimated that 6 to 7 years would be necessary to complete a project of this magnitude assuming a desire to minimize construction cost. However, this could vary depending upon the overall level of steel consumption in the United States. Based on the following schedule, it is concluded that time requirements for construction of large quantities of aboveground steel tankage will be at least as great as for salt dome storage.

Construction of 180 MMB of crude storage in aboveground steel tanks on the East Coast could probably be completed by 1982 if security storage legislation is enacted by mid-year 1975. The additional time to complete storage fill would depend on crude availability. Items critical to completion are as follows:

PROJECT SCHEDULE

Key Events	Months
Develop project scope, complete environmental studies, prepare budget	6
Order tanks (includes engineering, specifications, bids, bid evaluation, placing orders)	6
Lead time until delivery of first tank following order	12(2)
Construction time: 360 tanks, 500 MB each	54
Total time to completion	78 (6-1/2 years)(3)

Storage in Concrete Tanks

Prestressed concrete storage is also an alternative. In certain locations, cost of such storage in the 1 to 3 MMB size range could compare favorably with current steel tankage costs. Operation of storage of the above-noted size at 2 to 3 pounds per square inch (psi) would minimize vapor generation and thereby reduce the size of the vapor collection header and the vapor disposal system. At this pressure range, only the vapor generated during filling need be vented. The circular prestressed concrete tankage concept has been used in about 200 storage units with some tanks having been in service for almost 30 years. Pressurizing such tanks to 2 to 3 psi would involve existing technology.

CONCLUSIONS AND RECOMMENDATIONS

Consideration of the various alternatives available for providing security petroleum storage, the estimated costs and con-

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(2) During tank delivery lead time, construction of foundations and site preparation would be proceeding.

(3) Might be reduced by 1 to 2 years by dedicating the total resources of the U.S. tank building industry to this project. However, this would increase cost significantly and cause a delay in construction of other projects.

struction schedules leads to the following conclusions and recommendations:

- The lowest cost method of providing emergency crude storage is to leach caverns in Gulf Coast salt domes. For projects storing approximately 250 MMB, construction costs should range from $0.85 to $1.55 per barrel (1975 dollars) including the cost of tanker loading facilities. Such storage will utilize existing and proven technology and will be designed such that the impact on the environment will be minimal.

- Emergency crude storage must be effectively integrated into the existing and planned U.S. crude logistical system. Such storage should have direct access to tanker loading facilities as well as major crude trunk lines. If Gulf Coast deepwater terminals are constructed in a timely fashion, salt dome storage projects should be located near deepwater terminal onshore tank farms. If the construction of deepwater terminals is delayed substantially, then salt dome storage should be located near the three major Gulf Coast inland waterways (Houston and Sabine Ship Channels in Texas and the Mississippi River in Louisiana).

- A 250 MMB salt dome storage project can be constructed in about 5-1/2 years if given adequate priority by the government. If engineering design could be initiated by January, 1976, substantial salt dome storage could be ready to fill with crude by mid-1979.

- It is doubtful that significant salt dome storage could be ready to fill prior to 1979 because of the time required to construct both storage and crude receipt facilities such as pipelines or tanker docks. The amount of salt dome storage available for fill in mid-1979 could be accelerated substantially at a cost of about 20¢ per barrel by installing duplicate leaching and brine disposal facilities and leaching all caverns simultaneously. This would not be justified unless crude could also be delivered into storage at an accelerated rate.

- If a 500 MMB crude storage program is undertaken, at least two projects should be constructed, one in Texas and one in Louisiana. If a 1000 MMB program is undertaken, construction of multiple 250 MMB projects could be undertaken to speed completion of total storage construction.

- While steel tank storage offers maximum locational flexibility, construction cost ($6.00 to $12.50 per barrel depending on location) would greatly increase the cost of the storage program. It is estimated that the construction of a 250 MMB steel tank storage project would require at least as much time as a comparable amount of salt dome storage. In addition, steel requirements would be much greater and could, therefore, slow the development of other energy related projects.

- Other types of storage techniques do not appear to be applicable to large scale emergency storage projects because of cost, availability, and/or location relative to the U.S. crude logistical system.

- Storage of total emergency crude supplies in Gulf Coast salt domes is therefore recommended.

CHAPTER IV

FINANCING AND OWNERSHIP OF SECURITY STORAGE

INTRODUCTION

The two basic options for the financing and/or ownership of a crude security storage program are: government financing and ownership, or private sector financing and ownership. Between these two extremes are a number of alternative combinations involving hybrid government/private financing and/or ownership. After careful analyses of these alternatives this study has reached the conclusion that the most feasible, most efficient, and lowest cost crude security storage system for the United States is one which is owned and financed by the U.S. government, but which fully utilizes industry advice and expertise in its design, construction and operation. This conclusion may at first seem counter-intuitive in a nation which relies heavily on private industry enterprise to achieve its goals. However, a careful examination of the objectives and benefits derived from a security storage system, as well as a realistic assessment of the practical problems inherent in alternative ownership and financing possibilities, leads to this conclusion.

Government ownership and financing are not presented as the only possible approach. Several private ownership and financing approaches are possible, but in the long run appear more costly and less efficient. The objective of this chapter is to outline these alternatives and their advantages and disadvantages.

OBJECTIVES AND BENEFITS OF SECURITY STORAGE

An evaluation of the various ownership and financing alternatives requires that they be considered in the light of the Nation's security storage objectives as well as the benefits which result from security storage. These objectives and benefits are briefly summarized as follows.

The Nation has become increasingly dependent on oil imports, which currently constitute 35-40 percent of United States oil consumption and about 20 percent of total energy consumption. The objective of security storage is to reduce the nation's vulnerability to possible future embargoes of imported oil which might occur for a number of reasons. For example:

- As a result of armed conflict in foreign producing areas.

- For political reasons to bring pressure for changes in United States foreign (or even domestic) policies by disrupting the United States economy.

- In connection with direct military action by a foreign power against the United States or against nations which the United States is pledged by treaty to defend.

- As the result of accidents or natural disasters which result in reduced foreign oil supplies.

To better understand the significance of "to reduce the nation's vulnerability to future oil embargoes," it is instructive to examine the potential impacts of a future embargo. Based on previous NPC estimates in the NPC Emergency Preparedness Report dated September, 1974, an embargo which results in the loss of 3 MMB/D of United States oil supplies for an extended period of time could cause a reduction in real Gross National Product (GNP) of about 8 percent. Translated into human terms using Okon's correlation this would increase the unemployment level by over two percentage points--or in excess of <u>two million</u> workers could lose their jobs (depending on how the shortage was managed). Economic effects of this magnitude could not be confined to any one industry, any one group of consumers, or any one geographic area, but would affect the Nation as a whole.

This helps to illustrate that the justification for a security storage program is designed to protect the broadest national interest against a threat to its economic well-being and its military security. The beneficiaries of a security storage program are the Nation as a whole, its economy, and all its people in their roles of producers and consumers. Unfortunately, it is sometimes assumed that only selected industries (such as the petroleum industry), selected consumers (such as automobile owners), or selected areas of the country (such as the East Coast) benefit from protection against a future oil embargo.

Also the nature and purpose of crude petroleum security stocks needs to be clearly distinguished from the substantial working stocks of crude and products maintained by industry. These stocks are owned and financed by industry for the purpose of operating an efficient nation-wide supply network. The consumer needs for hundreds of different petroleum products in every region of the country are daily met by the United States oil industry. In order to accomplish this mammoth task reliably, highly dispersed increments of working stocks are used by many individual competing companies to prevent consumer supply disruptions which might result from a wide variety of normal operating contingencies such as tanker delays, refinery shutdowns, pipeline outages, etc., as well as for seasonal demand variations. The centrally controlled national security crude stocks on the other hand are intended to provide protection against an entirely different contingency, hopefully, one that might never occur again. Finally, it must be recognized that in the event of a national emergency resulting from an embargo, government, not industry, will likely have primary control over the access to and disposition of national security stocks.

The objectives of a national security storage system include other important criteria such as:

- Timely and expeditious construction. Import levels and our vulnerability to an embargo are already significant and growing.

- The system must be controlled to ensure that the desired crude stocks are actually on hand in the event of an emergency.

- Also the system must be able to respond quickly and efficiently to move the crude security stocks into the United States supply system to replace lost imports.

These requirements have been carefully considered in the recommendations contained in this report on the type of storage facilities, their design and location, and type of fill. It is equally important that they be considered in decisions about ownership and financing. Further, it can be anticipated that a system which is characterized by simplicity in its ownership and administrative requirements and in its financing methods is most likely to meet these needs from a practical standpoint.

DESCRIPTION OF PRIVATE OWNERSHIP ALTERNATIVES

All Refiners and Importers

Several approaches exist to structuring a private-owned security storage system. One obvious possibility is to require that all refiners and importers of crude and products expand their working stocks to provide a prescribed level of security storage protection. This could be similar to some European systems. Importers of liquified natural gas, chemical feedstocks, or even overland natural gas might be included. Presumably, a fully equitable system would require the industries which import these hydrocarbons to also provide national security storage.

This approach could distribute the burden of security storage proportionately on all refiners and finished and unfinished product importers. Also, it would result in wide physical dispersion of stocks which might be advantageous from the standpoint of safety from physical hazards, sabotage, etc. However, this approach would require a massive administrative system which would have to determine and define by regulation the normal working stock levels for each class of business (refiner, electric utility, terminal operator, etc.) and for each product (crude, fuel oil, mogas, etc., or establish crude oil equivalent factors for each product). Also working stock levels vary seasonally for each area of the country. Having defined working stock levels, a complex reporting and monitoring system would be required to audit and confirm the physical existence of the prescribed emergency stocks.

Because the storage would be dispersed and located primarily in aboveground steel tanks, it would lose the economy of scale and be much more costly than large volume salt dome storage. Due to the geographic dispersion of the storage, it would be much more difficult to ensure the existence of the required stock levels or to deploy them efficiently in an emergency. Because of the large impact in terms of construction effort and cost to many private owners, applications for relief from hardship, requests for exceptions, etc., would probably be substantial, which could delay speedy achievement of the much needed security benefits of the program. Experience to date suggests a strong likelihood that equitable administration of the program would be extremely difficult to achieve in the first instance and/or to maintain over the long period of years during which the Nation will require petroleum security storage.

Crude and Product Importers Only

Another commonly discussed approach is to require each importer of crude or products to be responsible for providing a prescribed level of security storage. This approach is arguable in that it places the responsibility for providing protection directly on those who import the supplies which are insecure. However, this argument ignores the fact that the alternative to imports for the foreseeable future is major energy shortages in the United States. This would cause the highly interdependent United States economy and all its people to suffer, not just importers or consumers of foreign oil.

Placing the burden of storage on the crude and product importers could result in a substantial disincentive to import depending on how the allocation financing burden was handled. Importers would be put at a substantial competitive disadvantage and inevitable pressures would arise to "equalize" the disparity by some further regulatory machinery such as inclusion in a raw material and products equalization or entitlement-type program. This approach would have many of the same inherent inefficiencies from poor economy of scale and wide geographic distribution of stocks as the plan discussed above, although to a lesser degree. Also this plan might tend to dictate large amounts of fuel oil storage in heated aboveground steel tanks by individual importers, including terminal operators and electric utilities. This could be highly inefficient because of its relatively high cost and unnecessary because the bulk of fuel oil denials could probably be handled by other emergency steps, as detailed in the earlier chapters of this report.

Industry Consortiums

A third and possibly more efficient approach to privately-owned storage would be the formation of one or more industry groups or consortiums to develop and operate large volume, centrally located salt dome storage. This method would be applicable whether the storage obligation applied to all refiners and importers, or only to importers. This approach would permit centralized storage to achieve economy of scale and would eliminate some of the problems of administration caused by widely diverse physical location.

Under this approach government might establish storage obligations for either all refiners, terminal operators, and other importers, or just for importers. The government could prescribe that each operator's security storage obligation be placed in large volume centralized salt dome storage. This, in addition to normal logistical and economic considerations, would probably result in the formation of one or more privately-owned consortiums to develop Gulf Coast salt dome storage. These groups could solicit industry participation on an equity basis and might provide smaller operators storage for a fee.

Among the many disadvantages of this approach is the fact that considerable time would be required to obtain private participation and negotiate operating agreements with the resulting delay to national security storage programs. Obtaining federal legislation enabling a workable security storage venture of this type which contains adequate antitrust safeguards presents a number of major practical obstacles to this method of ownership.

FINANCING A PRIVATELY-OWNED SECURITY STORAGE SYSTEM

Before considering options for private financing of national security storage, several important characteristics of security storage costs merit consideration. Key considerations include:

- Initial out-of-pocket expenditures for storage facilities and fill are substantial--as much as $7 billion for a 500 MMB system. Operating costs, while significant, are less substantial.
- Cost of fill is the major capital cost which might partially be recovered through ultimate sale of the oil after United States achieves a level of domestic self-sufficiency which would allow liquidation of the security storage program.

Thus, the nature of security storage requires a very large initial investment, but permits no income to be earned and profit (or loss) to be generated until it is ultimately sold and not replaced. In fact, the investors' ability to sell the asset (even at a loss) is prevented, except in the uncertain event of an embargo after which it must be replaced at possibly higher cost, or at some unknown time in the future when security storage is no longer needed. It has been argued that security storage can in fact be highly profitable for industry or government--if the price of oil rises sufficiently over the long term or in an emergency. This, however, is a fallacious argument. First, there is no guarantee that oil prices will always rise--some believe they will decline in the long-term. Also it is clear that any private owner of national security storage will be required to sell the security stocks at controlled prices during a national emergency. Finally, once the investment is made in security storage there is no assurance when, if ever, the oil will be sold at any price. Because of these characteristics there is no profit incentive for a private investor to build and own security storage. It will be built only in the interest of national security. Because there is no reasonable way for a private investor to earn a return directly on his security storage investment, he must seek to recover its cost from other sources.

PETROLEUM INDUSTRY CAPITAL NEEDS

Furthermore, when considering various financing alternatives for private ownership of security storage, it is necessary to understand the basic financial and capital formation outlook for the United States petroleum industry. The problem of sharply increased petroleum industry capital needs and their financing has a significant bearing on security storage financing options. The fundamental problem can be outlined briefly.

During recent years (1963-1972) total United States petroleum industry capital expenditures averaged about $8 billion per year. In 1973 total expenditures were about $10 billion, and in 1974 expenditures increased 30-40 percent to about $13-$14 billion. Knowledgeable people in the industry, the financial institutions, and the Federal Government all project that further sharp increases will be required over the next decade if the United States is to maintain or increase its level of energy independence. Estimates for petroleum industry capital requirements over the next decade range from $20-$30 billion per year (1974 dollars). While the precise figure is not known, it is clear a 200-300 percent increase in petroleum industry expenditures is necessary to move toward the Nation's energy goals.

The nature of most petroleum industry investments have historically dictated that a high degree of internal financing be employed, i.e., much of the industry's past investments have been financed internally from retained earnings and capital recovery allowances. This is because petroleum investments are characterized by relatively high risks (particularly in Exploration and Production), high cost, technical complexity and often high front end loading and relatively long lead times before prospective income is earned. In the future these problems are likely to become more important to the investors as industry moves into more remote offshore and arctic areas in the search for new reserves. In addition political uncertainties about oil and gas price regulation, taxation, and overall national energy policy continue to cloud the industry's financial picture. In spite of these constraints, the petroleum industry has increased its use of outside capital substantially over the past decade. During this time industry debt/shareholder equity ratios have about doubled from 15 to 30 percent.

In view of these conditions, financing a 200-300 percent increase in capital requirements is likely to stretch industry's debt capacity severely. A further commitment to a $7 billion non-energy producing, non-income producing security storage program will further drain industry resources and is likely to divert capital away from vitally needed energy resource development projects. It is also unlikely that a high cost, indefinite duration, non-income producing storage program would be able to attract capital on its own project financing merits. In short, a security storage program cannot be financed in the same way normal income producing investments are without creating a drain on petroleum industry financial resources which might be more productively used to increase domestic energy supplies directly.

Several options exist for financing a privately-owned storage system. These include:

- Complete industry financing with recovery of capital and operating cost in a free marketplace.
- Industry financing with government loan guarantees.
- Industry financing with cost recovery from the government by means of tax credits, import fees or tariff rebates, or even direct grants. Note that while these latter options maintain private ownership, they amount to indirect government financing to the extent costs are recovered through government mechanisms.

RECOVERY OF STORAGE COSTS IN THE FREE MARKETPLACE

While in theory industry should simply recover the costs of security storage in a free marketplace by increasing product prices, in practice this option is very uncertain. Should price controls exist, as they do now, anytime during the life of the security storage project, recovery of the cost would be placed in substantial jeopardy. Since there is no profit incentive for a private investor to build, fill, and own national security storage, it will be accomplished only in the interest of national security. Because there is no reasonable way for a private investor to earn a return on his security storage investment, he must ultimately seek to recover its cost from the government.

GOVERNMENT LOAN GUARANTEES

Government loan guarantees are a potential means of assisting private financing of national security storage. However, it must be recognized that this type guarantee protects only the private lender against default by the borrower, thus permitting a loan to be granted for an otherwise unacceptable risk. It does nothing to ensure cost recovery by the private borrower. Even with government guarantees, the borrower's repayment obligation is not abrogated--except in the event of his default. This is likely to be of little comfort to the oil industry investor; thus guaranteed security storage loans will almost certainly affect industry debt/equity ratios and credit standing and the ability to borrow capital for other projects.

OTHER METHODS OF GOVERNMENT SUPPORT FOR PRIVATELY-OWNED STORAGE

A number of approaches are available for government to provide financial support to the private sector for construction and ownership of security storage.

Government Loans

Direct government loans for security storage are an alternative to loan guarantees. However, to the extent that the program is really a loan creating a firm obligation to repay, it is fundamentally no different from other types of loan financing. It still leaves industry with increased debt and problems of cost recovery which affect capital resources.

One approach would be an interest-only loan by government with the principal to be repaid only when the stored oil is used. This would reduce the diversion of industry's capital availability and debt problems which result from other types of financing, with the out-of-pocket cash cost being interest only.

Tax Credits

Government could provide for recovery of storage costs by credits against income taxes. This approach has been used in the past as a tool to stimulate the economy by stimulating overall business investment, or to direct private capital into certain sectors of the economy. However, it has generally been applied in a fashion which merely reduces the total out of pocket investment required rather than providing full cost recovery. In other words, industry still assumes a major share of the risk. Tax credits are unlikely to provide adequate incentives for security storage unless they permit essentially full cost recovery. Also the adequacy of such incentives will depend on an individual's or corporation's tax situation at a particular time. Those with a low or negative earnings position or those with a relatively low effective tax rate because of law provisions will not be helped as much as others. Finally, it must be recognized that storage cost recovery through tax rebates in reality is a form of government subsidy and possibly less efficient than more direct means of government financing.

Rebates on Import Fees or Tariffs

Another way to permit storage cost recovery is through rebates of import fees and tariffs to refiners and importers. This approach has the appearance of having the insecure imports support the cost of storage. However, this approach is simply another indirect subsidy or means of government financing. Tariffs and import fees imposed for whatever reason provide revenue to the United States Treasury. To the extent this revenue is diverted by rebates for security storage, it is equivalent to indirect government financing from public funds.

Direct Grants

Direct grants can be made by government to cover the cost of national security storage. If the national interest is best served by having security storage owned and operated by private industry but financed by the government, this is the most efficient mechanism (except possibly interest-only loans) and might be preferred over more complex and indirect methods of government financing such as tax or fee rebates. With this approach (as with tax or fee rebates) the government is faced with the problem of establishing administrative machinery to ensure that only appropriate costs incurred are repaid as distinquished from poor project management, etc. Finally, a direct grant program of the size necessary for national security storage construction, fill and operation is likely to create political controversy and therefore introduces risk of substantial delays and uncertainty in implementing the program.

HYBRID SYSTEMS

The discussions above have assumed industry would be responsible for owning and financing both the storage facilities and the crude oil inventory. However, alternative split ownership possibilities exist. One approach would be for industry to construct and operate the storage facilities with government owning the oil. Under this concept, industry would finance and own the storage facilities and government would finance and own the storage oil. In essence, industry would be providing bonded storage to be utilized under the direction and control of government. This plan has several features:

- The capital requirements and financing of the facilities is a fraction of the total storage program cost. Also it could be anticipated that industy might generate a revenue stream by renting the storage to government through operating fees. This could facilitate outside project-type financing.

- It would encourage a high level of industry participation and expertise in the design, construction and operation of the facilities.

- Government ownership and control of the crude would be consistent with existing government ownership of Naval Petroleum Reserve stocks at Elk Hills (which has been proposed as the basis for security storage oil) as well as the fact that government will control use and disposition of the stocks in an emergency. Oil for storage, or money to buy oil, might be provided through immediate development of Naval Petroleum Reserves. Development of these reserves will make possible transfer of oil from relatively inaccessible storage in its natural reservoir to more readily accessible salt dome storage at a cost(1) to the public which is much less than the cost of imported oil. An alternative would be the reverse approach; government construction of the storage facilities and industry ownership of the stocks. However, all of the advantages cited above can be cited as disadvantages for this approach.

From the foregoing examination of alternative methods of financing it can be observed that all viable mechanisms to promptly implement a national security storage program provide for heavy government involvement one way or another.

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(1) Security storage system costs as used in this chapter means out-of-pocket expenditures for facilities, fill, operation and maintenance of the facilities, and actual interest charges on capital employed.

GOVERNMENT OWNERSHIP

The concept of government ownership of national security storage is straightforward. Passage of enabling legislation establishing the storage program, as well as funds to implement the program, is needed. Following that, the designated agency should rapidly be in a position to contract for the engineering design, site selection, and environmental studies necessary to begin construction. At this point, the agency will have the benefit of various studies of security storage requirements such as this report and the studies currently being contracted by the Federal Energy Administration.

There are a number of factors which support government ownership and financing of security storage. These include:

- The basic purpose of a national security storage system is to protect the physical and economic security of the Nation, a role analogous to that of a major weapons system.
- The benefits of a security storage system, in the event of an embargo, accrue to the Nation as a whole rather than a specific industry or group of consumers.
- The nature and requirements of a national security storage system are such that it cannot be readily undertaken and financed by private industry as a normal business investment, as discussed previously. It is of no direct benefit to private industry unless mandated or subsidized by government.
- The public policies will determine the level of security storage (i.e., what amount of protection the United States needs in view of the world situation, United States foreign policy objectives, etc.). Also government will control the access to and disposition of national security stocks in the event of an emergency.
- Government already owns and operates substantial publicly-owned reserves at NPR-1 and possibly at NPR-4. The NPR-1 (Elk Hills) reserves are the recommended basis for security storage fill.
- Substantial legal and historical precedent exists for government ownership and financing of emergency stockpiles of critical materials. Government owned and financed stockpiles have been and are being maintained under three separate acts (The National Stock Pile, Defense Production Act Stockpiles, and the Supplemental Stockpile authorized under the Agricultural Trade Development and Assistance Act).

While government ownership financing and control of national security storage is the most straightforward approach, this would not preclude involvement of the private sector in design, construction and operation. It is recognized that the design, construction and operating expertise for such a system is located in private industry.

This expertise can readily be obtained by government through the use of private contractors, which is common practice in a wide range of government procurement programs. It is essential that the security storage be so constructed and located to ensure efficient integration into the nationwide petroleum logistical system. This will both minimize cost and ensure effective and timely distribution of security storage crude under government direction during an emergency. This can be achieved through government supervision of knowledgeable private companies with extensive experience and proven record of performance in the various phases of projects of this nature.

GOVERNMENT FINANCING OF SECURITY STORAGE

Several options exist for government financing (in addition to indirect financing or privately owned storage). These include:

- Financing from general revenue funds.
- Financing from dedicated trust funds carved out of existing fees and taxes (such as fees on imports, gasoline excise taxes, etc.).
- Incremental financing by means of new fees or taxes, such as additional import fees or excise taxes on petroleum products.
- Revenue from the sale of gas liquids extracted from gas associated with the production of NPR-1.

Under the first two plans all taxpayers and government program beneficiaries, in effect, pay for the security storage. With the incremental financing method the public impact is more direct and the burden is placed directly on petroleum consumers, such as farmers, motorists, utilities, and industrial users. However, even this approach will spread the impact throughout the economy as the higher costs are passed on to the retail level in the form of higher prices for food, for manufactured goods and higher utility rates.

Financing through a properly controlled dedicated trust fund facilitates making the expenditures for storage more easily identifiable and controllable. Also this has the advantage of providing full funding immediately for the large initial construction costs. Under a system which attempted to recover actual storage costs from the consumer via direct retail level excise taxes, government would still have to provide this initial funding to be offset by tax collections over the life of the project. An alternative would be a more substantial temporary excise tax designed to recover the full initial cost of storage over a shorter period. This would have a greater impact on the consumer.

The direct consumer level excise tax has the appeal of requiring a visible beneficiary of storage, the consumer of petroleum products, to pay the cost. However, this ignores the fact that users of other fuels are affected by a sudden denial of petroleum imports. In fact, the entire economy and all citizens would feel the adverse impacts of a major embargo. Also, the mechanics of imposing an additional dedicated excise tax which is specifically related to the cost of storage is likely to create complex administrative problems.

RECOMMENDATIONS

Consideration of the various financing and ownership alternatives outlined in the foregoing discussion leads to the following conclusions and recommendations.

- Government should continue to own crude from NPR-1 (or its exchange equivalent) when transferred to and stored in Gulf Coast salt domes. Government should finance and own these crude security storage facilities.

- Design, construction, management, and operation of the system should be contracted on a competitive basis to qualified private companies, under supervision of the appropriate government agency. This agency should not itself attempt to duplicate or overlap existing private industry capability.

These conclusions have been reached in recognition that the project is a major national security undertaking in the broadest public interest. This project can appropriately be financed and controlled by the government in a manner consistent with that purpose. Operational utilization of this project, if any, other than in time of national emergency, cannot be predicted and should not be allowed. Therefore, national security storage has no predictable revenue stream nor risk/profit relationship. As such, it is outside the realm of private industry investment and would otherwise have the effect of reducing capital resources available for domestic energy resource development.

CHAPTER V

FEDERAL ACTIONS

INTRODUCTION

For overall energy emergency preparedness planning, the NPC has previously recommended several key federal actions. Those actions include:

- Adopting and implementing national energy policies designed to increase the United States self-sufficiency in energy.
- Developing an operational definition of an energy emergency.
- Easing of restrictions on industry personnel in order to allow the Federal Government to utilize the expertise of individuals knowledgeable in energy operations.
- Reassessing the role of the Naval Petroleum and Oil Shale reserves in overall emergency preparedness planning.
- Developing standby emergency programs for emergency consumption reduction measures, emergency oil and gas production, and additional use of coal.
- Implementing an emergency petroleum security storage system.

This latter recommendation will require the positive action of numerous federal departments and agencies as all facets of the design, construction, operation and use of the security storage program will be highly dependent on governmental actions or inactions.

GENERAL FEDERAL ORGANIZATION

An early and definitive resolution on the part of the Federal Government that a security storage petroleum reserve is a matter of high national priority is essential to the expeditious completion of the program. While existing legislation might be sufficient for such a program to be undertaken, new legislation designed to coordinate and expedite a security storage system is recommended so that the often competing objectives of the various federal departments and agencies can be met with minimal disruption to the purpose of security storage. Further, one single department or agency must be designated to be in charge of the overall program.

The major deterrent to the expeditious emplacement of a security storage system would be a lack of resolution on the part of the Federal Government. This study, as well as previous NPC reports, has demonstrated the logistical and economic advantages of a United

States security storage system being based on maintaining large volumes of crude oil in salt domes on the Gulf Coast. The constantly changing world political and economic environment will undoubtedly require constant adjustment and improvements to the overall storage program, but the cornerstone of the project would remain the same. It is clear that a substantial volume of petroleum security storage is needed within the United States and that efforts to implement such a program should begin immediately because of the long lead times involved. Thus, agreement and implementation of the base of the system should begin now with total system details developed at a later date. Attempts to answer all the questions about the ultimate nature of the program before acting can only delay the attainment of the crude storage portion. Further, the wisdom of finalizing the entire project at this time, as opposed to allowing review and modification as conditions change, is open to question.

Under existing statutes, more than a dozen federal departments and agencies could be involved in the planning and implementation of the storage program. These include:

- Federal Energy Administration (FEA)
- Council on Environmental Quality (CEQ)
- Environmental Protection Agency (EPA)
- Department of the Interior:
  - United States Geological Survey (USGS)
  - U.S. Fish & Wildlife Service
- Department of Defense:
  - Department of the Navy
  - Corps of Engineers (Department of the Army)
- Department of Commerce
  - National Oceanic and Atmospheric Administration (NOAA)
- Department of Transportation
  - Office of Pipeline Safety
  - Coast Guard
- Department of Justice
- General Services Administration (GSA)

While many of these departments and agencies will have a continuing monitoring role in a storage program, their involvement in construction and fill of a project must be coordinated by a single organization or delays will inevitably occur. The major objectives or milestones in the implementation of a security storage program, Federal Government actions required to help achieve them and the responsible agencies are listed in Table 13.

In order to expedite implementation and minimize costs, organizations knowledgeable in the construction and petroleum industries should be utilized throughout all phases of the planning, engineering, construction, and administration of a security storage program.

CONSTRUCTION

Existing technology would be employed in the construction of salt dome storage facilities and, therefore, planning, design and construction efforts should be initiated as soon as any necessary enabling legislation or executive orders are finalized. However, approximately 4 years would be required from the beginning of project organization to the time the first storage caverns are available for fill. Considering the time required to construct storage and logistical facilities, it is unlikely that any significant volume of crude oil in security storage could be available until 5 years after initiation of the program. Therefore, steps toward providing such storage should be started at the earliest possible date. One step, already undertaken by the government has been the letting of contracts for site-specific engineering, cost, logistical and environmental studies of Gulf Coast salt domes. These contracts, along with related consultant reports, should be completed by early 1976 and should help form the basis for affirmative action by the Federal Government.

Lead time for equipment or design during the construction phase of the program can be shortened by use of existing authorities under the Defense Production Act. Provided in that act is the power for the Federal Government to preempt orders for materials necessary for construction of national defense projects. Since a security storage system is clearly a program for the defense of the Nation's economic well-being, as well as a program contributing to the Nation's military defense, materials availability should not be allowed to delay the completion of the approved project. Similarly, acquisition of land for storage facilities, access to salt domes, and logistical facilities, including ports and pipeline rights of way, could be expedited by federal action. Federal preemption of land use authority and responsibility through the exercise of the right of Eminent Domain is consistent with the objectives of the storage system, and has precedent in other energy related projects such as hydroelectric plants.

ENVIRONMENTAL STUDIES

Of particular importance in considering development of a security storage system is the fact that salt dome storage requires no new technology and would be located in areas already containing similar facilities. The scale of the security storage project is the only aspect to present special challenges--mostly in the area of assuring protection of the environment. Here again, no new technologies are involved but the effects of large volume brine disposal must be thoroughly considered prior to commencement of construction.

TABLE 13

SECURITY STORAGE PROGRAM OBJECTIVES AND REQUIRED FEDERAL GOVERNMENT ACTION

OBJECTIVE	ACTION	BY WHOM	MOTIVATING LEGISLATION
Formulation and declaration of policy.	Pass enabling legislation (emergency storage bill)	Congress	Emergency Storage Bill
Safeguarding of environment	(a) Prepare draft and expedite final Environmental Impact Statements	Designated Agency	National Environmental Protection Act, Clean Air Act, Federal Water Pollution Congrol Act, etc.
	(b) Monitor and enforce environmental regulations	CEQ, EPA, NOAA, Fish and Wildlife Service	Coastal Zone Management Act of 1972, Marine Mammals Protection Act of 1972, Marine Protection Research and Sanctuaries Act of 1972, Endangered Species Act of 1973, Offshore Shrimp Fisheries Act of 1973.
Acquisition of salt dome land	(a) Expedite land purchase (b) Institute condemnation, eminent domain proceedings	Designated agency Attorney General	Emergency Storage Bill
Acquisition of pipeline rights	(a) Expedite land purchase (b) Institute condemnation eminent domain proceedings	Designated agency Attorney General Dept. of Transportation Office of Pipeline Safety	Emergency Storage Bill
Availability of port facilities	Authorize, plan and contract for construction of port facilities	Dept. of Transportation	
Assurance of material and supplies availability	Defense priorities on materials	Selected Agency General Services Administration, Dept. of Commerce	Defense Production Act, Federal Property and Administrative Services Act of 1949

TABLE 13 (CONT'D.)

OBJECTIVE	ACTION	BY WHOM	MOTIVATING LEGISLATION
Leaching water acquisition		Selected Agency, EPA	Marine Protection Research, and Sanctuaries Act of 1972, Federal Water Pollution Control Act, Rivers and Harbors Act of 1899
Brine Disposal	Acquire permission to dispose of brine	Selected Agency, EPA	
International Cooperation, IEP Agreement; coordination etc.	Possible treaty	Congress	1974 IEP Agreement signed
Acquisition of oil for filling storage			
(1) Naval Petroleum Reserve No. 1 (a) full scale development (b) dedication of oil to security storage	Joint resolution of Congress; new legislation	Congress, Navy, Interior, FEA	10 U.S.C. 641
(2) Royalty oil		Interior Selected Agency	Title 30, Code of Federal Regulations, Part 225, Mineral Leasing Act of 1920, OCS Lands Act of 1953
(3) Open market purchase by government		Monitoring by FEA,	Emergency Storage Bill
Begin drawdown	Formally declare emergency	Congress, President or other as per legislation	Emergency Storage Bill
Maximize effectiveness of drawdown policy	Allocate } oil Auction }	Administrator	Emergency Storage Bill
Provide seaborne transportation vessels for oil during drawdown	Temporarily Waive Jones Act, if necessary	President	Jones Act

The completion of required environmental studies, therefore, is the first and most important step to be taken by the Federal Government. As stated earlier, the engineering and technical knowledge is available and demonstrated to construct salt dome storage projects in an environmentally acceptable manner. Environmental Impact Statements (EIS), as required by the National Environmental Policy Act of 1969, could and should therefore proceed immediately. Public participation should be solicited early in the development of such studies to ensure the acceptability of procedures considered. As more than one storage project is desirable for logistical and economic reasons, a generic or multi-site EIS should be prepared and approved first with site-specific detail provided via the final engineering and geological studies.

If the Federal Government wished to expedite the discharge of the above responsibilities, some overlapping of projects could be employed. For example, generic EIS work could begin immediately under executive order, while enabling legislation was in preparation. Similarly, site-specific engineering could begin under government contract for input into the EIS studies and use by construction contractors. Consistent with the objective of reducing the time of completion of security storage, applications for brine discharge permits should be made promptly after approval of the site-specific EIS.

ELK HILLS

If it is determined that production from NPR-1 is to be used for fill or financing of the program, development of Elk Hills to its maximum efficient rate (MER) should begin immediately. Under current statutes, Elk Hills could not be produced unless a joint resolution of Congress and the approval of the President are obtained. Such action, either directly or indirectly (i.e., through new legislation), would assist the overall project both through timely availability of fill and through timely determination of the logistical requirements of the project. An additional logistical consideration would be to accelerate development of proposed deepwater port facilities. If these facilities were delayed or cancelled, the engineering and logistical conclusions may change.

USE OF SECURITY STORAGE PETROLEUM

Regardless of the ultimate form of a security storage program, the Federal Government will undoubtedly exercise strong initiatives in determining the release and use of the reserve in times of import interruption. While the detailed transactions would be made during the emergency, the nature and direction of these initiatives can and should be determined prior to the emergency. Since protection of the national economy is the primary reason for establishment of a security storage program, security storage facilities should be utilized only after a declaration of an energy emergency by the President. Further, the government should require that all other provisions of a national emergency preparedness plan be implemented before security storage supplies are called upon.

An element of federal pre-planning for the use of security storage petroleum would be the determination of triggering mechanisms whereby security reserves may be promptly released to ensure continuity of supply to consumers. Enabling legislation should state the specific conditions and procedures under which security storage stocks can be utilized. While a lag time of about 30 to 60 days could exist from the onset of an emergency similar to that experienced in October, 1973, and the initial impact on the United States, natural disasters or military emergencies could occur such that receipt of supplies would be interrupted and no lag time would exist. For this reason the President should be empowered to activate the utilization mechanisms of the security storage program at his discretion. Since expeditious movement of oil out of security storage will be necessary during an energy emergency, the President should be authorized to engage vessels not normally permitted in the coastwise trade to transport oil cargoes between U.S. ports if required. Further, he should be empowered to modify administration of the overall program as future conditions warrant.

Another key element of federal pre-planning involves the manner in which security storage oil is entered into the Nation's logistical system. Because of the sheer complexity of the system and the number of individuals and companies involved, the expertise of individual's knowledgeable in petroleum refining and distribution is essential. Under the National Plan for Energy Preparedness (1964) the President promulgated a plan for the establishment, staffing and training of the Emergency Petroleum and Gas Administration (EPGA). EPGA's primary function in a declared national emergency is to assist, coordinate and direct, when necessary, activities of the oil and gas industry to assure that domestic and foreign supplies of petroleum meet essential military and civilian needs. Central to EPGA's effectiveness is its staffing at all levels with volunteers from the petroleum and gas industry. During the 1973-1974 embargo it became clear that because of conflict-of-interest and antitrust statutes, industry personnel would not be able to respond to the government's request to staff the Energy Allocation Planning Task Force or the Office of Petroleum Allocation. To obviate such problems, prompt reviews should be made of all legal impediments to the use of experienced industry personnnel. Enabling legislation should include clear provisions to waive conflict-of-interest and antitrust restrictions to permit necessary use of qualified personnel during an emergency.

CHAPTER VI

INTERNATIONAL ASPECTS OF SECURITY STORAGE

Security storage of petroleum in the United States is a matter of international commitment and obligation in addition to being a matter of national security. The requirements for storage have not been finally established for international agreement, but the NPC recommends that the United States expeditiously implement a plan for the development of an emergency petroleum security storage system to store initially 500 MMB of produced crude.

Average medium case total crude and product imports are projected at 8.1 MMB/D, with average medium case crude imports at 5.5 MMB/D, between 1980 and 1990.(1) It is estimated that in the 1980's emergency conservation measures could reduce petroleum demand in the United States by 1.0 to 1.1 MMB/D, leaving a net shortfall of 4.4 to 4.5 MMB/D if there were a total crude oil denial, and about 7.0 to 7.1 MMB/D in the event of a total petroleum imports denial. A 500 MMB security storage supply could, therefore, protect against a total imports denial of about 70 days and a crude oil only total denial of about 110 days. Depending upon the bases assumed and computational techniques employed, a variety of security storage volumes can be calculated. Although the exact level of security storage is difficult to define, it appears that a reasonable volume of United States security storage is 500 MMB, which is commensurate with the level planned by other consuming countries.

The most recent and significant international obligation of the United States results from participation in the International Energy Program (IEP) Agreement signed officially on November 18, 1974(2) at the first meeting of the International Energy Agency (IEA). The IEA is an autonomous agency operating under the framework of the Organization for Economic Co-operation and Development (OECD). The objective of the IEP Agreement, as embodied in the IEA, is to develop an organization to effect an orderly international response by members to petroleum supply interruptions. The main provisions of the IEP Agreement are:

- Emergency Self-Sufficiency--required minimum levels of stored reserves
- Demand Restraint--predetermined programs for contingent oil demand restraint

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(1) Emergency Preparedness for Interruption of Petroleum Imports into the United States, September, 1974, Table 21, Page 59.

(2) Signatories to the International Energy Petroleum (IEP) Agreement now are Austria, Belgium, Canada, Denmark, West Germany, Ireland, Italy, Japan, Luxembourg, Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, Turkey, United Kingdom, and the United States.

- Allocation--sharing of oil when supplies are curtailed and the attendant mechanisms to activate these measures.

Positive action by the United States to develop a significant petroleum security storage system would fulfill our obligation under the agreement, would help to accomplish the IEP/IEA objectives, and could result in more favorable resolution of other IEP/IEA related matters. The United States obligation for emergency reserves results from our agreement under the IEP to maintain emergency reserves sufficient to sustain consumption for at least 60 days with no net oil imports based on the average daily consumption level of the previous calendar year. The governing board will determine the date on which emergency reserve requirements will be raised to 90 days. Emergency reserve commitments may be satisfied by oil stocks, fuel switching capacity or stand-by oil production to an extent which remains to be determined. Emergency reserve stocks are to be measured by the IEA according to definitions drawn largely from OECD and European Economic Community (EEC) definitions. A comparison of definitions related to petroleum stocks in the United States and IEA, as well as suggestions by the NPC for stocks to be included in calculations of U.S. requirements, is presented in Table 14.

Security Storage in the United States

Security storage requirements for emergency petroleum reserves in the United States are not fully comparable with most European requirements or the IEP definitions. In 1974, the United States' indigenous crude oil and natural gas production supplied almost 63 percent of petroleum demand.(3) The United States is also much larger geographically and requires a much higher level of working stocks to remain operable. This situation differs from that in the European countries and Japan which are almost solely dependent on imported petroleum, but which have relatively more compact logistical systems with smaller volumes of unavailable stocks. Also, European agreements generally allow no more than a 15 percent deduction from total oil demand for domestic production--a severe limitation if applied to the United States.

Table 15 illustrates the impact of alternative bases for calculating storage requirements. Case I includes net adjustments to petroleum stocks as suggested by the NPC. When minimum operating inventory levels for crude oil and refined products are evaluated realistically, the adjustment is over 800 MMB more than IEA definitions. At the current level of imports and stocks, as well as at the projected 1985 level, about 500 MMB of additional storage is required to provide for protection against a total crude and product import interruption for 90 days.

The IEA definitions used in Case II indicate that the United States has surplus storage capacity today and in 1985, on the basis that only the volume of net imports must be "protected." From the IEA definitions of what constitutes reserves, it would appear that

(3) Based on API 1974 preliminary figures.

TABLE 14

COMPARISON OF REPORTED PETROLEUM STOCKS

	AS REPORTED BY U.S.(1)	AS REPORTED BY IEA	AS SUGGESTED BY NPC FOR U.S.(2)
STOCKS INCLUDED			
Crude Oil, Major Products and Unfinished Oils held:			
In Refinery Tanks	Yes	Yes	Yes
In Bulk Terminals	Yes (3)	Yes	Yes
In Pipelines	Yes	No	No
In Pipeline Tankage	Yes	Yes	Yes
In Barges	Yes	Yes	No
In Intercoastal Tankers	Yes	Yes	No
In Truck and Tank Cars	Yes	No	No
In Oil Tankers in Port	NA	Yes	No
In Seagoing Ships Bunkers	Yes	No	No
In Inland Ship Bunkers	Yes	Yes	No
In Storage Tank Bottoms	Yes	Yes	No
In Working Stocks(4)	Yes	Yes	No
In Service Stations and Retail Stores	No	No	No
By Large Consumers as Required by Law	No	Yes	No
By Other Consumers	No	No	No
In Tankers at Sea	No	No	No
Military Stocks	No	No	No
Crude Oil Not Yet Produced	No	No	No

(1) U.S. Bureau of Mines, Mineral Industries Survey, Monthly and Annual Petroleum Statements.
(2) NPC definition reflects minimum operating level, which is the sum total of unavailable inventories, working stocks and is the stock level considered necessary for continuity of operations. For detailed discussion of minimum operating inventories see NPC Petroleum Storage Capacity, September 10, 1974, Page 4.
(3) Above 50,000 barrel capacity.
(4) Minimum quantities for continuous processing, blending, handling, and distribution of crude and products.

TABLE 15

PROJECTED UNITED STATES SECURITY STORAGE REQUIREMENTS
(IEA Base and U.S. Domestic Base)

	TOTAL STOCKS MMB	NET ADJUSTMENTS (NPC DEFINITION)	U.S. EMERGENCY RESERVE BASE	DAILY IMPORTS MMB/D	DAILY IMPORTS EQUIVALENTS	ADDITIONAL STOCKS REQUIRED MMB 90 Day Supply	ADDITIONAL STOCKS REQUIRED MMB 180 Day Supply
CASE I (NPC DEFINED ADJUSTMENTS)							
Current Stocks and Imports	1,074[1]	(934)[2]	140	6.2[3]	23	418	976
Projected Stocks and Imports-1985	1,127[4]	(934)[2]	193	8.4[5]	23	563	1,319

	TOTAL STOCKS MMB	NET ADJUSTMENTS	IEA EMERGENCY RESERVE BASE	DAILY IMPORTS MMB/D	DAILY IMPORTS EQUIVALENTS	ADDITIONAL STOCKS REQUIRED MMB 90 Day Supply	ADDITIONAL STOCKS REQUIRED MMB 180 Day Supply
CASE II (IEA DEFINED ADJUSTMENTS)							
Current Stocks and Imports	1,074[1]	(102)[6] 112[7] (107)[8]	977	6.2[3]	158	Excess 419	139
Projected Stocks and Imports-1985	1,127[4]	(102)[6] 112[7] (113)[8]	1,024	8.4[5]	122	Excess 268	488

(1) Bureau of Mines, Monthly Petroleum Statement, December, 1974.
(2) NPC estimates of minimum operating inventory levels including: crude oil--240 MMB, principal refined products--460 MMB, other refined products--234 MMB.
(3) API preliminary 1974 data, January 26, 1975.
(4) 1985 stocks projected from NPC Petroleum Storage Capacity (1985 days supply trend x projected demand).
(5) NPC, Emergency Preparedness for Interruption of Petroleum Imports into the U.S., September 10, 1974. Medium Case, Table 2, Page 11.
(6) Pipeline fill--NPC Petroleum Storage Capacity, September 10, 1974.
(7) Stock held by Utilities, FPC, December, 1974.
(8) 10% reduction required by IEA definition until unavailable stock calculations are agreed upon by members.

the U.S. already has the required amount of emergency reserves. This is misleading in that it does not recognize the need to keep the oil logistic system operating efficiently. As shown in Case I, it is estimated that readily available stocks of crude and products in the U.S. cover only 23 days of average annual net imports, not the 158 days implied by the IEA definitions used in Case II.

Western European Experience

Most European countries have little, if any indigenous production and must import most of their requirements, and those countries having indigenous production are dependent on imports for the major portion of their petroleum requirements. Obligations to maintain emergency reserves exist either by law or by gentlemen's agreement in all European countries except Austria and Greece. Compulsory storage of petroleum products established under the EEC dates back to 1968. Guidelines initially provided for a minimum inventory of 65 days of the previous year's domestic consumption, but were later increased to 90 days to be effective by January, 1975. Although this goal was not attained by most of the member countries, some have already attained in excess of 100 days of inventory and others plan to attain inventory levels of 120 days in the near future. Stocks in Western Europe now average about 75-80 days although they vary substantially from country to country.

EEC compulsory storage obligations are generally set under the form of a minimum stock level to be available at any time and expressed in terms of days of the previous year's inland consumption of major petroleum products (motor gasoline, aviation fuels, distillate, and fuel oil). The obligation applies to each major product individually and includes normal working inventories, some of which are not available for use. Substitution of crude oil for products is allowed either according to a refinery yield or on the basis of a number of specified substitution factors. In some European countries, products from indigenous production may be credited against emergency reserve requirements to an extent not exceeding 15 percent of the oil products consumed during the previous year.

While some European countries have a significant amount of aboveground storage in steel tanks, much of the security inventories are contained underground in salt beds or mined caverns. On the issue of financing, positions vary from country to country. The maintenance of storage facilities and product inventories always entails a considerable financial burden. This burden has been magnified by soaring construction costs and the tremendous increase in oil prices. Solutions to these problems vary from country to country. In a free market economy like West Germany, there are no special financial provisions as it is assumed that market conditions will allow the companies to recoup the costs incurred. In some countries where prices are controlled, allowances are included in determining ceiling prices. In a few countries, Denmark, Sweden and Switzerland, for example, government sponsored programs take over the financing burden in whole or in part.

In summary, there is a multitude of security storage programs existing throughout the world as part of different nations' energy emergency preparedness plans. In view of the experience of these countries and with due consideration of the various aspects of a United States security petroleum storage, the NPC recommends that the United States expeditiously implement a plan for the development of a security storage program to initially store 500 MMB of produced crude. This volume is consistent with the Nation's commitments under international agreements.

.........Appendices....

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

DEC 5 - 1972

Dear Mr. True:

The United States is in a period of rapidly increasing dependence on imported petroleum. Associated with this dependency is the high risk involved to the Nation's economic well-being and security in the event these needed, imported energy supplies are interrupted for any reason. With such an alarming trend it becomes mandatory that the Nation's emergency preparedness program to insure supply of petroleum be improved without delay.

Over the past years, the Council has provided the Department of Interior with many outstanding studies which have contributed directly to preparedness for a national emergency. The Council's recent comprehensive energy outlook study indicates national policy options which will minimize dependence on imported petroleum over the long term. However, the study does not examine and evaluate alternatives, possible emergency actions and the results of such actions in the event of a temporary denial or marked reduction in the volume of imported petroleum available to the Nation during the next few years ahead.

The Council is therefore requested to make a comprehensive study and analysis of possible emergency supplements to or alternatives for imported oil, natural gas liquids and products in the event of interruptions to current levels of imports of these energy supplies. Where possible, the results of emergency measures or actions that could be taken before or during an emergency under present conditions should be quantified. For the purpose of this study only, assume that current levels of petroleum imports to the United States are reduced by denial of (a) 1.5 million barrels per day for a 60-day period, and (b) 2.0 million barrels per day for a 90-day period.

Of particular interest are supplements to normal domestic supply such as: the capability for emergency increases in production, processing, transportation and related storage; the ability to provide and maintain an emergency storage capability and inventories; interfuel substitution or convertibility of primary fuels in the major fuel consuming sectors; side effects of abnormal emergency operations; gains in supply from varying levels of curtailments, rationing and conservation measures; gains from temporary relaxation of environmental restrictions; as well as the constraints, if any, imposed by deficient support capability if an extraordinary demand occurs for manpower, materials, associated capital requirements and operating expenses due to emergency measures.

Such studies should be completed as soon as practicable, with at least a preliminary report presented to me by July 1973.

Sincerely yours,
Hollis M. Dole

Assistant Secretary of the Interior

Mr. H. A. True, Jr.
Chairman
National Petroleum Council
1625 K Street, N. W.
Washington, D. C. 20006

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

In Reply Refer to:
MOG

JAN 22 1973

Dear Mr. True:

In our letter to you of December 5, 1972, we asked that the National Petroleum Council make a comprehensive study and analysis of possible emergency supplements to or alternatives for imported oil, natural gas liquids and products in the event of interruptions to current levels of imports of these energy supplies. We are pleased that the Council has agreed to undertake this study.

Our request letter set out several assumptions regarding petroleum supply levels which we now believe require clarification. Rather than assuming a reduction in petroleum imports to the United States of (a) 1.5 million barrels per day for a 60-day period, and (b) 2.0 million barrels per day for a 90-day period, it would be more useful to assume a denial of (a) 1.5 million barrels per day for 90 days, and (b) 3.0 million barrels per day for a period of 6 months. It is anticipated that the Committee will consider the current and predicted mix between crude and product imports in determining the impact of the assumed denials.

We wish to reaffirm that a preliminary report should be submitted by July 1973.

Sincerely yours,

Secretary of the Interior

Mr. H. A. True, Jr.
Chairman
National Petroleum Council
1625 K Street, N.W.
Washington, D. C. 20006

United States Department of the Interior

OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

DEC 31 1974

Dear Mr. Swearingen:

Thank you for your summary report of September 10, 1974, entitled Emergency Preparedness for Interruption of Petroleum Imports into the United States. That report clearly outlines the options available to the U.S. in the event of a future denial of imported petroleum. Of particular interest to the Department of the Interior is your recommendation for the immediate development of an emergency petroleum security storage system.

The United States is now in the position where it needs to move decisively and promptly in this most critical area of national security. It is, therefore, requested that the Council undertake as a matter of urgency a study of the major factors involved in the implementation of a security storage system similar to that recommended by you in your summary report of September 10.

Your analysis should include, but not necessarily be limited to, discussions of; the optimum size of the security storage system in terms of total volume and deliverability; the alternatives available for providing this storage as expeditiously as possible; the financing problems which could be expected to arise; the sources and types of fill for the storage; and Federal actions that could assist in expediting the development of the security storage system as well as Federal actions that might deter development. In addition your analysis should include discussions of the relative needs for crude versus product storage and any specific geographical, logistical or environmental problems which you would anticipate to be encountered were the Nation to be confronted with another energy emergency.

It would be most useful if your report would include analyses of both the 500 million barrel storage system recommended in your September 10 report and with a build up to a one billion barrel storage system. These systems should be analyzed on two bases; (1) normal development consistent with the objective of minimizing costs and (2) rapid

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development based on minimizing time to completion. With respect to the later case, critical materials problems should be identified.

Such studies should be completed as soon as practicable with a report submitted to me by May 1975.

Sincerely yours,

Jack W Carlson

Acting Secretary of the Interior

Mr. John E. Swearingen
Chairman
National Petroleum Council
1625 K Street, N. W.
Washington, D. C. 20006

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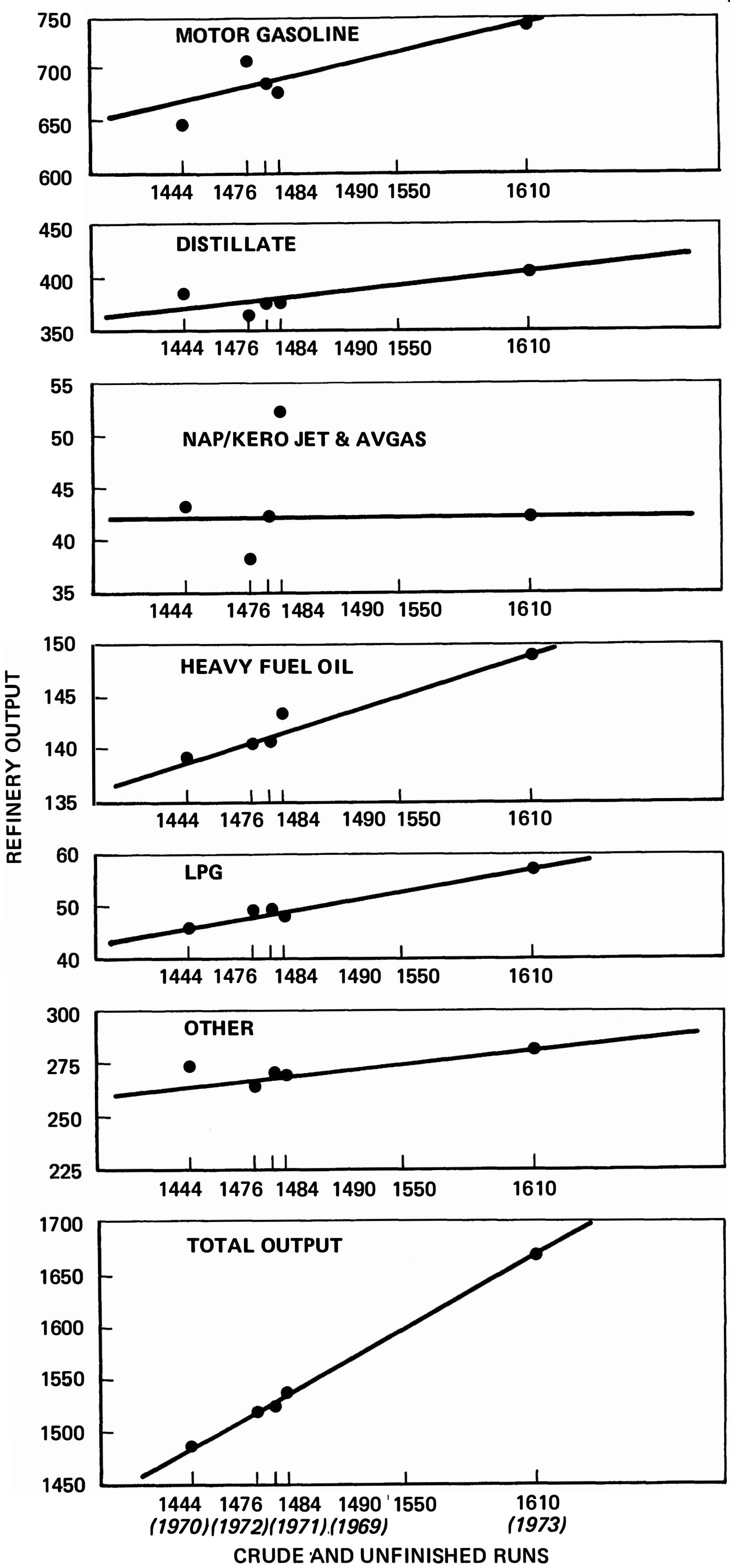

Figure 14. Incremental PAD I Refining Yield--1969-1973 (MB/D).

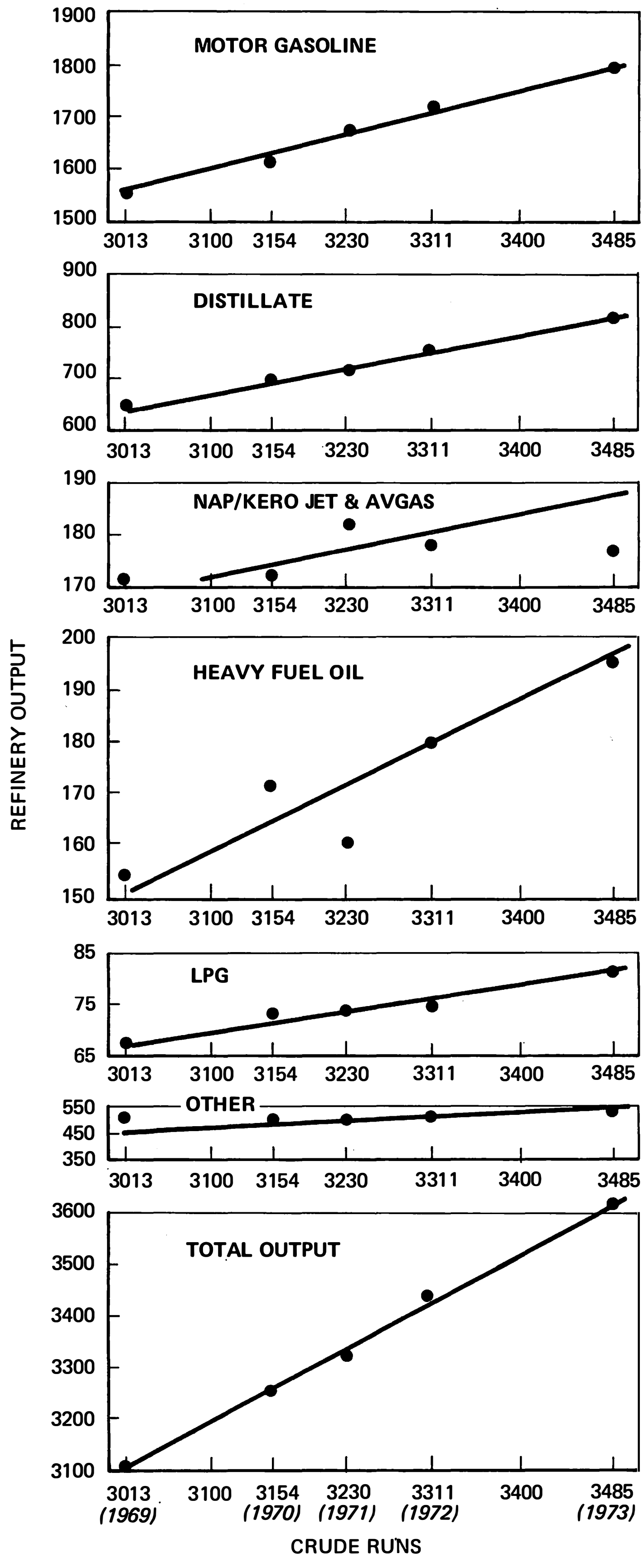

Figure 15. Incremental PAD II Refining Yield--1969-1973 (MB/D).

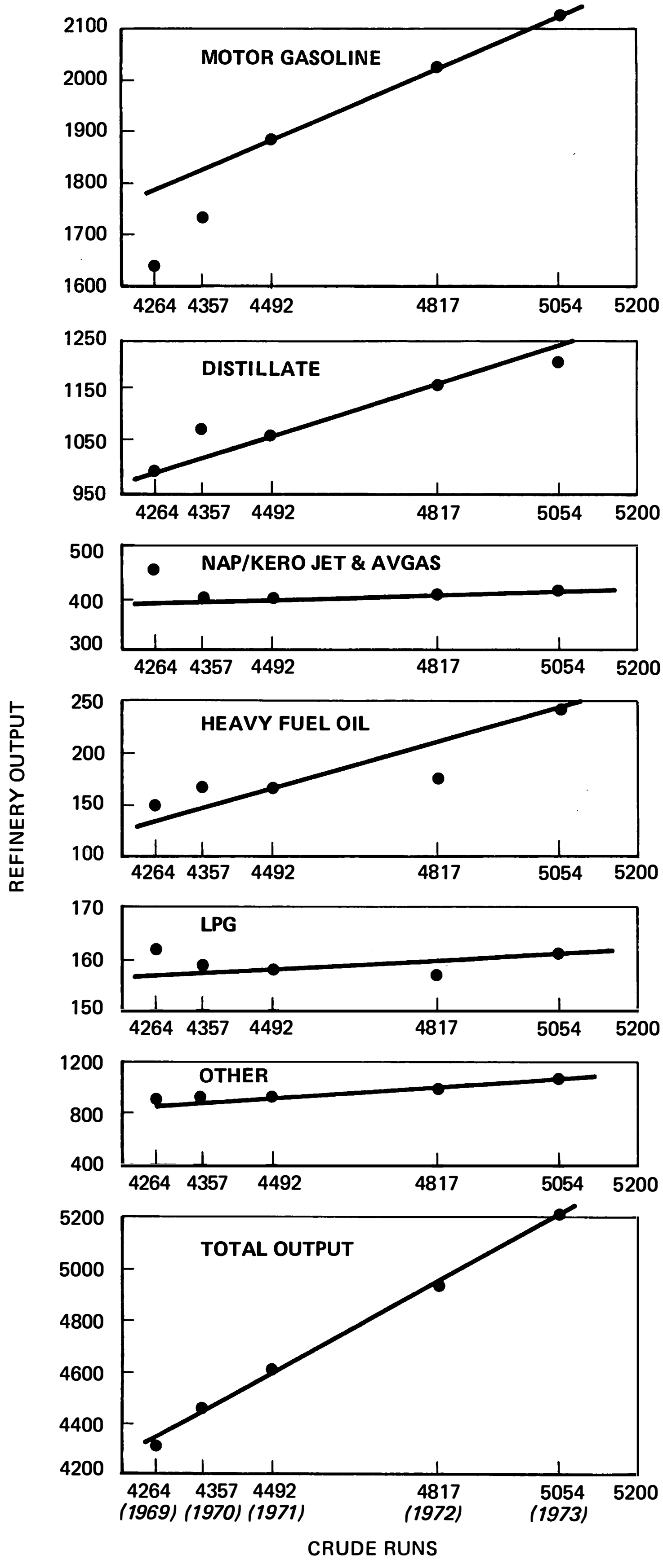

Figure 16. Incremental PAD III Refining Yield--1969-1973 (MB/D).

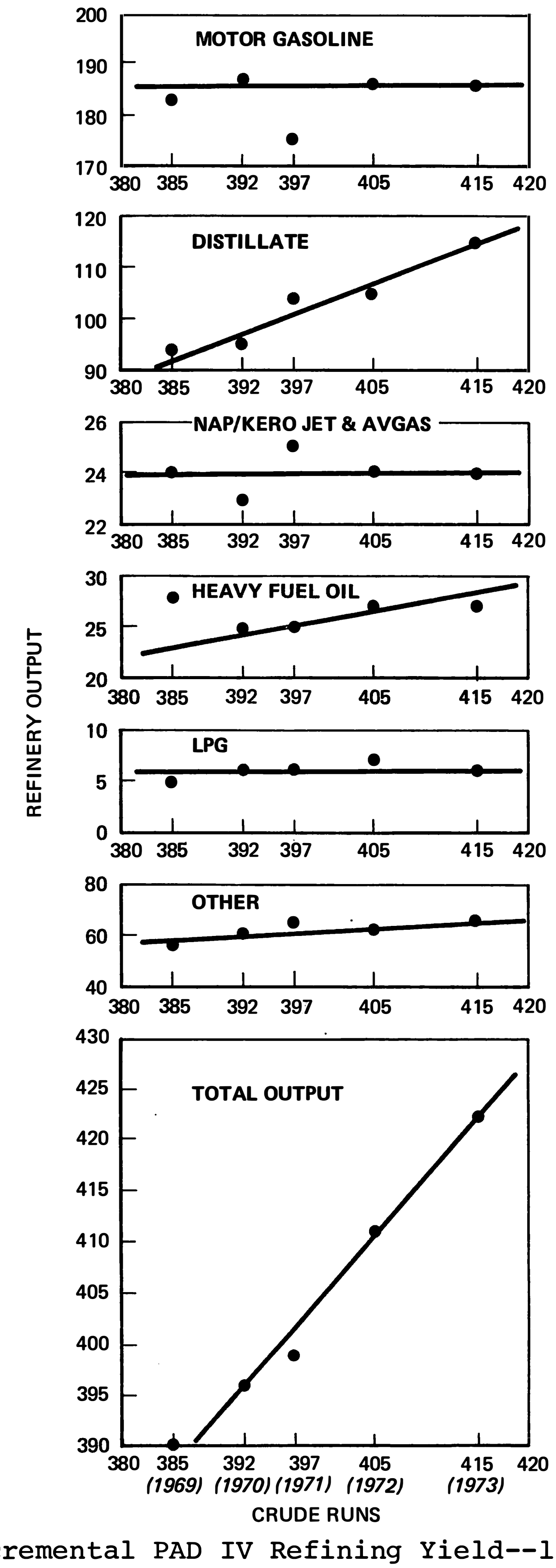

Figure 17. Incremental PAD IV Refining Yield--1969-1973 (MB/D).

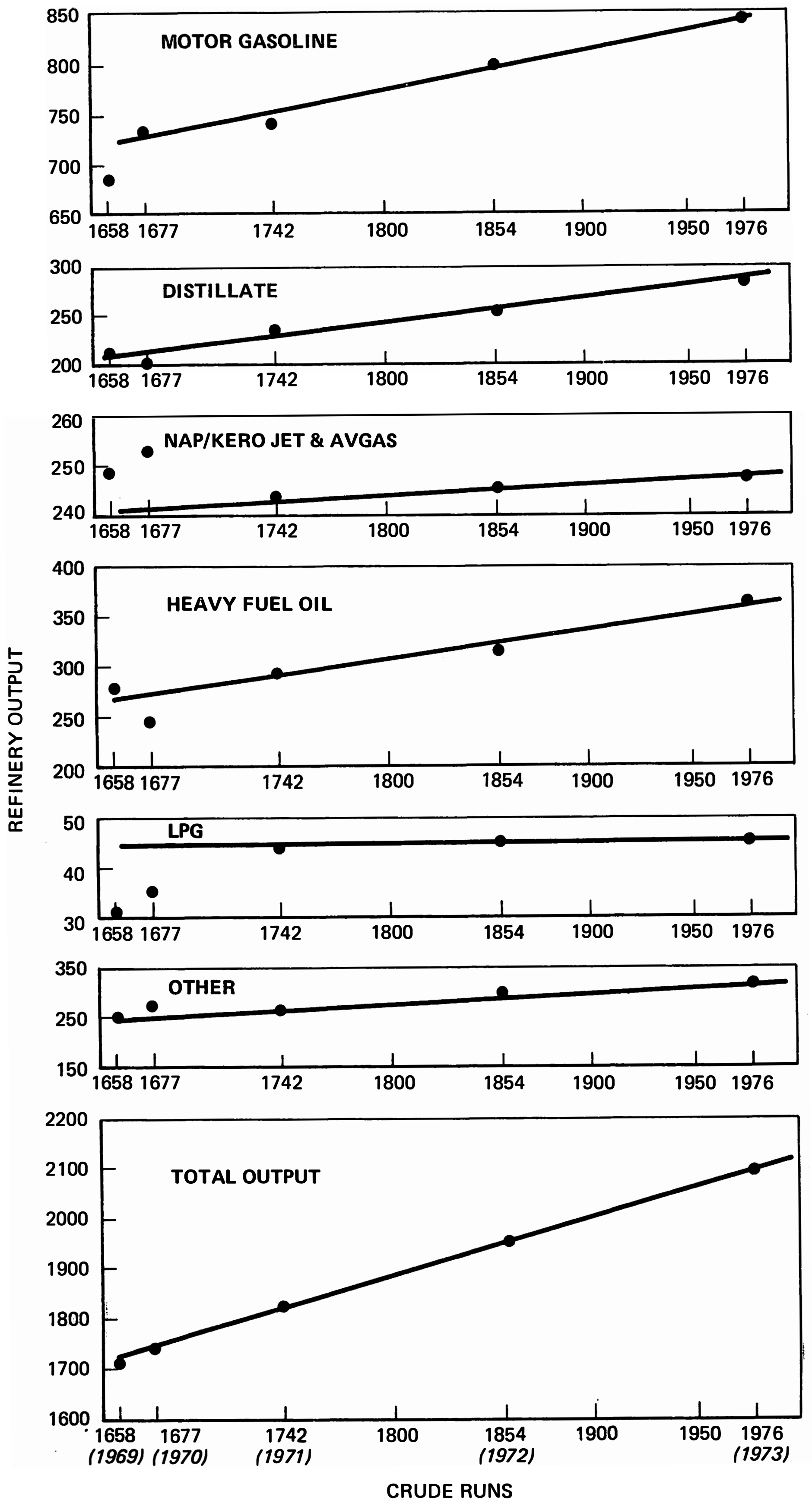

Figure 18. Incremental PAD V Refining Yield--1969-1973 (MB/D).

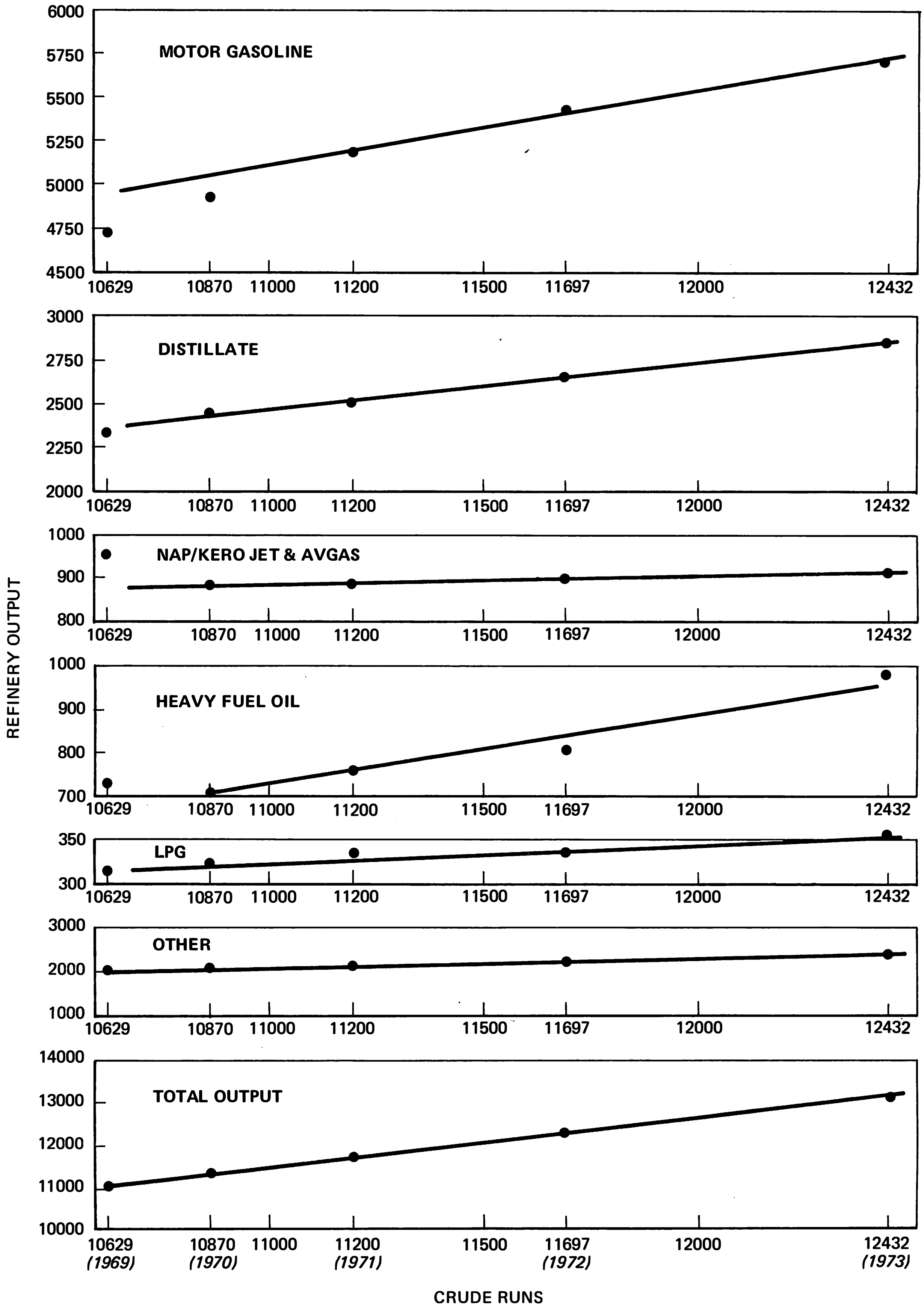

Figure 19. Total U.S. Incremental Refining Yield--1969-1973 (MB/D).

SUGGESTED QUESTIONS FOR REFINING INDUSTRY SURVEY OF RESIDUAL FUEL OIL PRODUCIBILITY

A questionnaire should be completed by each refinery located in PAD Districts I and III (and other U.S., Eastern Canadian and Caribbean refineries to the extent possible) in order to evaluate refinery yield flexibility and future ability to respond to a heavy fuel oil shortage in PAD I during an emergency situation. Detailed questions and instructions for the completion of the survey would be required to ensure validity and comparability of data; however, suggested areas to be covered in such a questionnaire are as follows:

- What was your estimated maximum 1974 year average crude refining capacity and actual crude throughput?
- What was your estimated maximum and actual 1974 year average heavy fuel oil production?
- What was your 1974 average yield of heavy fuel oil (% on crude throughput) and estimated maximum yield?
- What limited your maximum 1974 heavy fuel oil production capability? (e.g., refinery equipment, terminal facilities, transportation facilities, crude availability, fuel oil quality restrictions, other product considerations, market demand, economic factors, etc.?)
- What is your forecasted 1978 year average crude refining capacity?
- What is your estimated normal and maximum 1978 year average heavy fuel oil producibility?
- What is your expected 1978 average and maximum yield on crude of heavy fuel oil?
- What factors constrain your estimated 1978 maximum heavy fuel oil production?
- If product sulfur restrictions limit your 1978 fuel oil producibility, what is your maximum production of low-sulfur fuel oil and regular sulfur fuel oil? How much additional fuel oil could be produced with a total relaxation of product sulfur restrictions?
- What additional investment (facilities and cost) would be required to increase your 1978 maximum yield on crude of heavy fuel oil by 5%?
- What volume of additional heavy fuel oil over the normal maximum stated above for 1978 could be produced during an emergency situation with 90-days notice assuming constant crude throughput utilizing security storage crude and no additional major investment? What extraordinary steps are involved?