Availability of Materials, Manpower and Equipment for the Exploration, Drilling and Production of Oil During 1974-1976

Proposed Final Draft
Subject to Approval by the
National Petroleum Council
September 10, 1974

A Summary Report of the National Petroleum Council September 10, 1974

AVAILABILITY OF

MATERIALS, MANPOWER AND EQUIPMENT

FOR THE

EXPLORATION, DRILLING AND PRODUCTION

OF OIL DURING 1974-1976

A Report of the

National Petroleum Council's
Committee on Emergency Preparedness
Carroll M. Bennett, Chairman

and the

Subcommittee on Materials & Manpower
Requirements for Petroleum Exploration,
Drilling & Production
Kenneth E. Hill, Chairman

September 10, 1974

NATIONAL PETROLEUM COUNCIL

H. A. True, Jr., *Chairman*
Robert G. Dunlop, *Vice Chairman*
Vincent M. Brown, *Executive Director*

Industry Advisory Council

to the

U.S. DEPARTMENT OF THE INTERIOR

Rogers C. B. Morton, *Secretary*
Jack W. Carlson, *Asst. Secretary for Energy and Minerals*

Library of Congress Catalog Card Number: 74-19769

Printed in the United States of America

TABLE OF CONTENTS

INTRODUCTION

The substantial dependence of the United States on petroleum imports has major national security implications. Recognizing these security problems and the need for an effective emergency preparedness plan, the Secretary of the Interior on December 5, 1972, requested the National Petroleum Council to undertake 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." In response to this request, the National Petroleum Council's Committee on Emergency Preparedness issued on July 24, 1973, *Emergency Preparedness for Interruption of Petroleum Imports into the United States--An Interim Report,* followed by *Supplemental Interim Report* on November 15, 1973 and *Short-Term U.S. Petroleum Outlook--A Reappraisal* on February 26, 1974.

The Secretary of the Interior supplemented his original study request on December 21, 1973 with the statement:

> The Department of the Interior has an urgent need to know the availability of materials, manpower and equipment necessary for the exploration and production of oil during the next two years. Any shortages of materials, manpower or equipment needed for these tasks should indicate the probable limitation on drilling activity. The duration and causes of such shortages, together with any possible measures to alleviate them, should be set forth.

To address this request of the Secretary, the Committee on Emergency Preparedness appointed a Subcommittee on Materials and Manpower Requirements for Petroleum Exploration, Drilling and Production. This study has been conducted by six task groups under the Subcommittee--Outlook, Exploration and Drilling, Tubular Steel, Production, Well Servicing and Gas Processing Plants. In addition to Council member representation, a number of individuals have participated from manufacturers and suppliers of oilfield equipment, from drilling and construction contractors, and from service companies. This representation assured the consideration of the best information available on the present materials and manpower situation. (See Appendix A for Request Letters and Appendix B for Committee Rosters.)

SCOPE OF THE STUDY AND BASIC ASSUMPTIONS

The purpose of this study was to investigate the availability of materials, manpower and equipment necessary for the exploration, drilling and production functions of the petroleum industry to expand activities to lessen U.S. dependence upon petroleum imports. The scope and basic assumptions reflected in the report are as follows:

- In view of the long lead time for a number of significant equipment items, the Department of the Interior approved

extension of the study to include 1976. The outlook for expansion of activities to 1980 and 1985 is also appraised.

- It is assumed there will be adequate economic incentives for oil and gas producers to expand drilling and production activities within the limitation of available materials, equipment and manpower during the years ahead.

- No estimates are made of possible quantitative effects of any changes in prices and tax laws on the level of activities. However, the qualitative effects of government policies are discussed.

- It is assumed that there will be incentives for the orderly expansion of production capacity for oilfield equipment manufacturers, contractors and service companies and that financing will not be a constraint.

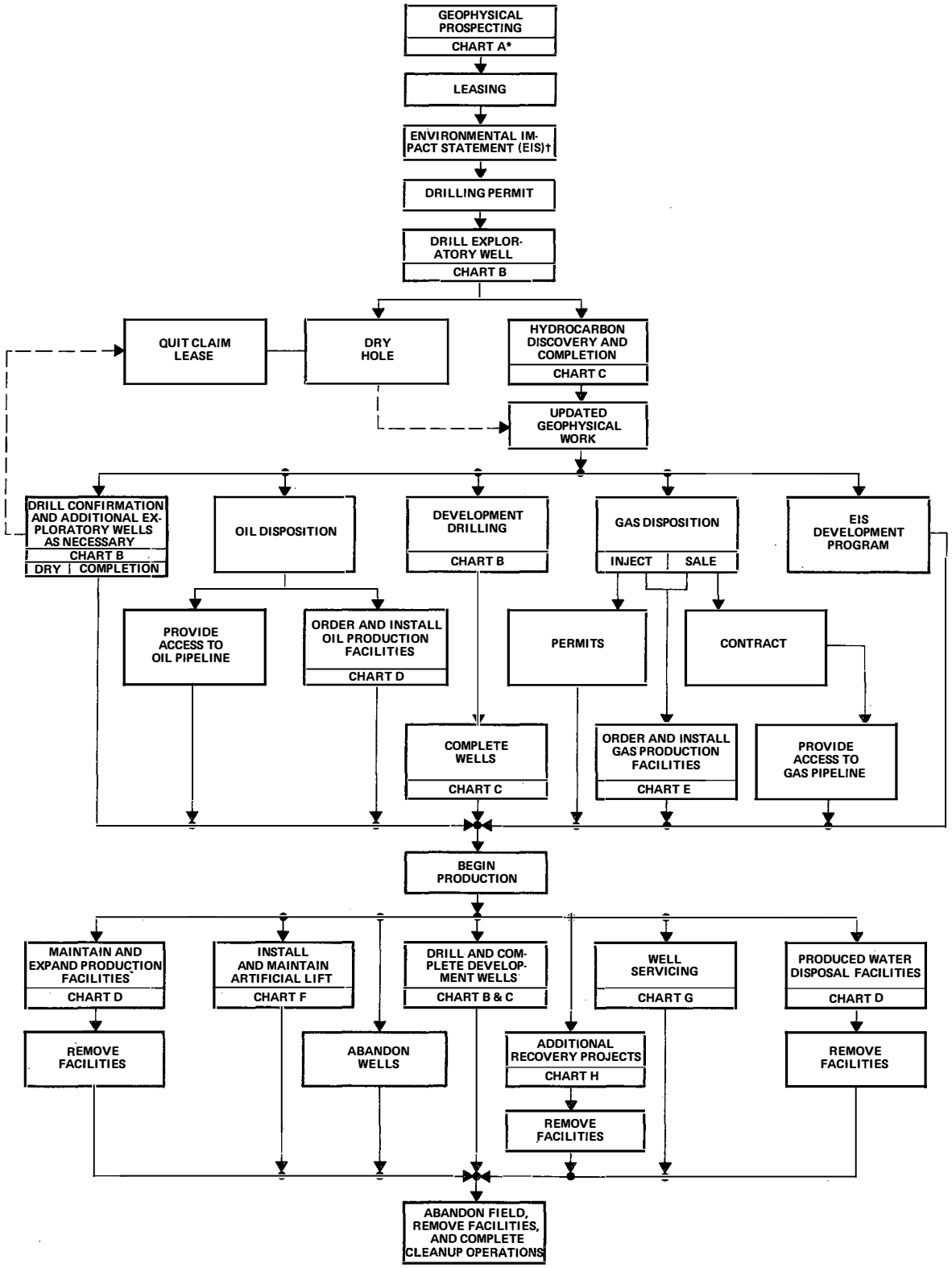
- No forecasts are made of the oil and gas producing rates which will result from the activity levels projected in this report.

OVERVIEW OF EXPLORATION AND PRODUCTION FUNCTIONS

The many facets of the oil and gas exploration and production business are interrelated and interdependent and do not function separately. This is illustrated in Figure 1 (see Appendix C, Figures 3-10 for more detail) which shows the flow of activities and the principal materials, equipment and services required from the time exploration starts through development of a commercial petroleum deposit to field abandonment. From this flow diagram, it is apparent that the exploration and production segment of the oil and gas industry is a complex, integrated matrix. The industry is made up of thousands of producers, served by hundreds of manufacturers, suppliers and service contractors, many of whom depend entirely upon oil and gas producers for their livelihood.

Exploration does not stop with the completion of a discovery well since confirmation and extension wells are necessary to determine if the reservoir is of commercial quality and quantity. While confirmation drilling is still in progress, production facilities will usually be installed and production initiated. During the production phase, it is usually necessary to employ servicing equipment to re-enter producing wells to do remedial work, such as control of water production or formation sand incursion. When the natural reservoir pressure declines as oil is extracted and a well no longer flows, artificial lift devices are usually installed, such as beam and rod supported subsurface pumps or gas lift facilities.

Throughout the life of the field to final abandonment, well and reservoir performance are studied, and remedial, stimulation and recompletion work is performed on wells by servicing companies to maintain production. Occasionally old wells must be deepened



* "CHART" DESIGNATIONS REFER TO ADDITIONAL FIGURES IN APPENDIX C.
† COMPLY WITH SECTION 102(2)(C) OF NATIONAL ENVIRONMENTAL POLICY ACT IF FEDERAL LEASE REQUIRES PREPARATION AND APPROVAL OF ENVIRONMENTAL IMPACT STATEMENT (EIS).

NOTES: (1) MANPOWER REQUIREMENTS WHILE NOT DETAILED IN THE ATTACHED CHARTS, ARE SUBSTANTIAL IN ALL PHASES OF THE PETROLEUM INDUSTRY. ALL TYPES ARE REQUIRED INCLUDING TECHNICAL, SKILLED AND COMMON LABOR.
(2) NOT SHOWN ARE REQUIREMENTS FOR PERMITS AND APPROVALS BY NUMEROUS FEDERAL, STATE AND LOCAL AGENCIES THROUGHOUT THE LIFE OF THE FIELD.

Figure 1. Simplified Flow Diagram Showing Operations Necessary for Discovery, Production and Abandonment of an Oilfield.

or supplemental wells drilled to maintain production from oilfields. A constant effort is maintained to save and sell, or inject all produced natural gas. Water produced with the oil is disposed of by injection into the ground or discharged into surface waters when legally and environmentally acceptable.

Most gas produced with oil or from gas wells is marketed, although some is injected for additional recovery of oil. A large part of the gas produced with oil and from gas wells contains enough heavy hydrocarbons (propane, butane and natural gasoline) to economically justify processing for extraction of natural gas liquids. Other produced gas may contain almost all light hydrocarbons (methane and ethane) and is marketed without liquids extraction.

As a field matures in productive life, reservoir engineering studies show what can be expected in ultimate recovery and if the field is susceptible to yielding additional oil by fluid injection. If the prospects are good, pressure maintenance and secondary recovery projects will be started, usually after reservoir ownership has been unitized to protect the correlative rights of both operators and royalty owners. Nearly all such projects require unitization because fluid injection into a reservoir will normally move oil or gas across ownership lines. Some oil reservoirs can be revived for a third productive life (tertiary recovery) by injection of extraneous materials such as steam or chemicals.

During secondary or tertiary recovery operations, the day-by-day business of producing operations must be continued. Remedial well work never stops, artificial lift equipment must be serviced, surface facilities maintained, and replacement and injection wells drilled. As wells become uneconomical to produce, they must be plugged with cement, casing pulled, surface equipment removed and the surface area cleaned up in an acceptable manner.

SUMMARY AND RECOMMENDATIONS

SUMMARY

The National Petroleum Council submits the following findings on U.S. oil operations:

- Over the past decade, the depressed economic climate in the oil and gas producing industry resulted in a decline of 24 percent in footage drilled, and about 20 percent in the number of available rigs. The service industry, however, did not deteriorate during this period because of the more intensive application of new technology to oil and gas reservoirs and the continuing need for workover of existing producing wells.

- Drilling activity in 1974 is projected to increase 15 percent over 1973 to about 160 million feet (31,800 wells). While workable drilling rigs are now approaching maximum utilization rates, their efficiencies have been reduced by delays in tubular goods availability, logistical and manpower problems. Oil country tubular goods (OCTG), particularly casing, has been a critical constraint during much of 1974.

- Oil country tubular goods have been in short supply due primarily to the need for each operator to develop an individual working inventory, after the steel companies, starting in the third-quarter of 1973, changed their prior practice of providing inventories for the industry near the point of consumption. The change in inventory practice from a few large and strategically placed stocks has created many smaller user and distributor inventories. Even though U.S. mill shipments of these products for domestic use are expected to increase 17 percent over 1973, a disruptive effect on the tubular goods supply will be felt until inventories are stabilized. At this time, although pipe is still in short supply, workable rigs are now being used at maximum rates. Therefore, in the latter part of 1974, rigs will probably become the more important constraint, although the rig/pipe availability system is so closely balanced that one or the other may be a constraint to an individual operator.

- During the current period of tight supply, shipments of oil country tubular goods from U.S. mills to domestic users and distributors are being made to a large extent on a purchase history basis. While most users are unable to buy all of their requirements, those independents who have no domestic casing purchase history are particularly hard hit. This situation can be resolved through cooperation by the steel industry, the government and all sectors of the oil producing industry without resorting to allocation programs.

- Drilling activity is projected to increase in 1975 to 172 million feet and 33,600 wells, and in 1976 to 179 million feet and 34,500 wells. The anticipated growth rate of 10 percent in 1975 and 5 percent in 1976 in U.S. oil country tubular goods mill production should maintain the supply near that required for optimum use of workable drilling rigs after 1974. There may still be spot shortages of high-strength casing and of other specific items in 1975, but the possible effect is difficult to quantify. These projections of drilling activity could be on the low side, considering the industry's record of rapid response to improving economic conditions. More rigs may be available than projected due to the potential effect of fewer rigs exported than expected and by rigs returning from overseas and imported from Canada.

- The long-range outlook for drilling activity indicates the need for rapid expansion of drilling equipment manufacturing capacity. For example, the highest drilling rate case (Case I) of the NPC 1972 *U.S. Energy Outlook* study, assumed a drilling effort of about 250 million feet in 1980 and nearly 300 million feet in 1985.* This is believed to be an attainable goal. If exports of newly assembled rigs were to continue at the historic rate of approximately 50 percent, new rig manufacturing would have to grow at an improbable 25 percent annual rate to reach these projected drilling levels by 1980. A more realistic expectation would be a growth of 10-15 percent. About 11 percent annually would provide sufficient rigs to reach the Case I rate by 1985. Corresponding expansion in tubular goods mill production and in the well servicing industry would be necessary for maximum utilization of these new rigs. Based on the projected output of offshore production platforms through 1976, annual expansion rates of 20 percent are necessary to reach Case I projections by 1980, or 12 percent by 1985. Furthermore, there will be significant increases in steel tonnage per platform because the additional drilling will be in deeper water and harsher environments.

- Basic steel output and many other commodities required for drilling and producing activities are in short supply, but none is expected to seriously restrain drilling activity. This outlook could change if there are serious disruptions, such as strikes.

- Manpower is not believed to be a critical constraint in most areas for drilling, well servicing and equipment manufacture and utilization. However, manpower problems on previously inactive rigs mobilized during 1974 have contributed to lowering the efficiency of the drilling indus-

* NPC, *U.S. Energy Outlook--A Report of the National Petroleum Council's Committee on U.S. Energy Outlook*, Washington, D.C., December 1972. Hereinafter referred to as *U.S. Energy Outlook*.

try. With the rapid expansion expected in the next few years, qualified manpower must be attracted to the industry so that manning will not be a limiting factor and to this end, training programs must be accelerated.

- This report assumes that adequate capital will be available to the petroleum industry to expand exploration and drilling along with available equipment and manpower. It should be noted, however, that the capital required will be of a magnitude unprecedented in the history of the industry. However, capital formation for all segments of the petroleum and service industry should be adequate if free market prices for oil and gas are allowed to generate the profits necessary to assure steady growth over the long term.

- Capital investment decisions must be made by manufacturers and service companies by late 1974 if supplies and services are to be significantly increased by 1976 and thereafter. Current uncertainties regarding national energy policies tend to delay the making of these decisions.

RECOMMENDATIONS

Based on the findings and conclusions set forth in this report, the National Petroleum Council recommends the following measures to improve and expand the exploration, drilling and production capabilities of the United States.

Develop and Implement National Energy Policies Designed to Increase the Nation's Domestic Energy Supplies

The essence of these policies has been enunciated by the NPC *U.S. Energy Outlook* study in the following suggestions.

- Assure adequate supplies of *secure* sources of energy.

- Promote efficiency and conservation in all energy operation and uses.

- Preserve the environment in the production and use of energy.

A clear mandate for a national dedication to the above policies is needed to assure the expansion of exploration, drilling and production required by private industry to reduce U.S. dependence on foreign oil sources.

Allow Free Market Forces to Determine Prices for Oil and Gas in the United States

Adequate capital must be generated to expand the exploration, producing and servicing sectors of the industry at the projected

rates. Any action of government that impairs profits by reducing prices or increasing taxes can critically impede the generation of the capital needed for such expansion.

Expand Steelmaking Capacity

Shortages of steel will hinder rapid expansion of nearly all facets of the drilling and service industry. Now that price controls on steel have ended, it is believed the steel industry will increase the production of materials used by the petroleum industry. Market clearing price levels will tend to equalize the present U.S. export-import imbalances, though the world steel industry is expected to be in a tight supply/demand position for some years.

Expand Availability of Drilling and Producing Equipment

Drilling rig construction capability should expand at least 11 percent per year from 1977 through 1985 to attain the NPC Case I drilling rate of near 300 million feet per year in 1985. Furthermore, manufacturing facilities for equipment necessary for well completion and production maintenance must expand to keep pace with the growing need for well servicing. Offshore production platform construction yard capacity should increase at least 12 percent per year during this period. Operators of equipment abroad should be encouraged to return rigs and service vessels to the United States by making it as attractive to operate here as abroad.

Intensify Efforts to Produce More Oil from Known Reservoirs

Economic incentives should be sufficient to encourage increased recovery of oil remaining in existing reservoirs. The well servicing industry has the capability to respond to increasing demands for services related to well stimulation and additional (secondary and tertiary) recovery projects.

FINDINGS AND CONCLUSIONS

HISTORICAL BACKGROUND

During the 1963-1973 period, activity levels in the domestic oil and gas producing industry have not been sufficient to maintain petroleum reserves in the proper relationship to production or demand. In fact, proved reserves have declined from 38.6 billion barrels of liquid hydrocarbons and 276.2 trillion cubic feet (TCF) of gas at the end of 1963 to 32.2 billion barrels and 224 TCF at the end of 1973.* (The 1973 data exclude 9.6 billion barrels and 26 TCF found on the North Slope of Alaska, since it is not yet on production.)

During this period, domestic production increased 26 percent for liquid hydrocarbons and 55 percent for natural gas. These increases resulted primarily from utilization of excess producing capacity. However, demand for oil and gas increased approximately 60 percent with increased imports filling the deficit between supply and demand.† In this period of rapid growth in demand and declining reserves, there were not adequate incentives or opportunities for operators to aggressively explore for new sources of energy in the United States.

Factors contributing to the decline in domestic activity and petroleum reserves include:

- Depressed oil and gas prices which resulted in decreasing exploratory activity.
- Reduced offerings of offshore areas for lease.
- Increased environmental restrictions.

The real (constant dollar) composite price of oil and gas declined 19 percent from 1963 through 1973.‡ Although the price of crude oil has increased considerably in the past year, gas committed to interstate markets continues to be regulated at an artificially low price when compared with other less desirable fuels on a heating value basis. Restricted offshore lease offerings and compliance with mounting environmental laws and regulations have significantly repressed the petroleum industry in expanding the domestic oil and gas reserve base.

---

* American Gas Association (AGA), American Petroleum Institute (API) and Canadian Petroleum Association (CPA). *Reserves of Crude Oil, Natural Gas Liquids, and Natural Gas in the United States and Canada and United States Production Capacity as of December 31, 1973,* Vol. 28, June 1974.

† Independent Petroleum Association of America (IPAA). *United States Petroleum Statistics* (Revised), 1974.

‡ IPAA, *ibid.*

Positive steps taken by government, as a result of the Middle East disturbances of the past year, are in the direction of increasing the domestic energy supply. Advancing petroleum prices, accelerated offshore leasing and approval of the Trans-Alaska pipeline have increased domestic activity substantially. However, reversing the historic downward trend requires a major commitment of capital by the petroleum industry and substantial time before results are evident.

The decline in activity during the 1963-1973 period is reflected in drilling as shown in Table 1. The decline in available rigs from 2,967 to 1,824 in the 10 year period reflects the forced liquidation of many drilling contractors due to lack of business and the consequent exporting or dismantling of their equipment for spare parts.

TABLE 1

HISTORICAL U.S. DRILLING ACTIVITY

	Rotary Drilling Rigs		Total Footage Drilled (Millions of Feet)	Total U.S. Wells Drilled	Active Producing Wells At Year End‖
	Available*	Running†			
1963	2,967	1,499	184.4‡	43,653‡	691,623
1973	1,824	1,194	138.9§	27,551§	623,002

*Reed Annual Rig Count—Includes some unworkable rigs stacked in contractor's yard.

†Hughes Weekly Rig Count, year average—December 1973 was 1,400.

‡*Oil and Gas Journal, Forecast/Review Issue,* Vol. 62, No. 4, Tulsa, Oklahoma, January 27, 1964. (Excludes core and stratographic tests.)

§American Petroleum Institute, *Quarterly Review of Drilling Statistics, Fourth Quarter 1973,* Vol. VII, No. 4, Washington. D.C.: API, March 1974. (Excludes core and stratographic tests.)

‖API—AAPG 1973 well count published in *World Oil,* Vol. 178, No. 3, Feb. 15, 1974.

The only activity showing any increase during the decade was the number of gas wells drilled which increased from some 4,800 wells in 1963 to nearly 6,400 wells last year. This was largely due to the increased price of natural gas in the intrastate market, and drilling needed to meet deliverability provisions of gas sales contracts in some areas.

OUTLOOK FOR DRILLING AND PRODUCTION ACTIVITY

The facets of the oil and gas industry which were investigated include: exploration, drilling, tubular steel, production facilities, well servicing, gas processing plants, and drilling and production transportation. Except for tubular goods and drilling rigs, only isolated shortages in equipment and manpower were identified. All other phases of this sector of the industry should be able to respond to the projected 1974-1976 activity levels. The substantial increases in domestic oil prices during the last-half of 1973 gave

producers increased incentives to search for new reserves and to maximize production from known reservoirs.

As shown in Table 2, the average number of drilling rigs operating in 1973 was 1,194. By year-end, some 1,400 were in operation, a level which is believed to represent near maximum utilization of the workable rigs available at that time. By the end of July 1974, operating rigs had reached 1,500 with an average for the first-half year near 1,400. Active rigs are expected to rise in 1976 to an average above 1,500, an increase of 27 percent over the 1973 average.

TABLE 2

PROJECTED U.S. DRILLING ACTIVITY

	Historical	Projected			Percent Increase
	1973	1974	1975	1976	1976 over 1973
Number of Wells Drilled	27,551	31,800	33,600	34,500	25
Number of Feet Drilled (Million Feet)	138.9	160	172	179	29
Average Depth (Feet)	5,042	5,030	5,130	5,190	3
Number of Rigs Operating	1,194	1,440	1,480	1,520	27

Figure 2 demonstrates that during 1974, tubular goods and other constraints will possibly cause a deferment of approximately 2,200 wells (11 million feet) that otherwise would have been drilled. Tubular goods supply is expected to balance drilling rig capability by the end of 1974; and therefore, drilling accomplished during the next 2 years should be constrained only by rig availability and efficiency. Lowered efficiency due to manpower and logistics problems may cause deferment of 600 wells (3 million feet) in 1975 but should have no effect in 1976.

CONSTRAINTS TO ACTIVITY EXPANSION

Tubular Steel

The shortages of oil country tubular goods (casing, tubing and drill pipe) stem from:

- A substantial rise in drilling activity caused by recent increases in the price of oil.
- A change in inventory and sales practices by the steel industry.
- The residual effects of price controls on the steel industry.
- The inability of the steel mills to increase production rapidly to meet these changing conditions.

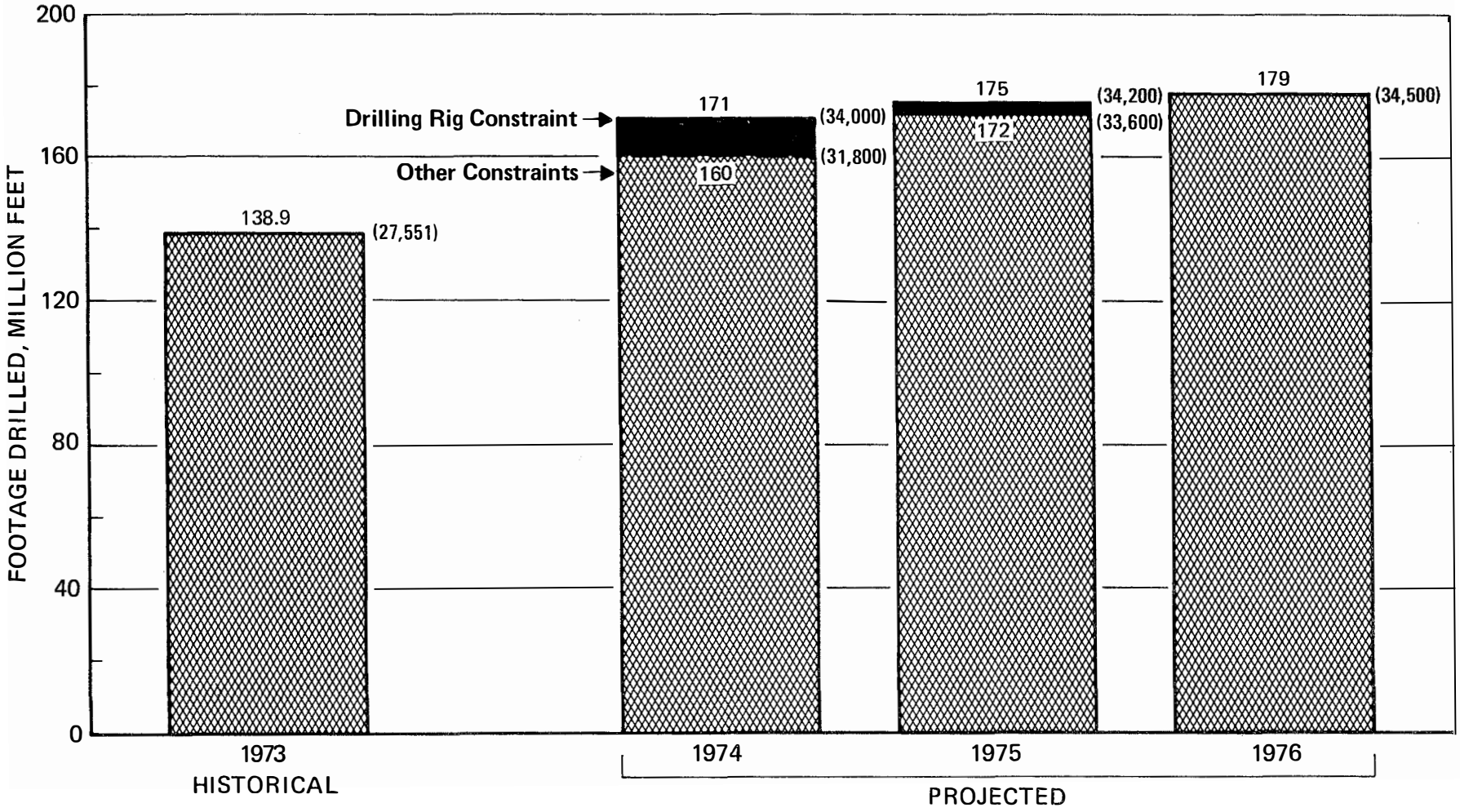


Figure 2. Projected U.S. Drilling Activity--1974-1976.

Changes in Steel Industry Supply Practices

For many years, the steel industry maintained inventories of oil country tubulars in several strategic locations near the heaviest drilling activities. The make-up and quantities were based on customers' estimates of requirements and the sales experience of the steel industry.

During the years of depressed drilling activity, these "in-transit" inventories were more than adequate. While the convenience and economies to the customer-operator were obvious, the return on investment to the steel industry was unattractive. In the third-quarter of 1973, each of the tubular goods manufacturers announced that mill shipments of oil country tubulars would be allocated based largely on each customer's purchase history, and that shipments to "in-transits" would be eliminated. As a consequence, each operator would have to maintain his own inventory.

An effective drilling program must be backed up by a "working inventory" of tubular goods, and therefore, a build-up of many individual inventories by oil companies has begun to replace the few strategic large ones. This change has substantially increased the total of inventories required overall (see Table 3). This, coupled with the large increase in demand, will cause oil country tubulars to remain in short supply until the inventory transition is completed. With the removal of price controls, increased manufacturing of tubulars has begun which speeded up the inventory transition process. Once the shift is completed, the flow of tubulars for consumption should be adequate to support drilling rig availability, although spot shortages of high-strength casing will probably continue through 1975.

Table 3 is a summary of the tubular goods situation and shows demand (determined by a detailed analysis of drilling activity), supply and inventory. During the 1970-1972 period, inventories remained virtually unchanged, indicating all tubulars shipped during that period were consumed. These shipments represented an average of 77 percent of the calculated demand, with the remaining 23 percent being made up of unidentified sources including salvaged pipe, line pipe used as oil country tubulars, unidentified imports and limited service or non-API pipe. With the assumption that the 23 percent figure will remain constant through 1976, usage from unidentified sources was calculated.

Industry estimates indicate that producer/operator inventories will rise to approximately 700,000 tons in 1974, 950,000 tons in 1975, and level off at approximately 1,050,000 tons in 1976. These inventory levels were used to estimate the portion of mill shipments going into user and supply store inventory and the portion consumed. The difference between the calculated demand at full rig utilization potential and the portion of mill shipments consumed, plus usage from miscellaneous sources, represents the estimated shortage.

The projected shortage of 167,000 tons in 1974 is the principal factor contributing to an expected drilling shortfall of some

TABLE 3

OIL COUNTRY TUBULAR STEEL SUPPLY AND DEMAND PROJECTION—CASING, TUBING AND DRILL PIPE FOR DOMESTIC DRILLING
(Thousand Tons)

	Historical				Projected		
	1970	1971	1972	1973	1974	1975	1976
Demand (Calculated consumption for History and Outlook Task Group Projection Based on Maximum Rig Utilization)	1,874	1,662	1,816	1,862	2,263	2,359	2,473
Supply							
Shipped from U.S. Mills Production	1,307	1,404	1,277	1,436	1,956	2,317	2,432
Plus shipments from U.S. Mill Inventory	—	—	—	300	150	—	—
Less exports	(88)	(81)	(95)	(198)	(300)	(300)	(300)
Plus imports	109	157	158	162	100	100	100
New Oil Country Tubular Goods (OCTG) available for domestic consumption	1,328	1,480	1,340	1,700	1,906	2,117	2,232
Consumption							
Consumption from miscellaneous sources*	546	182	476	429†	523†	492†	341†
Consumption of new OCTG	1,328	1,480	1,340	1,433	1,573	1,867	2,132
Total Consumption	1,874	1,662	1,816	1,862	2,096	2,359	2,473
Shortage (Demand less total supply consumed)	0	0	0	0	167	None‡	None‡
Domestic shipments to Pipe User Inventory	0	0	0	267	333	250	100
Inventory (Year-End)							
Pipe User Inventory	100	100	100	367	700	950	1,050
Steel Company Inventory	500	500	500	200	50	50	50
Total Inventory	600	600	600	567	750	1,000	1,100

*Use from inventory, rejects, line pipe used as oil country goods, secondhand pipe, unreported mill shipments and unidentified imports.

†Based on 1970-1972 average, 23 percent of demand assumed satisfied from miscellaneous sources. In 1975 and 1976 where "Total Consumption" equals calculated demand, consumption from miscellaneous sources may be reduced by some 53 and 230 thousand tons, respectively as more new tubulars become available.

‡ Annual figures indicate that by the end of 1975, supply will approach demand but there may be shortages during the year, particularly in high strength casing.

11 million feet (2,200 wells) from the projection of drilling that could be accomplished if drilling rigs were the only constraint. Table 3 indicates that in 1975, supply will approach demand; however, there may be spot shortages during the year, particularly in high-strength casing for deep drilling.

The following considerations are important to the interpretation and use of data in Table 3:

- While the total tonnage shipments projections for 1974-1976 are believed reasonable, shipments less than estimates could cause a reduction in wells and footage drilled.

- Availability of imports is quite uncertain because worldwide growth in demand has overtaken the world basic steel and pipe mill capacity. West German mills are committed to

deliveries to the USSR, and substantial sales have been made by Japanese mills to the Peoples Republic of China.

- Oil and gas well abandonments in the United States are a relatively small but important source of tubing and casing. These used tubular goods now bring prices comparable with new pipe because of the tight supply situation. Oil well abandonments dropped from around 20,000 in 1972 to under 15,000 in 1973 and are projected to decrease even further. Gas well abandonments which totaled about 4,000 a year in 1972 and 1973 are also expected to drop somewhat in 1974. The relative economics of abandonments for salvage *versus* continued production will dictate the magnitude of this supply.

- The total tonnage of oil country tubular goods shipped for domestic use cannot serve as a complete indication of supply/demand balance. The tight supply situation prevailing in 1974 and projected for 1975 includes grade and size availability as well as basic tonnage. All deep-wells must use some high-strength casing and, if successful, high-strength tubing.

- The American Iron and Steel Institute indicates about 44 percent of the casing, tubing and drill pipe shipped from U.S. mills in 1973 was high-strength material.* The need for high-strength pipe is increasing and is projected to continue to rise beyond 1976. Since there is restricted capability for production of this material, there may be a continuing restraint on deep-well drilling activity.

- Drill pipe is in short supply but is not a measurable constraint to drilling activity. In 1973, drill pipe represented less than 8 percent of total U.S. output of high-strength oil country tubular goods. Drill pipe manufacture is limited by the capacity of the same equipment that is used to make high-strength casing. The problem of competing for mill space is made more acute because a length of drill pipe requires twice as much mill capacity to produce as a comparable length of high-strength casing. Thus, in-increases in drill pipe production at present will reduce the output of twice that length of high-strength casing.

- The present attractive economics should encourage expansion of heat treating capacity as well as basic carbon steel tubular production, and only a small increase of both should bring tubular supply into balance with rig availability.

Drilling Rigs

Figure 2 indicates that if all workable drilling rigs in the United States are utilized at maximum feasible capacity, and if

* American Iron and Steel Institute, (published statistics for 1973).

there were no other constraints, 171 million feet could be drilled in 1974, 175 million feet in 1975 and 179 million feet in 1976. These rates represent an increase of 22 percent per year in 1974, but much smaller increases in 1975 and 1976. The footage estimates are calculated by geological regions and well-depth categories and are based upon the rig availability and utilization data summarized in Table 4.

TABLE 4

U.S. RIG AVAILABILITY AND UTILIZATION

Workable Rigs at Year End	Historical 1973	Projected 1974	1975	1976
Land Rigs	1,502	1,520	1,541	1,559
Offshore Rigs				
Stationary	75	81	88	96
Mobile-Bottom Supported	58	62	67	77
Floaters	15	21	32	41
Total Offshore	**148**	**164**	**187**	**214**
Total All Rigs	**1,650**	**1,684**	**1,728**	**1,773**
Net Additions		34	44	45
Workable Rigs–Annual Average	1,635	1,667	1,706	1,751
Utilization Factor–Percent	73	86	87	87
Active Rigs–Annual Average	1,194	1,440	1,480	1,520

After all existing workable rigs are being utilized at a near maximum feasible rate, additional drilling capacity will be limited by drilling rig equipment manufacturing capacity (with offshore expansion further limited by capacity of construction yards to produce offshore drilling platforms).

Projections of new rig availability are based on the assumption that steel will be made available to manufacture rig components such as derricks and masts, mud pumps and the many other necessary parts of the total drilling system to match the production of new draw works and other hoisting system components.

The export demand for drilling rig equipment and complete mobile offshore rigs is expected to continue at a high-level for many years. While total drilling rigs manufactured in the United States are projected to increase from 135 in 1974 to 162 in 1975 and 178 in 1976, 50-60 percent are believed to be under contract for export. Table 5 shows an estimate of net rig additions for the 1974-1976 period.

A significant increase in drilling rig availability will occur only several years after manufacturers undertake expansion of plant

TABLE 5

U.S. RIG AVAILABILITY, NEW RIG ALLOCATION AND WORKABLE RIGS

	1974		1975		1976	
Type and Number of New Rigs Manufactured in U.S.						
Offshore Mobile	49		50		50	
Remaining in U.S.		11		17		20
Exported		38		33		30
Fixed	86		112		128	
Remaining in U.S.		48		52		50
Exported		38		60		78
Total New Rigs Manufactured	**135**		**162**		**178**	
Distribution of New Rigs Remaining in U.S.						
Offshore Mobile	11		17		20	
Platform	7		8		9	
Land	41		44		41	
Total Remaining in U.S.	**59**		**69**		**70**	
Less: Attrition	25		25		25	
Offshore		2		2		2
Platform and Land		23		23		23
Net Rig Additions in U.S.	34		44		45	

capacity. But they cannot make decisions for the required capital investments to expand capacity unless assured of a continuing high-level of demand for many years.

Other Materials for Drilling

Materials for maintenance, repairs and operating supplies for drilling are generally difficult to obtain but none is expected to be a major deterrent to expanded activity. Many items that could be purchased off the shelf in early 1973 now have a lead time of many weeks. Tool joints for drill pipe, which were a constraint in 1973, have come into balance with drill pipe availability and are not expected to be a restraining influence. Drill bits are expected to keep pace with the growing demand. Drill collars, the thick walled sections of pipe which are placed between the drill pipe string and the bit to provide weight and rigidity in the drill string, are not expected to be a specific constraint to drilling activity.

The drilling process requires that a fluid be pumped down the drill pipe and circulated back to the surface to lubricate and cool the bit, carry drill cuttings out of the hole and supply hydrostatic head to control formation pressure. Drilling fluid varies from natural mud generated by simply drilling with fresh water to sophisticated chemical colloidal mixtures. The most commonly used material to add weight to the fluid is barite (barium sulphate). Since 47 percent of domestic requirements are imported, barite could become a constraint, but this is not expected to occur by

1976. There is a short supply of many drilling fluid chemicals, particularly caustic soda; however, the drilling industry's use of these materials is small compared with the total supply, and slight modifications in the distribution of these chemicals can alleviate potential problems.

In summary, spot shortages and longer lead times for other equipment and materials may impede the attainment of expanded drilling programs, but none is expected to be an important constraint.

Surface and Subsurface Production Equipment

Structural steel used in offshore production platforms is the largest single item of material requirements for production equipment. Present fabrication yard capacity is approximately 200,000 tons per year. This can be expanded to meet the requirements inherent in the platform projections shown in Table 6, subject to the availability of steel plate, pipe and structural shapes.

With lead times on beam pumping units being extended to a year or more, manufacturers of beam and rod pump equipment will continue to operate at capacity through 1976. While the 1974 supply/demand projection indicates a shortfall of 10 percent, this is sensitive to change in the historic rate of well abandonments (the majority of which are estimated to be beam and rod pumped), re-employment of surplus pumping units and use of alternate artificial lift equipment (gas lift, hydraulic, subsurface electric centrifugal pumps). Planned expansions of manufacturers should alleviate the problem but shortages will continue for some time. Capacity for furnishing gas lift, hydraulic and electric subsurface pumps and sucker rods for beam pumps is adequate for the next 3 years.

Many other items of equipment necessary for production of oil and gas now have long lead times for delivery; however, at this time none is expected to restrict production. These include electrical equipment, prime movers, surface oil and gas handling equipment, production chemicals, subsurface equipment, waterflood-gas injection equipment, wellhead equipment, christmas tree (well control) valves and line pipe for oil and gas gathering systems.

TABLE 6

OFFSHORE FIXED PLATFORM CONSTRUCTION

	Projected		
	1974	1975	1976
Number Fabricated and Installed	50	55	60
Average Water Depth (Feet)	175	185	195
Platform Tonnage (Thousand Tons)	150	176	204
Production and Drilling Rig Packages Added Requirements (Thousand Tons)	30	33	36
Total Steel Requirements (Thousand Tons)	**180**	**209**	**240**

Well Servicing Equipment and Service

The U.S. well servicing industry consists of more than 50 separate functions and supports drilling and producing activities from the time drilling starts until final well abandonment. Well servicing companies perform engineering, manufacturing and installation services. In 1973, they employed approximately 140,000 people in the United States with sales of around $4 billion. Services furnished include cementing, fracturing, acidizing, well sand control, directional drilling, electric and other types of well logging, perforating, artificial lift servicing and well workovers. Associated equipment includes production workover rigs, high pressure pumps, mixing devices, instruments and controls, electric wire line units and many types of specialized surface and subsurface tools and equipment.

It should be noted (see Appendix C, Figures 4, 5, and 9) that the same equipment and services are used for both drilling and producing wells. Therefore, the rapid increase in demand in late 1973 for services related to new well drilling was in addition to existing strong demand for production maintenance services. The services provided by this industry increased 15 percent in 1973 and are expected to increase 25 percent in 1974, primarily through improved utilization of existing equipment and manpower. Another 25 percent expansion can be accommodated in 1975 with a 10 percent addition to the service unit fleet (cementing trucks, electric wireline units, etc.), more efficient scheduling, and longer hours of operation of service units and workover rigs. Further expansion in 1976 will require major investment decisions before the end of 1974.

The availability of workover rigs is expected to be the most critical well servicing item during the next 3 years. The number of operating rigs is projected to increase about 5-6 percent per year through 1976. The average number of rigs available was about 3,200 in 1973 and is projected to exceed 3,700 in 1976. Since the demand for the workover rigs is anticipated to increase about 25 percent per year after 1973, projected rig availability will be insufficient by 1975 if rigs continue to operate only during daylight (10 usable hours). Around-the-clock utilization (a usable 16 hours) in critical geographical areas could handle a 35 percent annual increase in demand through 1976. If the estimated 1974 utilization rate of 91 percent and 10 hours operation continues, rig service availability can increase only as rig numbers increase, or about 6 percent for each of the next 2 years.

The above estimates of workover rig availability, and the estimates of workable drilling rigs (see Table 4), do not take into account the increasing use of the new larger rigs to drill shallow wells. Most new workover rigs are capable of new well drilling with the addition of mud pumps, tanks, blowout preventers and a power swivel. Relative economics and local opportunities for contractors and producers will determine whether such a rig will be used for drilling or continue to perform service work.

Gas Processing Plants

Gas processing plants extract liquid hydrocarbons from wet gas produced from oil and gas wells. Operations include compression, refrigeration, fractionation and removal of impurities. The extracted products are natural gasoline (pentane plus), butanes, propane, ethane or a combination of these hydrocarbons. Products are usually transferred in marketable form through liquid and gas transmission lines.

Carbon steel requirements for gas processing plants are expected to be about 250 thousand tons yearly in the 1974-1976 period. About 90 percent of this is for gathering systems with the balance for new plants, expansion of existing plants, compressors and plant maintenance. While the needs are small compared with other sectors of the petroleum industry, steel for gas processing could become a constraint if adequate steel supplies are not available.

Fabricated equipment is not believed to be a major restraint, although lead time for some essential items now exceeds 40 weeks (heat exchangers, process vessels and engines). Competing demand for these and other commonly used items (e.g., heaters, pumps, motors and controls) from refineries, petrochemical plants, fertilizer plants and other industries could cause delay of some gas plant projects.

Geophysical Services

Equipment utilized for geophysical work includes magnetometers, gravimeters, seismic energy generators, receivers and recorders, and data processing programs and equipment. Seismic services are not expected to constrain drilling over the next few years, since much of the seismic work has already been done on the prospects that will be drilled during this period. There do not appear to be any restraints to expansion of offshore seismic service. There is, however, a current shortage of onshore field crews and trained manpower for interpretation of the accumulated geophysical data.

Transportation and Fuel

No major constraints on drilling and producing activity are anticipated from basic transportation equipment (vehicles, boats and aircraft) or fuel. While the industry is not being impaired in 1974, the increasing lead time for replacement of equipment and availability of spare parts for trucks may be a problem in the next 2 years and could result in delayed movement of rigs between locations.

Basic Steel

While the petroleum industry uses only 6 percent of the domestic output of basic steel, most manufacturers of oilfield equip-

ment are highly dependent on adequate steel supplies. Without exception, all oil equipment manufacturers express concern over their ability to continue to obtain currently required supplies and, more particularly, the additional steel supplies required for indicated increases in output. In many cases, plans of manufacturers are predicated on maximum domestic allocations supplemented by significant imported steel supplies. Steel supplies could be a serious constraint for such primary uses as plate for platform construction and surface handling facilities, as well as secondary steel requirements of manufacturers and sub-suppliers. Any shortfall of total steel supply will cause a net reduction in the indicated capacities of the various manufactured equipment segments. The situation could become critical in the event of a coal strike resulting in a disruption of steel production.

Other Basic Materials and Equipment

Tight supplies of basic resources (plant capacity, materials and manpower) have created extended lead times for most other required items.

- *Castings and Forgings:* All manufacturers identify these as shortage items, often critically, and with no immediate foreseeable relief. Rigorous enforcement of Occupational Safety and Health Administration (OSHA) and Environmental Protection Agency (EPA) regulations have caused the shutdown of many small marginally economical foundries. Such foundries in the aggregate have historically been a significant source of supply.

- *Electrical Equipment:* Manufacturers identify the shortage of copper wire and related insulating materials as a constraint to equipment delivery. Bronze for bearings is also in short supply.

- *Machine Tools:* Long lead times are a potential constraint expansion of manufacturing capacity.

Despite tight supplies for these items, none is expected to be a critical constraint to needed expansion of exploration, drilling and production.

Manpower

Trained manpower availability is a definite problem in expansion of all exploration, drilling and production activities and their supporting industries. The most critical shortage identified at this time is in personnel for interpretation of geophysical data, but this should not delay short-term exploratory drilling programs.

Oil and gas producers and drilling and well servicing contractors have continuous programs for recruiting and training new em-

ployees and for upgrading their existing work forces, but labor turnover is high for drilling and workover rig contractors. The work is difficult, must be performed in all kinds of weather and is nomadic. This high turnover rate does not reduce the number of active rigs but reduces operating efficiency. Previously inactive rigs mobilized during 1974 have lowered the overall efficiency of the drilling industry, due partly to manpower problems. Intensive training is expected to relieve the drilling manpower constraint by 1976.

Nearly all manufacturers of oilfield equipment indicated a concern for the availability of adequate skilled manpower such as welders, machinists and pipefitters. Most manufacturers have increased internal training programs to develop their own skilled labor forces, but the supply of qualified candidates is limited. Several manufacturers also identified shortages of engineering personnel, draftsmen and common laborers for the 1974-1976 period.

Several manufacturers, particularly those in the fabrication business, indicated that Occupational Safety and Health Administration regulations have adversely affected productivity by as much as 15 percent.

In summary, while specific limitations cannot be quantified, shortages of skilled manpower will be a problem in rapid expansion of manufacturing capacity and new construction. Drilling and well servicing contractors are manning reactivated and new rigs as they become available, but with lower operating efficiency.

Capital Availability

It appears that adequate capital will be available to the petroleum industry to expand exploration and drilling in line with availability of equipment and manpower during the 1974-1976 period. Longer-range, free market prices of domestically produced hydrocarbons will be needed to generate sufficient internal capital (in the form of profits) to attract enough outside funds to increase exploration and drilling within the United States, at a rate consistent with the expansion outlined in this report.

Similarly, capital formation of all segments of the petroleum service industry appears adequate to provide equipment and supplies for increased operations through 1976. But for the longer-term, a clear energy policy leading toward increased development of indigenous energy supplies must be set forth to assure the service industry of steadily rising profits so that adequate plant expansion can begin soon and be financed, if necessary.

LONG-RANGE OUTLOOK FOR DRILLING ACTIVITY

Over the long term, drilling rig availability will most likely be the primary restraining influence on increased drilling activity.

The National Petroleum Council's 1972 report, *U.S. Energy Outlook*, examined several levels of possible drilling activity through 1985. Case I of the report assumed a drilling rate reaching 250 million feet per year in 1980 (35 million offshore) and nearly 300 million feet in 1985 (50 million offshore). The report indicated that the domestic oil and gas resource base, discoverable and producible, is adequate to support such a large expansion of the industry.

For purposes of the current study, it was assumed that economic incentives will be sufficient to motivate this rapid growth of petroleum activity, that governmental policies will encourage expansion, and that financing of the large investments required will be available. Current trends indicate that tubular goods and other equipment and services can be made available to supply expanded needs. With these assumptions, drilling rig requirements were calculated to achieve NPC Case I activity levels for the 1977-1985 period.

Due to the relatively low projected output of domestic rigs through 1976, domestic rig additions for 1977--the first year in which significant increases in rig deliveries can be made--would have to be more than 250 rigs to reach Case I activity levels in that year and this figure is considered to be unattainable. A more plausible approach is to assume that drilling rig manufacturers in the United States can expand deliveries at an increasing rate after 1976 by beginning a substantial expansion of manufacturing capacity in 1974.

If one-half of the new rigs to be built from 1976 to 1980 are exported, an expansion of more than 30 percent per year from 1976 would be needed to reach a rig level of 2,400 rigs in 1980 which would be required to drill at the rate of the 250 million feet for Case I. A more reasonable growth rate of 10-15 percent annually after 1976 (a rate of 11 percent calculated) would allow realization of Case I activity of 300 million feet by 1985 with about 2,900 workable rigs. Although the NPC drilling activity levels are ambitious, they are achievable in the 1980-1985 period if the industry is given adequate economic incentives and stable governmental policies.

Comparable growth rates must be attained in all other segments of the oil producing industry, particularly offshore production platforms, workover and rod pulling units, pumps, trucks and allied equipment for bulk material handling and formation stimulation jobs.

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

DEC 21 1973

Dear Mr. True:

The present energy situation makes it imperative that increased domestic exploration for energy sources, particularly oil, be undertaken at the earliest possible time.

So that a rational program might be developed the Department of the Interior has an urgent need to know the availability of materials, manpower and equipment necessary for the exploration, drilling and production of oil during the next two years. Any shortages of materials, manpower or equipment needed for these tasks should indicate the probable limitation on drilling activity. The duration and causes of such shortages, together with any possible measures to alleviate them, should be set forth.

At our request the National Petroleum Council's Committee on Emergency Preparedness is presently conducting a study to 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.

In our letter to you of December 5, 1972, requesting the National Petroleum Council to undertake the above study one of the items mentioned was the capability for emergency increases in production. Because the information needed on the availability of materials, manpower and equipment for exploration and production falls within this category I am requesting that you have the National Petroleum Council's Committee on Emergency Preparedness appoint an appropriate subcommittee to undertake this task.

Because of the urgency of this matter your early response and cooperation will be greatly appreciated.

Sincerely yours,

Stephen A. Wakefield

Stephen A. Wakefield
Assistant Secretary

CONSERVE AMERICA'S ENERGY

Mr. H. A. True, Jr.
Chairman
National Petroleum Council
c/o True Oil Company
Post Office Drawer 2360, Casper, Wyo. 82601

Save Energy and You Serve America!

The following industry representatives have participated in this study.

NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

Carrol M. Bennett
Chairman of the Board
Texas Pacific Oil Company, Inc.

VICE CHAIRMAN

M. A. Wright
Chairman and Chief
Executive Officer
Exxon Company, U.S.A.

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

EX OFFICIO

H. A. True, Jr.
Chairman
National Petroleum Council

SPECIAL ASSISTANT TO THE CHAIRMAN

Harry Green
General Manager
Administrative Services
Texas Pacific Oil Company, Inc.

* * * * * *

Z. D. Bonner
President
Gulf Oil Company--U.S.

H. Bridges
President
Shell Oil Company

Richard J. Gonzalez
Consultant
Houston, Texas

Maurice F. Granville
Chairman of the Board
Texaco Inc.

Jake L. Hamon
Oil and Gas Producer
Dallas, Texas

H. J. Haynes
Chairman of the Board
Standard Oil Company of California

John A. Kaneb
President
Northeast Petroleum Industries, Inc.

George F. Kirby
President
Texas Eastern Transmission Corp.

William A. Lockwood
Senior Vice President
First National City Bank of
New York

W. F. Martin
Chairman
Phillips Petroleum Company

Harold M. McClure, Jr.
President
McClure Oil Company

D. A. McGee
Chairman
Kerr-McGee-Corporation

E. Clyde McGraw
Chairman of the Board
Transcontinental Gas Pipe Line Corporation

C. John Miller
President
Independent Petroleum Association of America

Robert V. Sellers
Chairman of the Board
Cities Service Company

Irving S. Shapiro
Chairman of the Board
E.I. duPont de Nemours & Company, Inc.

John E. Swearingen
Chairman of the Board
Standard Oil Company (Indiana)

Rawleigh Warner, Jr.
Chairman of the Board
Mobil Oil Corporation

COORDINATING SUBCOMMITTEE OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

Dr. James S. Cross
Director, Economics and Industry Affairs
Corporate Development
Sun Oil Company

SECRETARY

Vincent M. Brown
Executive Director
National Petroleum Council

ALTERNATE SECRETARY

Marshall W. Nichols
Assistant Director for Committee Operations
National Petroleum Council

* * * * * *

Thomas H. Burbank
Vice President
Edison Electric Institute

Edward T. DiCorcia
Assistant General Manager
Supply Department
Exxon Company, U.S.A.

Theodore R. Eck
Chief Economist
Standard Oil Company (Indiana)

Harry Green
General Manager
Administrative Services
Texas Pacific Oil Company, Inc.

Kenneth E. Hill
Executive Vice President
Corporate Finance
Blyth Eastman Dillon & Co., Inc.

Thomas A. Peake
Assistant to the President
Standard Oil Company of California

John F. Roorda
Vice President
Planning and Economics
Shell Oil Company

S. E. Watterson, Jr.
Manager, Tanker Planning
Standard Oil Company of California

SPECIAL ASSISTANTS

Richard B. Guerin
Staff Economics Specialist
Forecasting, Planning & Economics
Shell Oil Company

H. L. Hilleary
Senior Staff Economy Analyst
Comptroller's Department
Standard Oil Company of California

A. R. Talpt
Staff Director
Industry Supply Economics
Standard Oil Company (Indiana)

SUBCOMMITTEE
ON
MATERIALS & MANPOWER REQUIREMENTS FOR
PETROLEUM EXPLORATION, DRILLING & PRODUCTION
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

Kenneth E. Hill
Executive Vice President
Corporate Finance
Blyth Eastman Dillon & Co., Inc.

VICE CHAIRMAN

W. H. Klarquist
General Manager of Purchasing
Standard Oil Company of California

SECRETARY

James W. Winfrey
Consultant to the National
Petroleum Council

* * * * * *

J. E. Barnes
Vice President
Purchasing
Continental Oil Company

Minor S. Jameson, Jr.
Consultant
Independent Petroleum
Association of America

R. J. Bauer
Vice President, Purchasing
& General Servicing
Shell Oil Company

Stan T. McCardell
General Manager
Purchasing Department
Texaco Inc.

E. H. Clark, Jr.
President
Baker Oil Tools, Inc.

William G. Osborne
Vice President
Cities Service Oil Company

Harold T. Wright
Manager of Engineering
Production Department
Exxon Company, U.S.A.

SPECIAL ASSISTANTS

H. B. Douglas
Manager, Organization
& Cost Control
Chevron Oil Company

J. C. Grindal
Staff Engineer
Exxon Company, U.S.A.

EXPLORATION/DRILLING OUTLOOK TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

Harold T. Wright
Manager of Engineering
Production Department
Exxon Company, U.S.A.

SECRETARY

Marshall W. Nichols
Assistant Director for
Committee Operations
National Petroleum Council

* * * * * *

B. L. Choate
Production Coordinator
Production Department
Gulf Oil Corporation

W. C. Hauber
Manager Forecasting
Exploration & Production Economics
Shell Oil Company

Frank X. Jordan
Director of Special Studies
Independent Petroleum
Association of America

SPECIAL ASSISTANT

J. C. Grindal
Staff Engineer
Exxon Company, U.S.A.

TUBULAR STEEL TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

Stan T. McCardell
General Manager
Purchasing Department
Texaco Inc.

SECRETARY

Peter J. Cover
Committee Coordinator
National Petroleum Council

* * * * * *

David H. Hoag
Manager, Tubular Products Sales
Jones & Laughlin Steel Corp.

James C. Phelps
President & Chief Operating
Officer
Tesoro Petroleum Corporation

C. T. McClure
Manager, Tube Sales
Youngstown Sheet & Tube Company

Robert G. Wilkins
Purchasing Agent, Purchasing Dept.
Tenneco Oil Company

SPECIAL ASSISTANT

W. A. Power
Senior Buyer, Purchasing Department
Texaco Inc.

EXPLORATION & DEVELOPMENT DRILLING EQUIPMENT & MATERIALS TASK GROUP OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

R. J. Bauer
Vice President
Purchasing & General Services
Shell Oil Company

SECRETARY

James W. Winfrey
Consultant to the National Petroleum Council

* * * * * *

F. T. Alexander
Vice President
Administrative Services
Hughes Tool Company

E. C. Broun, Jr.
Vice President, Market Develop.
Petroleum & Minerals Group
Dresser Industries, Inc.

H. S. Erskine
Vice President
Kewanee Oil Company

R. H. Etnyre
President
Machinery & Equipment Division
Armco Steel Corporation

D. L. Kastner
Vice President, Exploration & Production- Central Area
Cities Service Oil Company

Alden J. Laborde
President
Ocean Drilling & Exploration Company

Donald K. Lawrence
Manager
Materials Management
Sun Oil Company (Delaware)

C. R. Palmer
President
Rowan Companies, Inc.

Raymond Plank
President & Chief Executive Officer
Apache Corporation

Thomas R. Smith
Manager
Minerals Department
General Crude Oil Company

SPECIAL ASSISTANT

R. D. Horst
Manager, Economics
Purchasing and General Services
Shell Oil Company

SURFACE & SUBSURFACE PRODUCTION FACILITIES TASK GROUP OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

J. E. Barnes
Vice President, Purchasing
Continental Oil Company

SECRETARY

Peter J. Cover
Committee Coordinator
National Petroleum Council

ASSISTANT TO THE CHAIRMAN

Martin P. Lascor
Manager, WHPD Purchasing
Continental Oil Company

* * * * * *

B. C. Anderson
Industry Analysis Manager
Atlantic Richfield Company

Harry G. Austin
Executive Vice President
Construction
Brown & Root, Inc.

J. A. Neish
Vice President
Marketing
C-E NATCO

R. G. Tribble
Manager, Production Staff
Cities Service Oil Company

SPECIAL ASSISTANTS

B. F. Caver
Special Operations Manager
Cities Service Oil Company

W. B. Pieper
Senior Vice President
Marine Industries
Brown & Root, Inc.

E. C. Roberts
Consultant
Atlantic Richfield Company

D. C. Unwin
Assistant to the Manager
of Marketing
C-E NATCO

GAS PROCESSING PLANTS TASK GORUP OF THE NATIONAL PETROLEUM COUNCIL'S COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

William G. Osborne
Vice President
Cities Service Oil Company

SECRETARY

John H. Guy, IV
Assistant Committee Coordinator
National Petroleum Council

Leslie M. Burgess
Director, Energy Analysis
Fluor Corporation

C. W. Miller
Vice President-Manufacturing
Warren Petroleum Company

B. F. Wobker
Vice President
Plant Operations
Northern Gas Products Co.

SPECIAL ASSISTANTS

J. F. Burris
Industry
Economist, Planning Division
Cities Service Oil Company

J. D. Harlan, Jr.
General Manager of Manufacturing
NGL Division
Cities Service Oil Company

George C. Vaughn
General Manager
Marketing, Supply & Distribution
NGL Division
Cities Service Oil Company

WELL SERVICING TASK GROUP
OF THE
NATIONAL PETROLEUM COUNCIL'S
COMMITTEE ON EMERGENCY PREPAREDNESS

CHAIRMAN

E. H. Clark, Jr.
President
Baker Oil Tools, Inc.

SECRETARY

Marshall W. Nichols
Assistant Director for
Committee Operations
National Petroleum Council

* * * * * *

Leonard Leon
Executive Vice President
Halliburton Services

John M. Lloyd, Jr.
Supervisor, Production Planning
& Coordination
Amoco Production Company

Frank M. Pool
President
Pool Company

SPECIAL ASSISTANT

Wendell W. Suydam
Vice President
Baker Oil Tools, Inc.

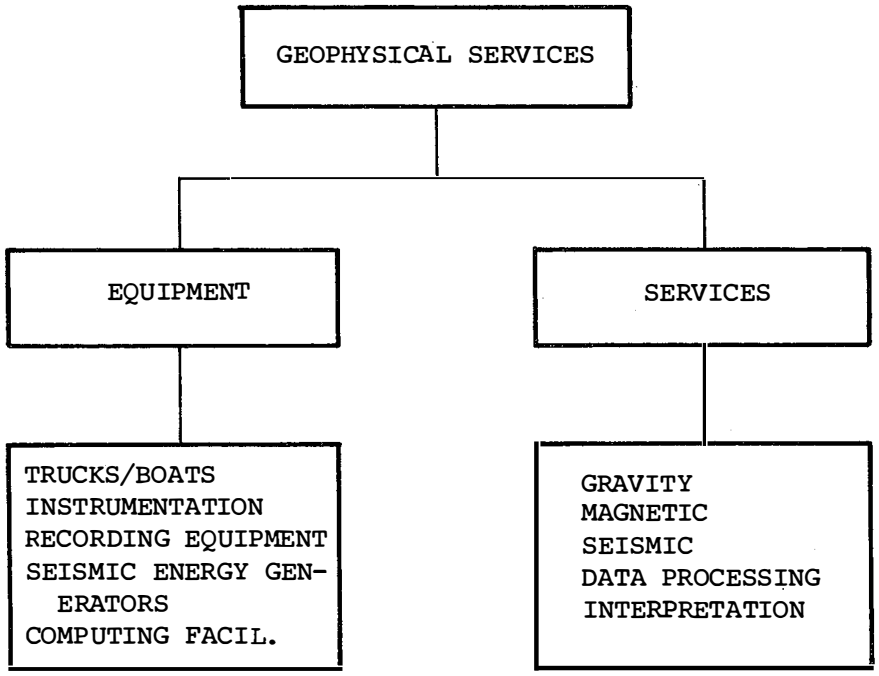


Figure 3. Chart A--Geophysical Services.

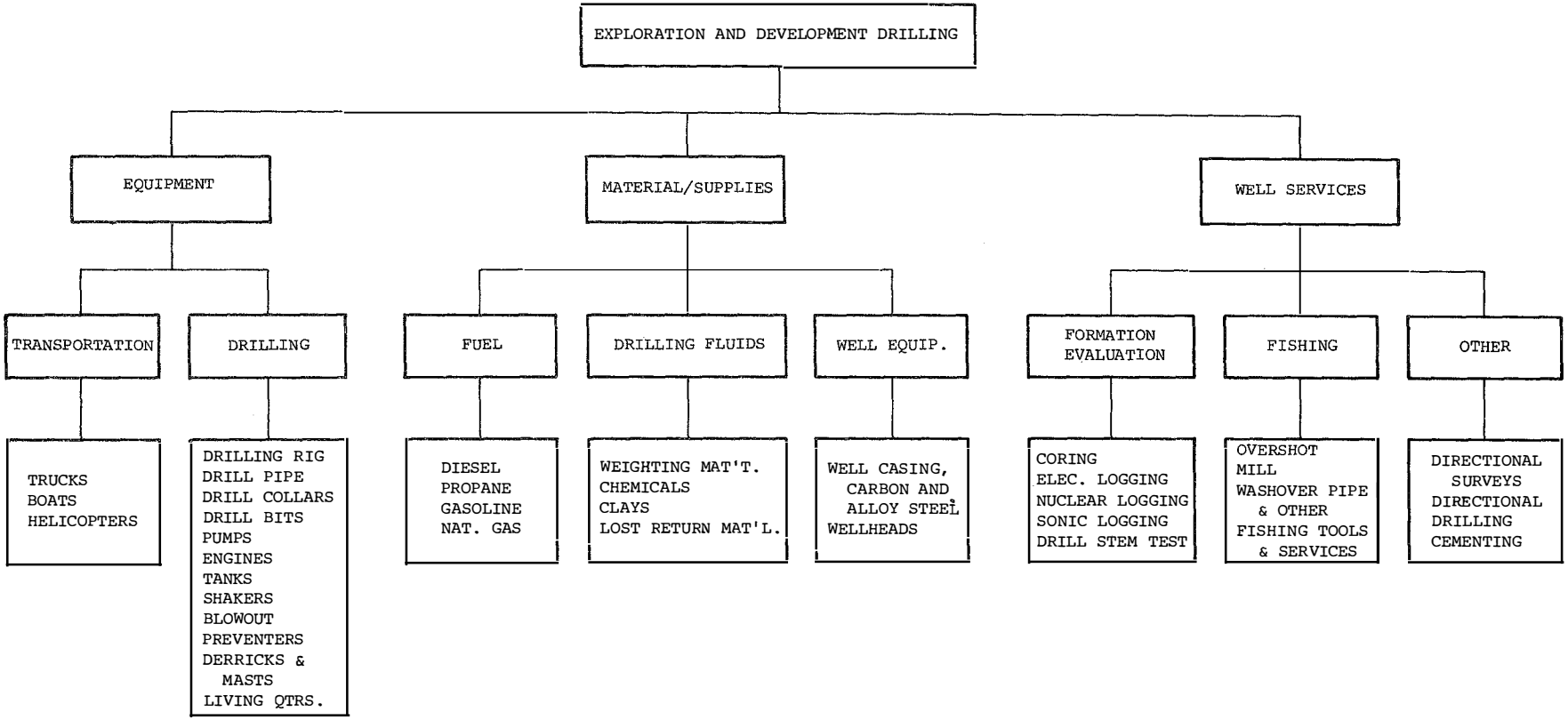


Figure 4. Chart B--Exploration and Development Drilling.

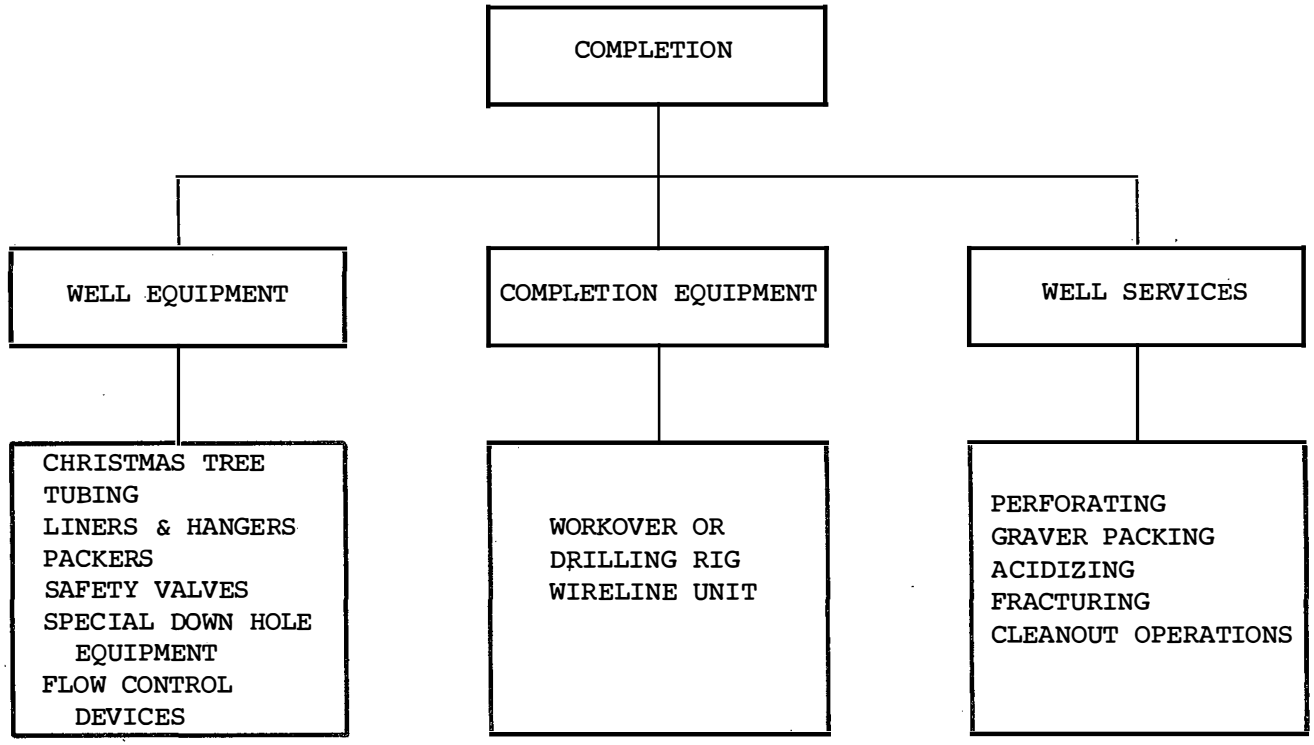


Figure 5. Chart C--Completion.

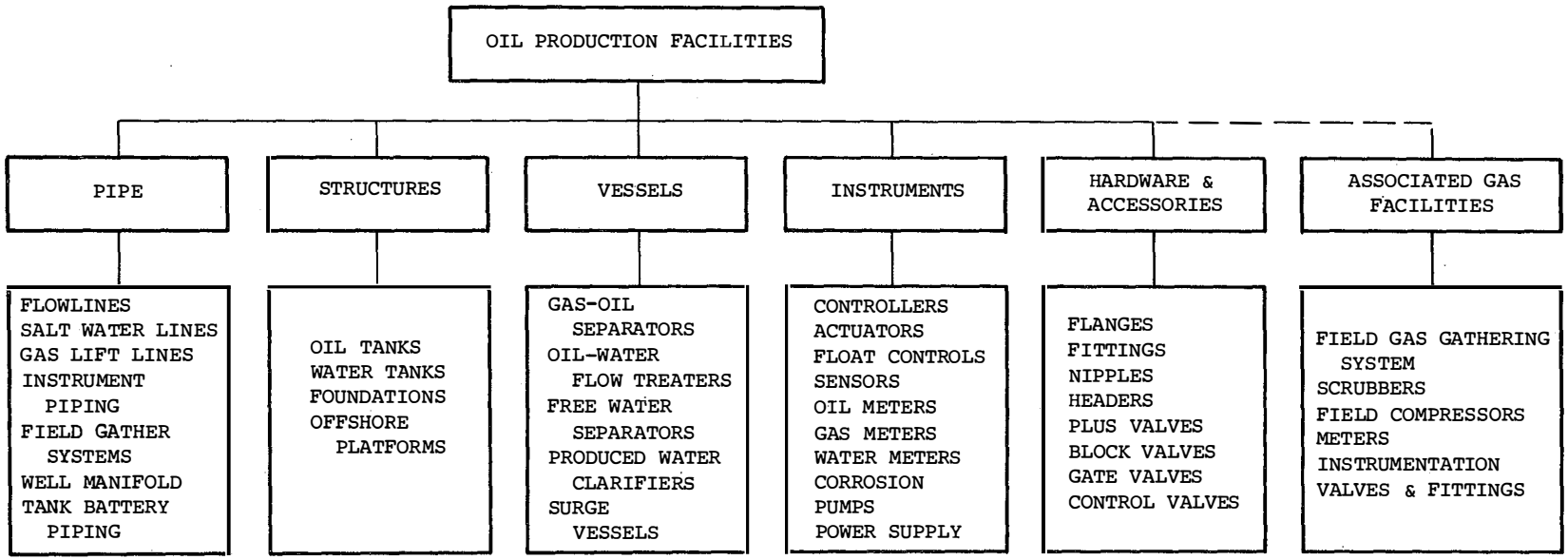


Figure 6. Chart D--Oil Production Facilities.

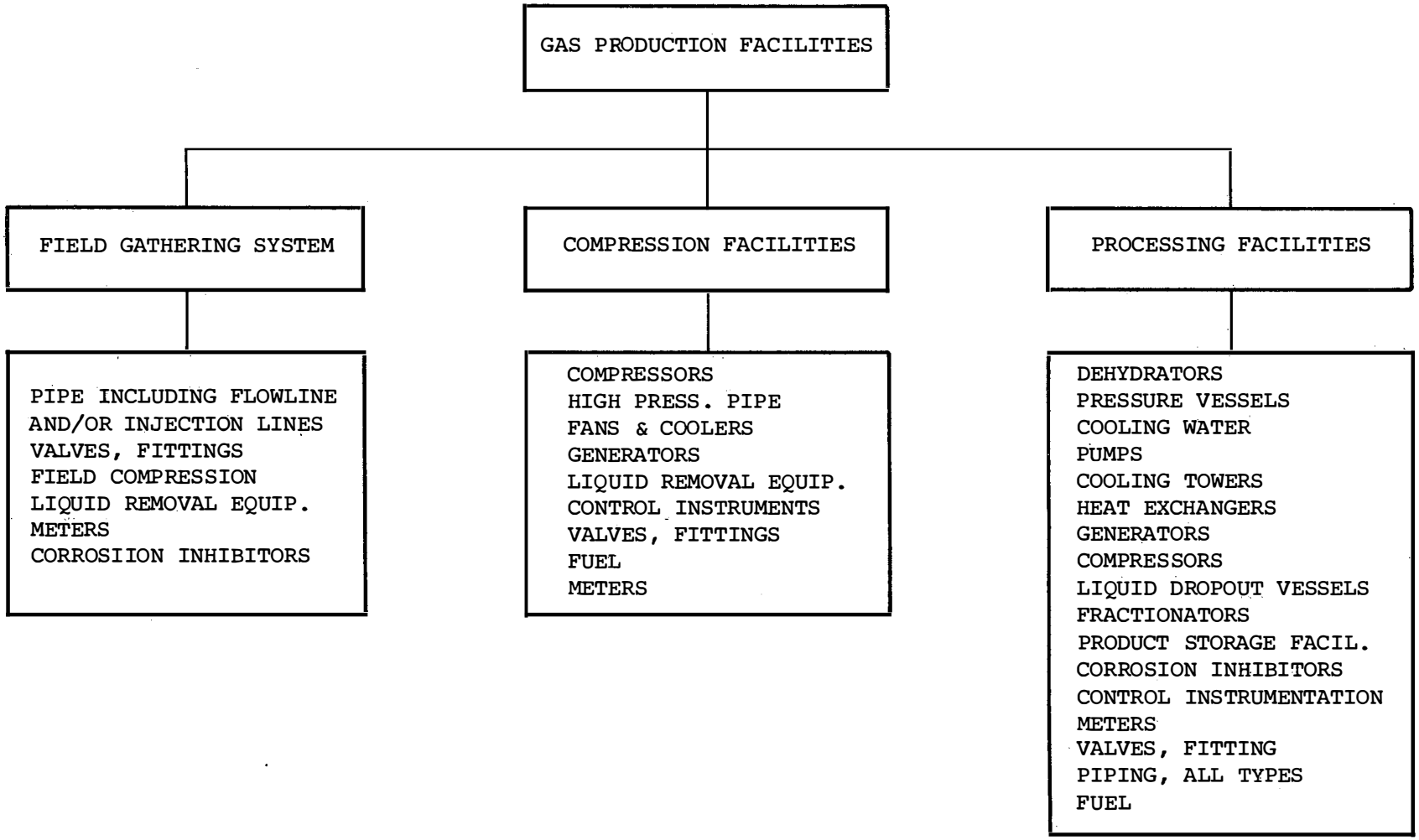


Figure 7. Chart E--Gas Production Facilities.

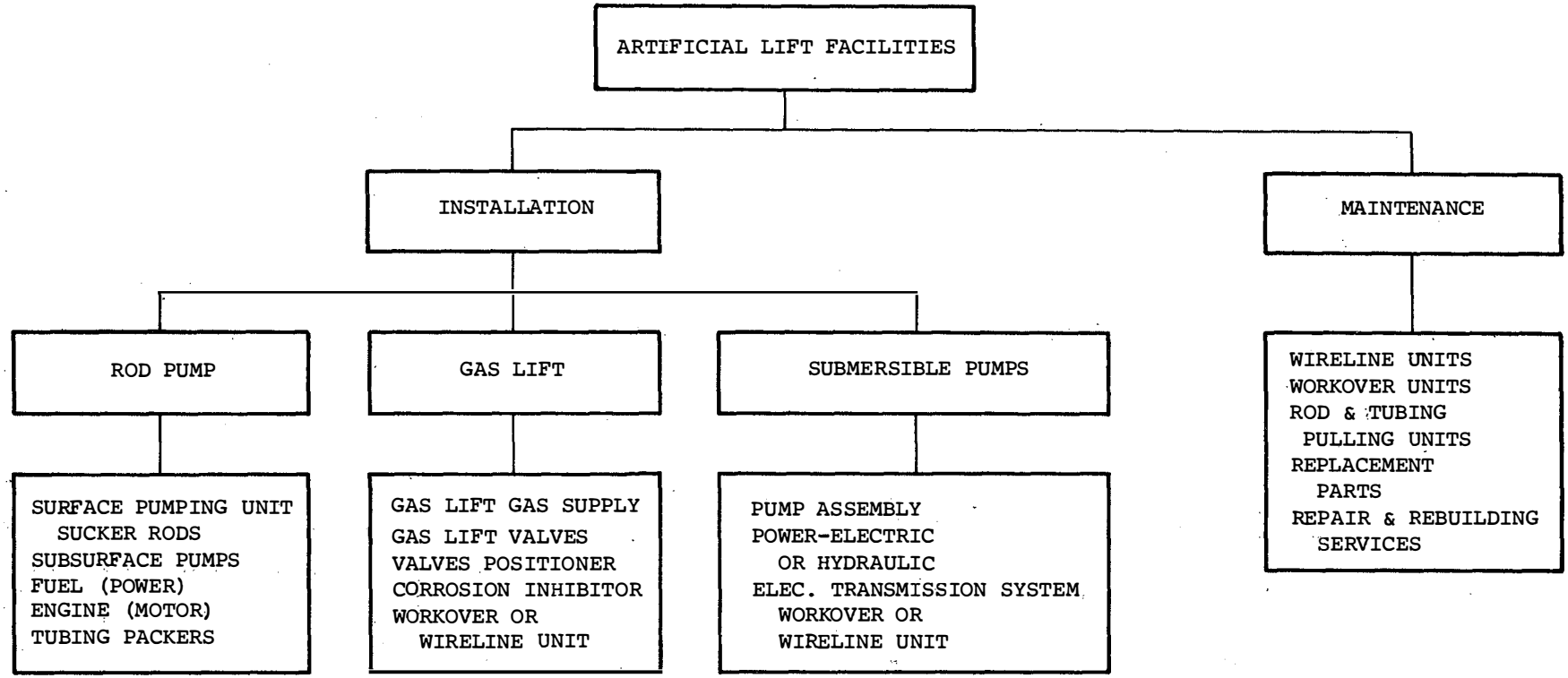


Figure 8. Chart F--Artificial Lift Facilities.

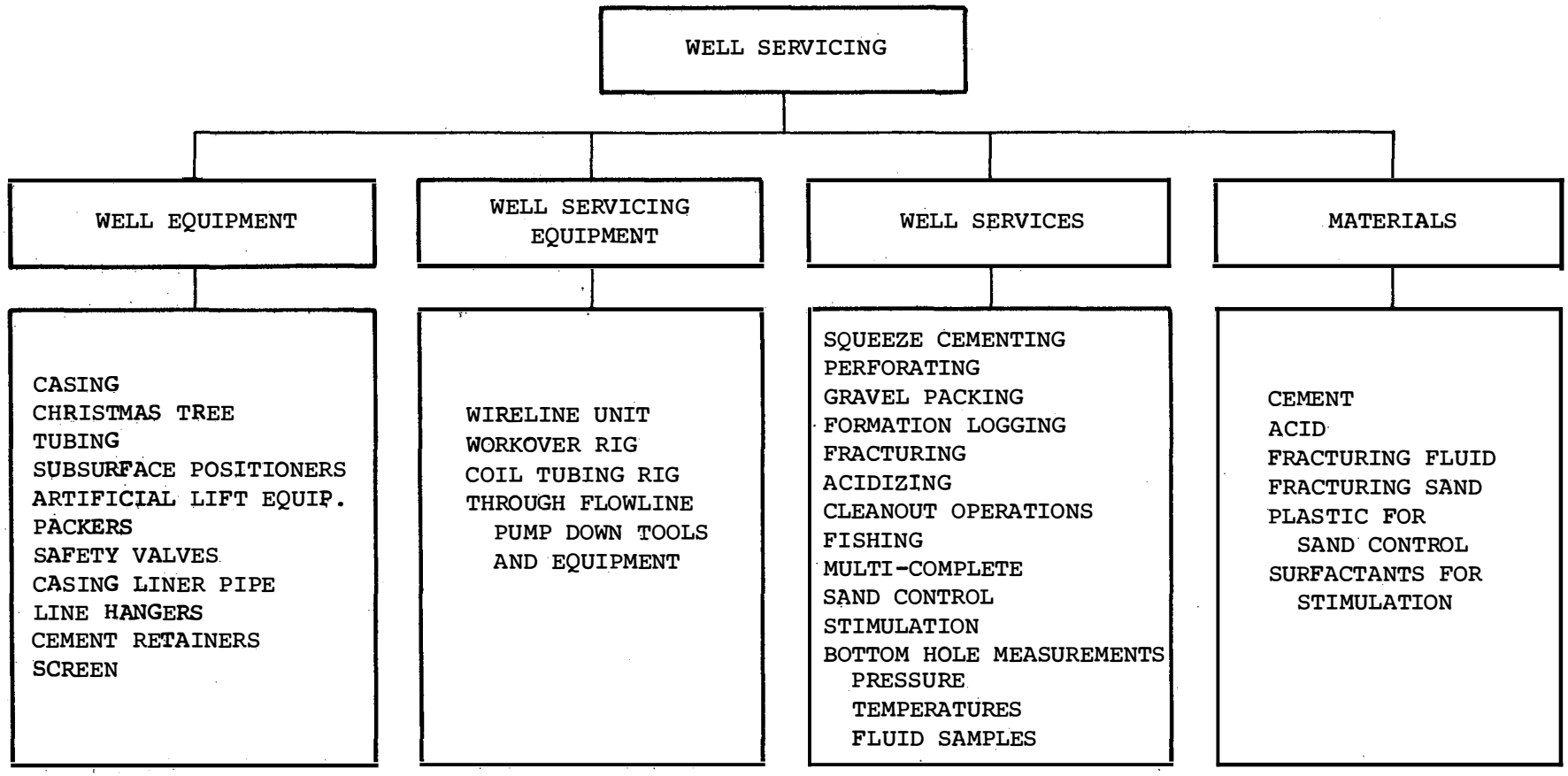


Figure 9. Chart G--Well Servicing.

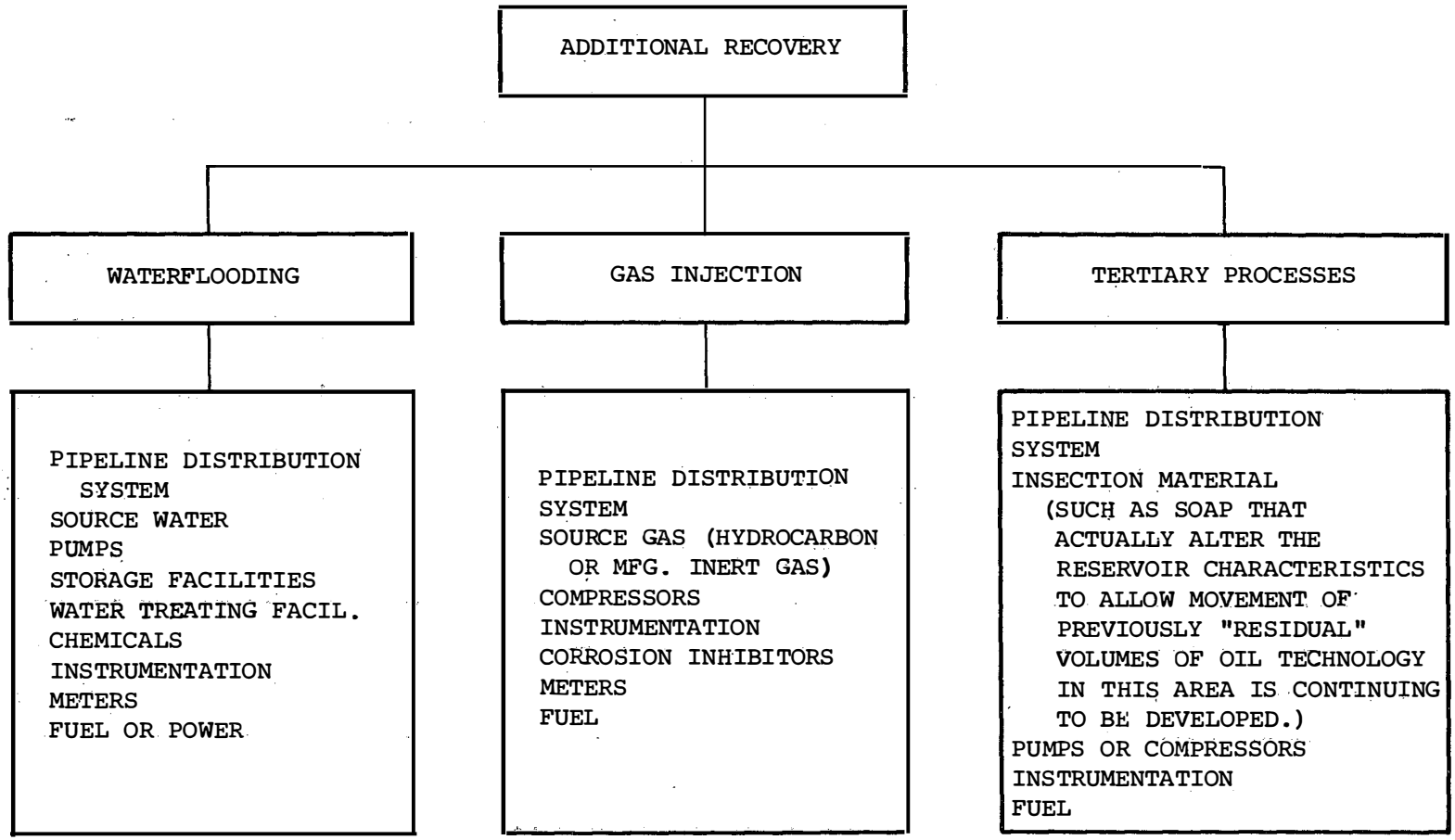


Figure 10. Chart H--Additional Recovery.