

**Skills and Occupations of
PEOPLE
in the United States Oil and
Gas industries**

A REPORT OF THE NATIONAL PETROLEUM COUNCIL

NATIONAL PETROLEUM COUNCIL
1625 K Street, N.W., Washington, D.C. 20006

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to the
DEPARTMENT OF THE INTERIOR
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and to the
OFFICE OF OIL AND GAS

Onnie P. Lattu
Director

Prepared by the
National Petroleum Council
in response to a request of the
Department of the Interior

Additional copies of this report may be obtained from the
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PEOPLE
IN THE
UNITED STATES
OIL AND GAS
INDUSTRIES

THEIR SKILLS AND
OCCUPATIONS

March 1969

Prepared by the

National Petroleum Council's Committee
on Petroleum and Gas Industries
Manpower Requirements

Stanley Learned, *Chairman*

with the assistance of the

Technical Subcommittee
Frank Piersol, *Chairman*

CONTENTS

	<u>Page</u>
Committee List	iii
Subcommittee List	iv
Letter of Request	v
 PART I	
Summary and Recommendations	3
 PART II	
Levels of Employment by Skills and Occupations	11
A. DOMESTIC OIL AND NATURAL GAS OPERATIONS	11
Section 1—Supporting Services	11
Section 2—Extraction	11
Section 3—Refining	13
Section 4—Pipelines	16
Section 5—Marketing and Product Delivery	17
Section 6—Research and Development	20
Section 7—Marine Transportation	23
B. FOREIGN OIL AND NATURAL GAS OPERATIONS (UNITED STATES CITIZENS ONLY)	26
C. GAS DISTRIBUTION OPERATIONS	26
D. CONTRACT CONSTRUCTION	30
Section 1—Refineries	30
Section 2—Natural Gas Processing Plants	33
Section 3—Pipeline Systems	33
 PART III	
Review and Outlook for Engineers, Scientists and Technicians in the Oil and Natural Gas Industries	37
A. SUMMARY AND FINDINGS	37
B. USE OF SCIENTISTS AND ENGINEERS	37
C. USE OF TECHNICIANS	42
D. CONCLUSIONS AND RECOMMENDATIONS	43
E. FACTORS CAUSING INCREASED REQUIREMENTS FOR ENGINEERS, SCIENTISTS AND TECHNICIANS	46

APPENDICES

TABLE OF CONTENTS TO APPENDICES..... 50

A Survey of United States Domestic Oil Industry Operations 51

B Survey of United States Domestic Natural Gas Pipeline Operations 65

C Survey of Foreign Oil and Natural Gas Operations (United States Citizens Only)..... 73

D Survey of United States Domestic Natural Gas Distribution Industry Operations..... 79

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UNITED STATES
DEPARTMENT OF THE INTERIOR
OFFICE OF THE SECRETARY
WASHINGTON, D.C. 20240

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January 30, 1967

Dear Mr. Donnell:

The National Petroleum Council has conducted several studies of the industry's manpower needs in the past, the most recent being the 1963 report "Petroleum and Gas Industries Manpower Requirements." We believe that the latest report should be updated and at the same time expanded to cover other phases of the manpower picture which have not been treated in previous studies.

The study should be extended to include Americans in foreign operations. Since World War II the large increase in the number of American petroleum companies engaged in foreign activities has continued to draw professional and skilled manpower from the U.S. manpower pool despite increased employment of indigenous manpower as required by local regulations. As a minimum this facet of the study should cover (1) the total number of U.S. nationals in assignments at home or abroad by broad geographical areas, and (2) a breakdown of this total by profession (such as geologists, engineers, lawyers, etc.) and by types of skilled crafts (such as drillers, refinery operators, maintenance crafts, etc.).

We also feel that the manpower balance in the petroleum industry might be reviewed with considerable benefit to all concerned. Our objective in this facet of the study is to elicit guidance for young people contemplating careers as engineers or scientists in the petroleum industry and to the educational institutions which must equip them for their chosen professions. This could be in the form of industry employment projections for these professions laid out in broad terms over several years. Inasmuch as the industry's capability to find and develop oil and gas resources in the future depends on its earth scientists and engineers, shortages in these long-lead-time skill categories have important implications for national security over the long term.

The study should also include the inventory of and future requirement for skilled personnel, including drillers, refinery operators, maintenance crafts, and other specialized skills.

The study should take into account long-term trends toward the use of automated data, the increasing efficiency of geophysical and geological methods, greater emphasis on increased recovery. The effect of long-term changes which are occurring in the industry should be related to the outlook for future needs for scientific and engineering skills.

Therefore, it is requested that the National Petroleum Council update the 1963 "Report on Petroleum and Gas Industries Manpower Requirements," and expand it to cover Americans in foreign operations here and abroad and future requirements for earth scientists and engineers.

Sincerely yours,

/s/J. CORDELL MOORE

Assistant Secretary of the Interior

Mr. J. C. Donnell II
Chairman
National Petroleum Council
1625 K Street, N.W.
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PART I

SUMMARY AND RECOMMENDATIONS

PART I

SUMMARY AND RECOMMENDATIONS

INTRODUCTION

People in the U.S. oil and gas industries make an important contribution to the economic well-being, progress and security of this Nation. Oil and gas now provide 75 percent of all the energy used in the United States—and the United States is, by far, the largest consumer of energy in the world.

Since its inception in 1859, the petroleum industry has experienced tremendous growth and has a long history of stability and opportunity. Creative, enterprising and talented people are primarily responsible for the success of the oil and gas industries over the years. These industries now employ directly over a million individuals; indirectly, many thousands of additional people.

The National Petroleum Council (NPC) has made several studies in the past of the level of employment, and composition of the industry's work force. These were made at the request of the Department of the Interior, with primary emphasis on the possibility that under national emergency conditions there might well develop a shortage of skilled manpower requiring long lead-time training. The current study, based on mid-1967 levels of employment, was also requested by the Department of the Interior, and has been expanded to cover other aspects of the manpower situation which were not treated in previous studies by the Council. These aspects include the following:

1. A review of U.S. citizens engaged in foreign oil and natural gas operations whether here or in other countries of the world. This includes an analysis of the number of professional and skilled manpower so employed.

2. A more definitive examination of the manpower balance in the oil and gas industries, providing better information on occupations that require long lead-time training or education within each function. These data are important, not only for emergency planning purposes, but as a basis for guidance for young people contemplat-

ing careers in the oil and gas industries and for the educational institutions which must train them.

3. Future requirements for the scientists, engineers and technicians who make it possible for industry to meet its responsibility to find and develop oil and gas resources.

4. Information on the level of employment and job profiles in the gas distribution industry.

This study also includes a thorough revision and updating of the lists of key occupations within the oil and gas industries, together with the addition of new job descriptions, where required, and descriptions covering the gas distribution industry. This effort represents a selected listing of occupations with Dictionary of Occupational Titles and Codes, or definitions references, representative of the skills needed for continuity of operations and the availability of essential products. This list is published as a separate brochure.

SCOPE OF THIS STUDY

This report contains detailed estimates of the number of employees as of mid-1967, where they are located and the nature of their primary duties for the following major functions of the oil and gas industries:

1. *Extraction*—Involves exploration, development, and production of crude oil, natural gas, and natural gas liquids, including natural gas processing. Also covered in this function are contract services for such activities as geological and geophysical exploration, drilling, and servicing of wells and production equipment.

2. *Petroleum Refining*—Includes contract maintenance and repair services.

3. *Oil and Gas Pipelines*—Includes employees engaged in oil and gas pipeline gathering, processing, transmission, and storage operations, as well as contract pipeline maintenance services.

4. *Marketing and Product Delivery*—Includes an estimate of oil company employees engaged only in sales activities and in the handling and delivery of the finished product to the point of consumption or resale. Specifically excluded are independent bulk station and terminal operators and wholesale jobbers/distributors and their employees. Neither oil company nor independent retail service station personnel are included in this function. With some 12,500 wholesale jobbers and over 250,000 retail service stations in the United States, no practical method of obtaining manpower information on these activities appears. However, data is included on tow-hire tank truck (over-the-road) and railroad tank car product delivery services.

5. *Marine Transportation*—Includes company employees engaged in U.S.-flag oceangoing vessel transportation and in barge and tug/towboat operations, as well as contract tanker and barge services.

6. *Research and Development*—Includes company employees engaged primarily in research and development activities.

7. *Gas Distribution*—Includes all employees engaged in the sale and distribution of natural gas within the "city gates," that is, employed by local gas utility companies. Also covered are employees engaged in contract repair and maintenance of gas utility pipeline systems.

8. *Other*—Includes, in addition to the above major functions, supporting services associated with these activities and average level of manpower engaged in the construction of major plant and pipeline facilities.

With respect to all of the above functions or activities, the following major exclusions should be mentioned:

1. With the exception of research and development activities, no employees engaged in the manufacture, transportation or sale of petrochemicals are included in this study.

2. Foreign nationals in the employ of U.S. companies are excluded.

SUMMARY OF FINDINGS

Based upon a thorough review and analysis of all the information and data available from official government sources, and based upon detailed information supplied by a large sampling of oil and gas companies, and by contractors, the

total level of employment in domestic and foreign oil and gas operations, including contract services and construction, is as follows:

		<u>Total</u>
Domestic oil and gas operations:		
Company employees	487,430	
Contractor employees	<u>204,809</u>	692,239
Foreign oil and gas operations:		15,035
Gas distribution operations:		
Company employees	177,970	
Contractor employees	<u>2,850</u>	180,820
Contract construction manpower:		<u>52,088</u>
<u>Total employment included in this study</u>		<u>940,182</u>

A condensed summary of total employment in the U.S. oil and gas industries by broad-skill categories for each major component of the industry appears in *Summary Table 1*. Detailed data for each of the major industry functions appears in Part II of this study, together with an analysis and discussion of the data. A geographical distribution of manpower by each major function, and within each of the eight Office of Civil Defense/Office of Emergency Planning (OCD/OEP) regions, is presented in *Summary Table 2*.

METHODOLOGY

Four questionnaires provided the main sources of data for this study. Sample copies of these questionnaires, their accompanying instructions, along with a summary of responses, are provided in the Appendices as follows:

NPC Questionnaire No. 1—Manpower Engaged in United States Domestic Oil Industry Operations—(Mid-1967)¹

Seventy-nine oil companies responded to this questionnaire. This included all of the so-called major companies and a large number of smaller but fully integrated companies. A substantial number of relatively small producing companies and refining companies also responded. These responses provided a sample that represents 93 percent of crude runs to refineries and 74 percent of crude oil production in 1967.

¹See Appendix A, page 55

Summary Table 1—Major Components of United States Oil and Natural Gas Industries Manpower Requirements (Mid-1967)

Manpower Components Studied	Total Manpower—By Skills		Total Manpower By Source		Grand Total
	Jobs That Require Lead-Time Training Significant ^a	Semiskilled and Unskilled Jobs	Company Payroll	Contract ^c	
Domestic operations (oil & gas)					
Extraction:					
Company-operating manpower:					
Exploration	13,372	2,878	16,250	—	—
Land	3,937	1,163	5,100	—	—
Producing	54,738	22,412	77,150	—	—
Company-supporting manpower	8,737	9,417	18,154	—	—
Contract services manpower	58,676	51,038	—	109,714	—
Total extraction manpower	139,460	86,908	116,654	109,714	226,368
Refining:					
Company-operating manpower	69,349	24,151	93,500	—	—
Company-supporting manpower	12,644	12,252	24,896	—	—
Contract services manpower	4,860	540	—	5,400	—
Total refining manpower	86,853	36,943	118,396	5,400	123,796
Pipelines: (oil & gas)					
Oil pipeline—company-operating	14,469	6,031	20,500	—	—
Oil pipeline—company-supporting	2,217	2,359	4,576	—	—
Total oil pipeline manpower	16,686	8,390	25,076	—	—
Gas transmission company manpower:					
Gathering & processing operations	3,164	2,271	5,435	—	—
Transmission operations	19,595	13,505	33,100	—	—
Supporting services	7,141	5,324	12,465	—	—
Total gas trans. company manpower	29,900	21,100	51,000	—	—
Contract maintenance services	1,250	550	—	1,800	—
Total pipelines manpower	47,836	30,040	76,076	1,800	77,876
Marketing & product delivery:					
Company-sales, plant & product delivery	66,861	44,389	111,250	—	—
Company-supporting services	12,792	14,253	27,045	—	—
For-hire truck transportation	8,496	50,504	—	59,000	—
R.R. tank car transportation	1,790	370	—	2,160	—
Total marketing & product delivery	89,939	109,516	138,295	61,160	199,455
Research & development:					
Company-R&D manpower	19,721	3,629	23,350	—	—
Company-supporting services manpower	1,684	1,888	3,572	—	—
Total R&D manpower	21,405	5,517	26,922	—	26,922
Marine transportation:					
Ocean tanker manpower	4,573	11,461	8,580	7,454	16,034
Barges & tug/towboats manpower	10,587	8,694	—	19,281 ^b	19,281
Supporting services manpower (oil cos.)	1,221	1,286	2,507	—	2,507
Total marine transportation manpower	16,381	21,441	11,087	26,735	37,822
Total manpower—domestic oil & gas operations	401,874	290,365	487,430	204,809	692,239
Foreign operations (U.S. citizens only)	11,955	3,080	15,035	—	15,035
Total manpower—domestic and foreign oil & gas operations	413,829	293,445	502,465	204,809	707,274
Gas distribution manpower (inside "city gates")					
Gas utility company manpower	101,756	76,214	177,970	—	—
Contract services manpower	1,965	885	—	2,850	—
Total gas distribution manpower	103,721	77,099	177,970	2,850	180,820
Contract construction manpower (selected major areas of activity—avg.-1967)					
Refinery construction	11,762	2,426	—	14,188	—
Oil & gas mainline pipeline construction	10,100	14,200	—	24,300	—
Oil & gas pipeline station construction	2,038	562	—	2,600	—
Natural gas processing plant construction	2,690	660	—	3,350	—
Natural gas distribution industry construction	3,150	4,500	—	7,650	—
Total contract construction manpower	29,740	22,348	—	52,088	52,088
TOTAL—ALL MANPOWER COMPONENTS STUDIED	547,290	392,892	680,435	259,747	940,182

^aIncludes all jobs that are exempt from overtime provisions of Fair Labor Standards Act plus those nonexempt jobs that would require at least two years training and/or experience.

^bBecause company operations are so small all barge manpower is reported under "Contract."

NPC Questionnaire No. 2—Manpower Engaged in United States Domestic Natural Gas Pipeline Operations—(Mid-1967)²

Thirty-six gas transmission companies responded to this questionnaire. This sample represents 95 percent of the nation's field and gathering lines and 62 percent of the natural gas transmission mains.

NPC Questionnaire No. 3—United States Citizens Assigned Abroad or Otherwise Engaged in Supporting Foreign Oil and Natural Gas Operations³

Thirty-six companies having foreign oil and gas operations responded to this questionnaire. These companies account for over 90 percent of the total free foreign crude oil produced by U.S. companies.

NPC Questionnaire on Manpower Requirements of the United States Gas Distribution Industry⁴

Seventy-five companies that distribute gas inside "city gates" responded to this questionnaire. The sample was selected to compensate for differences in company size and geographical area.

Definitions for the various job skill categories are included in the instructions that accompanied each questionnaire form. These definitions were important to assure that the responding companies reported their data in a uniform manner regardless of differences in job titles and organization structures. These definitions, therefore, are equally important to the reader in interpreting the data presented in this report.

It will be noted that the well-understood criteria established by the overtime provisions of the Fair Labor Standards Act (FLSA) were utilized to help survey participants to interpret uniformly the various skill categories. These criteria also provided a basis for identifying employees in jobs that require the longer lead-time skills, i.e., those jobs that are "exempt" from the overtime provisions of the FLSA.

CONCLUSIONS AND RECOMMENDATIONS

A special and informative review of the current status and outlook for engineering, scientific, and

technician manpower is presented in Part III. The current and anticipated critical shortage of these types of personnel will continue to be experienced and will probably become more severe unless prompt and positive steps are taken to increase the number of new graduates available for employment by the oil and gas industries. The data accumulated in this special review do not define the degree of shortage existing or point out the disciplines or degree areas where the shortage is most severe. The review does show that there is considerable difference among the industry's functional divisions as to the types and degree levels of engineers and scientists currently employed, and in the use of technicians. In order that definitive plans can be made to remedy shortages of technically trained personnel, the National Petroleum Council recommends that:

1. When more factual information becomes available about the increased requirements for engineers, scientists and technicians, a positive program should be developed to direct students into needed disciplines and assist educational institutions in their effort to train graduates with the qualifications the oil and gas industries need. Such a program would take into account the technical manpower needs generated by the prospective movement of engineers and scientists into management jobs.

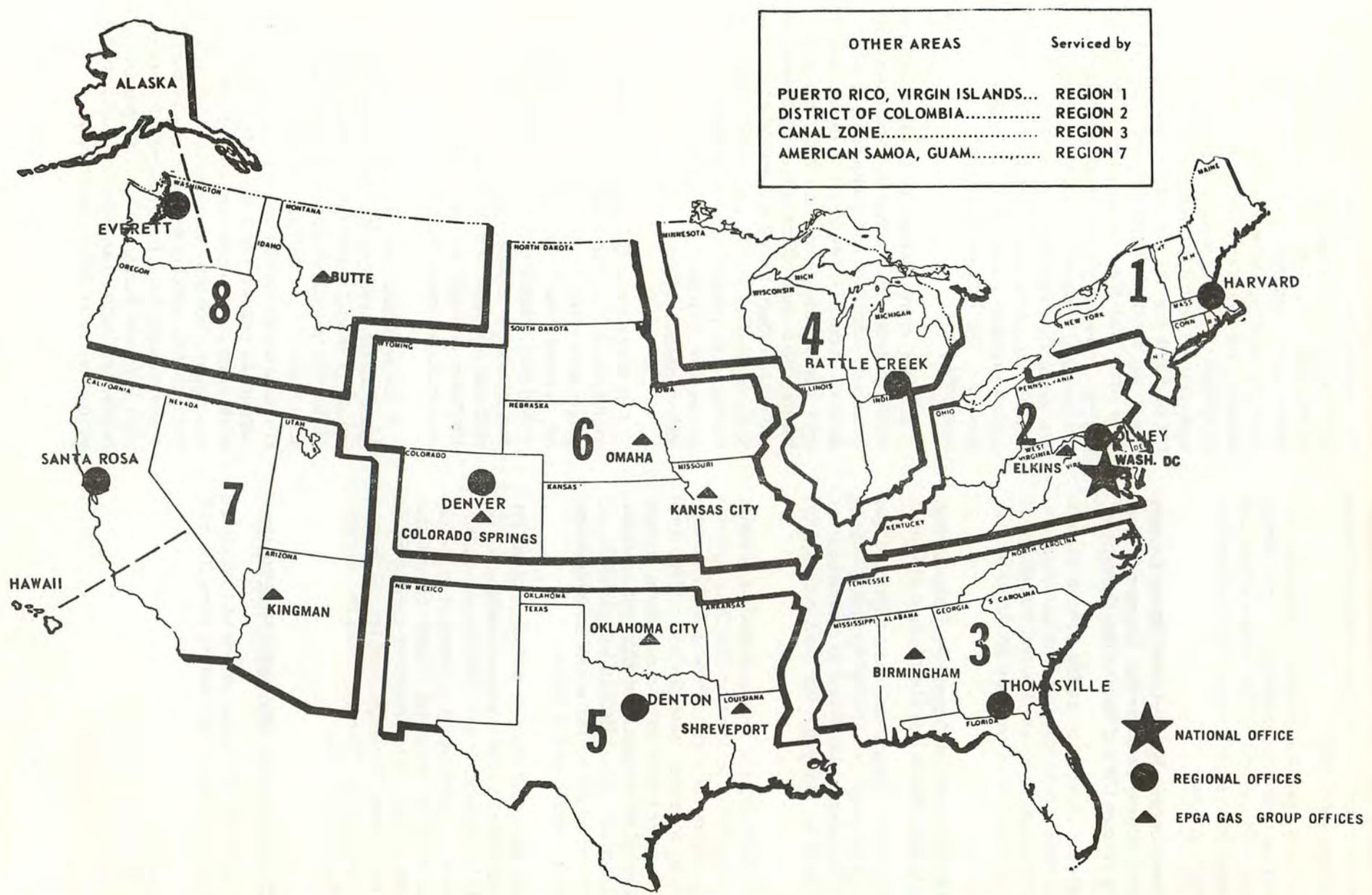
2. It is important that industry technical personnel join in local efforts aimed at guiding young people with aptitudes toward degrees in the critical demand areas. The oil and gas industries should take leadership in supporting activities of this nature by making personnel available for guidance activities and by giving the financial assistance necessary to assure that effective guidance materials are available.

3. To minimize the effects of current and future shortages of engineers and scientists, these industries should ensure that the talents of those technically trained personnel currently employed are utilized to the fullest. Increased and more effective use of technicians and other personnel supporting engineers and scientists must be one of the main steps in achieving this. These actions are required not only to alleviate the shortage at the technical working level, but also to meet the ever-increasing need for management personnel with technical backgrounds. This problem can best be dealt with on an individual company basis rather than on an industrywide basis.

² See Appendix B, page 69

³ See Appendix C, page 77

⁴ See Appendix D, page 83



Map Illustrates Boundaries for Office of Emergency Planning—Office of Civil Defense and EPGA Regions

PART II

**LEVELS OF EMPLOYMENT SKILLS
AND OCCUPATIONS**

PART II

LEVELS OF EMPLOYMENT SKILLS AND OCCUPATIONS

A. DOMESTIC OIL AND GAS OPERATIONS

Section 1—Supporting Services

For purposes of this study, all manpower that could not be directly assigned to one of the major functional divisions (extraction, refining, marketing, etc.) was reported as “supporting services” manpower. Engineers who are organized in a centralized unit serving various functional divisions were reported separately.

The “all other” supporting services manpower includes a wide variety of specialized skills that are important to the overall operations of integrated companies. This category includes chief executive officers, other high-level management, and staff personnel at corporation headquarters locations. It includes such essential functions as employee relations, industrial relations, accounting, tax, economics, organization, purchasing, computer services, medical, legal, security, and many other activities organized to provide corporate or areawide services to more than one major functional division.

The number of employees reported in central engineering activities was 2,984 (Appendix A, page 55). An additional 105 employees were later reassigned from “foreign” to “domestic” and this new total was rounded upward to 3,100 as the estimate of total U.S. manpower engaged in central engineering activities. Because only the larger, fully integrated oil companies in the sample reported engineers in a central organization, it seemed reasonable to assume that companies not included in the sample would not be organized in this manner.

The “all other” supporting services manpower reported in the sample was distributed to major functions on a pro rata basis—then expanded on the same basis used to project the individual major functions. By this method the “all other” portion of supporting services manpower in mid-1967 is estimated at 77,650.

The geographical distribution of supporting services manpower was based on known headquarter locations of a selected sample of 32 companies covering about 90 percent of these employees; the balance was distributed according to Questionnaire No. 1, page 2, item IV (Appendix A-4).

Because of the many individual departments and activities included in this total, the cumulative forecast of 1972 manpower requirements reported by respondents to the questionnaire was not considered significant.

The detail by skill categories for supporting services manpower on oil company payrolls is shown in *Table 1*.

Table 2 shows the allocation of supporting services manpower to each of the major functional divisions that are discussed in the following sections of this Part II. Central engineering manpower was allocated based on committee judgment; “all other” was prorated in accordance with manpower totals for each major function as reported by the 79 companies surveyed.

An additional 12,465 supporting services manpower reported by gas transmission companies was allocated for gas pipeline gathering and transmission operations in Section 4.

Section 2—Extraction

The manpower reported in this section is engaged in all phases relating to the following domestic oil and natural gas extraction activities:

1. Exploring for prospects.
2. Acquiring and managing land and leases.
3. Drilling of exploratory and field development wells.

Table 1—Oil Company Manpower Providing Central Engineering and All Other Services Supporting Major Functional Divisions of the Industry (Mid-1967)

Job Skill Requirements	Supporting Services Manpower					
	Central Engineering		All Other		Total	
	No.	%	No.	%	No.	%
Jobs that require significant lead-time training:						
Management	186	6.00	6,561	8.45	6,747	8.35
Scientists	15	0.47	513	0.66	528	0.65
Engineers	1,471	47.46	916	1.18	2,387	2.95
Other professionals	69	2.21	3,393	4.37	3,462	4.29
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	352	11.36	19,902	25.63	20,254	25.08
All other skilled exempt jobs (nontechnical)	86	2.78	2,112	2.72	2,198	2.72
Total exempt FLSA jobs	2,179	70.28	33,397	43.01	35,576	44.04
Technicians (nonexempt)						
Draftsmen	316	10.22	450	0.58	766	0.95
Technicians supporting scientists	13	0.40	163	0.21	176	0.22
Technicians supporting engineers	92	2.98	225	0.29	317	0.39
Total technicians	421	13.60	838	1.08	1,259	1.56
Operators (nonexempt)	—	—	932	1.20	932	1.15
Craftsmen (nonexempt)						
Electricians	4	0.13	54	0.07	58	0.07
Instrument mechanics	—	—	62	0.08	62	0.08
Boilermakers	—	—	47	0.06	47	0.06
Machinists	—	—	62	0.08	62	0.08
Pipefitters	23	0.74	62	0.08	85	0.11
Welders	7	0.24	39	0.05	46	0.06
Maintenance mechanics	9	0.30	210	0.27	219	0.27
Auto mechanics	—	—	62	0.08	62	0.08
All other skilled craftsmen	39	1.24	847	1.09	886	1.10
Total craftsmen	82	2.65	1,445	1.86	1,527	1.91
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	2,682	86.53	36,612	47.15	39,294	48.66
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	418	13.47	41,038	52.85	41,456	51.34
TOTAL COMPANY MANPOWER (MID-1967)	3,100	100.00	77,650	100.00	80,750	100.00

Table 2

Allocation of Supporting Services Manpower to Major Functional Divisions	Oil Company Manpower					
	Engineering		All Other		Total	
	No.	%	No.	%	No.	%
Extraction	450	14.50	17,704	22.80	18,154	22.50
Refining	2,300	74.20	22,596	29.10	24,896	30.80
Pipeline (oil)	150	4.90	4,426	5.70	4,576	5.70
Marketing and product delivery	100	3.20	26,945	34.70	27,045	33.50
Research and development	—	—	3,572	4.60	3,572	4.40
Marine transportation	100	3.20	2,407	3.10	2,507	3.10
TOTAL MANPOWER ALLOCATED	3,100	100.00	77,650	100.00	80,750	100.00

4. Completing and equipping wells.

5. Producing the wells and operating surface equipment and natural gas processing plants.

6. Other activities incidental to making crude oil, liquid hydrocarbons and natural gas marketable or useable up to the point of shipment from the producing properties and plants.

During 1967, the people in these activities located and drilled over 32,000 exploratory and development wells; produced over 3.6 billion barrels of liquid hydrocarbons and over 18 trillion cubic feet of natural gas.

A combination of improved technology and a long-term decline in drilling activity has resulted in substantially reduced manpower requirements

in this functional area over the past two decades. In the face of this historical trend, it is significant that nearly all respondents forecast increased manpower requirements for exploration and producing activities in 1972.

The report *United States Petroleum Through 1980*, recently released by the Department of Interior, illustrates that the long-term downward trend in exploration, drilling and additions to oil and gas reserves must be reversed if national security objectives are to be achieved. The current trend is simply not acceptable to either government or to the oil and gas industries.

The urgent need for industry to increase domestic exploration, development drilling and assisted recovery activities is evident. This need will bring about the incentives necessary for individual companies to accelerate their efforts in these fields. Accordingly, as indicated by the questionnaire responses, a significant increase is expected in industry requirements for manpower with the skills necessary to find and produce increasing quantities of domestic crude oil and natural gas over the next five years.

A detailed summary of company and contract services manpower engaged in U.S. domestic oil and gas extraction activities in mid-1967 is presented in *Table 3*.

Manpower on oil and gas company payrolls was projected from the 79 oil company responses to NPC Questionnaire No. 1. These responses covered 68,027 employees directly engaged in exploration, land and producing activities and accounted for 74 percent of total U.S. crude production and 60 percent of natural gas production in 1967. This sample was expanded to a U.S. total of 98,500 based on a selected subsample of 16 small independent producing companies that averaged 75 barrels daily of crude oil production per man. Use of the total sample factor of 96 barrels daily per employee would undoubtedly result in an understatement of total extraction manpower. United States oil and gas companies depend heavily on a large number of general and specialized service establishments for their extraction activities. Services performed by these establishments on a contract, fee or other basis, include:

1. Performing geophysical, geological and other exploration work.
2. Drilling wells.
3. Performing oil and gas field services such as:
 - a. Excavating slush pits.

- b. Grading and building foundations at well locations.
- c. Well surveying.
- d. Perforating casing.
- e. Acidizing and chemically treating wells.
- f. Fracturing, cementing, cleansing, bailing and swabbing wells.
- g. Installing well equipment.

Manpower performing such contract services has been estimated at 109,714 based on a special survey utilizing data from various associations and contacts with some establishments offering these services.

The geographical location of extraction manpower by OCD/OEP regions has been estimated based on 1967 crude oil production data by states.

Section 3—Refining

The manpower reported in this section is engaged in all phases of work required to transform crude oils into finished petroleum products in about 300 domestic refineries.

Processes involved in oil refining include crude distillation, cracking, reforming, hydrogen treating, alkylation, polymerization and others. Physical treatment may involve receiving, storing, blending and compounding, pumping, packaging, loading and shipping. Steam generation, air compression, and water pumping and cooling are also involved. Electric power may be self-supplied or purchased.

The manpower shown in *Table 4* processed over 3.5 billion barrels of crude oil in 1967.

Advancements in technology and management over the past two decades have had a dramatic effect on total levels of employment and skill requirements in oil refining. Modern refinery units are characterized by high throughputs, long run-lengths, and extensive use of automatic-control instruments. As total manpower requirements go down, average skill requirements increase significantly.

Table 5, reproduced from the recent NPC report *Impact of New Technology on the U.S. Petroleum Industry 1946-1965*, effectively summarizes the trends and relationships of refinery output, refinery investment, employment levels, output per production worker and investment per worker.

Table 3—Manpower Engaged in United States Domestic Oil and Natural Gas Extraction Activities (Mid-1967)

Job Skill Requirements	Manpower on Oil and Gas Company Payrolls												Contract Services Manpower ^a		Total Extraction Manpower		
	Extraction Operations, Maintenance and Construction								Supporting Services (Allocated)		Total Company Manpower						
	Exploration		Land		Producing		Total										
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	
Jobs that require significant lead-time training:																	
Management	1,331	8.19	604	11.84	5,671	7.35	7,606	7.70	1,523	8.39	9,129	7.83	4,258	3.88	13,387	5.91	
Scientists	6,113	37.62	18	0.36	764	0.99	6,895	7.95	120	0.66	7,015	6.01	2,596	2.37	9,611	4.25	
Engineers	449	2.76	38	0.75	8,865	11.49	9,352	9.38	423	2.33	9,775	8.38	4,532	4.13	14,307	6.32	
Other professionals	330	2.03	232	4.55	301	0.39	863	0.88	784	4.32	1,647	1.41	1,864	1.70	3,511	1.55	
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	1,475	9.08	2,383	46.73	5,709	7.40	9,567	9.35	4,588	25.27	14,155	12.13	8,408	7.66	22,563	9.97	
All other skilled exempt jobs (nontechnical)	575	3.54	238	4.66	6,133	7.95	6,946	6.97	494	2.72	7,440	6.38	9,196	8.38	16,636	7.35	
Total exempt FLSA jobs	10,273	63.22	3,513	68.89	27,443	35.57	41,229	42.23	7,932	43.69	49,161	42.14	30,854	28.12	80,015	35.35	
Technicians (nonexempt):																	
Draftsmen	1,300	8.00	418	8.21	347	0.45	2,065	2.21	149	0.82	2,214	1.90	698	0.64	2,912	1.28	
Technicians supporting scientists	949	5.84	2	0.03	154	0.20	1,105	1.27	39	0.21	1,144	0.98	301	0.27	1,445	0.64	
Technicians supporting engineers	297	1.83	4	0.07	1,674	2.17	1,975	2.02	64	0.35	2,039	1.75	1,535	1.40	3,574	1.58	
Total technicians	2,546	15.67	424	8.31	2,175	2.82	5,145	5.50	252	1.38	5,397	4.63	2,534	2.31	7,931	3.50	
Operators (nonexempt)	120	0.74	—	—	11,488	14.89	11,608	11.57	213	1.17	11,821	10.13	15,270	13.92	27,091	11.97	
Craftsmen (nonexempt):																	
Electricians	20	0.12	—	—	594	0.77	614	0.61	12	0.07	626	0.54	195	0.18	821	0.37	
Instrument mechanics	39	0.24	—	—	555	0.72	594	0.60	14	0.08	608	0.52	149	0.14	757	0.33	
Boilermakers	—	—	—	—	62	0.08	62	0.06	11	0.06	73	0.06	82	0.07	155	0.07	
Machinists	—	—	—	—	147	0.19	147	0.15	14	0.08	161	0.14	3,109	2.83	3,270	1.44	
Pipefitters	—	—	—	—	85	0.11	85	0.08	17	0.09	102	0.09	325	0.30	427	0.19	
Welders	10	0.06	—	—	409	0.53	419	0.42	10	0.06	429	0.37	762	0.69	1,191	0.53	
Maintenance mechanics	33	0.20	—	—	3,418	4.43	3,451	3.44	49	0.27	3,500	3.00	983	0.90	4,483	1.98	
Auto mechanics	331	2.04	—	—	85	0.11	416	0.08	14	0.08	430	0.37	1,971	1.80	2,401	1.06	
All other skilled craftsmen	—	—	—	—	8,277	10.73	8,277	8.63	198	1.09	8,475	7.26	2,442	2.22	10,917	4.82	
Total craftsmen	433	2.66	—	—	13,632	17.67	14,065	14.07	339	1.87	14,404	12.35	10,018	9.13	24,422	10.79	
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	13,372	82.29	3,937	77.20	54,738	70.95	72,047	73.37	8,736	48.12	80,783	69.25	58,676	53.48	139,459	61.61	
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	2,878	17.71	1,163	22.80	22,412	29.05	26,453	26.63	9,418	51.88	35,871	30.75	51,038	46.52	86,909	38.39	
TOTAL COMPANY MANPOWER (MID-1967)	16,250	100.00	5,100	100.00	77,150	100.00	98,500	100.00	18,154	100.00	116,654	100.00	109,714	100.00	226,368	100.00	

^aIncludes Drilling, Geological and Geophysical, and Well Servicing combined.

Table 4—United States Oil Industry Manpower Engaged in Domestic Oil Refining and Manufacturing Activities (Mid-1967)

Job Skill Requirements	Refinery Operations, Mtce. and Construction		Supporting Services (Allocated)		Total Manpower	
	No.	%	No.	%	No.	%
Manpower on oil company payrolls						
Jobs that require significant lead-time training:						
Management	4,217	4.51	2,047	8.22	6,264	5.30
Scientists	926	.99	160	.64	1,086	.92
Engineers	4,582	4.90	1,357	5.45	5,939	5.01
Other professionals	290	.31	1,038	4.17	1,328	1.12
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	3,273	3.50	6,054	24.32	9,327	7.88
All other skilled exempt jobs (nontechnical)	5,161	5.52	679	2.73	5,840	4.93
Total exempt FLSA jobs	18,449	19.73	11,335	45.53	29,784	25.16
Technicians (nonexempt)						
Draftsmen	440	.47	366	1.47	806	.68
Technicians supporting scientists	1,646	1.76	56	.23	1,702	1.44
Technicians supporting engineers	1,505	1.61	135	.54	1,640	1.39
Total technicians	3,591	3.84	557	2.24	4,148	3.51
Operators (nonexempt)	24,478	26.18	271	1.09	24,749	20.90
Craftsmen (nonexempt)						
Electricians	1,646	1.76	19	.08	1,665	1.41
Instrument mechanics	1,785	1.91	18	.07	1,803	1.52
Boilermakers	1,814	1.94	14	.06	1,828	1.54
Machinists	3,132	3.35	18	.07	3,150	2.66
Pipefitters	3,852	4.12	35	.14	3,887	3.28
Welders	1,767	1.89	17	.07	1,784	1.51
Maintenance mechanics	1,486	1.59	68	.27	1,554	1.31
Auto mechanics	196	.21	18	.07	214	.18
All other skilled craftsmen	7,153	7.65	275	1.11	7,428	6.27
Total craftsmen	22,831	24.42	482	1.94	23,313	19.68
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	69,349	74.17	12,645	50.80	81,994	69.25
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	24,151	25.83	12,251	49.20	36,402	30.75
TOTAL COMPANY MANPOWER (MID-1967)	93,500	100.00	24,896	100.00	118,396	100.00
CONTRACT MAINTENANCE SERVICES MANPOWER—TOTAL	—	—	—	—	5,400	—
TOTAL COMPANY AND CONTRACT MANPOWER	—	—	—	—	123,796	—

Table 5—Productivity and Investment in the United States Petroleum Industry

	Total Refinery Output (Million Barrels)	Total Refinery Investment (\$, Millions)	Investment When Adjusted to 1965 Dollars (\$, Millions)	Total Refinery Production Workers (Thousands)	Refinery Output Per Worker (BBL./Yr.)	Investment Per Production Worker (1965 \$)
1947 . . .	1,923	3,600 (pc)	6,100 (pc)	145	13,300	42,000
1950 . . .	2,190	4,600 (pc)	6,780 (pc)	140	15,600	48,000
1955 . . .	2,857	6,000	7,500	138	20,800	54,000
1960 . . .	3,119	8,400	9,350	114	27,400	83,000
1965 . . .	3,639	9,450	9,450	90	40,300	104,000

(pc) Includes some investment in petrochemicals. Separate investment data for refineries ex petrochemicals not available prior to 1955.

Sources: American Petroleum Institute, *Petroleum Facts and Figures*, (Centennial Ed., 1959), pp. 110-111. Ibid., (1965) p. 82.

Bureau of Labor Statistics, "Employment and Earnings Statistics for the U.S. 1909-1965," pp. 546, 548.

Frederick G. Coqueron, "Annual Financial Analysis of the Petroleum Industry for 1955, 1965," (Chase Manhattan Bank).

In view of the substantial declines in total refinery manpower requirements over the past two decades, it is probably significant that the 79 respondents to NPC Questionnaire No. 1 have

indicated that they expect this downward trend to continue for another five years. The small size of the expected decline, however, would indicate that the opportunities for further improvements

in productivity per worker are limited and therefore total employment may again turn upward after this leveling-off period.

The estimated 93,500 personnel directly engaged in oil refinery operations, maintenance, and construction activities is a straight-line projection of the 79-company sample that covered 93 percent of crude runs to U.S. refineries in 1967. The employment of contract maintenance manpower was reported on page 2 of the questionnaire for each individual refinery.¹ The utilization of contract maintenance manpower varies widely by refineries and geographical areas.

The geographical location of both company and contract refining manpower is based on refinery locations reported on the questionnaire.

Section 4—Pipelines

1. *Crude and Products Pipelines*—Crude oil and natural gas liquids are usually gathered by pipeline and then generally move through main trunk lines directly to refineries or to other points for transshipment by vessels, tank cars or tank trucks. As of 1967 there were about 77,000 miles of crude oil gathering lines and 72,000 miles of crude oil trunk lines in the United States. Refined petroleum products are transported from the refineries by pipeline to bulk terminals or from ship and barge terminals to distribution centers. In 1965 there were about 61,000 miles of products trunk lines.

The pipeline transportation business requires employees who are highly knowledgeable of pipeline systems and their operation and maintenance; of the characteristics of the material transported and stored, and maintenance of its "quality integrity," and of safe and proper work practices in compliance with regulations.

New technology in the past two decades has been extensively applied to all forms of petroleum transportation. The result is significant, particularly in the case of crude oil pipelines. In this area the developments include highly automated large-diameter thin-wall (high-strength steel) pipeline systems. The hardware (pipe valving, pumping equipment, etc.) is essentially the same for both crude oil and products pipelines. Crude lines are generally of larger diameter than products lines, however, this pattern is changing with the construction of multiowner large product pipelines. One other major difference between crude and products pipeline

systems is the distribution of personnel. On a crude oil system employee concentration is at originating field areas where the oil is gathered, gauged and put into the pipeline. Here, depending on the size of the producing area and the extent of the gathering system, is where more people are required and where most of the records on oil movements originate. Automation in the past ten years, particularly in lease automatic custody transfer (LACT), has greatly reduced the number of leased tanks and the number of gaugers required in most producing areas. By contrast, in the case of an automated products system, few, if any, employees are required at origin. While most pipeline operators prefer to control their systems from one end to the other, the pipeline operator may contract with the refiner to operate the origin station, "stamp out" hourly or daily readings and maintain pipeline-owned equipment. If the pipeline company performs terminaling service for its shippers (as many do), employee concentration occurs at such terminaling points, generally far downstream from origin.

Oil company manpower engaged in the operation, maintenance and construction of crude and products pipelines is estimated at 20,500 employees in mid-1967 as indicated in *Table 6*. After allocating supporting services to this activity the total level of company manpower is estimated at some 25,000. As might be expected, the largest number of jobs requiring significant lead-time training are those for operators, which represents some 18 percent of the total work force.

The estimate is based on a selected subsample of 20 companies surveyed which reported 12,411 manpower for 131,612 miles of pipeline (crude gathering, trunk and products lines combined). This sample provided a factor of 10.6 miles of pipeline per employee. This relationship appears significant since most companies were close to the average and the two extremes were 7.1 and 19.1 miles per employee.

Statistics published for 86 companies reporting to the Interstate Commerce Commission (ICC) cover 165,337 miles of pipeline and indicate an average of 10.3 miles per employee. Using this factor and the 210,000 total miles of oil pipelines in the United States, a total employment level of 20,500 was indicated.

To determine the geographical distribution of this manpower, it was necessary to treat gathering lines (37 percent of total mileage) and trunk and products lines (63 percent of total mileage) separately. The gathering lines portion was distributed among OCD/OEP regions based on 1967

¹See Appendix A-4, page 62

crude production by states. The trunk and products line portion was distributed according to state mileage statistics.

Respondents indicated that employment levels in oil pipeline operations would hold even over the next five years. This would appear to be a reasonable expectation in view of the trend toward automatic control and the rapid improvement of control hardware as discussed above.

2. *Natural Gas Transmission Pipelines*—Unlike the movement of crude oil and refined products, products, natural gas is gathered, processed, transmitted and distributed solely by pipeline. This activity, then, covers the level of employment for those companies which own, construct and operate long-distance, high-pressure pipelines for the gathering of natural gas from producing areas and transmission to consuming areas. There it is sold to local public utility companies, generally at the “city gates,” for distribution to individual customers or is sold directly to industrial customers.

Compressor stations and processing facilities are located at intervals along the pipelines in order to maintain necessary pressures and to control quality. Many natural gas transmission companies maintain underground reservoirs to help minimize seasonal variations in the demand for gas. Transmission mains in service aggregate about 220,000 miles, and field and gathering mains service total about 65,000 miles. The gas distribution (see PART II, C) and the gas pipeline industries serve an average of more than 38.5 million customers. There is an average of 35.5 million residential gas customers, 3 million commercial customers and 176 thousand industrial customers.

The natural gas industry accounted for 30.1 percent of the total energy requirements for the United States in 1966, as compared to 28.4 percent in 1960. The miles of pipelines have increased 45,690 miles since 1961 to a 1967 total of 284,430 miles.

Table 6 shows that there were 5,435 employees engaged in natural gas field and gathering operations and 33,100 in transmission operations. In addition there were 12,465 support service personnel attached to these operations, for a total mid-1967 level of employment in all natural gas pipeline activities of 51,000 people. Just as in the case of oil pipelines, the predominant number of jobs requiring significant lead-time training was for operators representing some 17 percent of the aggregate employment.

The survey sample of 36 gas transmission companies represents a coverage of 95 percent of the field and gathering lines and 62 percent of the transmission mains. The total employees related to these activities, including support services, represents 8.7 miles of gathering line per employee and 5.0 miles of transmission line per employee. This checks closely with a previous 1967 NPC transportation survey which showed 161,174 miles of transmission mains for 29,839 employees or 5.4 miles per employee. Applying the 8.7 and the 5.0 factors for gathering and transmission lines respectively to the total mileage also recorded by NPC in its transportation study gives the average level of employment of 51,000 individuals.

The companies participating in the survey indicate employment levels in gas pipeline operations would, as in the case of oil pipeline operations, hold about even over the next five years.

Section 5—Marketing and Product Delivery

1. *Oil Company Manpower*—Oil company personnel engaged in sales, plant and product delivery operations and related maintenance and construction activities is estimated at 111,250 in mid-1967 (Table 7). To arrive at this total, the rail and motor truck personnel, reported separately by a few companies, was combined with marketing personnel. It was then assumed that marketing personnel maintained on company payrolls, as covered by the sample, would represent about the same proportion of the total as refinery crude runs covered by the sample (93 percent).

It should be emphasized, however, that companies, establishments or individuals engaged solely in marketing and/or product delivery activities were not included in the 79-company sample. There are many thousands of such establishments—large and small—that sell and deliver petroleum products to consumers and service stations throughout the country. For purposes of this study, no attempt has been made to estimate the total manpower of this type that would be additive to the oil company total. Similarly, service station manpower was also excluded.

Any analysis of the job skill requirements shown in the oil company manpower data should recognize that supplying oil companies often provide engineering, maintenance, sales promotion and other services for their jobbers, distributors and dealers.

Table 6—Manpower Engaged in United States Domestic Oil and Gas Pipeline Activities (Mid-1967)

Job Skill Requirements	Crude and Product Pipelines						Natural Gas Pipelines						Total Oil and Gas Pipeline Manpower			
	Operations, Maintenance and Construction		Supporting Services (Allocated)		Total Manpower		Oper. Maint. and Constr.		Supporting Services		Total Manpower					
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%		
Company manpower																
Jobs that require significant lead-time training:																
Management	1,058	5.16	383	8.37	1,441	5.75	253	4.66	1,946	5.88	1,422	11.41	3,621	7.10	5,062	6.65
Scientists	29	0.14	30	0.66	59	0.24	37	0.68	23	0.07	60	0.48	120	0.23	179	0.24
Engineers	808	3.94	122	2.67	930	3.71	156	2.87	821	2.48	1,013	8.13	1,990	3.90	2,920	3.84
Other professionals	41	0.20	197	4.31	238	0.95	2	0.03	182	0.55	298	2.39	482	0.95	720	0.95
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	1,660	8.10	1,151	25.15	2,811	11.21	137	2.52	1,251	3.78	2,124	17.04	3,512	6.89	6,323	8.31
All other skilled exempt jobs (nontechnical)	2,615	12.76	125	2.73	2,740	10.93	291	5.35	1,976	5.97	775	6.22	3,042	5.97	5,782	7.60
Total exempt FLSA jobs	6,211	30.30	2,008	43.89	8,219	32.79	876	16.11	6,199	18.73	5,692	45.67	12,767	25.04	20,986	27.59
Technicians (nonexempt)																
Draftsmen	176	0.85	41	0.90	217	0.87	50	0.92	126	0.38	558	4.47	734	1.44	951	1.25
Technicians supporting scientists	68	0.33	10	0.22	78	0.31	8	0.16	132	0.40	8	0.06	148	0.29	226	0.30
Technicians supporting engineers	513	2.50	17	0.37	530	2.11	29	0.53	725	2.19	300	2.41	1,054	2.07	1,584	2.08
Total technicians	757	3.68	68	1.49	825	3.29	87	1.61	983	2.97	866	6.94	1,936	3.80	2,761	3.63
Operators (nonexempt)	4,428	21.60	53	1.16	4,481	17.87	1,079	19.85	7,411	22.39	43	0.35	8,533	16.73	13,014	17.11
Craftsmen (nonexempt)																
Electricians	674	3.29	4	0.09	678	2.70	46	0.85	209	0.63	27	0.21	282	0.55	960	1.26
Instrument mechanics	68	0.33	4	0.09	72	0.29	182	3.35	271	0.82	51	0.41	504	0.99	576	0.76
Boilermakers	4	0.02	2	0.04	6	0.02	—	—	3	0.01	—	—	3	0.01	9	0.01
Machinists	88	0.43	4	0.09	92	0.36	58	1.07	212	0.64	22	0.18	292	0.57	384	0.50
Pipefitters	172	0.84	5	0.10	177	0.70	10	0.18	40	0.12	—	—	50	0.10	227	0.30
Welders	349	1.70	2	0.04	351	1.40	61	1.12	738	2.23	56	0.45	855	1.67	1,206	1.58
Maintenance mechanics	531	2.59	13	0.28	544	2.17	223	4.10	1,821	5.50	26	0.21	2,070	4.06	2,614	3.44
Auto mechanics	21	0.11	4	0.09	25	0.10	50	0.92	116	0.35	59	0.47	225	0.44	250	0.33
All other skilled craftsmen	1,166	5.69	50	1.09	1,216	4.85	492	9.05	1,592	4.81	299	2.40	2,383	4.67	3,599	4.73
Total craftsmen	3,073	15.00	88	1.91	3,161	12.59	1,122	20.64	5,002	15.11	540	4.33	6,664	13.06	9,825	12.91
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	14,469	70.58	2,217	48.45	16,686	66.54	3,164	58.21	19,595	59.20	7,141	57.29	29,900	58.63	46,586	61.24
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	6,031	29.42	2,359	51.55	8,390	33.46	2,271	41.79	13,505	40.80	5,324	42.71	21,100	41.37	29,490	38.76
TOTAL COMPANY MANPOWER (MID-1967)	20,500	100.00	4,576	100.00	25,076	100.00	5,435	100.00	33,100	100.00	12,465	100.00	51,000	100.00	76,076	100.00
CONTRACT MAINTENANCE SERVICES MANPOWER—TOTAL	—	—	—	—	775	—	—	—	—	—	—	—	1,025	—	1,800	—
TOTAL—ALL OIL AND GAS PIPELINE ACTIVITIES MANPOWER	—	—	—	—	25,851	—	—	—	—	—	—	—	52,025	—	77,876	—

Table 7—United States Oil Industry Manpower Engaged in Domestic Marketing and Product Delivery Activities (Mid-1967)

Job Skill Requirements	Direct Marketing Manpower ^a		Supporting Services Manpower (Allocated)		Total Marketing Manpower	
	No.	%	No.	%	No.	%
Oil company manpower						
Jobs that require significant lead-time training:						
Management	9,156	8.23	2,283	8.44	11,439	8.27
Scientists	212	0.19	179	0.66	391	0.28
Engineers	2,603	2.34	365	1.35	2,968	2.15
Other professionals	423	0.38	1,179	4.36	1,602	1.16
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	30,627	27.53	6,918	25.58	37,545	27.15
All other skilled exempt jobs (nontechnical)	10,135	9.11	736	2.72	10,871	7.86
Total exempt FLSA jobs	53,156	47.78	11,660	43.11	64,816	46.87
Technicians (nonexempt)						
Draftsmen	479	0.43	166	0.61	645	0.47
Technicians supporting scientists	67	0.06	57	0.21	124	0.09
Technicians supporting engineers	122	0.11	81	0.30	203	0.15
Total technicians	668	0.60	304	1.12	972	0.71
Operators (nonexempt)	4,305	3.87	323	1.20	4,628	3.35
Craftsmen (nonexempt)						
Electricians	26	0.02	19	0.07	45	0.03
Instrument mechanics	7	—	22	0.08	29	0.02
Boilermakers	21	0.02	16	0.06	37	0.03
Machinists	19	0.02	22	0.08	41	0.03
Pipefitters	52	0.05	23	0.09	75	0.05
Welders	29	0.03	13	0.05	42	0.03
Maintenance mechanics	2,381	2.14	73	0.27	2,454	1.77
Auto mechanics	1,335	1.20	21	0.08	1,356	0.98
All other skilled craftsmen	4,862	4.37	295	1.09	5,157	3.73
Total craftsmen	8,732	7.85	504	1.87	9,236	6.67
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	66,861	60.10	12,791	47.30	79,652	57.60
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	44,389	39.90	14,254	52.70	58,643	42.40
TOTAL OIL COMPANY MANPOWER (MID-1967)	111,250	100.00	27,045	100.00	138,295	100.00
FOR-HIRE TANK TRUCK TRANSPORT MANPOWER—TOTAL	—	—	—	—	59,000	—
RAIL ROAD TANK CAR TRANSPORTATION MANPOWER—TOTAL	—	—	—	—	2,160	—
TOTAL MARKETING AND PRODUCT DELIVERY MANPOWER	—	—	—	—	199,455	—

^aIncludes company manpower engaged in sales, plant and product delivery operations as well as rail and motor truck transportation.

The Committee attaches no significance to the aggregate forecast of 1972 marketing manpower requirements reported by respondents to the questionnaire. In this highly competitive phase of the oil business, such forecasts by individual companies would reflect conflicting appraisals of the market.

2. *Contract Product Delivery Manpower*—In addition to the foregoing oil company manpower, establishments providing *for-hire tank truck* and *railroad tank car* product delivery services were also studied.

It is estimated that in mid-1967 manpower totaling 59,000 was engaged in operating and maintaining some 49,200 over-the-road tank truck and trailer units on a "fore-hire" basis.

Table 8 shows this manpower broken down by broad-skill categories.

Drivers account for nearly 65 percent of the manpower providing for-hire tank truck product delivery services. It may be noted that truck-drivers have been included in the "semiskilled and unskilled" category of jobs. This, in no way, is meant to diminish the responsibility or fine safety record accomplished by this important segment of the industry. For purposes of this study, however, it is believed that under emergency conditions the training of truckdrivers could be accelerated and accomplished in a relatively short period of time.

3. *Railroad Tank Car Manpower*—It is estimated that in mid-1967 a total of 2,160 people

Table 8—Manpower Engaged in United States Domestic For-Hire Tank Truck Operations (Mid-1967)

Job Skill Requirements	Jobs That Require Significant Lead-Time Skills		Semiskilled and Unskilled Jobs		Total	
	No.	%	No.	%	No.	%
Administration	852	—	2,747	—	3,599	6.1
Transportation Supervision	4,956	—	—	—	4,956	8.4
Shop Supervision	1,357	—	—	—	1,357	2.3
Mechanics	1,331	—	10,174	—	11,505	19.5
Truckdrivers	—	—	37,583	—	37,583	63.7
TOTAL MANPOWER	8,496	14.4	50,504	85.6	59,000	100.0

Table 9—Geographical Distribution of Manpower and Trucks Engaged in For-Hire Tank Truck Operations by Pad Districts (Mid-1967)

Pad District No.	No. of Units Tank Truck and Trailer	Total Manpower	
		No.	%
1	18,138	21,771	36.9
2	16,636	19,942	33.8
3	7,513	9,027	15.3
4	2,447	2,891	4.9
5	4,469	5,369	9.1
TOTAL UNITED STATES	49,203	59,000	100.0

were engaged in fleet operations (maintenance and related general overhead) of the 35,000 rail tank cars leased by oil companies from car companies.

There are some 142,000 Group I tank cars suitable for petroleum service, but only 50,600 are actually owned or leased by oil companies and regularly assigned to petroleum service. Oil companies own 15,600 and the remaining 35,000 are leased. The estimated manpower required to administer and maintain the operation of these leased units is as follows:

Administrative manpower	875
Maintenance manpower	<u>1,285</u>
Total Railroad Tank Car Company Manpower	2,160

Section 6—Research and Development

Research and development (R&D) is characterized by a much higher proportion of technically oriented employees in relation to all other personnel. As shown in *Figure 1*, engineers, scientists, and their supporting technicians, comprise the majority of the direct R&D work force.

The R&D function uses a higher proportion of skilled technicians to back up and supplement engineers and scientists than is the case in other industry functions (*Figure 2*).

Because of the growing use of instrumentation in all facets of R&D, the demand in the craft categories is shifting to men with formal instrumentation training at the expense of men having

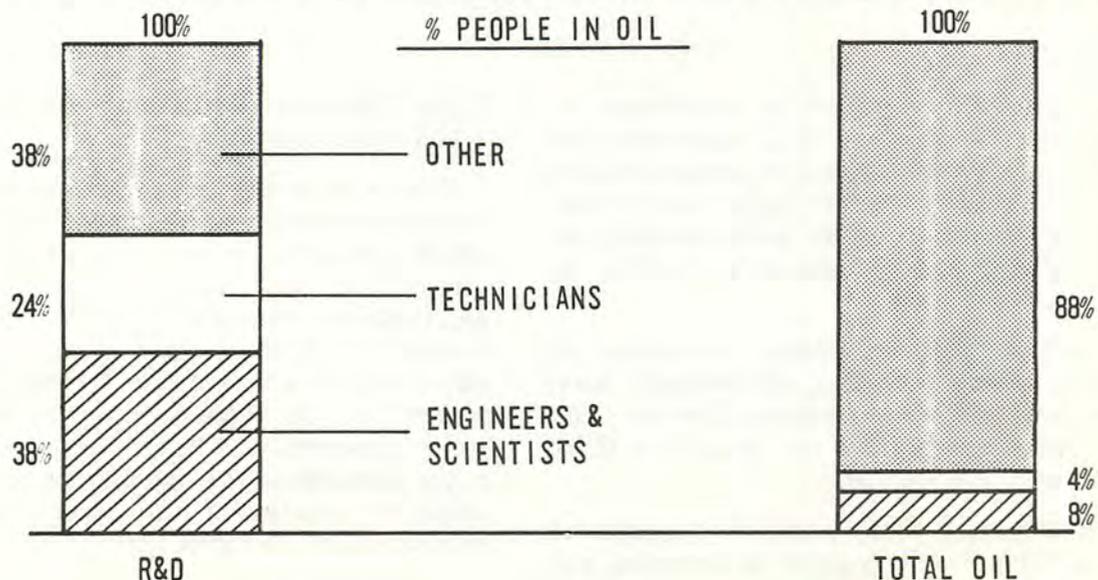


Figure 1. Mix of technical jobs is much higher in R&D.

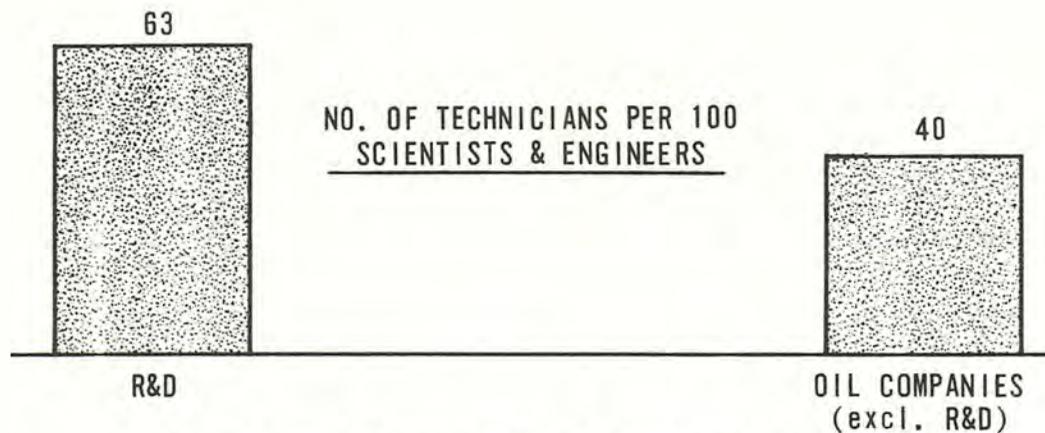


Figure 2. R&D backs up engineers and scientists with more technicians than other industry functions.

traditional craft skills such as electricians, pipefitters and mechanics.

Since R&D organizations are typically centralized, it was considered impractical to single out "oil" R&D. Therefore, this segment of manpower includes chemical and other nonoil R&D activities.

The manpower estimate of 23,350 shown in Table 10 was based on a special survey of fourteen large integrated oil companies to determine the average R&D expenditure per R&D employee. These companies reported total 1967 expenditures of \$298 million for 14,782 manpower—an average of \$20,168 per R&D employee.

Table 10—United States Petroleum Industry Manpower Engaged in Research and Development Activities (Mid-1967)^a

Job Skill Requirements	Direct Research and Development Manpower		Supporting Services Manpower (Allocated)		Total Company R&D Manpower	
	No.	%	No.	%	No.	%
Jobs that require significant lead-time training:						
Management	955	4.09	302	8.45	1,257	4.67
Scientists	5,602	23.99	24	0.66	5,626	20.90
Engineers	3,227	13.82	42	1.18	3,269	12.14
Other professionals	570	2.44	156	4.37	726	2.70
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	1,053	4.51	915	25.63	1,968	7.31
All other skilled exempt jobs (nontechnical)	451	1.93	97	2.72	548	2.03
Total exempt FLSA jobs	11,858	50.78	1,536	43.01	13,394	49.75
Technicians (nonexempt)						
Draftsmen	205	0.88	21	0.58	226	0.84
Technicians supporting scientists	3,715	15.91	7	0.21	3,722	13.83
Technicians supporting engineers	1,606	6.88	10	0.29	1,616	6.00
Total technicians	5,526	23.67	38	1.08	5,564	20.67
Operators (nonexempt)	497	2.13	43	1.20	540	2.01
Craftsmen (nonexempt)						
Electricians	107	0.46	2	0.07	109	0.40
Instrument mechanics	168	0.72	3	0.08	171	0.64
Boilermakers	—	—	2	0.06	2	0.01
Machinists	208	0.89	3	0.08	211	0.78
Pipefitters	140	0.60	3	0.08	143	0.53
Welders	49	0.21	2	0.05	51	0.19
Maintenance mechanics	159	0.68	10	0.27	169	0.63
Auto mechanics	89	0.38	3	0.08	92	0.34
All other skilled craftsmen	920	3.94	39	1.09	959	3.56
Total craftsmen	1,840	7.88	67	1.86	1,907	7.08
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	19,721	84.46	1,684	47.15	21,405	79.51
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	3,629	15.54	1,888	52.85	5,517	20.49
TOTAL COMPANY MANPOWER (MID-1967)	23,350	100.00	3,572	100.00	26,922	100.00

^aIncludes petrochemicals.

It is estimated that 1967 R&D expenditures for petroleum refining and extraction will total \$450 million based on the trend indicated by National Science Foundation (NSF) studies over the past several years. This permitted the following computation:

	<u>Manpower</u>
\$298 million @ 20,168	= 14,782
\$152 million @ 17,740 ²	= 8,568
Total \$450 million	23,350

The distribution of R&D manpower by skills was based on responses to the NPC Questionnaire No. 1 which covered 13,781 employees. The geographic distribution of manpower was based upon the reported location of the research centers.

In addition to the NPC questionnaire, a separate study was made to analyze the composition of the R&D technical force. This special study was performed on a sample basis covering about 65 percent of the engineers and scientists in R&D. The special study revealed that there are opportunities for all degree levels in R&D, as shown in *Figure 3*.

It may be noted that over 60 percent of these men were trained in chemical disciplines (37 per-

²Based on the NPC special survey adjusted to exclude two companies which reported average expenditures per employee above the other participating companies.

cent in chemistry and 24 percent in chemical engineering). These disciplines will continue to be in greatest demand for petroleum R&D work, both because of the importance of petrochemicals to petroleum economics and because of their need in doing research in petroleum processing, products, and oil recovery.

The special study included age characteristics. The median age was 1.6 years higher than that for scientists and engineers in non-R&D functions of oil companies. This reflects the weighting of upper degree levels.

Table 11—Age Analysis of Engineers and Scientists Engaged in Research and Development Activities—1967

Age	Percent of Total
30 years and less	13.4
31-35 years	17.6
36-40 years	20.0
41-45 years	16.3
46-50 years	14.9
51-55 years	10.1
56-60 years	5.2
61-65 years	1.9

NOTE: Median age is 39.9 years

Respondents to the NPC questionnaire indicate that R&D manpower will increase 12 percent during the next five years, the greatest increase of any functional division of the oil industry. This leads to the conclusion that increasing emphasis needs to be given to science and engineering degrees and strong technician-oriented non-degree backup in relation to industrywide manpower.

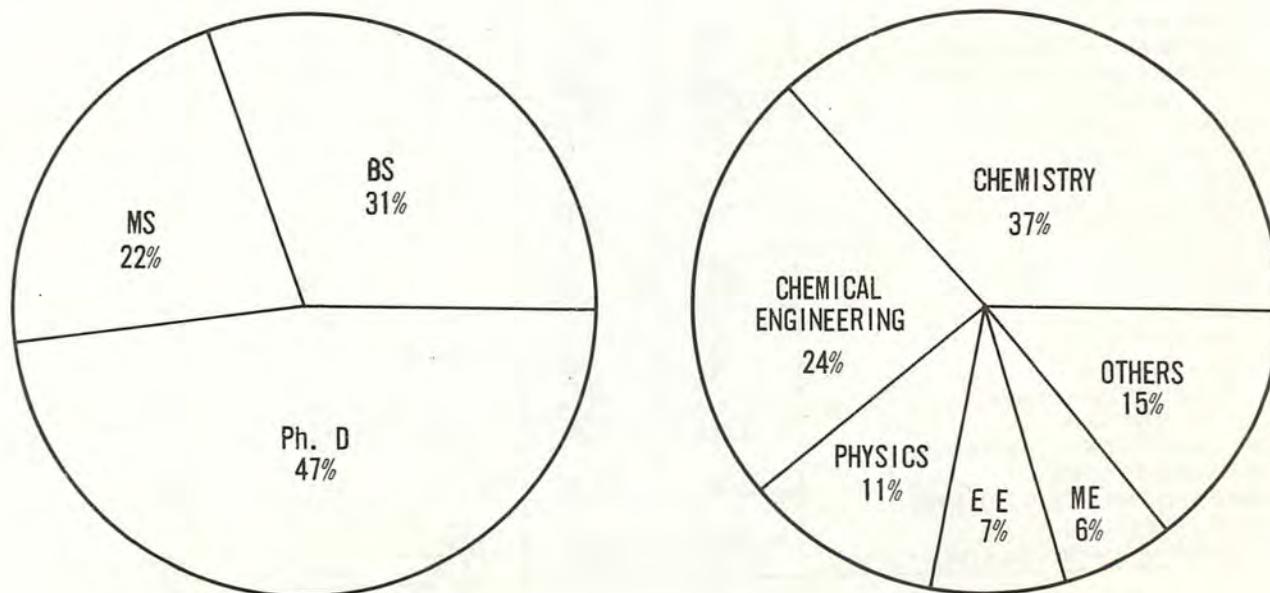


Figure 3. Degrees and disciplines in R&D.

If these growth rates are implemented, there will be about 600 new jobs per year in the R&D portion of the industry from growth alone (not turnover).

Section 7—Marine Transportation

1. *Oceangoing Tankers*—Oil company and contract manpower engaged in U.S.-flag ocean tanker transportation activities is estimated at 16,034 in mid-1967, as detailed in *Table 12*. This represents the total seagoing and relief personnel, as well as shore personnel engaged in this particular activity. Some additional U.S. personnel engaged in operation of non-U.S.-flag tankers is reported in Section B of Part II covering foreign operations.

The estimated 1967 manpower requirement for ocean tanker transportation is based on a total of 271 American-flag tankers in operation—145 owned by oil companies, and 126 under charter. A sampling of companies having 89 vessels, or 33 percent of the total American-flag tanker fleet, provided information on crewing factors. These factors when applied to the total American-flag tanker fleet provided an estimate of the number of officers and crew required to man the vessels. It was determined from another source that the ratio of relief or vacation seagoing personnel to personnel actually at sea is 1:2. Information on job skill requirements of shore personnel was obtained from the 79 oil company survey. In addition, it was estimated that an average of three people per vessel are required for onshore functions, including management, port engineers, port captains, and other staff.

Table 13 details manpower requirements by size of vessel and types of personnel. The total manpower unit requirement per vessel is 59.16 men, which compares with 63.79 reported in the NPC 1962 study. Support services are not included in the unit requirement. The unit decrease results primarily from a decrease in shore personnel.

Based on the samplings obtained, the aggregate level of employment in ocean marine transportation is anticipated to remain about constant through 1972 (*Table 14*).

During any emergency situation in which total mobilization is required, substantial departures from what are considered normal operations can be effected. This, of course, presupposes the cooperation of management, labor, and government involved in the operation of oceangoing equipment. Under such emergency operations, where

all private tonnage would be considered as one fleet, reduction in personnel would be possible principally by the implementation of the following:

- a. Fleetwide maintenance rather than maintenance carried out on an individual company or vessel basis.
- b. Full utilization of automated equipment.

Naval architects and marine engineers engaged in design, and shipyard personnel for either new construction or repairs are not included in this study. Furthermore, this study does not include manpower for the operation of 117 U.S. government-owned and operated tankers.

2. *Barges and Tug/Towboats*—The total estimated manpower requirements for operating barges, tugs and towboats in 1967, whether on the oceans or on the inland waterways, is 19,281.

Based on data in the NPC 1967 transportation study, and on additional information supplied by barge operators, the numbers of vessels operated by these people are as follows:

Self-propelled barges	149
Nonpropelled barges	2,731
LPG/LIG barges	45
Tug/Towboats	<u>896</u>
Total Units	3,821

The majority of this equipment is operated on the Mississippi River and Gulf of Mexico waterways systems. *Table 15* provides detail on the manning requirements for these vessels, by area.

The manning requirement on self-propelled vessels varies with the size and type of service, and the figures in *Table 15* reflect an average.

The ratio of barges to tugboats in each of the areas was estimated to be as follows:

East Coast	1.61
West Coast	1.61
Great Lakes	1.58
Alaska	1.67
Hawaii	1.00
Mississippi River	4.00

There are presently in operation nine unmanned barges in excess of 50,000-barrel capacity operating in coastwide service on the East, West and Gulf Coasts. As the trend to larger barges continues, less manning of barges will be required in those areas where manning has been necessary.

The substantial decrease in the 1967 manpower requirements from the 1962 level essentially results from the reduction in the number of towboats utilized on the Mississippi River system.

Table 12—Manpower Engaged in Marine Transportation Activities (Mid-1967)
(Oil Company and Non-Oil Company Combined)

Job Skill Requirements	Ocean Tanker Manpower						Barges and Tug/Towboats Manpower						Supporting Services Manpower (Oil Companies)		Total Marine Manpower	
	Shore Personnel		Vessel Personnel		Total		Shore Personnel		Vessel Personnel		Total		No.	%	No.	%
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%				
Jobs that require significant lead-time training:																
Management	115	14.15	—	—	115	0.72	351	14.15	—	—	351	1.82	210	8.38	676	1.79
Scientists	—	—	—	—	—	—	—	—	—	—	—	—	17	0.68	17	0.04
Engineers	98	12.06	—	—	98	0.61	299	12.06	—	—	299	1.55	75	2.99	472	1.25
Other professionals	42	5.21	—	—	42	0.26	129	5.21	—	—	129	0.67	107	4.27	278	0.74
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	150	18.47	—	—	150	0.94	458	18.47	—	—	458	2.37	628	25.05	1,236	3.27
All other skilled exempt jobs	41	4.99	—	—	41	0.26	124	4.99	—	—	124	0.64	69	2.75	234	0.62
Deck officers	—	—	1,794	11.80	1,794	11.19	—	—	5,196	30.92	5,196	26.95	—	—	6,990	18.48
Engine officers	—	—	1,782	11.70	1,782	11.11	—	—	3,588	21.35	3,588	18.61	—	—	5,370	14.20
Radio officers	—	—	406	2.70	406	2.53	—	—	—	—	—	—	—	—	406	1.07
Total exempt FLSA jobs	446	54.88	3,982	26.20	4,428	27.62	1,361	54.88	8,784	52.27	10,145	52.61	1,106	44.12	15,679	41.46
Technicians (nonexempt)																
Draftsmen	2	0.22	—	—	2	0.01	5	0.22	—	—	5	0.03	24	0.96	31	0.08
Technicians supporting scientists	—	—	—	—	—	—	—	—	—	—	—	—	6	0.24	6	0.01
Technicians supporting engineers	—	—	—	—	—	—	—	—	—	—	—	—	10	0.40	10	0.03
Total technicians	2	0.22	—	—	2	0.01	5	0.22	—	—	5	0.03	40	1.60	47	0.12
Operators (nonexempt)	46	5.66	—	—	46	0.29	140	5.66	—	—	140	0.73	29	1.16	215	0.57
Craftsmen (nonexempt)																
Electricians	7	0.89	—	—	7	0.04	22	0.89	—	—	22	0.11	2	0.08	31	0.08
Instrument mechanics	2	0.22	—	—	2	0.01	5	0.22	—	—	5	0.03	2	0.08	9	0.02
Boilermakers	—	—	—	—	—	—	—	—	—	—	—	—	1	0.04	1	0.01
Machinists	16	1.94	—	—	16	0.10	48	1.94	—	—	48	0.25	2	0.08	66	0.17
Pipefitters	1	0.15	—	—	1	—	4	0.15	—	—	4	0.02	3	0.12	8	0.02
Welders	5	0.67	—	—	5	0.03	17	0.67	—	—	17	0.09	1	0.04	23	0.06
Maintenance mechanics	38	4.69	—	—	38	0.24	116	4.69	—	—	116	0.60	6	0.24	160	0.42
Auto mechanics	—	—	—	—	—	—	—	—	—	—	—	—	2	0.08	2	0.01
All other skilled craftsmen	28	3.43	—	—	28	0.17	85	3.43	—	—	85	0.44	27	1.08	140	0.37
Total craftsmen	97	11.99	—	—	97	0.59	297	11.99	—	—	297	1.54	46	1.84	440	1.16
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	591	72.75	3,982	26.20	4,573	28.51	1,803	72.75	8,784	52.27	10,587	54.91	1,221	48.72	16,381	43.31
Semiskilled and unskilled jobs																
Marine crew—unlicensed	—	—	11,239	73.80	11,239	70.10	—	—	8,019	47.73	8,019	41.59	—	—	19,258	50.92
All other	222	27.25	—	—	222	1.39	675	27.25	—	—	675	3.50	1,286	51.28	2,183	5.77
SEMISKILLED AND UNSKILLED—TOTAL	222	27.25	11,239	73.80	11,461	71.49	675	27.25	8,019	47.73	8,694	45.09	1,286	51.28	21,441	56.69
TOTAL MARINE TRANSPORTATION MANPOWER	813	100.00	15,221	100.00	16,034	100.00	2,478	100.00	16,803	100.00	19,281	100.00	2,507	100.00	37,822	100.00

Table 13—Estimated Manpower Requirements for Ocean Tankers (1967)

Size of Vessel (Deadweight Tons)	Number of Vessels		Vessel Officers			Crew	Relief Total	Shore Personnel	Total
	Oil Company	Non-Oil Company	Deck	Engine	Radio	Unlicensed			
Under 25,000 . . .	70	76	614	614	146	4,205	2,789	438	8,806
25,000 to 40,000 .	65	38	474	464	103	2,761	1,906	309	6,017
41,000 to 55,000 .	8	9	87	85	17	403	296	51	939
56,000 to 70,000 .	0	2	8	8	2	38	28	6	90
70,000 to 100,000	2	0	8	8	2	38	28	6	90
Over 100,000 . . .	0	1	5	9	1	44	30	3	92
TOTAL	145	126	1,196	1,188	271	7,489	5,077	813	16,034
Percent	—	—	7.46	7.41	1.69	46.71	31.66	5.07	100.00

Table 14—Estimated Manpower Requirements for Ocean Tankers (1972)

Size of Vessel (Deadweight Tons)	Number of Vessels		Vessel Officers			Crew	Relief Total	Shore Personnel	Total
	Oil Company	Non-Oil Company	Deck	Engine	Radio	Unlicensed			
Under 25,000 . . .	61	70	538	538	131	3,826	2,516	393	7,942
25,000 to 40,000 .	63	49	504	504	112	2,912	2,016	336	6,384
41,000 to 55,000 .	10	9	97	95	19	449	331	57	1,048
56,000 to 70,000 .	2	2	18	18	4	114	78	12	244
71,000 to 100,000	7	0	31	24	7	66	64	21	213
Over 100,000	0	1	5	9	1	44	30	3	92
TOTAL	143	131	1,193	1,188	274	7,411	5,035	822	15,923
Percent	—	—	7.49	7.46	1.72	46.55	31.62	5.16	100.00

Table 15—Estimated Manpower Requirements for Barges and Tug/Towboats (1967)

Waterways System	Vessels		Officers		Crew	Relief Total	Shore Personnel	Total
	Type	Number	Deck	Engine				
East Coast (Baltimore and North)	Self-Propelled	81	162	162	365	624	106	1,419
	Nonpropelled	270	540	0	0	540	702	1,782
	Tugboats	168	336	336	504	1,680	219	3,075
(South of Baltimore)	Self-Propelled	27	54	54	108	108	38	372
	Nonpropelled	90	90	0	0	0	126	216
	Tugboats	56	112	112	224	336	79	863
West Coast	Self-Propelled	11	22	22	66	55	165	330
	Nonpropelled	121	182	0	0	91	121	384
	Tugboats	75	75	75	225	375	75	825
Great Lakes	Self-Propelled	24	96	96	448	328	31	999
	Nonpropelled	19	38	0	0	19	25	82
	Tugboats	12	24	24	60	54	16	178
Alaska	Self-Propelled	2	4	4	10	9	2	29
	Nonpropelled	40	60	0	0	30	40	130
	Tugboats	24	24	24	72	120	24	264
Hawaii	Self-Propelled	1	2	2	5	5	1	15
	Nonpropelled	2	3	0	0	2	2	7
	Tugboats	2	2	2	6	10	2	22
Mississippi River and Gulf of Mexico	Self-Propelled	3	6	6	15	11	4	42
	Nonpropelled	2,189	0	0	0	0	548	548
	LPG/LIG	45	0	0	0	0	12	12
	Tug/Towboats	559	1,118	1,118	2,795	2,516	140	7,687
TOTAL		3,821	2,950	2,037	4,903	6,913	2,478	19,281
Percent		—	15.30	10.57	25.43	35.85	12.85	100.00

Only those employees concerned with the direct operation of barges, tugs and towboats have been included herein. Manpower concerned

with the design, shore operations, and shipyard repair of these vessels is excluded.

B. FOREIGN OIL AND NATURAL GAS OPERATIONS (UNITED STATES CITIZENS ONLY)

Assistant Secretary J. Cordell Moore's letter dated January 30, 1967, specifically requested that this study be extended to include Americans in foreign operations. It is believed that this is the first attempt ever made to determine the numbers, skills and geographical locations of all U.S. citizens engaged in foreign oil and natural gas operations.

At the outset, it was obvious that there would be no reliable basis for projecting a sample to the whole. Accordingly, it was determined that a fairly complete census would be required covering all U.S. companies having significant interests in foreign oil and gas operations.

It is estimated that responses to the NPC Questionnaire No. 3³ account for upwards of 90 percent of all U.S. citizens on oil company payrolls who are engaged in foreign oil and gas operations. (No attempt has been made to determine the number of U.S. citizens on contractors' payrolls who are so engaged.)

By subtracting the crude oil produced by three major foreign companies and various foreign governments, it was determined that U.S. companies account for approximately 60 percent of free foreign crude oil production. An analysis of data accumulated by The Chase Manhattan Bank shows that 25 U.S. companies account for over 90 percent of the total free foreign crude oil produced by U.S. companies.

All 25 of these companies responded to the NPC questionnaire. An additional 11 companies responded including the largest jointly owned companies and several independent companies with substantial foreign operations.

Table 16 shows the skill requirements by geographic location of the 15,035 U.S. citizens engaged in foreign oil and gas operations. About one-half (6,929) of these employees are based in foreign countries. As might be anticipated, 95 percent of these foreign-based employees are in skilled jobs of the type that would be exempt from the overtime provisions of the FLSA if based in the United States. About one-half of the foreign-based employees are in positions that require technical degrees. Further analysis shows that the majority of these technically trained employees are earth scientists and engineers engaged in exploration and producing activities.

³See Appendix C, page 77

Table 17 shows the functional activities in which the employees are engaged. The preponderance of highly skilled people among the foreign-based employees is not surprising. As a basic policy, U.S. oil companies consider it good business practice to hire and train nationals wherever possible. Beyond the goodwill features of such policy, it is estimated that payroll and related costs to maintain a U.S. citizen abroad are seldom less than 50 percent greater than for a comparable U.S.-based employee. These costs are seldom less than two or three times greater than for a national employee. Relative costs, of course, vary widely by area.

The requirement for exporting skills also varies widely. Skill requirements are greatest at startup of a foreign development or project and tend to decline thereafter. The overall requirement is greater in an underdeveloped country than in an industrialized country.

Because of the variables cited above, plus the uncertainties of balance-of-payment programs and attitudes and actions of governments, etc., it was impractical to make a meaningful estimate of future foreign manpower requirements.

It can be stated, however, that investments in new foreign developments or projects—particularly in underdeveloped countries—will cause the demand for U.S. citizens abroad to increase. Conversely, as established foreign operations move toward maturity, the requirement for maintaining U.S. citizens aboard will diminish. The foreign-based manpower requirements at any point in the future will be a composite reflecting the number; size, location and age of all the industry's foreign operations, projects and developments existing at that time.

C. GAS DISTRIBUTION OPERATIONS

The Gas Distribution Industry—Gas distribution companies operating within "city gates" are generally intermediaries between wholesale gas suppliers and the ultimate customer. Their principal functions include: (a) receipt and temporary storage of large volume gas supplies, (b) delivery of gas to residential, commercial, and industrial consumers through distribution lines (main and service), (c) control and measurement of gas flow, (d) maintenance of proper pressures and other conditions within the distribution network, (e) installation, hookup, maintenance and servicing of customer appliances and equipment, (f) construction, maintenance, and repair of capital facilities, principal storage facilities, gas lines, pressure stations, regulator and measurement stations, (g) maintenance and repair of metering and regulator equipment, (h)

Table 16—United States Citizens Assigned Abroad or Otherwise Engaged in Supporting Foreign Oil and Natural Gas Operations
Summary by Job Skills and Geographical Location (Mid-1967)

	U.S. Citizens Assigned Abroad									U.S. Based Manpower	Others Not Identified	Total Foreign and U.S. Based	
	Canada	Venezuela	Other Western Hemisphere	Western Europe	Africa	Middle East	Far East	Unallocated	Total Foreign Based			No.	%
Skilled jobs—exempt FLSA^a													
Executive and General Management	53	20	106	80	47	28	50	5	389	139	—	528	3.5
Earth Scientists	98	53	53	156	237	54	107	18	776	184	66	1,026	6.8
Engineers													
Exploration, land and producing	43	192	50	71	220	114	96	6	792	122	56	970	—
Transportation and traffic	—	9	5	49	3	10	19	—	95	235	—	330	—
Refining	3	71	81	77	21	48	89	—	390	92	—	482	—
Marketing	—	7	29	9	2	—	39	—	86	115	24	225	—
Research and development	—	2	—	7	4	14	—	—	27	—	4	31	—
Central engineering	—	23	5	113	62	128	20	—	351	293	—	644	—
Other supporting services	3	8	6	31	7	27	5	1	88	184	—	272	—
Total Engineers	49	312	176	357	319	341	268	7	1,829	1,041	84	2,954	19.7
Technical degrees other than earth sciences and engineering													
Exploration, land and producing	15	—	11	3	22	1	1	2	55	28	2	85	—
Transportation and traffic	—	—	—	4	—	1	—	—	5	8	—	13	—
Refining	—	5	10	5	4	2	2	—	28	—	—	28	—
Marketing	—	—	4	4	—	—	—	—	8	1	7	16	—
Research and development	—	—	—	8	3	—	—	—	11	—	5	16	—
Central engineering	—	—	—	—	—	—	—	—	—	7	—	7	—
Other supporting services	—	1	2	26	16	57	—	—	102	144	—	246	—
Total other technical	15	6	27	50	45	61	3	2	209	188	14	411	2.7
Other skilled jobs—exempt FLSA													
Nontechnical degree or no degree													
Exploration, land and producing	192	63	44	34	177	107	23	1	641	96	49	786	—
Transportation and traffic	—	16	19	17	36	23	9	—	120	227	—	347	—
Refining	—	17	45	34	26	21	16	—	159	19	—	178	—
Marketing	1	9	82	89	30	9	50	1	271	298	137	706	—
Research and development	—	—	—	4	—	—	—	—	4	—	1	5	—
Central engineering	—	—	1	16	5	18	9	—	49	9	—	58	—
Other supporting services	7	271	138	369	391	605	131	11	1,923	2,450	—	4,373	—
Total other skilled	200	376	329	563	665	783	238	13	3,167	3,099	187	6,453	42.9
Subtotal—exempt jobs identified above	415	767	691	1,206	1,313	1,267	666	45	6,370	4,651	—	—	—
Other exempt jobs—not identified	5	54	92	24	8	4	1	2	190	161	—	—	—
Total exempt FLSA jobs	420	821	783	1,230	1,321	1,271	667	47	6,560	4,812	—	11,372	75.6
OTHER JOBS (NONEXEMPT FLSA)—TOTAL	41	—	—	1	7	319	—	1	369	3,294	—	3,663	24.4
TOTAL U.S. MANPOWER ENGAGED IN FOREIGN OIL AND NATURAL GAS OPERATIONS	461	821	783	1,231	1,328	1,590	667	48	6,929	8,106	—	15,035	100.0
Percent	3.1	5.5	5.2	8.2	8.8	10.6	4.4	0.3	46.1	53.9	—	100.0	—

^aSkilled jobs of the type that would be exempt from the overtime provisions of the Fair Labor Standards Act if based in the United States.

Table 17—Summary By Job Skills and Industry Functions (Mid-1967)

	Industry Functions							Total	
	Oil and Gas Extraction	Trans. and Traffic	Oil Refining	Marketing	R&D	Central Engr.	Supporting Services	No.	%
Skilled jobs—exempt FLSA									
Executive and General management	—	—	—	—	—	—	528	528	3.5
Earth scientists	1,026	—	—	—	—	—	—	1,026	6.8
Engineers	970	330	482	225	31	644	272	2,954	19.7
Jobs that require other technical degrees	85	13	28	16	16	7	246	411	2.7
Jobs that require nontechnical degrees/no degrees	786	347	178	706	5	58	4,373	6,453	42.9
Total skilled jobs— exempt FLSA	2,867	690	688	947	52	709	5,419	11,372	75.6
OTHER JOBS (NONEXEMPT FLSA)—TOTAL								3,663	24.4
TOTAL U.S. MANPOWER ENGAGED IN FOREIGN OIL AND NATURAL GAS OPERATIONS								15,035	100.0

Table 18—Manpower Engaged in United States Domestic Gas Distribution Activities (Mid-1967)

Job Skill Requirements	Number Employees	Percent of Total Manpower
Company Manpower		
Jobs that require significant lead-time training:		
Officials and Managers	18,740	10.53
Professional	9,078	5.10
R&D engineers	219	0.12
Engineers in sales	806	0.45
Other engineers	2,011	1.13
Scientists	194	0.11
Programmers	486	0.27
Accountants and related	1,857	1.05
Lawyers	144	0.08
Other professionals	3,361	1.89
Technicians	6,802	3.82
Draftsmen	1,530	0.86
Surveyors	347	0.20
Technicians in R&D	168	0.09
Programmers	378	0.21
Other technicians	4,379	2.46
Sales	5,735	3.22
Skilled craftsmen	61,401	34.50
Foremen	5,714	3.21
Construction		
Electricians	391	0.22
Plumbers and pipefitters	5,267	2.96
Carpenters	195	0.11
Excavating and Grading machine operators	1,878	1.06
Others	6,252	3.51
Other craftsmen		
Mechanics and repairmen	8,603	4.83
Metal workers	1,011	0.57
Utility customer servicemen	25,611	14.39
Gas mfg. operators	1,802	1.01
Others	4,677	2.63
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	101,756	57.20
Semiskilled and unskilled jobs		
Semiskilled operators	16,395	9.21
Metal workers	129	0.07
Bus, truck, tractor drivers	2,470	1.39
Other operators	13,796	7.75
Office and clerical	47,555	26.72
Computer operators	695	0.39
Office machine opr.	1,902	1.07
Meter readers	6,658	3.74
Other office and clerical	38,300	21.52
Unskilled	8,878	4.99
Service	3,386	1.91
SEMISKILLED, OFFICE AND CLERICAL, UNSKILLED, SERVICE—TOTAL	76,214	42.80
TOTAL COMPANY MANPOWER	177,970	100.00
Contract Manpower	2,850	—
Maintenance	702	—
Services	2,148	—
TOTAL COMPANY AND CONTRACT MANPOWER	180,820	—

consulting on utilization of gas energized appliances, equipment and processes, (i) conventional management and administrative functions.

Some gas distribution companies manufacture gas for use during periods of high demand. Some gas distribution companies sell gas appliances at retail. Some sell liquefied petroleum gas.

Gas distribution companies vary widely in size, from 2 to over 5,000 employees. They also vary in the extent to which they subcontract capital construction and maintenance and repair work.

Manpower Requirements—The gas distribution industry employed some 178,000 people in 1967. Employment is expected to increase to 181,600 in 1972, reflecting a slow but steady growth rate.

The 1967 manpower, broken down by skills, is shown in *Table 18*. Two occupation groups dominate—skilled craftsmen 34.5 percent, and office and clerical 26.7 percent.

The industry forecasts approximately a 2 percent increase in employment between 1967 and 1972. *Table 19* presents the 1972 forecast by occupation groups. The largest percentage increases are foreseen for professionals (11.3 percent), sales workers (10.6 percent) and technicians (9 percent). An increase of slightly more than 3 percent is predicted for both skilled and unskilled labor occupations.

There were approximately 3,200 engineers and scientists and 6,800 technicians employed in 1967. The following increases in requirements are expected by 1972:

Research and Development	
Engineering	+14.3%
Sales and Sales Support Engineering	+21.8%
Other Engineering	+12.5%
Chemical, Physical, Earth Sciences	+ 6.2%
Technicians	+ 9.0%

Table 19—Manpower Engaged in United States Domestic Gas Distribution Activities

Occupation Group	1965	1967	Forecast 1972
Officials and managers		18,740	19,195
Professional		9,078	10,107
Technician		6,802	7,414
Sales		5,735	6,341
Office and clerical		47,555	47,132
Skilled craftsmen		61,401	63,372
Semiskilled operatives		16,395	16,029
Unskilled		8,879	9,151
Service		3,386	2,827
TOTAL	170,000	177,971	181,568

Sources: American Gas Association (1965)
National Petroleum Council Survey (1967-1972), 1968.

In 1967 the industry employed about 1,850 professional level accountants, financial analysts, statisticians and allied professionals. This number is expected to increase 12 percent by 1972.

Contract workers supplied by protective service, food service, and janitorial service firms provide additional manpower. The industry reported, for the summer of 1967, that 2,850 contract workers were servicing this industry's needs.

In summary, the anticipated change in the industry's occupation profile is in tune with the emphasis on technological improvement in operations, greater computerization and even more analytical work in the administrative functions.

Sharp increases in sales personnel and engineering support to sales functions are consistent with anticipated customer requirements in both the residential and industrial/commercial mar-

kets. Sales activities in the industry are increasingly dependent on technical evaluations requiring graduate engineers.

D. CONTRACT CONSTRUCTION

Section 1—Refineries

The average manpower requirements for additional and replacement refinery capacity constructed during 1967 is estimated at 14,188. In the 1962 NPC manpower report, it was estimated that 11,200 men were required to construct new refinery facilities, representing an investment of \$350 million. The 14,188 manpower estimated for 1967 was engaged in the construction of new refinery facilities valued at \$839 million.⁴ A large, international construction firm—the major source of the 1967 manpower estimate—points

⁴Oil & Gas Journal, February 5, 1968.

Table 20—Average Contractor Manpower Engaged in United States Domestic Refinery Construction Activities (1967)

Job Skill Requirements	Man-Hours Per \$ Million	Total Manpower Required for \$839 Million in Expenditures	
		No.	%
Jobs that require significant lead-time training:			
Management	1,800	724	5.1
Scientists	—	—	—
Engineers			
Mechanical	1,326	539	3.8
Civil	882	355	2.5
Electrical	882	355	2.5
Chemical and all other	1,320	525	3.7
Total Engineers	4,410	1,774	12.5
Other professionals	190	71	0.5
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	2,000	809	5.7
All other skilled exempt jobs (nontechnical)	—	—	—
Total exempt FLSA jobs	8,400	3,378	23.8
Technicians (nonexempt)			
Draftsmen	1,000	397	2.8
Technicians supporting scientists	—	—	—
Technicians supporting engineers	800	326	2.3
Total technicians	1,800	723	5.1
Operators (nonexempt)	—	—	—
Craftsmen (nonexempt)			
Electricians	3,300	1,334	9.4
Instrument mechanics	—	—	—
Boilermakers	800	326	2.3
Machinists	400	156	1.1
Pipefitters	6,750	2,724	19.2
Welders	2,250	908	6.4
Maintenance Mechanics	—	—	—
Auto mechanics	—	—	—
All other skilled craftsmen	5,500	2,213	15.6
Total craftsmen	19,000	7,661	54.0
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	29,200	11,762	82.9
SEMISKILLED AND UNSKILLED JOBS (NONEXEMPT)—TOTAL	6,000	2,426	17.1
TOTAL COMPANY MANPOWER (MID-1967)	35,200	14,188	100.0

out the following factors that account for this difference:

1. Refinery units constructed in 1967 were much more complex and sophisticated, and required more expensive materials than those constructed in 1962. Hydrocracking facilities, for example, require costly alloys and electronic systems that increase dollar costs without corresponding increases in manpower requirements.

2. Recent trends towards shop prefabrication of refinery units has resulted in overall labor savings.

3. Contractors are now using new and better equipment to construct refineries with resultant savings in manpower.

Table 20 shows a detailed estimate of the total manpower requirements, by skills, for the \$839 million expenditure for refinery facilities built during 1967.

A profile demonstrating the use of skills in the construction of a refinery is included on the following pages:

BENECIA REFINERY PROJECT

ORDER OF MAGNITUDE— \$135,000,000

Engineering and Construction Manpower Profile

(32 Months Actual; 7 Months Estimated)

Exhibit A shows the average number of men per month at 40 hours per week by various skills employed on this project. The refinery includes the following facilities:

Crude Unit

Hydrocracker

Hydrogen Manufacturing Plant

Cat Feed Hydrotreater

Catalytic Cracker

Alkylation Plant

Coker

Sulfur Plant

Treating & Blending Facilities

Boiler Plant

Tankage and other associated facilities such as Waste Disposal, Water Supply, Cooling Tower, Electrical Power Distribution, etc.

Product Tankage and Loading Racks

Wharf

Offices, Laboratory and Shop Buildings

Exhibit A—Benecia Refinery Project
Construction Manpower by Months From Start to Finish—Average Number of Men Per Month at 40 Hours Per Week
Contract Manpower

Months	Boiler-makers	Iron-workers	Car-penters	Ce-ment Fin-ishers	Labor-ers	Elec-tricians	Pipe-fitters	Pipe-welders	Insu-lators	Painters	Mill-wrights	Opera-tors	Survey-ors	Truck-drivers	Sub-total	Cleri-cal Staff	Super-visory Staff	Total Contract (On-Site)	Contract and Company Design/Engr. Manpower	Grand Total (Project)
1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	35	35
2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	52
3	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	52	52
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	86	86
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	121	121
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	125	125
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	121	121
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	146	146
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	122	122
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	99	99
11	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	97	97
12	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	74	74
13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73	73
14	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	75	75
15	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	88	88
16	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82	82
17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	73	73
18	113	3	49	2	44	2	-	-	-	-	-	2	11	11	237	30	10	277	103	380
19	146	30	72	2	80	4	20	8	-	-	-	18	19	24	423	38	15	476	91	567
20	175	30	120	5	155	10	35	10	-	-	-	45	25	35	645	55	20	720	92	812
21	225	40	140	6	200	10	50	20	-	-	3	60	30	40	824	70	25	919	93	1,012
22	275	60	125	7	200	15	105	40	-	-	6	70	30	45	978	85	30	1,093	76	1,169
23	295	65	130	10	200	30	130	50	-	-	10	80	30	50	1,080	90	35	1,205	90	1,295
24	300	85	135	12	250	50	150	60	-	-	10	80	35	50	1,217	100	40	1,357	92	1,449
25	305	100	140	15	300	75	200	70	-	-	15	90	35	55	1,400	110	40	1,550	87	1,637
26	280	115	145	20	350	100	250	80	-	10	20	100	35	60	1,565	115	40	1,720	78	1,798
27	255	135	140	20	350	120	300	95	10	20	25	110	35	60	1,675	120	40	1,835	61	1,896
28	230	135	130	15	300	140	350	115	20	30	30	120	30	60	1,705	135	45	1,885	68	1,953
29	205	135	125	15	280	150	400	130	60	40	30	130	30	60	1,790	140	45	1,975	58	2,033
30	145	120	120	10	260	175	450	140	100	50	25	140	25	55	1,815	145	45	2,005	41	2,046
31	90	120	110	10	240	200	500	150	150	60	20	140	25	50	1,865	145	45	2,055	31	2,086
32	60	105	100	10	220	250	500	150	175	80	20	130	20	45	1,865	140	45	2,050	24	2,074
33	55	95	90	5	200	230	450	130	200	100	25	110	20	35	1,745	135	45	1,925	24	1,949
34	50	85	80	5	150	200	400	120	250	120	30	100	15	30	1,635	120	40	1,795	23	1,818
35	45	60	70	5	100	180	350	100	250	120	30	80	15	25	1,430	110	40	1,580	21	1,601
36	40	40	60	5	75	150	250	80	200	120	20	60	10	20	1,130	95	35	1,260	20	1,280
37	40	30	50	-	50	130	200	60	150	100	15	40	10	15	890	80	30	1,000	19	1,019
38	30	20	40	-	40	100	150	40	100	60	10	20	5	15	630	65	25	720	18	738
39	20	10	20	-	30	50	50	20	50	40	6	10	5	10	321	55	20	396	11	407
TOTAL MAN- MONTHS	3,379	1,618	2,191	179	4,074	2,371	5,290	1,668	1,715	950	350	1,735	495	850	26,865	2,178	755	29,798	2,742	32,540
Percent	-	-	-	-	-	-	-	-	-	-	-	-	-	-	82.5	-	-	91.6	8.4	100.0

Section 2—Natural Gas Processing Plants

The estimated average manpower engaged in the construction of natural gas processing plant facilities in 1967 was 3,350. The total capacity of new plants added by the industry, on which this estimate is based, was 6,032 million cubic feet per day.

In the 1962 NPC report the estimate for construction manpower in this activity was based on capital expenditures, and was slightly larger than the current estimate. This may be accounted for by increase in construction efficiencies since that time.

Table 21 indicates a breakdown of skills based on a sampling taken from some of the firms engaged in natural gas processing plant construction.

Table 21—Average Manpower Engaged in Natural Gas Processing Plant Construction Activities (1967)

Job Skill Requirements	Total Average Manpower	
	No.	%
Jobs that require significant lead-time training:		
Managers, supervisors and administrators	174	5.20
Engineers	67	2.00
Operating engineers	177	5.30
Craftsmen		
Electricians	260	7.80
Boilermakers	40	1.20
Pipefitters	580	17.30
Millwrights	57	1.70
Ironworkers	374	11.20
All other skilled	930	27.70
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	2,659	79.40
Semiskilled and unskilled jobs		
Teamsters	60	1.80
Laborers	604	18.00
Others	27	0.80
SEMISKILLED AND UNSKILLED JOBS—TOTAL	691	20.60
TOTAL MANPOWER	3,350	100.00

Section 3—Pipeline Systems

1. *Mainline Construction*—In the five-year period 1962-1966, 23,000 miles of new crude oil and product main trunk lines, and 45,690 miles of main natural gas transmission lines were built.

With information and assistance supplied by the Pipe Line Contractors Association, it is estimated that the average manpower requirements in 1967 for mainline pipeline construction (petroleum and natural gas) was 24,300. While no estimate is offered for 1972, indications are that

these average requirements will decline due to increased construction efficiencies.

A breakdown of the average manpower engaged in mainline oil and gas pipeline construction activities in 1967 appears in Table 22.

Table 22—Average Manpower Engaged in Mainline Oil and Gas Pipeline Construction Activities (1967)

Job Skill Requirements	Total Mainline Pipeline Construction	
	Manpower	%
Jobs that require significant lead-time training:		
Managers, supervisors, engineers, technical and administrative	1,500	6.17
Operating engineers (operators of a variety of equipment such as bulldozers, back hoes, clam shells, sideboom tractors, etc.)	6,000	24.69
Welders	2,600	10.70
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	10,100	41.15
Semiskilled and unskilled jobs		
Welders-helpers	3,000	12.35
Teamsters	1,200	4.94
Laborers	10,000	41.15
SEMISKILLED AND UNSKILLED JOBS—TOTAL	14,200	58.44
TOTAL OIL AND GAS PIPELINE CONSTRUCTION MANPOWER	24,300	100.00

2. *Pipeline Station Construction*—The 1967 average level of employment for pipeline station construction activities was 2,600. Table 23 shows

Table 23—Manpower Engaged in United States Pipeline Station Construction (Average 1967)

Job Skill Requirements	Total Average Manpower	
	No.	%
Jobs that require significant lead-time training:		
Superintendents	198	7.60
Engineers	116	4.50
Operating engineers	254	9.80
Craftsmen		
Electricians	318	12.20
Millwrights	188	7.20
Steamfitters	398	15.30
Ironworkers	36	1.40
Welders	398	15.30
Cement Masons	132	5.10
Total craftsmen	1,470	56.50
TOTAL JOBS THAT REQUIRE SIGNIFICANT LEAD-TIME TRAINING	2,038	78.40
SEMISKILLED AND UNSKILLED—TOTAL	562	21.60
TOTAL PIPELINE STATION CONSTRUCTION MANPOWER	2,600	100.00

Table 24—Pipeline Station Construction Manpower Requirements By Types Of Stations (Average 1967)

Classification	Gas Turbine			Reciprocating			Electrical		
	Man-hours	%	Manpower Equivalent	Man-hours	%	Manpower Equivalent	Man-hours	%	Manpower Equivalent
Engineers	4,000	4.0	28.7	700	1.6	12.3	1,600	6.9	75.2
Superintendents . . .	4,000	4.0	28.7	2,000	4.7	36.2	2,800	12.2	133.0
Steamfitters	24,000	24.2	173.5	7,000	16.3	125.5	2,100	9.1	99.2
Welders	24,000	24.2	173.5	7,000	16.3	125.5	2,100	9.1	99.2
Millwrights	4,000	4.0	28.7	5,500	12.8	98.6	1,300	5.6	61.0
Carpenters	4,000	4.0	28.7	5,500	12.8	98.6	800	3.5	38.2
Cement masons	4,000	4.0	28.7	5,500	12.8	98.6	90	0.4	4.3
Operating engineers .	12,000	12.1	86.7	1,400	3.3	25.4	3,000	13.0	141.7
Ironworkers	2,000	2.0	14.3	1,200	2.8	21.5	—	—	—
Truckdrivers	3,000	3.0	21.5	750	1.7	13.1	450	2.0	21.8
Electricians	4,400	4.4	31.6	4,400	10.2	78.5	4,400	19.1	208.2
Laborers	10,000	10.1	72.4	2,000	4.7	36.2	4,400	19.1	208.2
TOTAL	99,400	100.0	717.0	42,950	100.0	770.0	23,040	100.0	1,090.0

the job skill requirements for this activity based on contractor estimates.

This estimate is considerably lower than the NPC 1962 estimate. In the previous study it was estimated that new construction was limited to six months a year; in 1967, based on experience of contractors, this was extended to eight months. Moreover, the 1962 study based its estimates on the average capital expenditures for each added horsepower regardless of type of station. The 1967 estimates are based on man-hours per horsepower for each station added taking into consideration that manpower and skill requirements vary with different types of stations (Table 24).

The total station horsepower added in 1967 was taken at 932,426 HP. Based on separate tabulation of 1967 new station construction covering some 569,000 HP, the following estimates were made of the total number of stations added in 1967, by types:

Type of Stations	Number of Added Stations	Average HP Added per Station
Gas Turbine	86	4,300
Reciprocating	78	2,400
Electrical	134	2,800

3. Gas Utility Pipeline Construction—Limited information on the average level of employment engaged in the construction of new or replacement gas distribution pipelines (i.e., within the “city gates”) was obtained through the survey of gas utility companies described in the preceding section on gas distribution operations.

The industry reported, for the summer of 1967, that an average of 7,650 contract workers were supplied by construction firms. The number of contract workers required for this activity is estimated to remain at about the same level through 1972.

PART-III

**REVIEW AND OUTLOOK FOR
ENGINEERS, SCIENTISTS AND
TECHNICIANS IN THE OIL AND
NATURAL GAS INDUSTRIES**

Part III

REVIEW AND OUTLOOK FOR ENGINEERS, SCIENTISTS AND TECHNICIANS IN THE OIL AND NATURAL GAS INDUSTRIES

A. SUMMARY OF FINDINGS

Data obtained through the various surveys previously mentioned, together with an additional special detailed study of technical manpower now on oil company payrolls, provide useful background for constructive thought in this critical area of employment.

A total of 85,129 engineers, scientists and technicians can be identified in this NPC manpower study. This represents about 16 percent of all jobs that require significant lead-time training as shown in *Summary Table 1* of Part I.

Table 25 summarizes the following number of engineers, scientists and technicians by various components included in this study:

	Total Number	Percent of Total
Scientists	18,539	21.8
Engineers	37,642	44.2
Technicians	28,948	34.0
Total	85,129	

Table 26 shows the distribution of technical manpower among functional divisions of domestic

oil companies which accounts for nearly two-thirds of the overall technical manpower.

A detailed analysis of technical manpower engaged in research and development activities was presented in Section 6, Part II of this report.

Some relationships of current interest and benchmarks that may become more meaningful when compared with similar data in future studies are as follows:

1. Engineers and scientists bear a 1:12 ratio to total oil company manpower and 1:5 ratio to manpower in occupations that are exempt under the FLSA.

2. There is one person classified as a technician for every 2.2 persons working as engineers and scientists.

The special, detailed study of technical manpower revealed further background on the disciplines, functional use, and degree levels of scientists and engineers on oil company payrolls.

B. USE OF SCIENTISTS AND ENGINEERS

Some 28,332 "nonresearch" scientists and engineers were identified on domestic payrolls of

Table 25—Total Manpower—Engineers, Scientists and Technicians

Study Components	Jobs That Require Technical Degrees			Technicians	Engineers, Scientists and Technicians	
	Scientists	Engineers	Total		Total	%
Oil companies (Domestic activities) . . .	14,192	22,959	37,151	16,946	54,097	63.5
Gas gathering & transmission .	120	1,990	2,110	1,936	4,046	4.8
Gas distribution	194	3,036	3,230	6,802	10,032	11.8
Marine transportation	—	397	397	7	404	0.4
Foreign activities				Not surveyed		
U.S. based	372	1,041	1,413		1,413	1.7
Foreign based (U.S. citizens)	1,065	1,913	2,978	"	2,978	3.5
Contractors ^a	2,596	6,306	8,902	3,257	12,159	14.3
TOTAL NUMBER	18,539	37,642	56,181	28,948	85,129	100.0
Percent of technical force . .	21.8	44.2	66.0	34.0	—	—

^aOil field services and refinery construction.

Table 26—Functional Distribution of Engineers, Scientists and Technicians Engaged in Domestic Activities of United States Oil Companies

Functions	Scientists		Engineers		Total Scientists & Engineers		Technicians		Total	
	No.	%	No.	%	No.	%	No.	%	No.	%
Extraction	6,895	48.6	9,352	40.7	16,247	43.7	5,145 ^a	30.4	21,392	39.6
Refining	926	6.5	4,582	20.0	5,508	14.8	3,591 ^b	21.2	9,099	16.8
Pipeline transportation . . .	29	0.2	808	3.5	837	2.3	757	4.5	1,594	3.0
Marketing	212	1.5	2,603	11.3	2,815	7.6	668	3.9	3,483	6.4
R&D	5,602	39.5	3,227	14.1	8,829	23.8	5,526 ^a	32.6	14,355	26.5
Central engineering	15	0.1	1,471	6.4	1,486	4.0	421	2.5	1,907	3.5
All other	513	3.6	916	4.0	1,429	3.8	838	4.9	2,267	4.2
TOTAL	14,192	26.2	22,959	42.5	37,151	68.7	16,946	31.3	54,097	100.0

^aProbably includes draftsmen, lab technicians, and related jobs not directly supporting engineers and scientists.

^bProbably a significant number are performing work not in direct support of engineers or scientists, e.g., quality control, research lab technician, drafting, highly skilled craftsmen (electronics and instrument technicians).

U.S. oil companies through this study. *Table 27* summarizes their educational disciplines by functional activities. Highlights of these data are illustrated in *Figures 1 and 2* below:

In examining the functional pursuits of technical degree holders,¹ it was determined that the majority (about 75 percent are engaged in engineering and scientific staff services. The

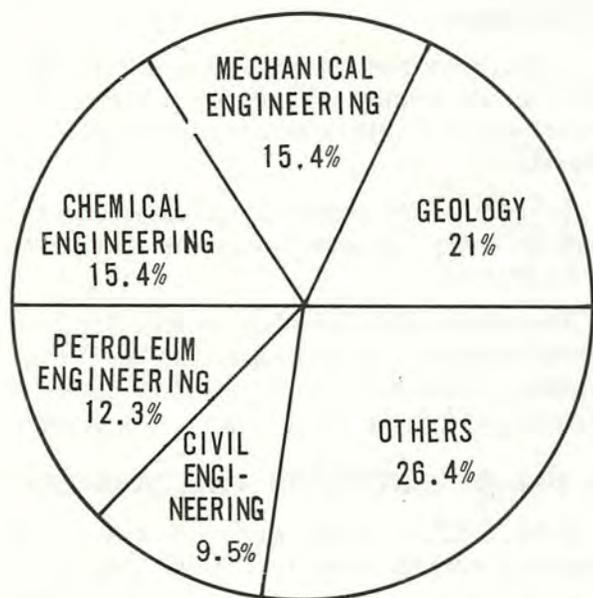


Figure 1. Educational disciplines as a percent of all technical degree holders. (Excludes Research & Development.)

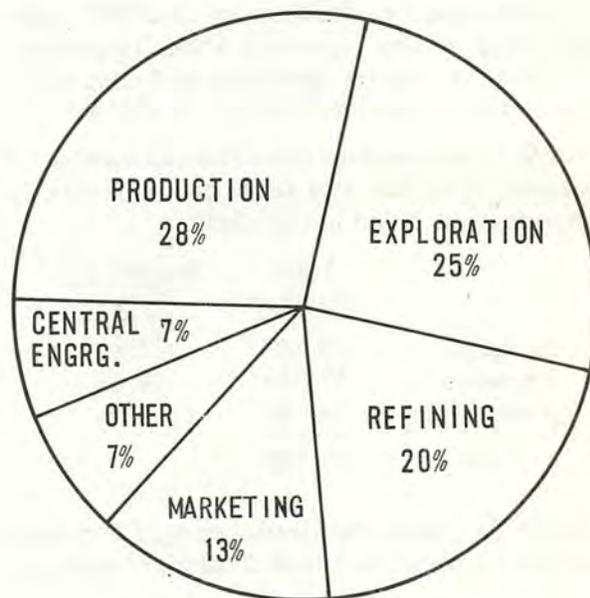


Figure 2. Functional location of all technical degree holders. (Excludes Research & Development.)

It will be noted that five disciplines account for about three-fourths of all educational backgrounds. The remaining one-fourth cover a broad spectrum of 51 additional fields of degree.

By degree level, 75 percent have a BS Degree, 23 percent have an MS Degree and 2 percent have a Ph.D. Degree. Utilization of the advanced degree levels is illustrated in *Figure 3*.

remainder are primarily engaged in management functions where a technical background is becoming increasingly important. Others have migrated to supporting services not generally identified with technical backgrounds.

Table 27 also reflects the high degree of occupational flexibility associated with technical

¹See Appendix A-2 for examples of technical degrees referred to.

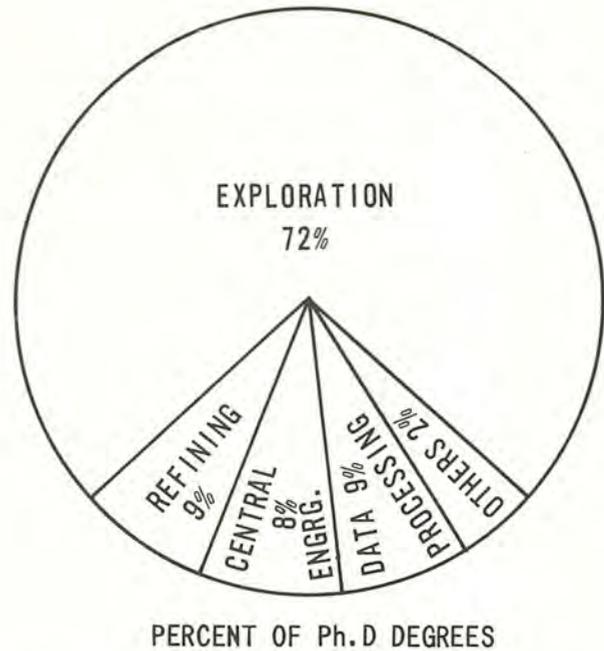
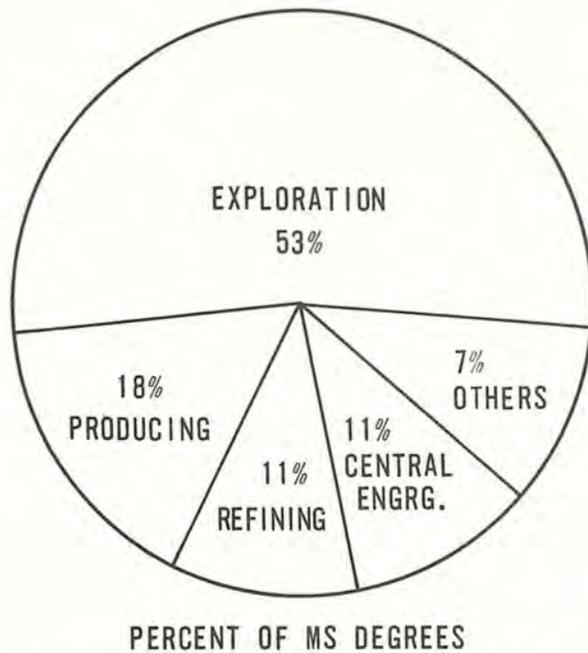


Figure 3. Functional use of engineers-scientists with advanced degrees (Excludes Research and Development)

backgrounds as now employed in the U.S. oil industry.

Ninety-one percent of geologists are performing geological functions and 93 percent of petroleum engineers are associated with the producing function. The other heavily populated disciplines are spread over a number of functions. This suggests that many technical jobs can be filled by a variety of degree disciplines. The data further indicates that there is a general level of technical competence in many disciplines that enables scientists and engineers to successfully handle other specializations. A good example has been the ability of the producing function to alleviate the short supply of petroleum engineers by utilizing engineers of other disciplines.

This study did not provide a definitive appraisal of the industry's need for technical manpower *vis-a-vis* the current and projected supply of graduates with various technical degrees. Some general observations, however, indicate that the availability of qualified graduates will continue to be a matter of considerable concern to the industry in the foreseeable future.

A 1966 survey conducted by the Engineering Manpower Commission (EMC) of the Engineer's Joint Council (EJC)² reports that employers "... think they will need almost twice as many engineers as are likely to become available

during the next decade." A predicted 33 percent increase in engineering employment plus an allowance for attrition will require an average of about 70,000 new engineers per year. About 36,500 engineering bachelor degrees were awarded in 1967. An increase to 46,000 per year through 1974 is forecast. Thus, on a cumulative basis, the supply will be roughly half the demand. This is illustrated in *Figure 4*.

In the same survey, the petroleum industry forecasts a modest increase of 17 percent in engineering employment through 1975. Chemicals forecast 48 percent in the same period; education—a large employer of engineers—forecasts a 66 percent increase. These published forecasts could be drastically changed by economic and political forces now at work. However, the average yearly growth of about 3 percent a year in U.S. engineering employment is not unreasonable. Neither is the need to replace attrition. It is safe, therefore, to assume that there will be a growing shortage of engineers on a nationwide basis.

For the petroleum industry, this problem is further compounded by each company's desire to attract and hold engineers having some technical capabilities plus broad aptitudes and interests. To the extent that such policies express real needs, the petroleum industry's gap could be even wider for certain disciplines.

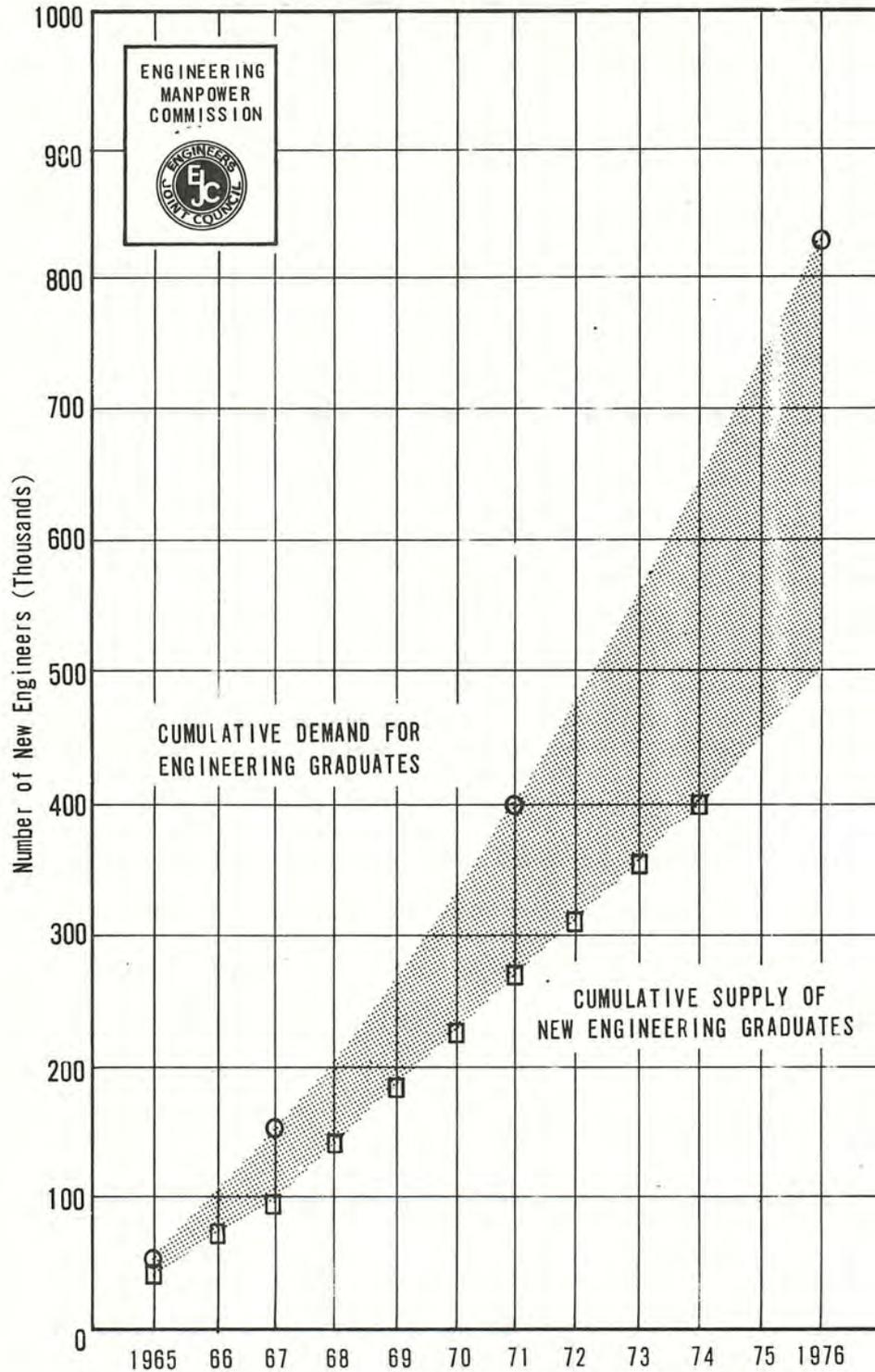
The application of new technology and extensive capital investments has improved output per man-hour and enabled the industry to meet

²*Demand for Engineers & Technicians—1966*; Report of survey by EMC, (September 1966).

Table 27—An Analysis of Technical Degree Holders in the Oil Industry in Relation to Basic Functional Activities

Functional Activities	Percentage of All Technical Backgrounds (Excluding R&D)															Total
	Geol.	Mech. Engr.	Chem. Engr.	Petr. Engr.	Civil Engr.	Elec. Engr.	Math and Statis.	Chem.	Gen. Engr.	Geol. Engr.	Physics	Indust. Engr.	Geophy.	Min-ing Engr.	Misc.	
Exploration:																
Geological services	14.30	*	*	*	—	*	*	*	*	0.74	—	—	*	*	0.41	15.60
Geophysical services	3.29	*	*	*	*	0.73	0.73	*	*	0.52	0.88	—	0.89	0.11	0.48	7.80
Exploration management	0.92	—	—	*	*	*	*	—	—	*	*	—	*	*	*	1.20
Land	0.25	*	*	*	*	—	*	*	—	—	—	—	—	*	*	0.30
Producing:																
Engineering services	0.89	3.50	2.11	8.93	2.57	1.13	*	0.30	0.30	0.43	0.15	0.13	*	0.61	0.28	21.30
Operation and maintenance	0.30	1.17	0.43	2.34	0.43	0.29	*	0.11	0.13	*	*	*	—	0.11	0.12	6.50
Refining:																
Engineering services	*	3.20	5.68	0.12	1.13	0.83	*	0.97	0.15	*	*	0.15	—	*	0.23	12.50
Operation and maintenance	—	2.00	2.94	*	0.60	0.45	*	0.73	0.11	—	—	0.12	—	*	0.15	7.50
Marketing:																
Constr. and maint. engr.	*	0.49	*	*	1.90	*	*	*	0.59	—	*	*	—	*	0.43	3.80
Sales representation	0.50	2.07	0.62	0.18	0.70	0.33	0.36	0.90	1.50	*	0.11	0.26	*	*	1.40	9.00
Central engineering	—	2.14	1.96	0.13	1.73	0.52	*	*	*	—	*	*	—	—	0.28	7.10
Other:																
Employee relations	*	0.21	0.33	*	0.11	*	0.10	0.19	*	—	*	*	*	—	0.18	1.40
Computer programming	0.18	0.23	0.57	0.10	*	0.17	1.84	0.16	*	*	0.16	0.10	*	—	0.19	3.80
Supply	*	*	0.45	*	*	*	*	*	0.10	*	*	*	—	—	*	1.00
Finance	*	*	0.20	*	*	*	0.15	*	*	—	*	*	—	—	0.14	0.70
Real estate	*	*	*	*	*	*	*	*	*	—	*	—	*	—	*	0.30
Legal	*	*	*	—	—	*	*	*	*	—	*	—	—	—	*	0.20
Other subtotal	0.38	0.64	1.61	0.27	0.23	0.29	2.22	0.55	0.28	*	0.23	0.19	*	—	0.63	7.40
TOTAL PERCENT	21.00	15.40	15.40	12.40	9.60	4.80	3.70	3.70	3.20	1.80	1.50	1.00	1.00	1.00	4.50	100.00

*Represents less than 0.1 percent of the cases. This data was developed from a 1967 special survey of oil companies representing 37 percent of total U.S. crude oil production and 47 percent of refinery crude runs in United States. This is considered to reflect a typical profile of the petroleum industry (excluding R&D).



Source: Data from "Demand for Engineers and Technicians-1966" EMC of the EJC.

Figure 4. The growing engineering manpower gap 1965-1976

increasing product demands with decreasing numbers of personnel. Technically trained personnel are largely responsible for these achievements and, accordingly, their numbers and proportion of the total mix have increased.

The growing technical complexity of processes and procedures in the petroleum industry is increasing the placement of technically trained personnel in management positions. Technical training is becoming ever more important to those who manage men and activities where there are opportunities for technological advances.

A special survey was made of the professional recruitment experience of eleven major oil companies over the past five years. These same companies were also asked to forecast their requirements for engineers, earth scientists and other scientists for the next five years.

The eleven-company sample represented 45 percent of the crude production and 52 percent of the crude refinery runs in the United States during 1967.

Based on the eleven-company forecast and the functional relationships developed from Questionnaire No. 1, an estimate of the total oil industry's recruiting requirements were made for the years 1969 through 1973.

The results summarized in *Table 28* indicate a favorable success ratio in meeting past requirements and a growing demand for engineers, earth scientists and other scientists in the oil industry.

Careful evaluations at regular intervals are needed to assure that students are not misdirected and that the industry continues to meet its requirements for professional talent.

C. USE OF TECHNICIANS

There is little agreement among employers on a precise definition of a technician or on technician work. Within U.S. industry, people classed as technicians may be found in widely differing occupations. These include developing electronic equipment, quality control, construction supervision, drating, testing, design, equipment maintenance, surveying, and assisting engineers and scientists in professional work. Some of these people may have had formal college training, while others have learned their skills on the job.

The most widely accepted definition of a technician is one who has had post high school education in a specialized field to qualify him to apply known principles and methods in support

Table 28—National Petroleum Council Special Survey of Professional Recruitment in United States Oil Industry
Experience Summary of Eleven Major Oil Companies (1964 Through 1968)

	Engineers			Earth Scientists			Other Scientists			Total Engineers, Earth Scientists, Other Scientists		
	Recruitment Requirement	Recruits		Recruitment Requirement	Recruits		Recruitment Requirement	Recruits		Recruitment Requirement	Recruits	
		Hired	%		Hired	%		Hired	%		Hired	%
1964 . . .	1,073	962	89.7	261	246	94.3	238	243	102.1	1,572	1,451	92.3
1965 . . .	1,229	1,043	84.9	298	269	90.3	278	241	86.7	1,805	1,553	86.0
1966 . . .	1,463	1,081	73.9	305	214	70.2	349	289	82.8	2,117	1,584	74.8
1967 . . .	1,605	1,402	87.4	360	264	73.3	356	346	97.2	2,321	2,012	86.7
1968 . . .	1,662	1,450	87.2	256	218	85.2	340	317	93.2	2,258	1,985	87.9
5-YEAR TOTALS	7,032	5,938	84.4	1,480	1,211	81.8	1,561	1,436	92.0	10,073	8,585	85.2

Indicated Future Demand for Professional Manpower (1969 Through 1973)

	Engineers		Earth Scientists		Other Scientists		Total Engineers, Earth Scientists, Other Scientists	
	11-Company Forecast	Total Oil Industry ^a	11-Company Forecast	Total Oil Industry ^a	11-Company Forecast	Total Oil Industry ^a	11-Company Forecast	Total Oil Industry ^a
1969	1,372	2,850	286	645	255	560	1,913	4,055
1970	1,487	3,090	301	680	304	670	2,092	4,440
1971	1,509	3,135	335	760	330	725	2,174	4,620
1972	1,579	3,280	359	810	346	760	2,284	4,850
1973	1,604	3,330	382	865	366	805	2,352	5,000
5-YEAR TOTALS . . .	7,551	15,685	1,663	3,760	1,601	3,520	10,815	22,965

^aProjections based on the 11-company forecasts and relationships established by the 79-company survey. (Companies in 11-company sample account for 45 percent of U.S. crude production and 52 percent of refinery runs.)

of engineering and scientific activities. In many cases he has taken over areas of work previously performed by the professional. Because of the continuing shortage of engineers and scientists, it is timely to examine how technicians are being utilized by the oil industry.

The oil industry has made considerable progress in its use of technicians. *Table 26* shows a current total of 16,946 within the domestic activities of oil companies, or 46 technicians for each 100 total engineers and scientists. Three types of technicians were surveyed with results as follows:

	Number	Percent Total
Technicians supporting scientists	6,777	40.0
Technicians supporting engineers	6,038	35.6
Draftsmen	4,131	24.4
Total	16,946	100.0

A closer examination of the present utilization of technicians by functional divisions of industry is shown in *Figure 5*. Technicians are being used more extensively where engineers and scientists are concentrated. *Figure 5* demonstrates this particularly with respect to oil refining and research and development activities. With a continuing shortage of engineers and scientists, the need for highly trained technicians will increase. This increasing need will result from industry efforts to redesign technical jobs and shift more work from engineers and scientists to technicians.

As in the case of engineers and scientists, the petroleum industry should take positive action to ensure that appropriately trained technicians will be available to match future requirements.

D. CONCLUSIONS AND RECOMMENDATIONS

Many interrelated factors contribute to the increased requirements for engineers, scientists and technicians. This makes it difficult to project future requirements on an industrywide basis from data now available. This study has clearly indicated that more factual information is needed to make an intelligent appraisal of the nature and extent of this problem.

Once the essential facts are known, a positive program should be developed to direct students into needed disciplines and assist educational institutions in their efforts to train graduates with the qualifications the industry needs. Es-

sential management support for such a program can more readily be gained when the problem is documented and understood.

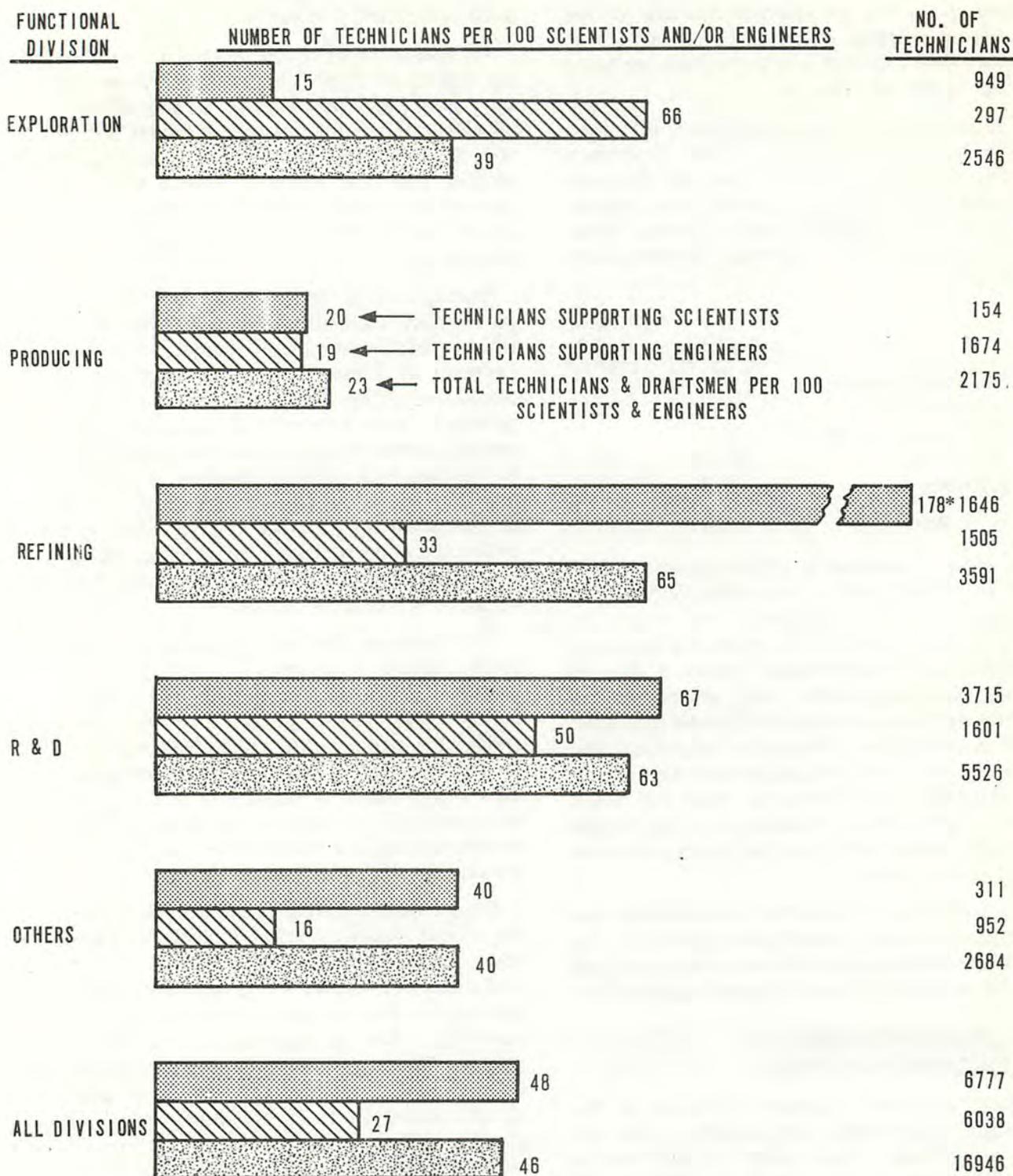
Professional employees themselves, with varying degrees of support and encouragement from their employers, are already making efforts to alleviate the growing shortage of technical graduates. The engineering profession, in particular, is making new and renewed efforts to provide counsel to students at the junior and senior high school levels and assist their teachers and counselors.

Students with aptitude are encouraged to pursue a science/math curriculum in high school, which would prepare them for any type of college endeavor of interest to them. Information and counsel regarding the engineering profession is provided. Other interested students are directed toward courses of study that would qualify them to become technicians supporting engineers or scientists. These activities are an effective means of communicating a clear understanding of the nature and opportunities in engineering, and help students determine their interest in undertaking engineering studies in college.³

It is believed that this program can significantly increase the number and quality of young people undertaking the study of engineering in college. With proper guidance before entering college the attrition rate will be reduced, further contributing to the number of engineers graduated and available to employers. For maximum accomplishments, however, all disciplines must be represented in a unified effort with appropriate support from employers.

Once a qualified student has entered engineering school, followup effort is needed to assure that he graduates as an engineer or as a technician in a needed discipline. Some employers handle this as part of their professional recruiting visits to engineering and technical schools. While on campus, company representatives give talks to student chapters of professional societies, to professional orientation classes, and to informal student groups. The subject matter may be a technical subject in which the speaker is well versed. Equally effective are talks covering what engineers do in a particular branch of the industry.

³*The Guidance of Pre College Youth—An Engineer's Responsibility*, (Washington, D.C.: National Society of Professional Engineers, April 1968). This booklet advocates guidance at the local level by the 525 Chapters of NSPE in cooperation with other local engineering groups.



*This high ratio probably results from inclusion of a large number of technicians in quality control laboratories supervised by chemists. It may also include highly skilled craftsmen, e.g., electronics and instrument repairmen.

Source: Based on data from NPC Questionnaire No. 1 for oil industry.

Figure 5. Use of technicians in selected functions of the oil industry

The oil and gas industries, as major employers of professional talent, have much to gain from taking an aggressive role in making available effective aids and personnel to evaluate aptitudes and advise students regarding the opportunities, rewards and challenges of a professional career in oil and gas. The timing of this effort is urgent since it takes approximately ten years from the time a student elects the science/math college preparatory route in junior high school until he actually graduates from college.

It should also be noted here that as a result of the emphasis during academic studies on theoretical—rather than practical—aspects of engineering, graduates tend to seek jobs in which they can apply these theoretical “tools.” Graduates want challenging assignments and they want early responsibility.

Some other positive or complementary means of attacking the shortage of technical manpower should include:

1. Provide opportunities for professors to maintain familiarity with current industry practices and requirements through seminars and summer employment.

2. Provide equipment and personnel to aid the teaching of key courses—particularly in the field of petroleum and chemical engineering. This will help to assure that graduates are up-to-date in their knowledge of equipment and procedures.

3. Encourage students in their quest for knowledge and experience through summer employment, cooperative school/work plans, scholarships, etc.

4. Take appropriate action to ensure that the draft does not further aggravate the shortage of technical manpower. This should include consideration of deferments for technicians trained in the critical disciplines as well as engineers and scientists.

5. Take an active interest in schools engaged in the training of engineering technicians and make available the support and encouragement required to help them graduate technicians that match the industry's needs in terms of quality and quantity.

Concurrently, individual companies within the industry must improve the status of the technician. Engineers and scientists must be educated to better utilize the skills, aptitudes, and training of the technician, as well as give them meaningful and challenging work. The employer, in turn, must provide a job progres-

sion structure within which the technician can grow in stature, as well as financially, commensurate with his abilities and motivation.

In facing the higher demand and limited supply of professionals, the industry's most direct solution to the immediate problem is to improve the effectiveness of its engineers and scientists. A significant question has been raised regarding the industry's full and appropriate use of the talents and brainpower of its technical personnel.⁴ Engineers and scientists need trained support people to handle the lower levels of their professional duties that do not require four years or more of college training to accomplish. In view of the fact that some courses are now requiring four years for a technician, even more work can be given qualified technicians having such training.

Increased use of technicians and assistants coupled with a redefinition of professional duties is necessary. Along with this, actions must be taken to increase the supply of these trained support personnel. The long-term solution is in active programs to stimulate enrollment of able young people—both men and women—into post high school education, leading toward a professional degree or technician support work in engineering or science.

* * *

There is every indication that the long-term employment outlook is good for engineers, scientists and technicians in the petroleum industry. Following are some of the factors that may influence graduates to consider and seek employment in the oil and gas industries:

1. There is a strong and growing demand for energy in the United States and other areas of the free world. Increasing volumes of oil and gas will be needed to supply the major portion of this growth in energy requirements. This is illustrated in *Figure 6* that was included in the recently released publication by the Office of Oil and Gas, U.S. Department of the Interior, entitled *United States Petroleum Through 1980*.

2. Petroleum is a mature industry with higher average ages for engineers and scientists than in the newer, so-called “glamour industries.” This offers greater opportunity to move up the ladder as older employees reach retirement age.

⁴“The Engineer's Viewpoint,” *Petroleum Engineer*, November 1967.

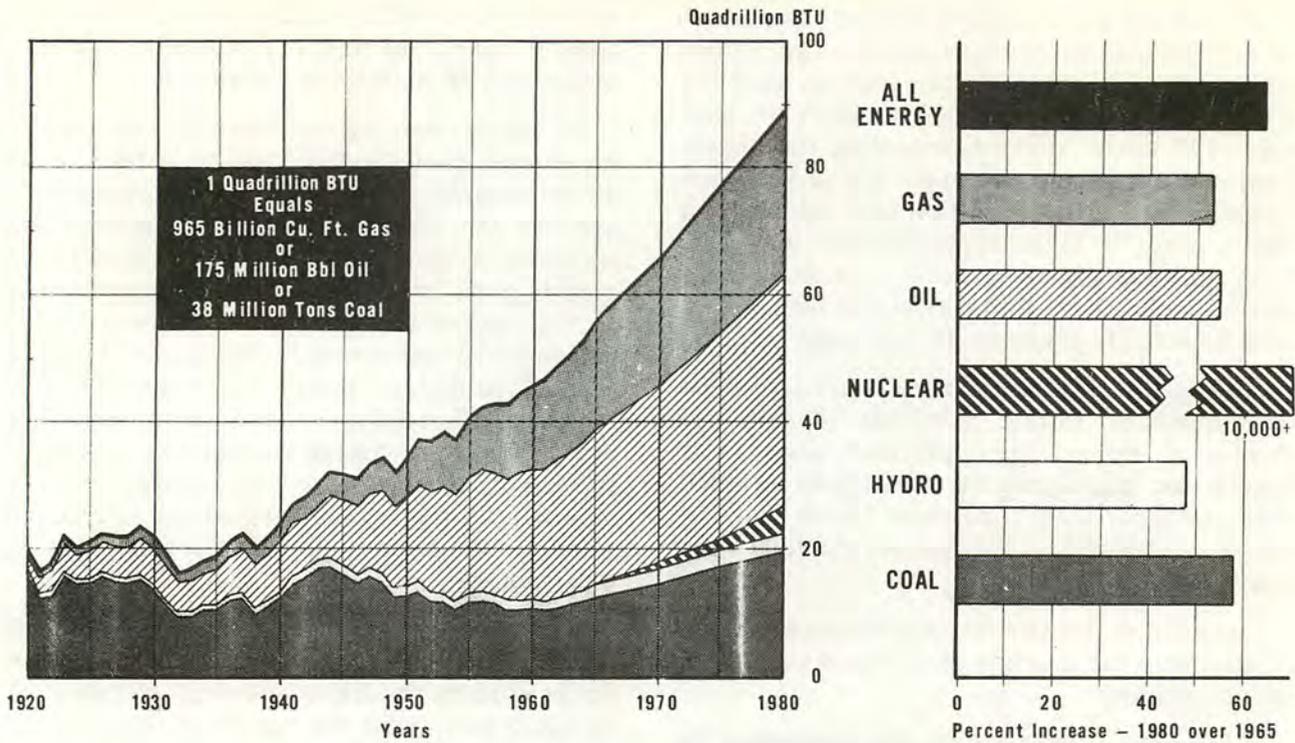


Figure 6. Energy consumption in the United States is growing at record rate

Table 29—Age Distribution Analysis
Engineers and Scientists in Oil Companies (1967)

Age	Percent of Total
30 years and less	22.0
31-35 years	16.0
36-40 years	18.2
41-45 years	18.7
46-50 years	12.7
51-55 years	6.6
56-60 years	4.1
61-65 years	1.7
	100.0

NOTE: Median age is 38.3 years.

3. Scientists, engineers and technicians are making up an increasing portion of the total industry mix. Opportunities for creative and challenging careers in petroleum are awaiting graduates in a wide variety of disciplines. This is summarized in *Figure 7* taken from the November 14, 1966 *Oil and Gas Journal* article, "Career Opportunities in Oil and Gas."

4. The petroleum industry's salary status is above the average of other industries.⁵

5. The mature nature of the oil and gas industries offers an outlook for stable employment over the individual's working career. At

⁵EMC of EJC, *Professional Income of Engineers, 1966-1967*; Idem., *Salaries of Engineering Technicians 1966*.

the same time, the application of new technology to old functions, and the adventuresome new pursuits of the industry portend an exciting as well as stable career.

The NPC's recent report on *Impact of New Technology on the U.S. Petroleum Industry* presents an excellent review of the industry's progress over the past two decades. From this review, it can only be concluded that the next twenty to forty years will require even greater imagination and creative genius of people in the U.S. oil and gas industries.

* * *

The concluding pages (Section E) of this review list a number of key factors that will influence the future need for engineers, scientists and technicians in the oil and gas industries. This list also demonstrates the changing and challenging nature of the future for these technically trained people.

E. FACTORS CAUSING INCREASED REQUIREMENTS FOR ENGINEERS, SCIENTISTS AND TECHNICIANS

1. Normal growth in demand for products derived from petroleum as a function of population growth and improved standard of living.

Field of study	Exploration-drilling	Production	Refining, processing & petrochemicals	Transportation	Marketing	Research-development	Administration
Accounting	•	•	•	•	•	•	•
Biology						•	
Business Administration				•	•		•
Chemistry			•			•	
Chemical engineering	•	•	•		•	•	
Civil engineering	•	•	•	•	•	•	
Economics			•		•		•
Electrical engineering	•	•	•	•	•	•	
Finance							•
Geology	•					•	
Geophysics	•					•	
Industrial engineering	•		•	•			
Industrial relations			•				•
Liberal arts					•		•
Law	•			•	•		•
Marketing			•		•		•
Mechanical engineering	•	•	•	•	•	•	•
Metallurgical engineering			•	•			
Petroleum engineering	•	•	•	•		•	
Physics		•				•	
Statistics			•		•		•
Tax specialist		•					•

Figure 7. Oil industry's talent chart

2. Increased complexity of operations in all areas of the industry requiring technically trained people to operate, manage, and administer smaller increments of activity.

- a. Increasing numbers of specialists in both technical and nontechnical activities.
- b. A background in science or engineering, knowledge of sophisticated business analytical methods, plus engineering design and operating experience is often required.

3. Increased competition for markets, profits, resources, and people.

- a. Close analysis of all operations.
- b. Manpower reduction—increased automation.
- c. Reduction of costs to offset inflation.

4. Broadened geographic areas of operations.

- a. Pipelines.
- b. Larger tankers and terminals to accommodate.

c. Products to match local needs.

d. New manufacturing and distribution facilities.

5. Demand for new or improved products.

- a. Low sulfur fuel.
- b. Aviation turbine fuel.
- c. New fuels and lubes to match manufacturers' requirements.

6. Search for—and exploitation of—technological breakthroughs in exploration, production, transportation, manufacturing, marketing, and business management.

- a. Development of new engineering design criteria.
- b. Development, test, and application of new materials of construction.
- c. Familiarization and integration of new computer information, and data gathering systems into own operations.

7. Development and application of conservation techniques.

8. Movement of the search for oil into more hostile environments than those encountered in traditional onshore inland areas; i.e., far North, and deep offshore water depths.

9. Diversification into "nonpetroleum" activities:

- a. Chemicals and plastics
- b. Plant foods
- c. Synthetic proteins
- d. Land management and development
- e. Mining
- f. Car leasing

10. Air and water pollution control.

- a. Development of processes to reduce or eliminate.
- b. Development of auxiliary equipment and facilities to alleviate.

11. Increased participation in community and government affairs.

- a. Create jobs; train, and supervise underemployed.
- b. Maintain surveillance; participate actively in the formulation of regulatory codes, standards, and legislation, of both technical and nontechnical nature, relating to the broadened scope of industry activities.

12. Turnover of engineers and scientists during early years of employment—frequently to jobs outside the industry.

13. Military (Selective Service) duty.

14. Longer vacations.

15. Early retirements.

16. Increased participation by businessmen in human affairs—in the management of the human resources for which they are responsible.

APPENDICES

APPENDICES
TABLE OF CONTENTS

	Page
APPENDIX A—Survey of United States Domestic Oil Industry Operations	
1. Transmittal to Survey Participants and General Comments	55
2. Instructions Relative to Questionnaire Form No. 1	57
3. Sample of Questionnaire Form No. 1	60
4. Summary of 79 Oil Company Responses	62
5. Estimated United States Total of Oil Industry Manpower on Oil Company Payrolls	65
APPENDIX B—Survey of United States Domestic Natural Gas Pipeline Operations	
1. Instructions Relative to Questionnaire Form No. 2	69
2. Sample of Questionnaire Form No. 2	71
3. Summary of 36 Natural Gas Transmission Company Responses	72
4. Estimated United States Total of Gas Gathering and Transmission Manpower	73
APPENDIX C—Survey of Foreign Oil and Natural Gas Operations (United States Citizens Only)	
1. Instructions Relative to Questionnaire Form No. 3	77
2. Sample of Questionnaire Form No. 3	79
3. Summary of 37 Oil Company Responses	80
APPENDIX D—Survey of United States Domestic Natural Gas Distribution Industry Operations	
1. Transmittal and Instructions Relative to Gas Distribution Questionnaire	83
2. Sample of Gas Distribution Questionnaire	86
3. Data Sources and Survey Methods	91

APPENDIX A

**Survey of United States Domestic Oil
Industry Operations**

APPENDIX A-1

NATIONAL PETROLEUM COUNCIL

*(Established by the Secretary of the Interior)*J. C. Donnell II
Chairman

May 21, 1968

Vincent M. Brown
Secretary-TreasurerJack H. Abernathy
Vice-ChairmanMaxwell S. McKnight
Asst. Secretary-Treasurer

TO U.S. PETROLEUM AND GAS COMPANY OFFICERS

Gentlemen:

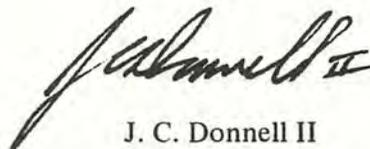
The National Petroleum Council has conducted several studies of the oil and gas industries' manpower needs in the past, the most recent being the 1963 report, "Petroleum and Gas Industries Manpower Requirements." The Department of the Interior has asked the Council to update the 1963 report and expand it to cover Americans in foreign operations and future requirements for earth scientists and engineers. The study is also to include the level of employment and manpower balance in the natural gas distribution industry (already being covered by separate survey).

Your participation in this effort is earnestly requested. In view of the importance of the oil and gas industries to the national security, the joint efforts of the Government and these industries are necessary to assure that we will have adequate information and be properly prepared to meet any emergency. Adequate manpower, of course, is a critical item in any emergency.

The NPC Committee on Manpower Requirements in the Petroleum and Gas Industries has developed three separate questionnaire forms covering manpower engaged in (1) U.S. domestic oil industry operations, (2) U.S. domestic natural gas pipeline operations, and (3) foreign oil and natural gas operations. Copies of the appropriate questionnaire form or forms applicable to your operations, together with relevant instructions, are enclosed. I would appreciate your filling out one set of the forms for your company's operations and sending it to Vincent M. Brown, Secretary-Treasurer of the National Petroleum Council, at the above address. Should you have any questions concerning the survey, kindly contact Mr. Brown.

We would like to have your response by June 21, 1968. Compilation of the data will be made by the Council staff. No individual company data will be disclosed; the published report will contain aggregate figures only. Your participation in this important survey will be extremely valuable to the Government in its efforts in preparing for any national emergency or disaster. Thank you for your cooperation.

Sincerely,



J. C. Donnell II

Enclosures

NATIONAL PETROLEUM COUNCIL
MANPOWER REQUIREMENTS SURVEY—1967

GENERAL COMMENTS

1. For emergency planning purposes, and in order to review the manpower balance in the petroleum industry, the Department of the Interior has requested the NPC to make a study of manpower requirements in the U.S. It was also requested that the Council's previous study on this subject (1963) be extended to include U.S. citizens in foreign oil and gas operations.

2. Your assistance in providing the required information is requested. Three separate questionnaire forms have been developed. These are as follows:

Questionnaire No. 1—Manpower engaged in U.S. domestic oil industry operations. (This questionnaire covers all manpower located in the U.S. and engaged in domestic oil industry operations including the production and processing of natural gas.)

Questionnaire No. 2—Manpower engaged in U.S. domestic natural gas pipeline operations. (This questionnaire covers manpower located in the U.S. and engaged in natural gas pipeline operations including extraction, field processing, gathering and transmission operations up to the "city gate.")

Questionnaire No. 3—Manpower engaged in foreign oil and natural gas operations. (This questionnaire covers U.S. citizens assigned abroad and also U.S. based manpower engaged primarily in supporting foreign oil and natural gas operations.)

Copies of the appropriate questionnaire form or forms applicable to your operations are enclosed.

3. The term "manpower" as used in this survey means the level of the work force employed under work practices and situations prevailing in 1967. This generally should represent an employment count about mid-year for most activities, but in some instances an average count for an appropriate period might better represent the normal or seasonal work situation. Current manpower data sources may be used if you find it more convenient. Please indicate period used if other than mid-1967 or average-1967.

4. The term "exempt" refers to jobs that are exempt from the *overtime provisions* of the Fair Labor Standards Act (F.L.S.A.). The term

"nonexempt" refers to jobs that are subject to F.L.S.A. overtime provisions.

5. *Exclude* manpower engaged in *petrochemical* and various nonpetroleum activities where it is possible to identify and separate them. Please indicate by footnote where significant chemical operations are included and it has not been possible to separate the number of employees reported.

6. The emphasis in this manpower study is on selected job skills that require significant lead-time training. Please be certain that manpower data reported represents the educational degrees, skills or training *required by the jobs*—not the disciplines or skills of the particular incumbents in the jobs. Some specific guides are provided to help establish a common understanding of the disciplines and job skills that are to be included in the various categories of the questionnaires.

7. The individual company data furnished for these questionnaires will be treated as confidential, except that it will be available to Government Defense Agencies for their own use in classified studies. Only customary industry group totals will be published by the Council.

8. Please complete each of the questionnaires applicable to your operation on a consolidated basis, i.e., include all data for your company and its principal majority-owned subsidiaries or affiliates. Detailed instructions are included for each questionnaire form enclosed. In the case of jointly owned companies (e.g., capline) please include the manpower for same if you are the operator even though you have less than a majority interest.

9. Please attach one of the cover pages being sent herewith to your report forms. The cover page only will show your company name. Filled in forms should be returned to Vincent M. Brown, Executive Secretary-Treasurer, National Petroleum Council, Suite 601, 1625 K Street, N.W., Washington, D.C. 20006.

A code number has been assigned by the NPC staff for your company, and the detailed forms will carry only the code number, the cover page having previously been removed. From this point on, tabulating will be done by the NPC staff on the basis of code number only. If you should have any further questions, or require additional copies of the questionnaire forms, please contact Mr. Vincent M. Brown.

APPENDIX A-2

INSTRUCTIONS RELATIVE TO QUESTIONNAIRE FORM NO. 1 (Page 1)

GENERAL COMMENTS

This questionnaire covers manpower located in the United States and engaged in domestic oil industry operations (including production and processing of natural gas). *Exclude* from this questionnaire any U.S. based manpower primarily engaged (50% or more of time) in *foreign* oil and natural gas activities.

Exclude manpower engaged in *petrochemical* and various nonpetroleum activities where it is possible to identify and separate them. Please indicate by footnote where significant chemical operations are included and it has not been possible to separate the number of employees reported.

Questionnaire No. 1 contains the following four Sections:

- Section I – Oil Company Manpower
- Section II – Contract Manpower
- Section III – Operating Information
- Section IV – Geographical Distribution of Company Manpower

Please complete all Sections.

FOOTNOTE REFERENCES

Section I

1. For the job skills listed under "I. Oil Company Manpower," you are asked to report totals for the *main functional divisions* of the oil industry (columns 1 through 11). To the extent possible, please limit the manpower included in these totals to jobs that are mainly concerned with the basic operating, maintenance and construction activities of each major functional division, i.e., Exploration, Production, Refining, Pipeline, Marketing, etc.

2. Include Natural Gas Liquids Processing.

3. Exclude, where possible, manpower engaged in manufacturing of petrochemicals.

4. Report crude and oil products pipeline manpower only. Include gathering and trunk lines.

5. Include tank car repair manpower, if any.

6. Report product delivery manpower under marketing (column 10). If not convenient to separate marketing portion, please report all Motor Truck manpower under marketing.

7. Exclude manpower employed to operate retail service stations. Also exclude, where possible, manpower engaged in sales or distribution of petrochemicals.

8. Manpower that provides various supporting services for one or more of the major functional divisions should be included in column 12 or 13 as appropriate. "All Other" (column 13) should include corporate officers and staff and others who cannot be identified with the basic activities of one particular major function (columns 1 through 11) or Centralized Engineering services (column 12). It is intended that the "All Other" supporting service (column 13) will include manpower in the following types of organizational units:

- Accounting
- Advertising
- Company Aircraft
- Credit
- Crude & Product Supply and Distribution Planning
- Data Processing
- Economics
- Employee Relations
- Industrial Relations
- Legal
- Market Research
- Office Services
- Oil Purchase & Exchange
- Personnel
- Public Relations
- Purchasing
- Security
- Tax
- etc.

9. Under "A. Skilled Jobs," please include all "exempt F.L.S.A." jobs and certain "nonexempt F.L.S.A." jobs as specified. Please observe the following guides for manpower to be included in the skilled job categories A.1 through A.9 on the form.

A.1 MANAGEMENT

Include officers, executives, middle management, department managers, plant managers, superintendents, directors and other "heads" where administrative skills outweigh technical or other specialized skill requirements of the job.

A.2-4 SCIENTISTS, ENGINEERS, & OTHER PROFESSIONALS

Please use the following guide for examples of degrees or disciplines to be included under these three categories. Include supervisory jobs where technical or professional skill requirements outweigh the administrative skill requirements. Please be certain that manpower data represents the type of technical degrees required by the jobs and not the disciplines or skills of the particular incumbents in the jobs.

Examples of Degree Requirements for Jobs to be Included Under "Scientists," "Engineers," and "Other Professionals"

<u>Engineering Degrees</u>	<u>Science Degrees</u>
Aeronautical Engineer	Biology
Chemical Engineer	Chemistry
Civil Engineer	General Science
Designs Engineer	Geology
Electrical Engineer	Geophysics
Electronic Engineer	Mathematics
Geological Engineer	Mineralogy
Industrial Engineer	Paleontology
Mechanical Engineer	Palynology
Metallurgical Engineer	Petrology
Mining Engineer	Physical Science
Petroleum Engineer	Physics
	Seismology
	Stratigraphy
	Thermodynamics

Other Professionals

Architecture & Design
Law
Medicine

NOTE: The following types of degrees should be considered "nontechnical" for this study. Exempt staff jobs specializing in these subjects will be reported in categories A.5 or A.6 of the Questionnaire form:

Accounting
Business Administration
Economics
Finance
Industrial Management

Industrial Relations
Languages
Liberal Arts
Library Science
Public Health
Public Relations
Transportation

A.5 STAFF, ANALYTICAL, SPECIALIST AND OTHER EXEMPT OFFICE AND CLERICAL JOBS (NONTECHNICAL)

This broad category should include "exempt F.L.S.A." jobs that *do not* require the special degrees or disciplines indicated for inclusion under the above technical and professional categories. Such jobs as Salesman, Landman, Creditman, Buyer, Accountant, Rate Analyst, etc., are included here. Include supervisory jobs below the levels indicated for the "Management" category.

A.6 ALL OTHER SKILLED EXEMPT JOBS (NONTECHNICAL)

This category will include certain Foreman jobs and any other exempt jobs that cannot be properly included in the other categories of "Skilled Jobs."

A.7 TECHNICIANS (NONEXEMPT)

Include jobs whose primary function is to assist scientists and engineers by performing the more simple types of technical work as directed. Include only jobs that require a level of skill equal to 2 years post high school education in courses typically offered at many technical institutes and junior colleges. Some typical technician assignments include Engineering Aide, Paleo Assistant, Laboratory Assistant, Draftsman, Surveyor, Seismology Crew Member, Geophysical Computer, and the like.

A.8 OPERATORS (NONEXEMPT)

This is intended to include only the highly skilled, fully qualified operators typically found in refinery processing units, pipeline station and field operations, and oil field and natural gas plant operations. Include only jobs that require a level of skill equivalent to 3-4 years on-the-job experience and/or formal training.

A.9 CRAFTSMEN (NONEXEMPT)

For each craft, report only manpower being compensated at pay rates for your fully qualified or journeyman levels and higher non-

exempt jobs. Do not include Helper or other apprentice levels.

10. Under "B. Semiskilled & Unskilled," include all jobs having skill requirements less than those specified or indicated for the various "Skilled Jobs" categories. These jobs will all be "nonexempt F.L.S.A." and normally do not require long periods of leadtime training, e.g., Helpers, Laborers, Typists, Stenographers, Sales Clerks, Credit Clerks, File/Mail Clerks, Truck Drivers, Warehousemen, and various operators of mechanical equipment.

11. Please provide totals for Oil Company Manpower as of mid-1967 under each column (1 through 14).

12. Give us your best estimate of comparable total manpower requirements as of mid-1972.

Section II

13. Under Section "II. Contract Manpower," please report approximate *average* manpower (all skill levels) supplied by contractors during 1967 for major functional divisions that typically use large amounts of contract manpower for maintenance and exploratory services. (Other sources of data are being used to estimate contract construction and drilling manpower.)

14. Exclude retail service station maintenance services.

INSTRUCTIONS RELATIVE TO QUESTIONNAIRE FORM NO. 1 (Page 2)

Section III

15. Section III requests certain statistics which will be used as a basis for estimating total industry manpower by emergency planning regions. Please report production and sales statistics that most closely relate to the manpower you report in Section I of Questionnaire No. 1.

Section IV

16. Section IV is intended to provide a further basis for estimating the distribution of industry

manpower throughout various regions of the U.S. For this purpose any convenient, consistent source of data may be used, and it is recognized that the total employees reported will not balance precisely with the total manpower reported in Section I of Questionnaire No. 1.

17. Include only employees engaged in oil industry activities. Exclude wherever possible, employees whose primary function is related to the production or sale of petrochemicals.

APPENDIX A-3

SAMPLE

National Petroleum Council Manpower Requirements Survey (1967)—Questionnaire No. 1

Manpower Engaged in United States Domestic Oil Industry Operations (Mid-1967)

Page 1 of Questionnaire No. 1
Code No. _____

(Please see Instruction Sheet. Footnote numbers correspond to Instruction Sheet numbers)

(NPC use only)

Job-Skill Requirements		Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions											Supporting Services Manpower		Totals
		Oil and Gas Extractions			Oil Refining	Traffic and Transportation				Marketing Sales, Plant and Product Delivery Operations	Research and Development	Central Engineering	All Other		
		Exploration	Land	Producing		Pipeline (Oils)	Rail	Motor Truck	Marine (U.S. Flag)						
Function Code →	Job Code ↓	01	02	03	04	05	06	07	08 Onshore	09 Vessels	10	11	12	13	14
I. Oil Company Manpower															
A. Skilled jobs:															
1. Management	100														
2. Scientists	210														
3. Engineers	220														
4. Other professionals	230														
5. Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	300														
6. All other skilled exempt jobs (nontechnical)	400														
7. Technicians (nonexempt)															
a) Draftsmen	501														
b) Technicians supporting scientists	502														
c) Technicians supporting engineers	503														
8. Operators (nonexempt)	600														
9. Craftsmen (nonexempt)															
a) Electricians	701														
b) Instrument mechanics	702														
c) Boilermakers	703														
d) Machinists	704														
e) Pipefitters	705														
f) Welders	706														
g) Maintenance mechanics	707														
h) Auto mechanics	708														
i) All other skilled craftsmen	709														
B. Semiskilled and unskilled jobs (nonexempt)	800														
C. TOTAL OIL COMPANY MANPOWER (MID-1967)	967														
D. ESTIMATED TOTAL OIL COMPANY MANPOWER (MID-1972)	972														
II. Contract Manpower—average 1967															
1. Maintenance services															
2. Exploration services (geophysical)															

Report only total marine vessels manpower.

**National Petroleum Council Manpower Requirements
Survey (1967)—Questionnaire No. 1 (Continued)**

Manpower Engaged in United States Domestic Oil Industry Operations (Mid-1967)

III. Operating Information

Company statistics and other data related to the work performed during 1967
by the manpower reported in Section I of this questionnaire: (Domestic United States only)

	Units	Average-1967
1. Gross crude oil production ^a	B/D	
2. Natural gas production	MCF/D	
3. Refinery runs of crude oil	B/D	
4. Refined product sales (ex-resid) ^b	B/D	
5. Crude and oil product pipelines		
a) Gathering lines		
b) Trunk lines		
	Total miles	
	Barrel-miles/day	

6. Location of research laboratories included in this report:

City	State	Total Employees

7. Location of refineries included in this report:

City	State	Crude Capacity BBLs./Cal. Day	Total Employees on Refinery Payroll ^c	Average Contract Maintenance Manpower

IV. Geographical Distribution of Company Manpower

For each state in which your company does business, please show the total number of employees on your payroll as of a convenient period around mid-1967. For this purpose no distinction is necessary between employees engaged in foreign or domestic activities.

State	Total Employees Mid-1967	State	Total Employees Mid-1967	State	Total Employees Mid-1967
1. Alabama		18. Kentucky		35. North Dakota	
2. Alaska		19. Louisiana		36. Ohio	
3. Arizona		20. Maine		37. Oklahoma	
4. Arkansas		21. Maryland		38. Oregon	
5. California		22. Massachusetts		39. Pennsylvania	
6. Colorado		23. Michigan		40. Rhode Island	
7. Connecticut		24. Minnesota		41. South Carolina	
8. Delaware		25. Mississippi		42. South Dakota	
9. District of Columbia		26. Missouri		43. Tennessee	
10. Florida		27. Montana		44. Texas	
11. Georgia		28. Nebraska		45. Utah	
12. Hawaii		29. Nevada		46. Vermont	
13. Idaho		30. New Hampshire		47. Virginia	
14. Illinois		31. New Jersey		48. Washington	
15. Indiana		32. New Mexico		49. West Virginia	
16. Iowa		33. New York		50. Wisconsin	
17. Kansas		34. North Carolina		51. Wyoming	
				52. Territories & Possessions	
				Total	

NOTES:

- a. Include royalty oil. Include only your company's share of unit production.
- b. Include bonded sales.
- c. Exclude employees primarily engaged in petrochemical activities.

APPENDIX A-4

Summary of 79 Oil Company Responses to NPC Questionnaire No. 1

Job Skill Requirements	Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Division										
	Function Code → Job Code ↓	Oil and Gas Extraction						Total Extraction Columns 01, 02, 03		Oil Refining	
		Exploration		Land		Producing		No.	%	No.	%
		01		02		03					
Oil Company Manpower		No.	%	No.	%	No.	%	No.	%	No.	%
Skilled jobs:											
Management	100	1,063	8.19	333	11.84	3,839	7.35	5,235	7.70	3,925	4.51
Scientists	210	4,884	37.62	10	0.36	517	0.99	5,411	7.95	863	0.99
Engineers	220	358	2.76	21	0.75	6,004	11.49	6,383	9.38	4,264	4.90
Other professionals	230	263	2.03	128	4.55	206	0.39	597	0.88	274	0.31
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	300	1,179	9.08	1,314	46.73	3,867	7.40	6,360	9.35	3,047	3.50
All other skilled exempt jobs (nontechnical)	400	459	3.54	131	4.66	4,150	7.95	4,740	6.97	4,804	5.52
Technicians (nonexempt)											
Draftsmen	501	1,039	8.00	231	8.21	234	0.45	1,503	2.21	407	0.47
Technicians supporting scientists	502	758	5.84	1	0.03	102	0.20	861	1.27	1,533	1.76
Technicians supporting engineers	503	238	1.83	2	0.07	1,133	2.17	1,373	2.02	1,402	1.61
Operators (nonexempt)	600	96	0.74	—	—	7,775	14.89	7,872	11.57	22,789	26.18
Craftsmen (nonexempt)											
Electricians	701	15	0.12	—	—	402	0.77	417	0.61	1,529	1.76
Instrument mechanics	702	31	0.24	—	—	376	0.72	407	0.60	1,665	1.91
Boilermakers	703	—	—	—	—	44	0.08	44	0.06	1,687	1.94
Machinists	704	1	—	—	—	100	0.19	101	0.15	2,912	3.35
Pipefitters	705	—	—	—	—	56	0.11	56	0.08	3,585	4.12
Welders	706	8	0.06	—	—	276	0.53	284	0.42	1,648	1.89
Maintenance mechanics	707	26	0.20	—	—	2,315	4.43	2,341	3.44	1,382	1.59
Auto mechanics	708	—	—	—	—	57	0.11	57	0.08	184	0.21
All other skilled craftsmen	709	265	2.04	—	—	5,606	10.73	5,871	8.63	6,655	7.65
Semiskilled and unskilled jobs (nonexempt)	800	2,300	17.71	641	22.80	15,173	29.05	18,114	26.63	22,487	25.83
TOTAL OIL COMPANY MANPOWER (MID-1967)	967	12,983	100.00	2,812	100.00	52,232	100.00	68,027	100.00	87,042	100.00
ESTIMATED TOTAL OIL COMPANY MANPOWER (MID-1972)	972	14,166	—	2,717	—	55,581	—	72,464	—	85,318	—
Percent increase (decrease) over 1967		9.11	—	(3.38)	—	6.41	—	6.35	—	(1.99)	—

Summary of 79 Oil Company Responses to NPC Questionnaire No. 1 (Continued)

Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions (Cont.)										Supporting Services Manpower						Totals			
Traffic and Transportation					Marine (U.S. Flag)		Marketing Sales, Plant and Product Delivery Operations		Research and Development		Central Engineering		All Other						
Pipeline (Oils)		Rail		Motor Truck		Onshore	Vessels												
05		06		07		08		09		10		11		12				13	
No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
882	5.16	56	12.34	133	5.28	190	14.15			8,345	8.29	564	4.09	179	6.00	5,629	8.45	25,138	6.83
24	0.14	-	-	-	-	-	-			197	0.20	3,306	23.99	14	0.47	437	0.66	10,252	2.78
673	3.94	7	1.54	2	0.08	162	12.06			2,419	2.40	1,905	13.82	1,416	47.46	787	1.18	18,018	4.89
34	0.20	-	-	-	-	70	5.21			395	0.39	336	2.44	66	2.21	2,909	4.37	4,681	1.27
1,384	8.10	191	42.07	171	6.79	248	18.47			28,178	27.98	621	4.51	339	11.36	17,070	25.63	57,609	15.64
2,179	12.76	13	2.86	24	0.95	67	4.99			9,407	9.34	266	1.93	83	2.78	1,810	2.72	23,393	6.35
147	0.86	-	-	-	-	3	0.22			448	0.44	121	0.88	305	10.22	388	0.58	3,322	0.90
56	0.33	-	-	-	-	-	-			63	0.06	2,192	15.91	12	0.40	139	0.21	4,856	1.32
427	2.50	-	-	-	-	-	-			115	0.11	948	6.88	89	2.98	196	0.29	4,550	1.24
3,690	21.60	-	-	95	3.78	76	5.66			3,918	3.89	294	2.13	-	-	800	1.20	39,534	10.73
562	3.29	-	-	-	-	12	0.89			22	0.02	63	0.46	4	0.13	45	0.07	2,654	0.72
56	0.33	1	0.22	-	-	3	0.22			5	-	99	0.72	-	-	51	0.08	2,287	0.62
4	0.02	2	0.44	-	-	-	-			16	0.02	-	-	-	-	39	0.06	1,792	0.49
73	0.43	-	-	5	0.20	26	1.94			12	0.01	122	0.89	-	-	55	0.08	3,306	0.90
144	0.84	-	-	-	-	2	0.15			47	0.05	83	0.60	22	0.74	56	0.08	3,995	1.08
291	1.70	13	2.86	-	-	9	0.67			12	0.01	29	0.21	7	0.24	32	0.05	2,325	0.63
442	2.59	15	3.30	39	1.55	63	4.69			2,170	2.16	94	0.68	9	0.30	180	0.27	6,735	1.83
17	0.10	18	3.97	293	11.64	-	-			933	0.93	53	0.38	-	-	53	0.08	1,608	0.44
972	5.69	7	1.54	6	0.24	46	3.43			4,519	4.49	543	3.94	37	1.24	728	1.09	19,384	5.26
5,026	29.42	131	28.86	1,749	69.49	366	27.25			39,493	39.21	2,142	15.54	402	13.47	35,207	52.85	125,117	33.97
17,083	100.00	454	100.00	2,517	100.00	1,343	100.00	7,756	100.00	100,714	100.00	^a 13,781	100.00	^a 2,984	100.00	66,611	100.00	368,312	100.00
17,084	-	522	-	2,685	-	1,349	-	7,559	-	106,749	-	15,480	-	3,248	-	67,179	-	379,637	-
-	-	0.15	-	0.07	-	-	-	(2.54)	-	6.04	-	11.95	-	8.83	-	0.85	-	3.07	-

^aFigures do not include R&D and Central Engineering Manpower that was reported as foreign but could be allocated to Domestic totals as follows:

Research: 650 Exempt Central Engineering: 105 exempt
377 Nonexempt

Summary of 79 Oil Company Responses to NPC Questionnaire No. 1 (Page 2)

Operating Information

Company statistics and other data related to the work performed during 1967 by the manpower reported in Section I of this questionnaire: (Domestic U.S. only)

	Units	Average-1967	Total U.S. Per Bureau Mines-1967	Percent of Total U.S. Covered by Survey Sample of 79 Companies
Gross crude oil production ^a	B/D	6,540,114	8,812,000 B/D	74.2%
Natural gas production	MCF/D	30,054,424	50,358,000 MCF/D*	59.7%
Refinery runs of crude oil	B/D	9,154,969	9,815,000 B/D	93.2%
Refined product sales (ex-resid) ^b	B/D	**		
Crude and oil product pipelines				
Gathering lines	Total miles	**		
Trunk lines	Barrel-miles/day	**		

*American Gas Assn. net prod.
**Not useable

Location of Research Laboratories included in this report:*

City	State	Total Manpower	Region	No.	%
			1	5,012	28.5
			2	3,802	21.6
			3	-	-
			4	1,318	7.5
			5	4,722	26.8
			6	301	1.7
			7	2,448	13.9
			8	-	-
			TOTAL . . .	17,603	100.0

*(Incl. subsequent R&E adjustment based on information from an international company)

Location of refineries included in this report:*

City	State	Region	Crude Capacity BBLs./Cal. Day		Total Employees On Refinery Payroll ^c		Average Contract Maintenance Manpower		Contract Manpower as % of Company Manpower
			No.	%	No.	%	No.	%	%
		1	628,500	6.3	5,428	6.2	345	6.3	6.4
		2	1,415,870	14.3	13,841	15.8	602	12.0	4.3
		3	171,900	1.7	721	0.8	187	4.0	25.9
		4	1,362,200	13.8	12,954	14.8	389	8.0	3.0
		5	4,008,000	40.6	34,998	40.1	1,963	39.0	5.6
		6	615,700	6.2	4,980	5.7	246	5.0	4.9
		7	1,372,400	13.8	12,777	14.6	1,208	24.1	9.5
		8	328,800	3.3	1,730	2.0	83	1.6	4.8
		TOTAL . . .	9,903,370	100.0	87,429	100.0	5,023	100.0	5.7

*Estimated total average contract manpower based on survey coverage of 93.2% of U.S. refinery capacity = 5,400 (1962 estimate was 5,500)

Geographical Distribution of Company Manpower

For each state in which your company does business, please show the total number of employees on your payroll as of a convenient period around mid-1967. For this purpose no distinction is necessary between employees engaged in foreign or domestic activities.

State	Total Employees Mid-1967	State	Total Employees Mid-1967	State	Total Employees Mid-1967	State	Total Employees Mid-1967
1. Alabama	1,610	14. Illinois	21,845	28. Nebraska	1,092	42. South Dakota	474
2. Alaska	686	15. Indiana	9,197	29. Nevada	166	43. Tennessee	1,833
3. Arizona	816	16. Iowa	1,806	30. New Hampshire	130	44. Texas	79,669
4. Arkansas	2,362	17. Kansas	6,775	31. New Jersey	10,741	45. Utah	1,974
5. California	47,211	18. Kentucky	4,780	32. New Mexico	2,464	46. Vermont	115
6. Colorado	4,544	19. Louisiana	24,197	33. New York	19,282	47. Virginia	2,544
7. Connecticut	1,615	20. Maine	658	34. North Carolina	2,230	48. Washington	3,460
8. Delaware	1,171	21. Maryland	3,610	35. North Dakota	1,170	49. West Virginia	1,333
9. District of Columbia	369	22. Massachusetts	2,866	36. Ohio	14,312	50. Wisconsin	2,662
10. Florida	3,723	23. Michigan	5,938	37. Oklahoma	26,550	51. Wyoming	3,708
11. Georgia	4,941	24. Minnesota	3,923	38. Oregon	1,536	52. Territories & Possessions	1,018
12. Hawaii	371	25. Mississippi	2,315	39. Pennsylvania	28,133	53. Sea going	1,468
13. Idaho	264	26. Missouri	5,261	40. Rhode Island	989		
		27. Montana	1,626	41. South Carolina	929		
						TOTAL	374,462

Recap of Item IV by OEP Regions:

Region	No.	%	Region	No.	%
1	36,396	9.71	6	24,830	6.63
2	56,252	15.02	7	50,538	13.50
3	17,581	4.70	8	7,572	2.02
4	43,565	11.64	Other	2,486	0.66
5	135,242	36.12			
			TOTAL	374,462	100.00

NOTES: a. Include royalty oil. Include only your company's share of unit production. b. Include bonded sales.
c. Exclude employees primarily engaged in petrochemical activities.

APPENDIX A-5

Estimated Total Oil Industry Manpower on Oil Company Payrolls (Mid-1967)

Job Skill Requirements	Function Code → Job Code ↘	Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions									Research and Development	Supporting Services Manpower		Totals (Excluding Marine)
		Oil and Gas Extraction			Total Extraction Columns 01, 02, 03	Oil Refining	Traffic and Transportation			Marketing		Central Engineering	All Other	
		Exploration	Land	Producing			Pipe-line (Oils)	Marine (U.S. Flag)						
					On-shore	Vessels								
		01	02	03		04	05	08	09	10	11	12	13	14
Oil Company Manpower														
Skilled jobs:														
Management	100	1,331	604	5,671	7,606	4,217	1,058	—	—	9,156	955	186	6,561	29,739
Scientists	210	6,113	18	764	6,895	926	29	—	—	212	5,602	15	513	14,192
Engineers	220	449	38	8,865	9,352	4,582	808	—	—	2,603	3,227	1,471	916	22,959
Other professionals	230	330	232	301	863	290	41	—	—	423	570	69	3,393	5,649
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	300	1,475	2,383	5,709	9,567	3,273	1,660	—	—	30,627	1,053	352	19,902	66,434
All other skilled exempt jobs (nontechnical)	400	575	238	6,133	6,946	5,161	2,615	—	—	10,135	451	86	2,112	27,506
Technicians (nonexempt)														
Draftsmen	501	1,300	418	347	2,065	440	176	—	—	479	205	316	450	4,131
Technicians supporting scientists	502	949	2	154	1,105	1,646	68	—	—	67	3,715	13	163	6,777
Technicians supporting engineers	503	297	4	1,674	1,975	1,505	513	—	—	122	1,606	92	225	6,038
Operators (nonexempt)	600	120	—	11,488	11,608	24,478	4,428	—	—	4,305	497	—	932	46,248
Craftsmen (nonexempt)														
Electricians	701	20	—	594	614	1,646	674	—	—	26	107	4	54	3,125
Instrument mechanics	702	39	—	555	594	1,785	68	—	—	7	168	—	62	2,684
Boilermakers	703	—	—	62	62	1,814	4	—	—	21	—	—	47	1,948
Machinists	704	—	—	147	147	3,132	88	—	—	19	208	—	62	3,656
Pipefitters	705	—	—	85	85	3,852	172	—	—	52	140	23	62	4,386
Welders	706	10	—	409	419	1,767	349	—	—	29	49	7	39	2,659
Maintenance mechanics	707	33	—	3,418	3,451	1,486	531	—	—	2,381	159	9	210	8,227
Auto mechanics	708	331	—	85	416	196	21	—	—	1,335	89	—	62	2,119
All other skilled craftsmen	709	—	—	8,277	8,277	7,153	1,166	—	—	4,862	920	39	847	23,264
Semiskilled and unskilled jobs (nonexempt)	800	2,878	1,163	22,412	26,453	24,151	6,031	—	—	44,389	3,629	418	41,038	146,109
TOTAL OIL COMPANY MANPOWER (MID-1967)	967	16,250	5,100	77,150	98,500	93,500	20,500	8,580	—	111,250 ^a	23,350	3,100	77,650	436,430
Allocation of supporting services manpower														
Central engineering		—	—	450	450	2,300	150	100	—	100	—	3,100	—	—
All other (prorated)		3,339	776	13,589	17,704	22,596	4,426	388	2,019	26,945	3,572	—	77,650	—
TOTAL OIL COMPANY MANPOWER INCLUDING ALLOCATION OF SUPPORTING SERVICES MANPOWER		19,589	5,876	91,189	116,654	118,396	25,076	11,087		138,295	26,922	—	—	436,430

^aOil Company payrolls only. Includes Rail and Motor Truck Manpower.

APPENDIX B

**Survey of United States Domestic
Natural Gas Pipeline Operations**

APPENDIX B-1

INSTRUCTIONS RELATIVE TO QUESTIONNAIRE FORM NO. 2

GENERAL COMMENTS

This questionnaire covers manpower located in the United States and engaged in natural gas pipeline operations (both interstate and intrastate) including extraction, field processing, gathering and transmission operations up to "city gates." A few of the natural gas pipeline companies receiving this questionnaire will also be asked to complete Questionnaire No. 1 covering their oil operations. In such cases, please be certain that Extraction and Supporting Services Manpower is reported only once.

Questionnaire No. 2 contains the following three Sections:

- Section I – Natural Gas Pipeline Company Manpower
- Section II – Contract Maintenance Manpower
- Section III – Statistics Related to Company Manpower Reported in Sections I and II.

FOOTNOTE REFERENCES

1. For the job skills listed under "I. Company Manpower," you are asked to report totals for the *main functional divisions* of the Natural Gas Pipeline Industry (columns 1 through 6). To the extent possible, please limit the manpower included in these totals to jobs that are mainly concerned with basic operating, maintenance and construction activities of the major functional divisions: Extraction, Pipeline Operations, and Research and Development. *Exclude all manpower related to distribution operations inside "city gates."*

2. Manpower that provides various supporting services for one or more of the major functional divisions should be included in column 7 or 8 as appropriate. *Exclude* all manpower related to distribution operations inside "city gates." "All Other" (column 8) should include corporate officers and staff and others who cannot be identified with the basic activities of one particular major function (columns 1 through 6) or "Central Engineering" (column 7). It is intended that "All Other" supporting service (column 8) will include

manpower in the following types of organizational units:

- Accounting
- Advertising
- Company Aircraft
- Credit
- Data Processing
- Economics
- Employee Relations
- Industrial Relations
- Legal
- Market Research
- Office Services
- Personnel
- Public Relations
- Purchasing
- Security
- Supply & Distribution Planning
- Tax
- etc.

3. Under "A. Skilled Jobs," please include all "exempt F.L.S.A." jobs and certain "nonexempt F.L.S.A." jobs as specified. Please observe the following guides for manpower to be included in the "Skilled Jobs" categories A.1 through A.9 on the form.

A.1 MANAGEMENT

Include officers, executives, middle management, department managers, plant managers, superintendents, directors and other "heads" where administrative skills outweigh technical or other specialized skill requirements of the job.

A.2-4 SCIENTISTS, ENGINEERS, & OTHER PROFESSIONALS

Please use the following guide for examples of degrees or disciplines to be included under these three categories. Include supervisory jobs where technical or professional skill requirements outweigh the administrative skill requirements. Please be certain that manpower data represents the type of technical degrees required by the jobs and not the disciplines or skills of the particular incumbents in the jobs.

Engineering Degrees

Aeronautical Engineer
Chemical Engineer
Civil Engineer
Designs Engineer
Electrical Engineer
Electronic Engineer
Geological Engineer
Industrial Engineer
Mechanical Engineer
Metallurgical Engineer
Mining Engineering
Petroleum Engineer

Science Degrees

Biology
Chemistry
General Science
Geology
Geophysics
Mathematics
Mineralogy
Paleontology
Palynology
Petrology
Physical Science
Physics
Seismology
Stratigraphy
Thermodynamics

Other Professionals

Architecture & Design
Law
Medicine

NOTE: The following types of degrees should be considered "nontechnical" for this study. Exempt staff jobs specializing in these subjects will be reported in categories A.5 or A.6 of the Questionnaire form.

Accounting
Business Administration
Economics
Finance
Industrial Management
Industrial Relations
Languages
Liberal Arts
Library Science
Public Health
Public Relations
Transportation

A.5 *STAFF, ANALYTICAL, SPECIALIST AND OTHER EXEMPT OFFICE AND CLERICAL JOBS (NONTECHNICAL)*

This broad category should include "exempt F.L.S.A." jobs that *do not* require the special degrees or disciplines indicated for inclusion under the above technical and professional categories. Such jobs as Salesman, Landman, Creditman, Buyer, Accountant, Rate Analyst, etc., are included here. Include supervisory jobs below the levels indicated for the "Management" category.

A.6 *ALL OTHER SKILLED EXEMPT JOBS (NONTECHNICAL)*

This category will include certain Foreman jobs and any other exempt jobs that cannot

be properly included in the other categories of "Skilled Jobs."

A.7 *TECHNICIANS (NONEXEMPT)*

Include jobs whose primary function is to assist scientists and engineers by performing the more simple types of technical work as directed. Include only jobs that require a level of skill equal to 2 years post high school education in courses typically offered at many technical institutes and junior colleges. Some typical technician assignments include Engineering Aide, Paleo Assistant, Laboratory Assistant, Draftsman, Seismology Crew Member, Geophysical Computer, and the like.

A.8 *OPERATORS (NONEXEMPT)*

This is intended to include only the highly skilled, fully qualified operators typically found in pipeline station and field operations, and oil field and natural gas plant operations. Include only jobs that require a level of skill equivalent to 3-4 years on-the-job experience and/or formal training.

A.9 *CRAFTSMEN (NONEXEMPT)*

For each craft, report only manpower being compensated at pay rates for your fully qualified or journeyman levels and higher non-exempt jobs. Do not include Helper or other apprentice levels.

4. Under "B. Semiskilled & Unskilled," include all jobs having skill requirements less than those specified or indicated for the various "Skilled Jobs" categories. These jobs will all be "nonexempt F.L.S.A." and normally do not require long periods of leadtime training, e.g., Helpers, Laborers, Typists, Stenographers, Sales Clerks, Credit Clerks, File/Mail Clerks, Truck Drivers, Warehousemen, and various operators of mechanical equipment.

5. Please provide totals for Company Manpower as of mid-1967 under each column (1 through 9).

6. Give us your best estimate of comparable total manpower requirements as of mid-1972.

Section II

7. Under Section "II. Contract Maintenance Manpower," please report approximate *average* manpower (all skill levels) supplied by contractors during 1967 for services in Extraction and Pipeline Operations.

APPENDIX B-2

National Petroleum Council Manpower Requirements Survey (1967)—Questionnaire No. 2
 Manpower Engaged in United States Domestic Natural Gas Pipeline Operations (Mid-1967)
 (Please see Instruction Sheet. Footnote numbers correspond to Instruction Sheet numbers)

SAMPLE

Code No. _____
 (NPC use only)

Job Skill Requirements		Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions						Supporting Services Manpower		Totals
		Natural Gas Extraction			Natural Gas Pipeline Operations		Research and Develop- ment	Central Engineering	All Other	
		Explora- tion	Land	Produc- ing	Gathering and Processing	Transmission				
Function Code →	01	02	03	04	05	06	07	08	09	
I. Company Manpower	Job Code ↓									
A. Skilled jobs:										
1. Management	100									
2. Scientists	210									
3. Engineers	220									
4. Other professionals	230									
5. Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical) . .	300									
6. All other skilled exempt jobs (nontechnical)	400									
7. Technicians (nonexempt)										
a) Draftsmen	501									
b) Technicians supporting scientists	502									
c) Technicians supporting engineers	503									
8. Operators (nonexempt)	600									
9. Craftsmen (nonexempt)										
a) Electricians	701									
b) Instrument mechanics	702									
c) Boilermakers	703									
d) Machinists	704									
e) Pipefitters	705									
f) Welders	706									
g) Maintenance mechanics	707									
h) Auto mechanics	708									
i) All other skilled craftsmen	709									
B. Semiskilled and unskilled jobs	800									
C. TOTAL COMPANY MANPOWER (MID-1967)	967									
D. ESTIMATED TOTAL COMPANY MAN- POWER (MID-1972)	972									
II. CONTRACT MAINTENANCE MANPOWER (AVERAGE 1967)										
TOTAL SKILLED AND UNSKILLED										
III. STATISTICS RELATED TO COMPANY MAN- POWER REPORTED ABOVE:										
1. Miles of field and gathering lines _____ miles										
2. Miles of transmission mains _____ miles										
3. Peak day send out capacity _____ MMCF										
4. 1967 gas operating revenues from resale. _____ \$										

APPENDIX B-3

Summary of 36 Gas Transmission Company Responses to NPC Questionnaire No. 2

Job Skill Requirements	Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions										Supporting Services Manpower				Totals		
	Natural Gas Extraction			Natural Gas Pipeline Operations				Research and Development			Central Engineering		All Other				
	Exploration	Land	Producing	Gathering and Processing		Transmission		Research and Development			Central Engineering		All Other				
Function Code →	01	02	03	04		05		06			07		08		09		
Job Code ↓	No.	No.	No.	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
Company Manpower																	
Skilled jobs:																	
Management	100	111	43	165	240	4.66	1,162	5.88	9	11.84	209	10.00	1,003	11.75	2,942	7.42	
Scientists	210	115	-	35	35	.68	14	.07	7	9.21	12	.57	32	.38	250	.63	
Engineers	220	78	4	221	148	2.88	489	2.48	35	46.05	599	28.65	231	2.71	1,805	4.55	
Other professionals	230	8	9	9	2	.04	108	.55	-	-	13	.62	243	2.85	392	.99	
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	300	60	139	88	130	2.53	747	3.78	14	18.42	177	8.46	1,634	19.15	2,989	7.54	
All other skilled exempt jobs (nontechnical)	400	17	5	336	276	5.36	1,178	5.97	1	1.32	163	7.80	502	5.88	2,478	6.25	
Technicians (nonexempt)																	
Draftsmen	501	30	23	26	47	.91	75	.38	1	1.32	408	19.51	68	.80	678	1.71	
Technicians supporting scientists	502	6	-	2	7	.14	79	.40	1	1.32	4	.19	2	.02	101	.25	
Technicians supporting engineers	503	17	-	41	28	.54	432	2.19	5	6.57	101	4.83	151	1.77	775	1.96	
Operators (nonexempt)	600	5	-	662	1,022	19.85	4,422	22.39	-	-	-	-	37	.43	6,148	15.51	
Craftsmen (nonexempt)																	
Electricians	701	2	-	6	43	.84	124	.63	-	-	-	-	23	.27	198	.50	
Instrument mechanics	702	-	-	82	172	3.34	162	.82	-	-	3	.14	41	.48	460	1.16	
Boilermakers	703	-	-	-	-	-	2	.01	-	-	-	-	-	-	2	.01	
Machinists	704	-	-	-	55	1.07	127	.64	-	-	-	-	18	.21	200	.51	
Pipefitters	705	-	-	-	10	.19	23	.12	-	-	-	-	-	-	33	.08	
Welders	706	-	-	33	58	1.13	440	2.23	-	-	-	-	48	.56	579	1.46	
Maintenance mechanics	707	2	-	138	211	4.10	1,087	5.50	-	-	-	-	22	.26	1,460	3.68	
Auto mechanics	708	-	-	10	47	.91	69	.35	-	-	39	1.87	11	.13	176	.44	
All other skilled craftsmen	709	15	7	344	466	9.05	950	4.81	1	1.32	7	.33	250	2.93	2,040	5.15	
Semiskilled and unskilled jobs	800	121	56	973	2,151	41.78	8,057	40.80	2	2.63	356	17.03	4,217	49.42	15,933	40.20	
TOTAL COMPANY MANPOWER (MID-1967)	967	587	286	3,171	5,148	100.00	19,747	100.00	76	100.00	2,091	100.00	8,533	100.00	39,639	100.00	
ESTIMATED TOTAL COMPANY MANPOWER (MID-1972)	972	614	292	3,027	5,129		19,848		86		2,289		9,004		40,289		
Percent Increase or Decrease 1972 over 1967		+4.60	+2.10	-4.54	-37		+51		+13.16		+9.47		+5.52		+1.64		
CONTRACT MAINTENANCE MANPOWER (AVERAGE 1967)																	
TOTAL SKILLED AND UNSKILLED		- 150 -			- 705 -												
STATISTICS RELATED TO COMPANY MANPOWER REPORTED ABOVE																	
Miles of field and gathering lines	60,851 miles		196,892 miles or 69.2 percent of United States Total (284,430 miles)														
Miles of transmission mains	136,041 miles																
Peak day send out capacity	65,517 MMCF																
1967 gas operating revenues from resale.	3,964,919,356 \$		88.1 percent of United States Total (\$4,501,394,000)														

APPENDIX B-4

Estimated Total Gas Gathering and Transmission Manpower in United States

Job Skill Requirements		Manpower Engaged in Operations, Maintenance and Construction Activities of Principal Industry Divisions						Supporting Services Manpower ^a		Totals
		Natural Gas Extraction			Natural Gas Pipeline Operations		Research and Develop- ment	Central Engineering	All Other	
		Explora- tion	Land	Produc- ing	Gathering and Processing	Transmission				
Function Code →	01	02	03	04	05	06	07	08	09	
Company Manpower	Job Code ↓									
Skilled jobs:										
Management	100				253	1,946	11	245	1,166	3,621
Scientists	210				37	23	8	14	38	120
Engineers	220				156	821	42	702	269	1,990
Other professionals	230				2	182	-	15	283	482
Staff, analytical, specialist and other exempt office and clerical jobs (nontechnical)	300				137	1,251	17	207	1,900	3,512
All other skilled exempt jobs (nontechnical) Technicians (nonexempt)	400				291	1,976	1	191	583	3,042
Draftsmen	501	INCLUDED ON U. S. SUMMARY QUESTIONNAIRE NO. 1			50	126	1	478	79	734
Technicians supporting scientists	502				8	132	1	5	2	148
Technicians supporting engineers	503				29	725	6	119	175	1,054
Operators (nonexempt)	600				1,079	7,411	-	-	43	8,533
Craftsmen (nonexempt)										
Electricians	701				46	209	-	-	27	282
Instrument mechanics	702				182	271	-	3	48	504
Boilermakers	703				-	3	-	-	-	3
Machinists	704				58	212	1	-	21	292
Pipefitters	705				10	40	-	-	-	50
Welders	706				61	738	-	-	56	855
Maintenance mechanics	707				223	1,821	-	-	26	2,070
Auto mechanics	708				50	116	-	46	13	225
All other skilled craftsmen	709				492	1,592	-	8	291	2,383
Semiskilled and unskilled jobs	800				2,271	13,505	2	417	4,905	21,100
TOTAL COMPANY MANPOWER (MID-1967)	967				5,435	33,100	90	2,450	9,925	51,000
ESTIMATED TOTAL COMPANY MANPOWER (MID-1972)	972									

^aExcludes Manpower Supporting the Extraction function which has been summarized in total on Questionnaire No. 1.

APPENDIX C

Survey of Foreign Oil and Natural Gas Operations (United States Citizens Only)

APPENDIX C-1

INSTRUCTIONS RELATIVE TO QUESTIONNAIRE FORM NO. 3

UNITED STATES CITIZENS ASSIGNED ABROAD OR OTHERWISE ENGAGED IN SUPPORTING FOREIGN OIL AND NATURAL GAS OPERATIONS

GENERAL COMMENTS

1. Each company receiving this questionnaire is requested to report all U.S. citizens on their respective payrolls who are primarily engaged in foreign oil or natural gas activities. This should include U.S. based employees as well as foreign based. For the purposes of this questionnaire, those "primarily engaged" should include jobs spending more than 50% of the time in foreign oil or natural gas activities.

2. Please note that the following jointly owned companies are being asked to complete this questionnaire covering employees on their payrolls:

American Independent Oil Company
American Overseas Oil Company
Arabian American Oil Company
Caltex Oil Corporation
Oasis Oil Company of Libya, Inc.

Companies who have employees on loan to Iranian Oil Participants, Ltd., should include such employees on their individual reports.

3. Each company receiving this questionnaire should include employees who are on the payroll of subsidiary companies in which a majority interest is maintained.

4. Reported data should include any of your employees carried on the payroll of and paid by another subsidiary or operating company simply as a service to your company. Thus, each reporting company should exclude such employees carried on its payroll which fall under foregoing definition.

5. For joint ventures where one of the participating companies acts as operator, each participating company should report any employees

on their payroll they may have assigned to the project.

6. Reported data should *not* include employees who are on special temporary assignment working on foreign oil or natural gas activities, unless they are primarily engaged in such work on a normal basis.

FOOTNOTE REFERENCES

1. You are asked to submit manpower data on *exempt* F.L.S.A. jobs segregated into seven major functional groups (Items A.1 through A.7). Assignment to a functional group should include only those directly involved in the basic function itself. All others should be counted under "Supporting Services" (Item A.8). Below is a list to guide you in deciding which degree category a job is to be assigned within the functional group. Count manpower in any degree category where you would expect the incumbent to have certain educational background, even though the discipline is not being directly applied in performing the job.

Finally, be certain that manpower data represents the types of technical degrees *required by the jobs* and not the disciplines or skills of the particular incumbents in the jobs.

2. Include only positions with broad responsibilities, i.e., responsibility for two or more of the oil industry's major functional areas (Items A.2 through A.7), including those jobs which cannot be assigned to one of the major functional areas.

3. Includes such activities as employee and industrial relations, accounting, corporate, legal, government relations, taxes, purchasing, economics, aircraft operations, general administration, etc.

Examples of Degrees to be Included in the Various Categories of Job Requirements

Engineering Degrees

Aeronautical Engineer
 Chemical Engineer
 Civil Engineer
 Design Engineer
 Electrical Engineer
 Electronic Engineer
 Geological Engineer
 Industrial Engineer
 Mechanical Engineer
 Metallurgical Engineer
 Mining Engineer
 Petroleum Engineer

Earth Science Degrees

Geology
 Geophysics
 Mineralogy
 Paleontology
 Palynology
 Petrology
 Seismology
 Stratigraphy

Other Technical or Science Degrees

Biology
 Chemistry
 General Science
 Mathematics
 Medicine
 Physical Science
 Physics
 Thermodynamics

Nontechnical Degrees

Business Administration
 Economics
 Finance
 Industrial Management
 Industrial Relations
 Languages
 Law
 Liberal Arts
 Psychology
 Public Relations
 Transportation

APPENDIX C-2

Code No. _____
(NPC use only)

National Petroleum Council Manpower Requirements Survey (1967)—Questionnaire No. 3

United States Citizens Assigned Abroad or Otherwise Engaged in Supporting Foreign Oil and Natural Gas Operations
(Please see Instruction Sheet. Footnote numbers correspond to Instruction Sheet numbers)

U.S. Citizens on Oil Company Payrolls Only	Location Code	01	02	03	04	05	06	07	08	09	10
	Job Code	U.S.	Canada	Venezuela	Other Western Hemis.	Western Europe	Africa	Middle East	Far East	Unallo- cated	Total
A. Exempt jobs¹											
1. Executive and general management ²	100										
2. Exploration, production, land and natural gas processing -Jobs that require:											
a) Earth Science Degree	210										
b) Engineer Degree	211										
c) Other Technical Degree	212										
d) Nontechnical Degree; no Degree	213										
3. Transportation and traffic (exclude tanker personnel) -Jobs that require:											
a) Engineer Degree	311										
b) Other Technical Degree	312										
c) Nontechnical Degree; no Degree	313										
4. Oil refining -Jobs that require:											
a) Engineer Degree	411										
b) Other Technical Degree	412										
c) Nontechnical Degree; no Degree	413										
5. Marketing -Jobs that require:											
a) Engineer Degree	511										
b) Other Technical Degree	512										
c) Nontechnical Degree; no Degree	513										
6. Research and development -Jobs that require:											
a) Engineer Degree	611										
b) Other Technical Degree	612										
c) Nontechnical Degree; no Degree	613										
7. Central/general engineering -Jobs that require:											
a) Engineer Degree	711										
b) Other Technical Degree	712										
c) Nontechnical Degree; no Degree	713										
8. Other supporting services ³ -Jobs that require:											
a) Engineer Degree	811										
b) Other Technical Degree	812										
c) Nontechnical Degree; no Degree	813										
9. Others (please specify)											
a)	911										
b)	912										
10. TOTAL	950										
B. JOBS WHICH ARE SUBJECT TO OVERTIME PROVISIONS OF F.L.S.A. WHEN BASED IN UNITED STATES	999										

APPENDIX C-3

Summary of 37 Oil Company Responses to NPC Questionnaire No. 3

United States Citizens Assigned Abroad or Otherwise Engaged in Supporting Foreign Oil and Natural Gas Operations

U.S. Citizens on Oil Company Payrolls Only	Location Code	01	02	03	04	05	06	07	08	09	10	Total Identified	Total Identified and Not Identified
	Job Code	U.S.	Canada	Venezuela	Other Western Hemis.	Western Europe	Africa	Middle East	Far East	Unallocated	Total Identified		
Exempt jobs													
Executive and general management	100	139	53	20	106	80	47	28	50	5	528	-	528
Exploration, production, land and natural gas processing													
-Jobs that require:													
Earth Science Degree	210	184	98	53	53	156	237	54	107	18	960	66	1,026
Engineer Degree	211	122	43	192	50	71	220	114	96	6	914	56	970
Other Technical Degree	212	28	15	-	11	3	22	1	1	2	83	2	85
Nontechnical Degree; no Degree	213	96	192	63	44	34	177	107	23	1	737	49	786
Transportation and traffic (exclude tanker personnel)													
-Jobs that require:													
Engineer Degree	311	235	-	9	5	49	3	10	19	-	330	-	330
Other Technical Degree	312	8	-	-	-	4	-	1	-	-	13	-	13
Nontechnical Degree; no Degree	313	227	-	16	19	17	36	23	9	-	347	-	347
Oil refining													
-Jobs that require:													
Engineer Degree	411	92	3	71	81	77	21	48	89	-	482	-	482
Other Technical Degree	412	-	-	5	10	5	4	2	2	-	28	-	28
Nontechnical Degree; no Degree	413	19	-	17	45	34	26	21	16	-	178	-	178
Marketing													
-Jobs that require:													
Engineer Degree	511	115	-	7	29	9	2	-	39	-	201	24	225
Other Technical Degree	512	1	-	-	4	4	-	-	-	-	9	7	16
Nontechnical Degree; no Degree	513	298	1	9	82	89	30	9	50	1	569	137	706
Research and development													
-Jobs that require:													
Engineer Degree	611	-	-	2	-	7	4	14	-	-	27	4	31
Other Technical Degree	612	-	-	-	-	8	3	-	-	-	11	5	16
Nontechnical Degree; no Degree	613	-	-	-	-	4	-	-	-	-	4	1	5
Central/general engineering													
-Jobs that require:													
Engineer Degree	711	293	-	23	5	113	62	128	20	-	644	-	644
Other Technical Degree	712	7	-	-	-	-	-	-	-	-	7	-	7
Nontechnical Degree; no Degree	713	9	-	-	1	16	5	18	9	-	58	-	58
Other supporting services													
-Jobs that require:													
Engineer Degree	811	184	3	8	6	31	7	27	5	1	272	-	272
Other Technical Degree	812	144	-	1	2	26	16	57	-	-	246	-	246
Nontechnical Degree; no Degree	813	2,384	7	249	137	354	338	601	130	11	4,211	-	4,211
Others (please specify)													
School teachers	911	-	-	22	-	-	-	-	-	-	22	-	22
All others	912	66	-	-	1	15	53	4	1	-	140	-	140
TOTAL IDENTIFIED	950	4,651	415	767	691	1,206	1,313	1,267	666	45	11,021		
Other exempt-not identified		161	5	54	92	24	8	4	1	2		351	
TOTAL EXEMPT		4,812	420	821	783	1,230	1,321	1,271	667	47			11,372
TOTAL NON-EXEMPT	999	3,294	41	-	-	1	7	319	-	1			3,663
TOTAL EXEMPT AND NON-EXEMPT		8,106	461	821	783	1,231	1,328	1,590	667	48			15,035

APPENDIX D

**Survey of United States Domestic Natural Gas
Distribution Industry Operations**

APPENDIX D-1

NATIONAL PETROLEUM COUNCIL

(Established by the Secretary of the Interior)

J. C. Donnell II
Chairman
Jack H. Abernathy
Vice-Chairman

April 24, 1968

Vincent M. Brown
Secretary-Treasurer
Maxwell S. McKnight
Asst. Secretary-Treasurer

TO GAS DISTRIBUTION COMPANY OFFICIALS

Gentlemen:

The National Petroleum Council is an oil and gas industry advisory committee to the Secretary of the Interior. Its membership includes the President of the American Gas Association and 14 gas transmission or distribution company heads.

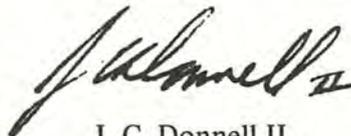
The Council has conducted several studies of the oil and gas industries' manpower needs in the past, the most recent being the 1963 report "Petroleum and Gas Industries Manpower Requirements." The Department of the Interior has asked the Council to update the 1963 report and expand it to cover Americans in foreign operations and future requirements for earth scientists and engineers. The study is also to include for the first time in NPC studies the level of employment and manpower balance in the natural gas distribution industry.

Your participation in this effort is earnestly requested. Attached is a letter from Mr. Buell G. Duncan, AGA President, concerning the survey. In view of the importance of the oil and gas industries to the national security, the joint efforts of the Government and these industries are necessary to assure that we will have adequate information and be properly prepared to meet any emergency. Adequate manpower, of course, is a critical item in any emergency.

The NPC Committee on Manpower Requirements in the Petroleum and Gas Industries has prepared the enclosed questionnaire. I would appreciate your filling out one of these for your Company's operations and sending the completed form to Mr. Vincent M. Brown, Executive Secretary, NPC, Suite 601, 1625 K Street, N.W., Washington, D.C. 20006. We would like to have your response by Monday, May 20. Compilation of the data will be made by the Council staff. No individual company data will be disclosed; the report will contain aggregate figures only.

Your participation in this important survey will be extremely valuable to Government in its efforts in preparing for any national emergency or disaster. Thank you for your cooperation.

Sincerely,



J. C. Donnell II

SAMPLE

**AMERICAN GAS ASSOCIATION
Inc.**

605 Third Avenue • New York, N.Y. 10016 Area Code 212—Telephone 972-5500

BUELL G. DUNCAN
President

April 24, 1968

TO GAS COMPANY MEMBER DELEGATES:

**SUBJECT: STUDY OF MANPOWER REQUIREMENTS IN THE
AMERICAN GAS DISTRIBUTION INDUSTRY**

Gentlemen:

Present needs to have a more precise understanding of manpower requirements in the petroleum and gas industries in the event of a national emergency have resulted in an assignment by the Department of the Interior to the National Petroleum Council to make a study of such matters.

The American Gas Association and representatives of the gas distribution industry, in association with the National Petroleum Council, are making every effort to provide Interior with a factual and complete statement of manpower requirements "within the city gates."

This is the first national study of manpower in gas distribution in many years. We anticipate, consequently, that the results of this study will be particularly influential in considerations relating to national emergency.

I encourage you to assist the industry in making its needs clearly understood by cooperating fully in this survey.

Cordially,



Buell G. Duncan:mhs

P.S. Attached is a listing of National Petroleum Council Manpower Committee members.

**NATIONAL PETROLEUM COUNCIL
STUDY OF MANPOWER REQUIREMENTS IN THE
PETROLEUM AND GAS INDUSTRIES**

**PARTIAL LISTING OF MANPOWER
COMMITTEE MEMBERS**

Chairman, Committee on
Petroleum and Gas Industry
Manpower Requirements

Mr. Stanley Learned
Vice Chairman of the Board
Phillips Petroleum Company
Phillips Building
Bartlesville, Oklahoma 74003

Chairman, Technical Subcommittee
on Petroleum and Gas Industry
Manpower Requirements

Mr. Frank W. Piersol, Manager
Department on Organization
Standard Oil Company of California
225 Bush Street
San Francisco, California 94120

Secretary, Technical Subcommittee

Mr. Maxwell S. McKnight
Assistant Secretary-Treasurer
National Petroleum Council
1625 K Street, N.W.
Washington, D.C. 20006

Task Force on the Gas
Distribution Industry

Mr. Richard H. Bussard
Vice President-Operations
Washington Gas Light Company
1100 H Street, N.W.
Washington, D.C. 20005

Mr. W. Dale McElroy
Vice President-Operations
United Gas Improvement Company
1401 Arch Street
Philadelphia, Pennsylvania 19105

Mr. Stanley A. Rogers
Director of Placement
Columbia Gas System Service Corporation
1600 Dublin Road
Columbus, Ohio 43212

SAMPLE

NATIONAL PETROLEUM COUNCIL
STUDY OF MANPOWER REQUIREMENTS IN THE
PETROLEUM AND GAS INDUSTRIES

PARTIAL LISTING OF MANPOWER
COMMITTEE MEMBERS

APPENDIX D-2

NATIONAL PETROLEUM COUNCIL

**SURVEY OF 1967 ACTUAL AND 1972 ESTIMATED MANPOWER
REQUIREMENTS OF THE GAS DISTRIBUTION INDUSTRY**

NATIONAL PETROLEUM COUNCIL

SURVEY OF 1967 ACTUAL AND 1972 ESTIMATED MANPOWER REQUIREMENTS OF THE GAS DISTRIBUTION INDUSTRY

INSTRUCTIONS FOR COMPLETING QUESTIONNAIRE

The attached questionnaire on manpower in the gas distribution industry is designed to provide information on the *total* manpower which the gas distribution industry requires. Accordingly, information is sought on contract workers as well as company officers and employees.

To provide information consistent with manpower information for other industries and to provide a basis for future planning, employment and contract worker information is requested relating to your firm's manpower in July, 1967 and to your firm's estimated manpower requirements in July, 1972.

The occupational breakout in this questionnaire is identical to that employed by the U.S. Department of Labor and other federal agencies. Firms supplying manpower information to these agencies on a regular basis will find they have directly comparable data already on hand.

To assist the Council in consolidating this survey data, please keep the following definitions clearly in mind:

EMPLOYEE—An individual on the payroll of your firm, or an officer of your firm, for whom payroll tax information is filed with government agencies.

CONTRACT WORKER—An individual performing services for your firm who is on the payroll of another company. This category includes employees of construction, maintenance, food service, and similar organizations with whom you have or expect to have contractual relationships during the months of July, 1967 and July, 1972. For most firms such contract workers will be working on construction jobs, providing food or building services, or be employees of temporary manpower agencies.

MANAGERS—Employees whose principal function is managerial. Employees whose function is predominantly non-managerial should be classified in another category, even though they carry the title of manager or supervisor. This category does include salaried foremen who are members of management.

PROFESSIONAL OCCUPATIONS—This category includes employees who are performing the work of a recognized profession usually requiring four (4) or more years college training. Employees should be categorized by the nature of their work, not their college degree. For example, employees with engineering degrees who are performing nonengineering work should not be categorized as being in an engineering occupation.

SKILLED AND SEMISKILLED OCCUPATIONS—Many manual occupation families contain both skilled and semiskilled jobs. For example, a *master carpenter* is skilled while a *rough carpenter* is semiskilled. Employees should be categorized as being in a skilled craft occupation only if they are performing work which typically requires performance at the journeyman or master craftsman level and typically requires training equivalent to an apprenticeship.

SERVICE OCCUPATIONS—Includes attendants, restaurant workers, cleaners, elevator operators, firemen, guards, watchmen, doorkeepers, stewards, janitors, waiters and escorts who do not perform clerical duties.

Messengers are classified as being in a clerical occupation.

Please mail your completed questionnaire by Monday, May 20, to Vincent M. Brown, Executive Secretary, National Petroleum Council, 1625 K Street, N.W., Suite 601, Washington, D.C. 20006.

**NATIONAL PETROLEUM COUNCIL
SURVEY OF 1967 ACTUAL AND 1972 ESTIMATED MANPOWER
REQUIREMENTS OF THE GAS DISTRIBUTION INDUSTRY**

Company Name

Address

	Actual	Estimated
Occupation Group	Number of Employees July, 1967	Number of Employees July, 1972

A. COMPANY OFFICERS AND EMPLOYEES

1. OFFICIALS AND MANAGERS

(Occupations requiring administrative personnel who set broad policies, exercise overall responsibility for execution of these policies, and direct individual departments or special phases of a firm's operations.)

2. PROFESSIONAL OCCUPATIONS

(Occupations requiring either college graduation or experience of such kind and amount as to provide a comparable background.)

- a. Engineers in research and development engineering
- b. Engineers in sales engineering
- c. Engineers performing other engineering assignments
- d. Physical, chemical, and earth scientists
- e. Programmers (professional level)
- f. Accountants, statisticians, financial analysts, and auditors
- g. Lawyers
- h. Other professional employees

3. TECHNICIAN OCCUPATIONS

(Occupations requiring a combination of basic scientific knowledge and manual skill which can be obtained through about two (2) years of post high school education such as is offered in many technical institutes and junior colleges.)

- a. Draftsmen
- b. Surveyors
- c. Technicians in research and development
- d. Programmers (sub-professional)
- e. Other technicians and kindred employees

4. SALES OCCUPATIONS

(Occupations engaging wholly or primarily in *direct* selling.)

**NATIONAL PETROLEUM COUNCIL
SURVEY OF 1967 ACTUAL AND 1972 ESTIMATED MANPOWER
REQUIREMENTS OF THE GAS DISTRIBUTION INDUSTRY**

Occupation Group	Actual Number of Employees July, 1967	Estimated Number of Employees July, 1972
5. OFFICE AND CLERICAL OCCUPATIONS		
(Includes all clerical-type work regardless of level of difficulty, where the activities are predominantly nonmanual.)		
a. Computer operators	_____	_____
b. Office machine operators	_____	_____
c. Meter readers	_____	_____
d. Secretarial, bookkeeper, and other clerical occupations	_____	_____
<hr/> <hr/>		
6. SKILLED CRAFT OCCUPATIONS		
(Manual workers of relatively high skill level having a thorough and comprehensive knowledge of the processes involved in their work. Exercise considerable judgment and usually receive an extensive period of training.)		
a. Foremen not in management	_____	_____
b. Construction craftsmen	_____	_____
1. Electricians	_____	_____
2. Plumbers and pipe fitters	_____	_____
3. Carpenters	_____	_____
4. Excavating and grading machine operators	_____	_____
5. Other construction craftsmen	_____	_____
c. Craftsmen other than Construction	_____	_____
1. Mechanics and repairmen	_____	_____
2. Metal workers other than mechanics	_____	_____
3. Utility customer servicemen	_____	_____
4. Gas manufacturing operators	_____	_____
5. Other nonconstruction craftsmen	_____	_____
<hr/> <hr/>		
7. SEMISKILLED OPERATIVE OCCUPATIONS		
(Workers who operate vehicles, machines or processing equipment or perform other manual duties of intermediate skill which can be mastered in only a few weeks and require only limited training.)		
a. Semiskilled metal workers	_____	_____
b. Bus, truck, and tractor drivers	_____	_____
c. Equipment operators and other semiskilled workers	_____	_____
<hr/> <hr/>		
8. UNSKILLED WAREHOUSEMEN AND LABORERS		
(Workers in manual occupations which generally require no special training. Perform elementary duties that may be learned in a few days and require the application of little or no independent judgment.)		
<hr/> <hr/>		

APPENDIX D-3

GAS DISTRIBUTION INDUSTRY

DATA SOURCES AND SURVEY METHODS

There being no known published study of employment in the United States gas distribution industry, a survey of companies in the industry was made to acquire actual 1967 and forecasted 1972 employment data. Data on contract workers was also acquired during this survey.

The survey methodology was as follows:

Step 1—The American Gas Association provided a stratified sample of gas distribution companies in accordance with the following:

a. The universe from which the companies to be sampled were selected was comprised of companies whose aggregate activities totaled somewhat more than 98 percent of those in the United States.

b. The sample companies were exclusively concerned with gas distribution or were able to segregate gas distribution employees from those employed in other activities.

c. Total employment in the sample companies comprised more than 50 percent of total United States gas distribution employment in 1965. This 50 percent criterion was met for each OCD/OEP region as well as for the total United States.

d. The companies were selected to be representative of company size in each OCD/OEP region as well as in the total United States. This criterion was required since occupation profiles vary with company size.

Step 2—In early summer of 1968, 115 companies, representing 50.5 percent of United States gas distribution employment in 1965, were contacted and requested to provide employee and contract worker census information for 1967 and 1972.

Through repeated followups, responses from 72 companies were obtained by mid-September, 1968. Aggregate employment of these 72 companies was 66,306 in 1965, an amount equal to 39.0 percent of the total industry census in 1967.

The 72 returns were compared with the 115-company sample in terms of the same criteria discussed above. It was determined that the returns provided an acceptable basis for conclusions on total United States employment, but not for separate region-by-region conclusions.

Step 3—Specific data on the sample companies is given below, as are the multiplying factors used to extrapolate to total United States 1967 occupation census data.

Multiplying Factors to be Used to Extrapolate from Survey Data to Total Regional and United States Data

OCD/OEP Region	Employees in Gas Distribution (1965)		Employees in Companies Returning Completed Questionnaire (1965 Census)		Multiplying Factor (Reciprocal of 1965 % of Regional Census)
	No.	% of Total U.S.	No.	% of 1965 Regional Census	
1	30,800	18.1	14,896	48.4	2.068
2	37,700	22.2	16,974	45.0	2.221
3 ^a	10,200	6.0	282	2.8	Not Applicable
4	32,400	19.1	16,266	50.2	1.992
5	20,800	12.2	4,797	23.1	4.336
6	13,900	8.2	3,497	25.2	3.975
7	20,400	12.0	9,046	44.3	2.255
8 ^b	3,800	2.2	548	14.4	Not Applicable
TOTAL U.S. . . .	170,000	100.0	66,306	39.0	2.564

^aRegion 3—0.734 of Region 6 data

^bRegion 8—0.273 of Region 6 data

Manpower requirements for 1972 were specified by the companies which were sampled. The 1967-1972 percentage increases specified by the companies were calculated item-by-item, and were applied to the extrapolated total United States 1967 census items to obtain the 1972 forecasted total United States data.

In summary, the survey method consisted of sampling on the basis of known company total employment and extrapolation by linear relationships from data provided directly by companies in the industry.