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PREFACE

The primary objective of this report is the presentation of statistical data about manpower involved in the development, production and distribution of energy.

A great number of sources, representing masses of statistical data, have been utilized in the compilation of this report. Selected tables are provided to illustrate the kinds of data contained in various reports analyzed, and the design of this report facilitates its use by the reader as a source document.

Most of the statistical data are contained in the various appendices, divided roughly into segments on employment, labor turnover, work injuries, college enrollments and degrees conferred, and various distributions of the energy work force. The text chapters, organized by major energy sector, are intended only to highlight the manpower situation in the various energy sectors and include some statistical data that are not in the appendices but apply only to a specific sector.

It should be recognized that this is a first compilation of a "Fact Book" about the utilization of energy manpower. Future reports will take account of the usage made of this type of report and of updating needs. The significant changes in energy research and development, production and consumption which are likely to develop in the months and years ahead require that information be as current as possible in order to evaluate the manpower requirements of this vital sector of the economy. It will be particularly important to develop and report on information about the manpower situation in emerging and developing energy fields about which current data are relatively sparse.

This study was directed by Leon Greenberg, Senior Associate of Kramer Associates, Inc. Most of the analytical work was performed by Senior Associate Lewis Earl with assistance by Anna Latimer and Gary Davis.

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CHAPTER I - INTRODUCTION

The output and availability of energy throughout the country is dependent on workers with appropriate skills located in varied industries and geographic areas. About three percent of the labor force in the United States is employed in industries primarily engaged in the direct production and distribution of energy. Significant changes in the level or patterns of energy consumption may produce disproportionate changes in employment and demand for workers of particular skills. The standard industry and occupational classifications into which employment and related economic data are organized are not ideal for the presentation or analysis of the relationship of employment and energy production. However, the standard bodies of historical data for the traditional energy production and distribution industries provide considerable data for decision making.

General Trends of Energy Production and Supply

While the domestically-produced supply of energy has been increasing since World War II, this trend peaked during the 1970's and shifts in the source of energy supplies are underway. The changes in the relative importance of various sources of energy are reflected in changes in employment and manpower utilization. The shifting of energy production from one source to another - for example, from oil to coal - may have important implications for employment and labor activities that may not be immediately reflected in the relative volume of energy obtained from particular sources.

Table I-1 shows the changing supply of energy in quadrillion Btu's per year from the major domestic and foreign sources. While this table reflects some of the shifts in the supply of energy and the relative importance of various major sources, the related manpower and labor matters, such as skills and employment, can be more appropriately understood from data available by production and distribution processes and by industry.

Table I-1. U.S. Energy Supply, Selected Years, 1965-79
(Quadrillion Btu's per year)

SOURCE	1965	1970	1973	1979
Total supply	53.73	68.23	75.12	79.20
Total domestic production	49.66	62.51	62.46	62.80
Crude oil	16.52	20.40	19.49	18.02
Natural gas	17.66	24.18	24.76	21.57
Coal	13.38	15.05	14.39	17.41
Nuclear power	.04	.24	.91	2.75
Other[b/]	2.06	2.65	2.91	3.04
Net imports[c/]	4.06	5.72	12.66	16.40
Petroleum[d/]	5.01	6.92	12.98	17.64
Natural gas	.44	.77	.98	1.27
Coal	-1.37	-1.93	-1.44	-1.78
Other[e/]	-.02	-.04	.14	-.72

a/ Preliminary.
b/ Includes hydropower, geothermal, and wood, refuse and other vegetable fuels used for electricity generation.
c/ Imports minus Exports.
d/ Crude oil and refined petroleum products.
e/ Includes electricity and coke made from coal.

SOURCE: U.S. Department of Energy, Energy Information Administration, Annual Report to Congress, 1979, DOE/EIA-0173 (79/2), Vol.2, p. 3.

The decline in domestic oil and gas production from 1973 to 1979 with an accompanying increase in net oil imports might be expected to reflect lower employment in such major industries as oil and gas extraction, petroleum refining and pipe lines. However, greater efforts to achieve more production of oil and gas resulted in greater employment. Because considerable planning and lead time is required for most forms of energy production, the manpower requirements may occur months or years ahead of production.

Organization of General Manpower Data for the Energy Industries

The major thrust of this report is toward manpower involved in the production and distribution of energy. Although considerable employment and manpower activities may be involved in the conservation of energy, consumption is not the focus of this report. While energy conservation may be an important factor in achieving the demand-supply balance, the organization and structure of socio-economic data do not make conservation the subject of easy manpower assessment. Certainly the shifting of energy sources for conservation purposes will have employment effects and will influence much of the data about traditional energy producing and distributing industries.

The Standard Industrial Classification (SIC), which provides the basis for organizing most of the public source information about industries, is based on economic activity in the production of goods and services. To the extent possible, the SIC and standard industry concepts have been used in selecting data for this report in order that the statistics herein presented will have comparability with other major sources. However, detailed analysis of manpower and employment in energy production and distribution will require data that are more disaggregated than those available in standard statistical series.

The general principles of the Standard Industrial Classification (SIC) are that it should conform to the existing structure of American industry, that each establishment should be classified according to primary activity and that establishments constituting a recognized industry must be statistically significant in number of persons employed, volume of business or other measures of economic activity. These principles tend to exclude new and innovative activities that have not been historically established in the industrial structure. Therefore, data from standard sources are not usually available for such energy production activities as wind power, geothermal and solar energy production. Furthermore, relatively recently developed industries such as nuclear power are not well-covered in current economic statistics. Any consideration of manpower for new and innovative sources of energy such as synthetic fuels requires better definition before data will be generally available. Research and development activities which are important to the development of new alternative sources of energy are not easily identifiable in the standard industrial statistical sources.

Table I-2 gives an indication of the relative importance of the major energy-related industries from an average total employment standpoint. As sources, markets and organizational structures change, the employment in these industries will be affected.

Table I-2. Employment in Selected Industries Primarily Engaged in the Production and Distribution of Energy, Annual Averages, 1979

Industry	Number (In thousands)
Coal mining	258.6
Oil and gas extraction	476.5
Petroleum refining	168.6
Mining machinery manufacture	38.9
Oil field machinery manufacture	85.6
Pipe lines, except natural gas	19.4
Electric, gas, and sanitary services	809.2
Wholesale distribution of petroleum and petroleum products	224.6
Gasoline service stations	585.6

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, 1979.

NOTE: Some industry employment data are available for some states and areas in various monthly and annual reports of Employment and Earnings (See Table A-18).

The Influence of Energy on Industry Output and Employment

Although employment in the industries engaged primarily in the production and distribution of energy is relatively small in terms of total national employment, the availability of energy resources has a significant influence on the employment in specific industries and the distribution of employment and output of particular industries. In turn, the price and availability of energy influences the geographical location of industry and employment. The impact of energy shortages and rapidly rising energy prices does not only have an initial shock on the economy and employment but the longer range adjustment to energy shortages affects all industries with variation as to their intensity of energy use and the type of energy used. Recognizing the relationship of energy resources to employment, the Congress has mandated that the National Commission for Employment Policy evaluate and continue to study the impact of energy shortages and new energy developments upon employment and training needs and include their findings and recommendations in periodic reports. The National Commission has energy-impact employment studies on their continuing work agenda.

A BLS study[1/] has found that changes in the price and availability of energy since 1973 have had a measurable effect on the output and employment growth patterns of important groups of industries. In general, those industries that consume relatively less energy in their production process experienced unusually high output growth rates during 1973-77.

1/ U.S. Department of Labor, Bureau of Labor Statistics "The Influence of Energy on Industry Output and Employment," Monthly Labor Review, December 1979.

Reversing the long-term trend, their output growth rate surpassed the growth rate of the most energy intensive industries. Examined by specific energy resources, however, the effect on industry growth patterns varied.

Trends for Energy Producers

Production and employment in energy-producing industries remain a relatively small proportion of national output and employment, accounting for about 4 percent of total output and less than 2 percent of total employment.

For the purpose of this analysis, production encompasses crude petroleum and natural and liquid gas extraction (including oil- and gas-well drilling) coal mining, petroleum refining, and both electric and gas utilities.[2/] This definition does not include solar, synthetic fuels, or other such unconventional energy sources that are largely in a research and development mode. Also, only a limited amount of energy distribution to users is included in the sectors listed above. For example, they cover the distribution of natural gas and electricity but exclude the distribution of petroleum or coal products. Construction of electrical generating plants or petroleum refineries is also excluded.

[2/] From the viewpoint of the Standard Industrial Classification (1967 version), this includes the following SIC codes: 11, 12, 1311, 1321, 138, 29, 491, and 493.

Table I-3. Employment Trends of Energy Producing Industries, Selected Years, 1958-77

Industry	Employment[1/] (000's)				Compound rates of growth		
	1958	1967	1973	1977	1958-1967	1967-1973	1973-1977
Coal mining	230	152	188	233	-4.5	2.6	7.1
Crude petroleum and natural and liquid gas extraction	210	167	160	195	-2.5	-.7	5.1
Oil and gas well drilling	135	126	136	230	-.8	1.3	14.0
Petroleum refining	224	183	193	209	-2.2	.9	2.0
Electric utilities	357	364	426	434	.2	1.2	.5
Gas utilities	213	217	219	214	.2	.1	-.6

1/ Employment includes wage and salary workers, self-employed, and unpaid family workers.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, December 1979, p. 4.

Overall, the employment situation for these energy-producing sectors can be summarized as follows: (1) employment in energy-producing industries is a small part of total employment; (2) in several energy-producing industries (especially coal mining, petroleum and liquid gas extraction, and oil and gas well drilling), employment declined through the late 1960's, stabilized, and then increased (Table I-3); (3) individual energy-producing industries have experienced differing growth patterns, as one type of energy appeared to be substituted for another because of changes in relative prices and because of other factors such as supply constraints and regulation; (4) several of these energy-producing industries have shown disparate changes in their rates of growth for output and employment since 1973, resulting in productivity increases for some industries (petroleum refining and both electric and gas utilities) and declines in productivity for others (oil and gas extraction and coal mining) (Appendix Tables G-1 through G-5).

Industry uses energy in many different ways, such as for lighting, heating or cooling work and storages spaces; as a raw material in a manufacturing process; as a power source to run machinery; as fuel for transportation of raw materials and distribution of goods; as a heat source in the industrial process, etc. Energy is a crucial factor to employment, whether as a substitute for labor, on the one hand, or as a tool of employment, on the other.

It is impossible at the present time to separate, in any systematic way, energy uses by industry. Therefore, an analysis of energy use by industry was performed for all energy uses combined. However, direct and indirect, or "embodied," energy consumption can be measured separately. Indirect energy use covers the proportion of energy used in producing parts, materials, power, or services used as inputs to production by an industry. Examined on this basis, an industry such as dairy and poultry production, which uses relatively small amounts of energy directly, is shown as a relatively large energy user because of the energy embodied in producing material or service inputs such as animal feeds or fertilizers.

Each industry produces its goods or services based on a mix of the factors of production--capital, labor, energy, and other material inputs. Over time, the mix of these factors can change in an industry because of changes in the relative prices of these factors, or because of changes in technology, even though one or another of the factors may predominate.

Industry input-output data for 1973 were used to calculate total energy use, direct use per $100 of production, and the total of direct and indirect use per $100 of production for each of the coal, oil, natural gas, and electricity sources of energy. (Table I-4.) The most and least energy intensive industries were determined based on these calculations.

Table I-4. The Most Energy Intensive Industries, by Industry and Type of Energy Used, 1973

Industry	Most energy intensive: Total use per $100 of production	Direct use per $100 of production	Direct use per 1,000 worker hours	Total value of directly consumed energy (millions)
	Coal			
Electric utilities	$ 5.99	$ 4.56	$1,430.38	$1,560.6
Blast furnaces, basic steel	4.12	2.73	728.43	944.0
Metal containers	1.58	.16	4.79	0.9
Cement and concrete	1.49	.83	188.44	82.2
Synthetic fibers	1.40	.86	192.21	47.9
Metal stampings	1.28	.04	6.81	3.9
Fabricated structural metal	1.23	[a]	.52	0.5
Water and sanitary services	1.09	.15	55.52	9.2
Iron and steel foundries	1.06	.07	10.86	7.6
Railroad equipment	1.02	.04	13.40	1.4
	Oil			
Industrial chemicals	$22.87	$16.38	$5,850.80	$3,879.1
Plastic and synthetic rubber	14.14	3.26	1,375.19	317.7
Agricultural chemicals	10.40	1.05	325.89	34.9
Miscellaneous chemical products	7.82	1.57	397.01	85.0
New highway construction	7.62	6.03	1,051.85	575.4
Paint and allied products	7.11	1.21	373.15	55.6
Air transportation	6.45	5.29	924.02	673.6
Food and feed grains	6.29	3.33	621.09	697.5
Synthetic fibers	6.03	.10	21.24	5.3
Cleaning and toilet preparations	5.07	.64	267.53	69.3

[a] Less than 0.005.

Table I-4. The Most Energy Intensive Industries, by Industry and Type of Energy Used, 1973--continued

Industry	Most energy intensive: Total use per $100 of production	Direct use per $100 of production	Direct use per 1,000 worker hours	Total value of directly consumed energy (millions)
	Electricity			
Water and sanitary services......	$ 7.69	$ 1.56	$ 578.42	$ 95.4
Pipeline transportation..........	7.39	6.39	3,101.43	108.6
Local government passenger transit	5.86	5.01	341.20	68.2
Other nonferrous mining..........	5.80	3.39	517.05	22.8
Iron ore mining..................	5.14	3.30	1,066.95	63.0
Chemical and fertilizer mineral mining........................	4.93	3.62	834.44	30.0
Primary aluminum products........	4.92	2.53	815.89	274.1
Nonprofit organizations..........	4.49	3.76	204.88	664.4
Copper ore mining................	4.47	2.64	385.68	33.9
Industrial chemicals.............	4.02	2.02	720.84	477.9
	Natural gas			
Structural clay products.........	$ 9.21	$ 5.60	$ 627.21	$ 69.6
Chemical and fertilizer mineral mining........................	5.73	3.15	725.28	26.1
Electric utilities...............	5.56	2.92	916.30	999.7
Industrial chemicals.............	4.72	1.83	655.05	434.3
Water and sanitary services......	3.42	.78	289.39	47.8
Glass manufacturing..............	3.39	1.84	224.21	121.5
Petroleum refining...............	3.35	1.45	1,225.63	507.4
Iron ore mining..................	3.26	1.46	473.73	28.0
Cement and concrete..............	3.05	1.36	307.00	133.9
Plaster and synthetic rubber.....	3.01	.36	151.56	35.0

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Monthly Labor Review, December 1979, p. 7.

The most energy intensive industries have experienced slower output growth since 1973, but this slowdown appears to be of about the same proportion as the drop in the rate of growth for the entire economy. Employment in the most energy intensive industries experienced an absolute decline during 1973-77, an appreciable change from the 0.8 percent long-term growth rate.

The least energy intensive industries had a faster rate of output growth during 1973-77 than both the overall economy and the most energy intensive industries. The faster growth rate for the least energy intensive industries compared to the most energy intensive industries reverses a pattern that had prevailed in all earlier periods examined. Employment growth in the least energy intensive industries remained stable--at about twice the national average--before and after 1973.

When the employment growth rates of the most and least energy intensive industries in each of the four energy types were compared, no consistent pattern emerged. The employment growth among each group of least energy intensive industries was faster than for their most energy intensive counterparts. Employment growth patterns among each group of most energy intensive industries during 1973-77 approximated the long-term trend, except for the most coal intensive industries. The latter showed a 1.4-percent average annual decline during 1973-77, a marked change from the growth rate posted in earlier periods. Another notable employment growth change during 1973-77 was the sharply narrowed growth rate differential between the most and least electricity intensive industries.

CHAPTER II - COAL MINING

Employment Trends

Employment in the coal mining industry, bituminous and anthracite, declined continuously over a twenty year period reaching a low point in 1969. Since that date there has been a general trend of increasing employment to a level of nearly 260,000 workers in 1979. (Table A-1.) The shortage of petroleum resources and higher prices of oil and gas have forced some return to coal as a source of energy which is reflected in the current trend of increasing employment.

The rise in production worker employment was somewhat slower than total employment. The share of total employment accounted for by production workers declined from 88 percent in 1960 to 84 percent in 1979.

The employment gain in bituminous and lignite mining, which accounted for 91 percent of the total industry employment in 1960 and nearly 99 percent in 1979, was more rapid than that of the total coal mining industry. Employment has shifted between underground and surface mines, with surface mining becoming more important, accounting for 16 percent of total mining employment in 1960, and 29 percent in 1976.[1/]

1/ U.S. Department of Labor, Bureau of Labor Statistics, Technological Change and its Labor Impact in Five Energy Industries, Bulletin 2005, 1979, and U.S. Departments of Energy and Labor, Determinants of Coal Mine Labor Productivity Change, November 1979.

West Virginia is the leading state in coal mining employment, providing jobs to about a quarter of the industry. Together with Kentucky and Pennsylvania, these three States account for over half of the Nation's coal mining employment. In addition there is significant employment in Ohio, Virginia, Illinois and Alabama. (Table A-18.) Surface and underground production data by States are available from the National Coal Association's Coal Facts.

Characteristics of the Work Force

Women workers have accounted for a small proportion of coal mining employment, about four percent of the total in 1978. (Table C-4) Openings for women have usually been limited to secretarial, typing and clerical jobs.

In 1979 over 60 percent of the coal miners were males age 40 and over compared to just over 31 percent for the total national work force. With the hiring of younger workers in the 1970's, the structure of the workforce may be expected to have changed considerably. The median age of working members of the United Mine Workers (UMW) dropped from 46 in 1966 to 34 in 1974 and to about 30 in 1977. The average miner is younger, better educated, more mobile, and more independent than in the past.

Employment by Occupation

Craft and operative workers make up the largest portion of the coal mining work force, accounting for more than four out of five jobs. About half of the coal mining employment is in the operative category, requiring some job skills. Mine operators account for the major occupational clas-sification, employing over thirty percent of the workers. Transport equipment operators make up another eight percent of the employment.

Common laborers are declining as a portion of total coal mining employ ment and account for less than eight percent of employment. The skilled crafts and kindred workers make up almost one third of coal mining employment with construction craft workers and equipment operators in heavy demand. Although professional, managerial and clerical workers account for less than ten percent of coal mining employment, the percentage of jobs in these nonproduction occupations is increasing. (Table D-2.)

Technological changes are increasing the need for professional and technical staff. More trained engineers and specialized technicians are needed to plan and introduce advanced mine layout and production methods. Mining technologists, a new occupation, are working on such environmental problems as spoil bank placement and reclamation through refertilization and planting of grasses and trees. Maintenance mechanics increasingly require higher levels of skill to service new and more complex coal mining equipment. Finally, more operatives will be needed as production expands to meet increased demand for coal and as new technology is diffused more widely.

Labor Supply and Training

There may be some problems in meeting the manpower required to achieve the future production goals of the National Energy Plan. Those goals are estimated to require a workforce of 400,000 by 1985, an increase of about 140,000 over the employment level in 1979. In addition, several thousand openings will occur each year as experienced miners retire, die or transfer to other fields of work 2/

2/U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook, 1978-79 Edition, Bulletin 1955, p. 617.

A limited number of colleges offer educational programs in coal mining technology. (Table II-1.)

Table II-1. Coal-Mining Technology Colleges

Regions	Colleges	Enroll-ments	1975 Graduates	1976 Graduates[a/]
East	5	466	12	74[b/]
South	4	453	25	88
Midwest	5	685	89	143
North Central	2	60	25	28
Southwest	1	40	2	10

a/ Projected.
b/ Estimated.
SOURCE: Energy Research and Development Administration, Manpower for Coal Mining: Supply-Demand-Training, September 1977.

Special programs in surface coal mining and reclamation are available in a few colleges. Most colleges are prepared to work closely with regional coal companies to develop programs needed by the local mines and related industries. Many college offerings are designed to upgrade experienced miners. (Table H-20 lists schools offering post-secondary coal mining technology programs.)

Hours, Earnings and Labor Turnover

The coal mining industry is on a 40-hour work week. Average weekly hours, reflecting some overtime, exceeded the 40-hour norm in several recent years. The average weekly earnings for the industry have risen from $184.30 in 1970 to $417.18 in 1979, reflecting a significant increase in pay scales. Workers in the coal industry have registered a larger increase in average hourly earnings since World War II than manufacturing and retail trade. The gains in earnings for coal miners are in line with those of construction and auto workers, but lag behind the gains for basic steel and railroads.

The rates of labor turnover in coal mining are about half as great as in manufacturing industries. With employment growing, the accession rates in bituminous coal and lignite mining have exceeded the separation rates since 1973. (Table B-1.) The labor turnover tates in anthracite mining are a bit higher and more erratic than in bituminous coal mining. (Tables B-2 and B-3.)

Productivity[3/]

Although improved integration of coal extraction, hauling, and cleaning processes, the development of special-purpose production equipment, and the use of new materials may assist the coal mining industry in opening and operating mines more efficiently, serious coal production and productivity problems are yet to be solved. The industry and the Federal government, working both independently and jointly, have been developing and testing new coal mining technology during

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3/U.S. Department of Labor, Bureau of Labor Statistics, Technological Change and its Labor Impact in Five Energy Industries, Bulletin 2005, 1979.

the 1970's in an effort to satisfy the requirements of legislation on coal mining health and safety, air and water pollution, and environmental protection of the land mined. Improvements in underground mining methods and modifications to surface mining equipment may increase output and productivity.

Productivity declined during the 1970's in both underground and surface bituminous mining. However, the overall decline was moderated by the growth of surface mining relative to underground mining. For the industry as a whole, output per hour of production workers decreased every year from 1973-78, at an average annual rate of 3.5 percent. (Table G-1.)

Several factors have contributed to the productivity decline. In underground mining, productivity growth is inhibited because resources must be allocated to prevent accidents, black lung disease, and acid runoffs. In surface mining, productivity growth is inhibited as resources must be allocated to meet land restoration standards and to present alternatives to proponents of exclusive agricultural use of mineral lands. Labor-management difficulties have also been a factor.

From 1960 through 1970, daily output of workers in surface bituminous mines was consistently more than double the daily output of workers in underground bituminous mines, according to Bureau of Mines data. During 1971-76, despite a decline in surface mining productivity, the daily output of surface bituminous workers amounted to about three times the daily tonnage mined by underground workers. Preliminary data for 1977 show a 2 percent increase over 1976 in surface mining productivity and a decline of 4 percent in underground productivity. Coal mining productivity, consequently, has benefited by the continuous rise in importance of surface bituminous production relative to total bituminous output.

The 1969 Coal Mining Health and Safety Act has required additional tasks to meet standards for dust suppression, mine lighting, gas control, mine subsidence, and surface control and treatment. The 1977 Federal and Health Amendments Act expands provisions for mine inspections and mine job and safety training. Resulting productivity losses from the added workload may be counterbalanced, in part, by fewer accidents and improved workmanship of better trained miners.

Work Injuries

Disabling injury rates fluctuated within a small range from 1960-73, 32-39 injuries for a 100,000 miner shift, then dropped sharply to 25-27 injuries per shift.

Fatalities for a 100,000 miner shift, although much lower than disabling injuries, showed greater annual fluctuations and also dropped sharply after 1971. (Table II-2.)

Table II-2. Deep Mine Injuries and Injury Rates

Year	Disabling injuries		Fatalities	
	Total	Per 100,000 miner shift	Total	Per 100,000 miner shift
1960	8590	32.15	274	1.03
1970	8943	36.22	205	0.83
1971	8895	38.75	140	0.61
1972	9872	38.74	121	0.47
1973	8843	34.46	98	0.38
1974	6355	25.96	89	0.36
1975	8236	26.82	99	0.32
1976	8376	25.85	104	0.32

SOURCE: U.S. Department of Labor, Mine Safety and Health Administration, mimeographed tables (Health and Safety Analysis Center, Denver, Colorado), Determinants of Coal Mine Labor Productivity Change.

Labor and Industrial Relations

The coal mining industry has been characterized by strong trade union organizations.

Work stoppages in the coal industry, especially wildcat strikes, increased dramatically in the 1970's. For the decade 1960-69, 1.1 percent of total working time was lost due to work stoppages; for the 1970-76 period, this increased to 5.1 percent.[4] These work stoppages also affected the demand and price for coal by creating demand and production surges prior to contract strikes and immediately following strike settlement.

Coal Gasification

One of the new alternative technologies being considered toward solving the current imbalance of energy supply-demand is coal gasification. Although gasification is not a part of the coal mining process the development of the technology would change the supply-demand situation and probably increase the total use of coal as an energy source. The development of coal gasification would require some skills not currently involved in the production of coal and could have considerable manpower implications. Recognizing the possibility for the commercialization of coal gasification systems, the Department of Energy commissioned a study of the labor impacts of commercialized coal gasification systems. (Table II-3) This study estimated the labor requirements to construct three different types of coal gasification plants.

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[4] Bureau of Labor Statistics, U.S. Department of Labor, Collective Bargaining in the Bituminous Coal Industry, Report 514, 1977.

The total estimated labor requirements by type of construction activity for each type of plant are shown in Table II-3. The estimated labor requirements by section for the low, medium, and high Btu systems are shown in Table II-4.

Table II-3. Number of Person-Hours Generated to Construct Low, Medium, and High Btu Coal Gasification System, by Activity

Activity	Person-hours (000's)		
	Low	Medium	High
Total	1,757	1,948	15,182
Equipment installation	133	147	949
Piping	639	726	5,512
Concrete	385	410	3,038
Steel	43	48	474
Instrumentation	36	54	333
Electrical	221	225	1,763
Insulation	122	123	1,424
Paint	53	78	625
Site development	53	58	455
Non-process buildings	70	78	607

Note: Low-Btu gas has a heating value of 200 Btu/SCF (standard cubic foot) or less. It is generated by reacting air and water (i.e., steam) with coal. The principal components of the product gas are nitrogen, carbon monoxide, and hydrogen.

Medium-Btu systems produce gases with a heating content between 200 and 550 Btu/SCF. In these systems, high-purity oxygen is utilized instead of air to eliminate nitrogen, which would dilute the energy content of the product gas.

High-Btu systems generate product gases with a heating value above 900 Btu/SCF. The gas can substitute for natural gas and is predominantly methane. As only a part of the direct gasifier product is methane, a catalytic methanation reaction is required to convert carbon monoxide and hydrogen to methane.

SOURCE: U.S. Department of Energy, Assessment of the Labor Impacts of the Commercalization of Coal Gasification System, DOE/TID/6646-1, October, 1979.

Table II-4. Number of Person-Hours Generated to Construct Low, Medium, and High Btu Coal Gasification Systems, by Section

Section	Person-hours (000's)		
	Low	Medium	High
Total	1,757	1,948	15,182
Direct Construction Labor			
Coal Handling Section	38	38	1,277
Gasification Section	370	642	2,925
Gas Treating Section	765	671	4,197
Liquids & Solid Treating Section	-	-	2,331
Utilities Section	461	461	3,389
Indirect Construction Labor			
Site Development Labor	53	58	455
Non-Process Building Labor	70	78	607

See note on Table II-3.

SOURCE: U.S. Department of Energy, Assessment of the Labor Impacts of the Commercialization of Coal Gasification Systems, DOE/TID/6646-1, October, 1979.

CHAPTER III - OIL AND GAS EXTRACTION

Employment Trends

This industry includes establishments primarily engaged in the production of crude petroleum and natural gas and closely related oil and gas field activities such as contractors performing oil field services for drilling and production property operators. With the substantial growth of oil field activity since 1973 total employment has increased to over 475,000 in 1979. (Tables A-4 to A-8.) There has been a significant increase in both continental and offshore drilling activity as well as geophysical surveys since 1971. The net addition of 140,000 workers in exploration and drilling activities between 1971 and 1977 reversed the steady decline in employment in the United States which had characterized the industry during the 1960's. Of the two major sectors of the oil and gas extraction industry, oil and gas field services (SIC 138) has doubled in total employment since 1971, whereas the oil and gas production sector (SIC 131) has increased only moderately.

In the production of crude petroleum and natural gas almost half of the employment is accounted for by non-production workers. In the oil and gas field service section the percentage of production workers is much greater, accounting for over 80 percent of total employment.

Characteristics of the Work Force

Since 1970 women have held over ten percent of the jobs in oil and gas extraction and the percentage of women workers has been growing significantly. Although most of the women are employed in the crude petroleum and natural gas production sector, the more pronounced growth in female employment in the 1970's has occurred in the expanding oil and gas field services sector. (Tables C-3 and C-5.)

With the increased oil field exploratory work in the 1970's, which is expected to continue, there are a number of inexperienced workers employed. This has been accompanied by lower productivity on drilling rigs recently brought into operation.

Texas, Kansas, Oklahoma and Louisiana are the leading states in oil and gas extraction. Many of the jobs are located in isolated rural areas and employment on offshore drilling rigs is even more isolated.

Employment by Occupation

The largest occupational group in oil and gas extraction--operatives--accounted for 37 percent of total industry employment in 1970. (Table D-3.) As drill crews and other operative occupations are expanded with growing oil and gas exploratory activity these occupations may be expected to grow. The greatest employment gains may be expected in professional, technical and kindred workers as petroleum engineers, geologists and related technical and professional people are required for extensive and complex exploratory work. With expanding oil field explorations increases in employment are also projected for managerial workers, clerical workers and craftsmen. Service workers and laborers who, combined, account for only slightly more than 3 percent of industry employment, are not anticipated to make significant gains.

Labor Supply and Training

According to the National Petroleum Council (NPC),[1] the upsurge in explorations and drilling since about 1971 could result in a continued shortage of qualified workers in a wide range of exploration, drilling, and production activities, with personnel skilled in the interpretation of geophysical data in especially short supply.

The National Petroleum Council concluded that although professional and skilled personnel are currently in tight supply, the manpower required for exploration, drilling, and production will be adequate to support substantial increases in activity. The study focused only on those occupational groups deemed critical to growth, such as geologists, geophysicists, engineers and skilled oil field workers.

Exploration and production companies employ specially trained exploration geophysicists and geologists to locate areas of potential oil and gas accumulation; production geologists to identify productive intervals and map productive zones; petroleum engineers to plan drilling procedures, oil and gas recovery programs, artificial lift, and surface and subsurface production systems; gas engineers to design gas gathering and processing systems; and civil engineers to design and build structures. This professional pool is also the prime source for operations management.

1/ National Petroleum Council, Availability of Materials, Manpower and Equipment for the Exploration, Drilling and Production of Oil, 1974-76, Washington, D.C., December 1979.

While most of these professionals, except the geophysicists, are employed by exploration and production companies, a growing number are with service and supply companies, consulting firms, or are self-employed.

Survey data indicate that the oil and gas industry employed about 10,000 geophysicists in 1978 at the end of a two-year period in which seismic crew months, an indicator of geophysicist requirements, increased at a compound annual rate of 15.9 percent. This increase followed a two-year period during which crew months declined 9.6 percent annually. Based on projected exploratory drilling activity and related seismic work, it is estimated that the need for geophysicists over the next decade will increase at a rate of six to seven percent yearly.

Those schools awarding degrees in geophysics which were surveyed by the International Association of Geophysical Contractors in 1978 indicated a present capacity to graduate about 400 geophysicists yearly. About 30 percent of the present geophysicist force is made up of such graduates.

Industry requirements for geologists are expected to increase because of more drilling activity and because geological interpretations have become more time consuming. The rate of increase in the total number of geologists required will be six to eight percent annually in 1980 and 1981, and approximately two percent thereafter.

In recent years, oil and gas industry employers have limited their hiring of geologists mainly to graduates with advanced degrees. In the years 1979 through 1981, a survey of 30 schools indicates that the number of such graduates will be insufficient to cover needed additions plus estimated attrition. However, total graduates, including B.S. degrees, will be adequate to meet both requirements.

The Society of Petroleum Engineers (SPE) Engineering Manpower Committee published Survey Number 2 in May 1979, showing trends in the number of engineers employed by a sampling of companies engaged in oil and gas activities.

The large increase in engineering population since 1974 is expected to continue but at a lower growth rate. Other qualifications being equal, oil, gas, drilling, and producing companies generally prefer to hire graduates with petroleum engineering degrees. The SPE report indicated that, in 1978, due to the existing shortage, companies met their new graduate hiring goals for petroleum engineers by employing graduates of other disciplines.

The historical cyclic demand for engineers in drilling and production activities is of serious concern to educational institutions because of its disruptive effects on faculty and facility requirements, on funding, and potentially on the future quality of the education of petroleum engineers. High starting salaries for B.S. graduates have reduced the number of students entering graduate programs and, consequently, the reservoir of qualified candidates for faculty positions.

Continuing education of engineers, through in-house schools and programs offered by universities and outside consulting groups, is vital in order for the industry to maintain the competence and level of performance required in this complex and varied business.

In summary, the rapid increase in demand for engineers in drilling and production operations, which may have peaked in 1979, resulted in a shortage of petroleum engineering graduates.

Employers are almost entirely dependent on professional schools to ensure an adequate supply of qualified geophysicists, geologists, and engineers. However, the demand for professionals will be met by increased enrollments in these critical disciplines.

Industry demand for these graduates is highly cyclical, in large measure because of government regulation of exploration and production. This feast/famine demand imposes serious problems on the universities and on young people in selecting a career.

Continuing education is essential to the maintenance of engineering competence. To meet this need, oil and gas companies conduct in-house training programs to promote early competence in specialized fields such as reservoir, drilling, production, and gas engineering. Similar short courses are offered by several universities and a growing number of commercial programs by independent consultants.

During the period 1973-79, growth in drilling activity was matched by other oil field service and supply organizations, demonstrating the ability of the industry in response to the accelerated demand. Regardless of that fact, however, service companies almost unanimously reported that their most critical potential limiting factor for the 1979-90 period will be manpower availability. Companies are spending much time in training personnel, especially on-site operators and technicians, but high turnover rates are being experienced. This is reportedly due to a lessening overall desire to pursue careers which involve 24-hour call-out status and working under harsh weather conditions. Thus, top priority is to attract and train operators, technicians, mechanics, and field supervisors.

Trained technicians who are required to perform and support field data collection operations for the geophysical services industry are divided into three categories:

- o Electronic technicians who operate and maintain the recording equipment, marine navigation, and other electronic equipment;
- o Surveyors who locate and map geophysical recording positions;
- o Mechanics and shot hole drillers who operate and maintain the mechanical, automotive, and seismic source machinery.

The present supply of skilled offshore marine service personnel is adequate. A potential constraint to rapid growth of the fleet would be requiring licensing of personnel.

Hours, Earnings and Labor Turnover

The work week in oil and gas extraction is irregular with weekly hours exceeding the 40 hours common to most industries. To meet the growing demand for workers there has been a steady increase in average weekly hours since 1971 with the oil and gas field service sector showing major lengthening of the work week. Average weekly hours in this sector were at a high point of 46.6 in 1978. (Tables A-4 through A-8.)

The average weekly earnings in the oil and gas extraction industry rose from $154.22 in 1970 to $343.21 in 1979. Average weekly earning in the petroleum and natural gas production sector exceed those in the oil field service sector.

The rates of labor turnover are quite high in the oil and gas extraction industry, particularly the oil field service sectors. (Tables B-4 through B-8.) Accessions, new hires, separations and quit rates exceed those of most industries. The turnover rates are traditionally high because the work is difficult and must be performed in all types of weather and often in isolated locations.

Safety and Industrial Hazards

Work in the oil and gas extraction industry is more than twice as hazardous as in private sector employment generally when measured by work injury days lost per 100 full-time workers. However, the work is less hazardous than coal mining. (Tables E-1 and E-2.)

Within the oil and gas extraction industry the drilling operation is the most hazardous according to information compiled by the American Petroleum Institute (API). The API collects and publishes detailed occupational injury and illness data annually for the petroleum industry from exploration through retail marketing.[2/]

Labor and Industrial Relations

The oil and gas extraction industry is composed of numerous small companies that are highly mobile and many independent contractors. Trade union organization is not strong in the industry. Work days idle from work stoppages in the industry are minimal.

2/ American Petroleum Institute, Summary of Occupational Injuries and Illnesses in the Petroleum Industry, Washington, D.C., August 1979.

CHAPTER IV - PETROLEUM REFINING

Employment Trends

Over 168,000 people were employed in the petroleum refining industry in 1979, the largest number since the early 1960's. (Table A-9.) This key manufacturing industry in the energy field experienced declining employment from the 1940's to a low point of less than 150,000 in 1973. Since that date total employment has been gradually increasing. The earlier period of declining employment reflected a reduction in the number of refineries and a marked rate of productivity growth.

Employment by Occupation

More than a third of those employed in petroleum refineries are non-production workers. This reflects the process nature of the industry, which is highly capital intensive. Operators constituted almost one-fourth of all refinery workers in 1970, approximately the same proportion of total employment as professional and technical workers. Chief operators, numerically one of the largest groups of workers, are the highest paid production workers in the refinery. BLS projections indicate a decline of about 8 percent in the number of operators from 1970 to 1985 but an increase in their share of the total to over 25 percent. Craft and kindred workers are expected to decrease in number by about 7 percent from 1970 to 1985; however, their share of the total may increase slightly. This group also constitutes more than one-fifth of all workers and includes general mechanics, instrument repairers, machinists, electricians, pipefitters, and welders.

Job content and skill requirements are being substantially changed by sophisticated instrumentation, particularly for maintenance and lab technicians. In many cases, decision-making functions are being transferred from the employee to the machine. In modern refineries, computer consoles in each process unit record the data from on-line instruments and feed the data into a central computer system.

Manual skills, already at minimum levels in the refinery, continue to decline. Even the truck driver who loads the gasoline for delivery uses an automated system.

Due to the many changes occurring in the industry, the occupational distribution in 1990 is expected to be significantly different from the 1970 pattern. In the BLS projections of occupational employment, professional and technical workers, more than one-fifth of all refinery workers, are expected to decline moderately from 1978 to 1990 but to retain about the same share of total employment. (Table D-4.) This is in contrast to the pattern of the 1960's, when professional and technical workers rose very sharply both in number of jobs and as a proportion of total employment. The major occupations in this group are chemical engineers, chemical technicians, and computer personnel. Other occupations are chemists and engineers.

Technological and structural changes are altering traditional concepts of job content and duties. More importantly, duties are being consolidated, as in the case of maintenance crafts, or partially removed from the refinery, as in the case of contract maintenance.

Maintenance craft consolidation is an important labor development of the last decade which increases the flexibility of the work force while it reduces the number of workers required per processing unit. Under most maintenance consolidation plans, skilled workers who have attained journey-worker status in one craft are trained to handle other crafts. Such consolidation is becoming more widespread. Of 104 refiners studied by BLS in 1976, about one-fourth reported craft consolidation plans, double the number reported in 1965. 1/ In most plants, consolidation was limited to two designated crafts, but in many plants consolidation incorporated all maintenance crafts. Craft consolidation practices generally establish new single job classifications with new duties and training.

Contract maintenance is performed by workers supplied by outside firms on a contract basis, and permits a refinery to have a relatively small year-round maintenance staff. Although contract workers are generally used for special peak work periods such as during shutdown, they may also be employed year-round on regular maintenance.

Labor Supply and Training

Training for new skills and changing job content is a continuous process in most refineries. Of the 13 collective bargaining agreements studied by the BLS, 2/ 4 had apprenticeship provisions, and 7 provided for on-the-job training. In refineries, training is required for 4 years or more for a senior technician.

1/ U.S. Department of Labor, Bureau of Labor Statistics, Industry Wage Survey: Petroleum Refining, April 1976, 1977. See also BLS Bulletin 1741, p. 2, for April 1971 data.

2/ U.S. Department of Labor, Bureau of Labor Statistics, Industry Wage Survey: Petroleum Refining, April 1979, 1980.

In one plant, the new worker, generally a high school graduate, receives 4 months of classroom training covering refinery equipment and the math and chemistry needed for the job. The trainee is then assigned to a shift but continues with on-the-job training, spending about 5 months on each of four assignments. After 2 years, the trainees are qualified as refinery technicians.

Hours, Earnings and Labor Turnover

While the 40 hour week is normal for most manufacturing industries, this industry experienced average weekly hours of more than 40 thoroughout the 1970's. Average weekly earnings rose from $189.93 in 1970 to $440.06 in 1979 -- above the average for all manufacturing.

From 1963 to 1978 the petroleum industry (refining and extraction) employed from 8,000 to 10,000 research engineers and scientists annually. [3/] The per capita cost of these high level personnel to the industry was considerably higher than the average for all industries, being exceeded only by the automobile and aircraft industries.

Being an industry of high average earnings and high skill levels, the labor turnover rates are quite low. (Table B-9.)

Technological Change and Productivity [4/]

Technological changes in the petroleum refining industry are being made in response to shifts in crude oil supply, changing demand for petroleum products, and environmental and energy considerations, in addition to the usual incentives of greater productivity and lower costs. These changes are primarily

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3/ National Science Foundation, National Patterns of R&D Resources, 1978, NSF 78-313.

4/ U.S. Department of Labor, Bureau of Labor Statistics, Technological Change and Its Labor Impact in Five Energy Industries, Bulletin 2005, 1979.

in the areas of cracking, hydrotreating, and reforming, in association with advanced instrumentation and computer control. The outlook is for greater emphasis on processes for desulfurization and octane improvement. Because the industry is capital intensive, the short-run effects on labor demand are likely to be minimal, but in the longer run they will alter job content and may reduce employment growth.

Output per hour rose nearly 3½ percent a year in the past 30 years and 3.1 percent a year in the past 5 years. The outlook to 1985 is for productivity to rise but at a slower rate than in the past. Many uncertain variables affect the outlook including crude imports, gas supplies, and government environmental and energy policies. But for the most part, the industry's productivity in the next decade will depend on the Nation's economic growth and consequent energy needs.

In the past, the objective of U.S. refineries was to maximize gasoline production rather than the output of heavier fuels. Consistent with this objective, they were geared, primarily, to producing high-octane gasoline from low sulfur (sweet) crude petroleum. Moreover, in general, there were no restrictions on levels of sulfur and other impurities in petroleum products.

However, the picture is changing. First, there appears to be a long-term shift in emphasis from gasoline to heavy fuels based on a projected slowdown in gasoline demand and an increase in the market for heavy fuels as a result of the natural gas shortage. Second, environmental protection regulations encourage or require low-sulfur, low-lead products, as well as the reduction of noxious wastes from the refining process itself. At the same time, however, the availability of low-sulfur varieties is declining.

As a result of these conditions, refineries must make adjustments to accommodate product changes.

Data on productivity differences among establishments in an industry with a high degree of specialization may provide some insight into the factors associated with high productivity performance within the industry. In a study of 1967 Census data, petroleum refineries were ranked by value added per production worker hour. Average value added per production worker hour in the highest quartile was almost 11 times greater than in the lowest quartile.

Establishments in the highest quartile had an average employment almost four times greater than those in the lowest quartile. This is verified by studies which show that labor productivity increases with capacity and with employment, up to a point. Small plants must maintain a minimum staff of operators and maintenance and technical personnel to run the refinery; as capacity increases, the number of production workers needed per thousand barrels of output declines sharply. But at some point, the advantages of size may be offset by duplication of process units.

Safety and Industrial Hazards

Occupational injury and illness rates in petroleum refining are the lowest among the energy industries except for pipe lines. (Table E-1.) However, in 1978 the American Petroleum Institute reported 19 fatalities in petroleum refining of a total of 75 throughout the entire petroleum industry. (Table E-3.)

Labor and Industrial Relations

In the refining industry, there is a high degree of unionization; approximately 90 percent of the employees are covered by collective bargaining agreements. Contracts usually run 2 years, and negotiations are conducted on a company basis, with the first settlement establishing the pattern for later bargaining. The Oil, Chemical and Atomic Workers Union (OCAW) represents about two-thirds of the workers covered; the other third are covered by several independent unions--the Teamsters, the Operating Engineers, and an affiliate of the Seafarers' Union.

Thirteen major agreements covering 1,000 workers or more were studied by the BLS in 1975. [5] In these contracts, covering 25,000 workers, employee seniority was generally the determinant in the order of layoff and recall, assuming equal ability. Interplant transfers and preferential hiring opportunities for displaced workers were mentioned in 8 of the 13 agreements, covering 13,200 workers. Four agreements provided relocation allowances for transferred workers.

Programs to protect employees from the adverse effects of changes in machinery and methods may be incorporated into contracts or they may be informal arrangements between labor and management. In general, such programs are more prevalent and more detailed in industries and companies which negotiate formal labor-management agreements. Contract provisions to assist workers in their adjustment to technological and associated changes may cover new wage rates, new job assignments, retraining,

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[5] U.S. Department of Labor, Bureau of Labor Statistics, Characteristics of Major Collective Bargaining Agreements, July 1, 1975, Bulletin 1957, 1977, p. 86.

transfer rights, layoff procedures, and advance notice of changes planned by management, including machine changes or plant closings. They may also include various types of income maintenance programs such as supplementary unemployment benefits or severance pay.

CHAPTER V - PETROLEUM PIPE LINES

This industry is composed of establishments primarily engaged in the pipe line transportation of crude petroleum and refined products of petroleum. Oil and gas field gathering lines are usually classified in the oil and gas extraction industry. The pipe line industry was regulated as a common carrier under the Interstate Commerce Commission until October 1, 1977, when the Federal Energy Regulatory Commission (FERC) became the interstate oil pipeline regulatory agency.

Employment Trends

With moderately increasing employment since 1972, the pipe line industry had 19,400 workers in 1979, about the 1965 level. Because of technological developments, particularly in computer controls, employment has not grown with the increasing pipe line productive activity. (Table A-13.) About a quarter of the employment is found in management and supervisory jobs.

The proportion of women employees in the industry has fluctuated within the range of 7 to 9 percent since 1960. The jobs held by women are usually located in central headquarters and are concentrated in secretarial and clerical positions.

Occupational Structure

As control of pipe line operations has been more completely centralized with advanced computerization, and as local manning of on-line facilities has been reduced, managerial jobs such as assistant regional manager and products manager have been eliminated. Also, as technology has advanced, the job content of a number of occupations has changed. Generally, persons with more education are being sought for entry level positions such as process control operator and maintenance technician. More knowledge is needed to handle routine and emergency tasks associated with more complex and costly technology.

Manual scheduling is becoming obsolete so a scheduler must be trained in both pipe line operations and computers. Dispatchers also require such dual training as they monitor the whole system centrally and must be able to isolate and shut down every line through computers. As the use of computers and telecommunications expands, additional technicians to program and service machines and to analyze data will be needed. Maintenance technicians increasingly will need both a thorough skill in their specialty and pipe line experience. A knowledge of electronic solid state communication systems, for example, will be necessary for electricians. Mechanical work also is more complex. Technology advances eliminate some gauging jobs in the field. In the office, some work of accounting clerks is becoming obsolete as many accounting entries are made directly through central control linkage with computers in the field.

Professional, technical and kindred workers account for about 17 percent of the employment in the pipe line industry and are expected to grow in importance. (Table D-6.) Consistent with anticipated growth in pipe line mileage, more drafters, electrical and electronic engineers and technicians, inspectors, airplane pilots, and support personnel such as administrators, secretaries, and bookkeepers are expected to be needed. Conversely, job possibilities for operatives are decreasing. Craft and kindred workers make up between 25 and 30 percent of total pipe line industry employment.

Labor Supply and Training

With relatively stable employment, added labor supply has not been a serious concern for this industry. With pipe lines geographically dispersed over the country and employment low relative to capital investment, availability of workers does not present serious problems except in pipe line construction which is not statistically a part of this industry.

Hours, Earnings and Labor Turnover

Weekly hours have averaged between 40 and 42 for the industry for many years. Average weekly earnings rose from $189.20 in 1970 to $399.84 in 1979 (Table A-13.), which was not as great an increase as for most energy related industries. Although data are not available on labor turnover, employment in this industry is considered to be relatively stable. With declining employment prior to 1972 most of the separations came from normal attrition.

Technological Change and Productivity

Refinements in the application of existing technologies rather than new inventions are expected to continue to be the primary source of productivity gains in the petroleum pipe line industry. Expanded use of improved computer applications are anticipated for pipe line delivery scheduling, field process control, and administrative business and auditing work. Occupations affected by advanced computer applications include process control operators located at field stations, whose responsibilities are being transferred, in part, to headquarters control, and schedulers, gaugers, and accounting clerks, whose job duties are also being modified as computers increasingly perform more complex tasks. Additional improvements in plant and equipment, such as wider diameter pipe of higher tensile strength and pumping stations of standardized design, will probably permit faster throughput of a larger volume of product and require fewer technicians to maintain the pipe line.

The diffusion of technological refinements, combined with expected increased demand for petroleum products and more capital stock per worker, should promote productivity growth by making possible both a larger output and increased productivity of production workers. However, the higher level of capability of the physical plant requires a wider technical background for such workers as schedulers, dispatchers, and technicians.

Productivity (output per hour for all employees) tripled between 1960 and 1973, but the rate of increase dropped off substantially after that, rising at 2.1 percent a year in 1973-78. (Table G-4.) The changing rate of productivity growth was closely related to the trends in output; the latter more than doubled between 1960 and 1973, then dropped off to a 3.0 percent annual rate, 1973-78. The industry has a high ratio of capital stock per worker and a high rate of capacity utilization, both of which are contributory factors to productivity.

Labor and Industrial Relations

Unionization of pipe line workers has been hindered by their geographic dispersion and the sizeable number of small companies. Pipe line workers are represented (on a vertically integrated industry basis) by the Oil, Chemical and Atomic Workers International Union (AFL-CIO), by craft unions affiliated with the AFL-CIO, such as the International Union of Operating Engineers, and by unaffiliated independents.

Collective bargaining agreements in the petroleum industry typically call for negotiation of wage practices and supplementary benefits, job and union security, working conditions, and other employer-employee relationships. Although the agreements may not refer to adjustments that are required when technological changes occur, it is likely that, under such conditions, the seniority provisions of the contract apply.

CHAPTER VI - NUCLEAR ENERGY

Nuclear power had its origins in the nuclear weapons research of World War II. The production of nuclear generated electricity began in the early 1960's. Jointly funded by government and industry, several demonstration plants pioneered the development of this source of commercial electric energy.

Government-subsidized training and research in basic and applied nuclear physics since World War II has contributed substantially to the development of nuclear technology. Since much of the nuclear energy technology is in the research and development stage, with supplies and components produced commercially by establishments primarily engaged in production of products that have uses other than in the nuclear energy field, there has not yet been developed a nuclear energy industry under the Standard Industrial Classification concept. Products related to the production of nuclear energy, therefore, may be found in a number of four-digit SIC manufacturing industries.

The rapid growth of the nuclear energy industry in the past two decades has made it the subject of special studies supported by the U.S. Department of Energy and predecessor agencies. Annual surveys developed primarily by the Oak Ridge Associated Universities have provided much of the data in this chapter.

The universe of firms, established by the Department of Energy, ranged from reactor design, manufacture and nuclear research to nuclear facility maintenance, manufacture of protective clothing, information services and radiography services.

Employment Trends

Employment in the nuclear energy industry grew at an annual rate of 3 percent from 1962 to 1973 and about 7 percent from 1973 to 1977, approaching a quarter of a million by the end of that period.[1/] Although survey data are not available since 1977, it is believed that employment growth has leveled off.

Since nuclear energy production is relatively new, much of the employment is attributed to either R&D or design and manufacture of nuclear reactors and facilities. In recent years nuclear power plants have become larger and more complicated, resulting in longer duration of the period of construction. The planning, siting and construction of a nuclear reactor required 6 to 7 years in the 1960's but now takes 10 to 11 years.[2/]

After a nuclear power plant is constructed the amount of labor required for operation is relatively small. (Table VI-1.) With the growth of nuclear power production there has been a decline in the R&D work and rapid growth of total employment in the production of fuels, plant construction and operations. Nevertheless, R&D accounts for over 20 percent of total nuclear-related employment. Details on the distribution of R&D employment are presented in Table VI-2.

1/ Figures exclude nuclear-related employment in governmental units, medical facilities, construction, and academic institutions. Based on preliminary examinations, the employment reported in the surveys appears to be at least 90 percent of the actual total survey universe employment in 1962 and 1968 and approximately 95 percent in 1973, 1975, and 1977. SOURCE: Larry M. Blair, "Update of Employment Trends in Nuclear Power Industries," paper prepared fo the National Conference on Meeting Energy Workforce Needs, Determining Education and Training Requirements, Washington, February 26-28, 1980.

2/ Congressional Budget Office, "Delays in Nuclear Reactor Licensing and Construction: The Possibilities for Reform," March 1979.

Table VI-1. Distribution of Employment for Selected Nuclear Segments, 1968-1977

Segment	1968 Number	1968 Percent	1973 Number	1973 Percent	1977 Number	1977 Percent
Nuclear fuel cycle						
Mining and milling....	6,100	04.2	5,000	02.7	13,000	05.4
Conversion and enrichment............	5,300	03.6	7,700	04.5	13,100	05.7
Fuel fabrication, waste disposal, reprocessing, transportation and materials............	6,200	05.2	16,500	09.5	16,900	07.2
Total...................	17,600	12.0	29,300	16.7	43,000	18.3
Power plant operation and maintenance.......	1,200	.8	7,700	4.4	18,300	7.8
Reactor design, maintenance...........	16,500	11.3	26,900	15.4	34,000	14.5
Design of nuclear facilities............	6,200	4.2	21,400	12.3	36,900	15.7
Nuclear-related research and development facilities[a/].........	54,500	37.2	37,000	21.2	36,500	15.6
Other..................	50,400	34.4	52,300	30.0	66,000	28.1
Total..................	146,400	100.0	174,500	100.0	234,800	100.0

a/Includes research and development in nuclear energy, environmental and ecological research, biological and medical research, accelerators, reactor research and development, commercial laboratories, and health and industrial safety.

SOURCE: Larry M. Blair, "Update of Employment Trends in Nuclear Power Industries," paper prepared for the National Conference on Meeting Energy Workforce Needs, Determining Education and Training Requirements, Washington, February 26-28, 1980.

Table VI-2. Employment by Nuclear Industrial Sector and Type of Establishment, 1977

Industrial sector	Employment		Type of establishment			
			Private		GOCO[1]	
	Total	R&D	Total	R&D	Total	R&D
All sectors	226,954	49,850	128,359*	9,661*	98,595	40,189
Uranium milling	1,926	12	1,926	12	0	0
Processing & enrichment of reactor fuel	13,729	389	553	6	13,176	383
Production of special materials for use in reactors	3,799	65	3,791	57	8	8
Reactors & reactor component design & manufacture	34,084	5,211	28,549	1,529	5,535	3,682
Fuel fabrication	2,739	85	2,739	85	0	0
Transportation of nuclear materials	845	72	845	72	0	0
Chemical processing & disposal of irradiated materials	9,528	868	843	9	8,685	859
Design & engineering of nuclear facilities	36,893	618	36,128*	378*	765	240
Reactor operations & maintenance	17,270	421	15,095*	77*	2,175	344
Radioisotopes	2,250	301	2,250	301*	0	0
Design & manufacturing of instruments, gauges, & control devices	8,056	851	7,867	846	189	5
Accelerators	5,771	4,107	639	55	5,132	4,052
Environment & ecological research and evaluation	1,485	338	1,307*	326*	178	12
Biology & medical research	1,355	849	1,170*	741*	185	108
Reactor research, development & evaluation	5,378	3,534	1,918	1,057	3,460	2,477

See footnotes on next page.

Table VI-2. Employment by Nuclear Industrial Sector, 1977, Total and R&D by Type of Establishment--continued

Industrial Sector	Total employment		Type of Establishment: Private		GOCO 1/	
	Total	R&D	Total	R&D	Total	R&D
Weapons development & production....	30,263	15,917	106	32	30,157	15,885
R&D in nuclear energy...............	20,690	2,261	2,021*	2,021*	18,429	11,126
Industrial radiography.............	979	2	979	2	0	0
Miscellaneous......................	28,128	2,940	17,609*	1,942*	10,519	1,008

*Includes not-for-profit

1/ Government-owned contractor-operated.

SOURCE: U.S. Department of Energy, Employment in Nuclear Activities, 1977: A Highlights Report, DOE/IR-0049, May, 1979, p. 21.

Employment by Occupation

While there has been an increase in the number of scientists, engineers and technicians employed in the nuclear energy field in the last ten years they have, as a group, stayed at about 43 percent of the nuclear energy work force. Most physical scientist categories declined as a proportion as did several of the engineering and technician occupations. There were increases in the proportion of civil and nuclear engineers, draftsmen and reactor operators. (Table VI-3.) The employment in nuclear energy activities is greatest in the Southeast, Southwest and Pacific Coast Regions. (Table D-11.)

Table VI-3. Percentage Distribution of Scientific and Technical Nuclear-Related Occupational Employment for 1968 and 1977

Occupation	1968	1977
Total engineers	16.0	18.0
Chemical	1.4	1.1
Civil	.7	1.7
Electrical and electronic	3.6	3.4
Mechanical	5.3	5.1
Nuclear	1.9	2.5
Metallurgical	.6	.5
All other	2.4	3.7
Mathematicians	1.3	.8
Total physical scientists	6.8	4.3
Chemists	2.7	1.6
Physicists	3.1	1.8
Metallurgists	.5	.3
All other	.4	.6
Total life scientists	1.2	1.5
Health physics	.4	.4
All other	.7	1.0

Table VI-3. Percentage Distribution of Scientific and Technical Nuclear-Related Occupational Employment for 1968 and 1977--continued

Occupation	1968	1977
Total technicians................	17.9	18.4
Drafting.......................	3.3	4.2
Electrical and electronic......	3.7	2.9
Other engineering..............	3.5	3.7
Physical science...............	1.8	1.2
Life science...................	.4	.3
Health physics.................	.9	1.1
Reactor operator...............	.6	1.8
All other......................	3.7	3.1
Other Workers....................	56.9	57.1
Total[a/].....................	100.0	100.0

a/ Column totals may not add to 100.0 percent because of rounding.

SOURCE: Larry M. Blair, "Update of Employment Trends in Nuclear Power Industries," paper prepared for the National Conference on Meeting Energy Workforce Needs, Determining Education and Training Requirements, Washington, February 26-28, 1980.

As the nuclear energy industry matured and commerical applications expanded during the 1970's, the involvement of scientists and engineers in research and development activities decreased substantially (Table VI-4), although the data for recent years indicates that the proportion may be stabilizing. About 80 percent of the scientists and engineers involved in research and development were employed in government-owned, contractor-operated facilities.

Table VI-4. Nuclear-Related Engineers and Scientists Involved Primarily in Research and Development Activities, 1968-1977

Occupation Group	Percentage Involved in Research and Development		
	1968	1973	1977
Engineers	58.9	33.8	31.5
Scientists[a/]	82.5	70.3	66.9

a/ Includes mathematicians, physical scientists, and life scientists.
SOURCE: Larry M. Blair, "Update of Employment Trends in Nuclear Power Industries," paper prepared for the National Conference on Meeting Energy Workforce Needs, Determining Education and Training Requirements, Washington, February 26-28, 1980.

According to a survey of union (IBEW) workers, the predominant occupations in the operation of nuclear power plants were in reactor operations, maintenance mechanics and instrumentation and control. (Table VI-5.)

Table VI-5. Occupational Distribution Within Nuclear Power Plants, Technician and Skilled Workers, 1977

Job Group	Percent
Reactor operations	
Licensed (senior and operator)	10.7
Unlicensed	
Journeyman	4.1
Helper and trainee	20.7
Maintenance electrician	
Senior and journeyman	6.5
Helper and apprentice	1.8

Table VI-5. Occupational Distribution Within Nuclear Power Plants, Technician and Skilled Workers, 1977--continued

Job Group	Percent
Maintenance Mechanic	
Senior and journeyman	14.0
Helper and apprentice	7.1
Maintenance, other	
Nonstandard craft and janitor	4.5
Instrument and control	
Senior and journeyman	8.9
Helper and apprentice	4.7
Health physics technician	
Senior and journeyman	7.6
Helper	1.6
Stores	
Journeyman storekeeper	.9
Helper storekeeper	2.2
Administration	
Senior and journeyman clerk	.3
Clerk helper	4.3
Not reported	.1
Total	100.0

SOURCE: The data were collected in the latter half of 1977 by the International Brotherhood of Electrical Workers (IBEW) in a survey of union locals in nuclear power plants. At the time of the survey, the IBEW represented approximately 60 percent of the United States nuclear power plants. Survey results were received from 1,804 workers in 30 of the 39 power stations represented by the IBEW. This is approximately a 60-percent response for the 30 stations that cooperated with the survey.

Labor Supply and Training

The nuclear energy industry has grown out of basic scientific research where new discoveries and developments bring rapid changes in technology and labor requirements. The frontiers of nuclear science are continually shifting and being redefined and it is believed that entirely new phenomena and principles are yet to be discovered. The National Academy of Sciences, the American Institute of Physics and other agencies have, therefore, conducted a number of surveys and maintained inventories of nuclear physics graduates.[3/] (Table A-25.) Nuclear physics is a field where employment opportunities are much less than they were in the early 1960's. Graduate-student enrollments have decreased by almost 50 percent from their peak in 1965. The number of postdoctorates has also decreased. The decline in graduate enrollments in nuclear physics and related high-level sciences raises some concern for the continued research and development in the nuclear energy field. (Table H-9.) Employment in nuclear-related R&D facilities decreased from 54,000 in 1968 to about 37,000 in 1977.

The nuclear power field also depends on high levels of skill and educational attainment for plant operations. Special training programs

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3/ National Academy of Sciences, Nuclear Science: A Survey of Funding, Facilities and Manpower, 1975.

have been developed by a number of educational institutions and other organizations (Appendix H-19). The level of educational attainment for skilled craft workers in nuclear power plants in 1977 is shown in Table VI-6.

Table VI-6. Percent Distribution of Power Plant Technicians and Skilled Craft Workers, by Highest Level of Schooling Completed, 1977

Highest Level of Schooling	All Technicians and Skilled Craft Workers	Job Groups: Operators[a/]	Maintenance[b/]	I&C[c/]	Health Physics
Less than high school graduate......	2	1	4	0	1
High school graduate or equivalent.........	41	41	52	23	26
1-4 years college, no bachelor's degree[d/].............	52	55	42	69	61
4 years college, bachelor's degree....	5	5	2	8	12
Total.................	100	100	100	100	100

a/ Includes licensed and non-licensed reactor operations staff.
b/ Maintenance includes electricians, mechanics, and other.
c/ Instrumentations and control technicians.
d/ Includes persons holding an associate degree from a two-year college.

NOTE: Columns may not add to 100 percent because of rounding.

SOURCE: Larry M. Blair, "Update of Employment Trends in Nuclear Power Industries," paper prepared for the National Conference on Meeting Energy Workforce Needs, Determining Education and Training Requirements, Washington, February 26-28, 1980.

Safety and Industrial Hazards

Because of the nature of the basic fuel supply, great concern is given to the safety and environmental hazards in the production of nuclear energy. These safety and environmental concerns have resulted in the slowdown of nuclear plant construction. The accident at the Three Mile Island facility in 1979 brought greater attention to the public health and safety aspects of nuclear energy.

Labor and Industrial Relations

The nuclear energy field is organized to a greater extent than most other energy industries. In the construction of power plants and other nuclear facilities the various construction trades are organized. In nuclear power plant operation, it is estimated that about 60 percent of the employees are members of the International Brotherhood of Electrical Workers.

CHAPTER VII - SOLAR ENERGY

The utilization of solar energy involves various techniques and processes, with strong emphasis on energy conservation. In the past, solar energy was a very small part of the total energy sector and of total economic activity in general. While greater attention is now being given to the use of solar energy, manpower data for this sub-sector are scarce and not yet organized in a standard system (e.g., the Standard Industrial Classification System) to permit ready comparison with other energy sectors. The employment related to solar energy production and distribution is found in several areas such as construction, manufacturing and retailing.

One of the oldest forms of solar energy is the burning of biomass materials, ranging from wood to garbage. The design and manufacture of stoves and furnaces to use such materials, often as a supplement to home heating, and the use of business fuel by electric utilities are activities in the solar energy scope. Wind and water power area also considered as part of the solar energy field.

The newly developing technologies are primarily concerned with capturing energy directly from the sun's rays and involve a wide variety of activities, many of which remain in the experimental stage. Considerable emphasis is being given to research and development of on-site passive and active solar energy systems. The manufacture of solar collectors, photovoltaic cells, heat exchange systems and other components is a part of the expanding activity in the solar energy field.

While the emerging solar energy industry has not been identified and classified in the normal statistical sources, there have been numerous studies made of solar energy activities with attention given to the employment aspects.[1/] Although experimental and demonstration work continues on the application of direct solar energy, the products and materials used come from a variety of existing manufacturing industries. Much of the work involving the installation of solar equipment requires direct on-site labor. Therefore, solar energy is more labor intensive than the normal sources. The skills required for installation of solar equipment are very similar to those required for conventional construction projects. The materials and equipment required for solar energy installations are manufactured by firms in several manufacturing industries.

Although empirical data on employment generated by solar energy production are very scarce, there are several models of employment generated from solar energy production compared to conventional energy sources. In using data from models it is important to understand the assumptions made by the model builder. Most of the comparative cost and manpower requirements models, for example, assume perfect substitutability of systems, which is seldom the case. A review of the analytical state-of-the-art of these comparative models may be found in a paper prepared for the U.S. Department of Energy.[2/] One of the well-recognized models in which the U.S. Office of Technology Assessment compared the direct labor requirements for a coal-fired generator plant with those for two solar energy systems is shown in Tables VII-1 and VII-2.

1/ Joint Economic Committee, Subcommittee on Energy: Creating Jobs Through Energy Policy, Hearings March 15 and 16, 1978.

2/ The Job Creation Potential of Solar and Conservation: A Critical Evaluation, May 7, 1979, prepared by Meg Schacter.

Table VII-1. Labor Requirements for a Conventional 800 MWe Coal Plant (Units of man-hours per megawatt-year)

	Total	Construction	Operating and maintenance
Total..................	2,050	670	1,380
800-Mw coal plant.................	590	270	320
Coal strip mine using western coal....................	390	20	370
Coal transportation...............	170	20	150
Electric transmission.............	51	50	1
Electric distribution.............	680	140	540
Turbine/generator manufacturing...................	70	170	0

ASSUMPTIONS: 800-MWe coal plant operating at 75 percent peak capacity for 30 years; western coal strip mine with 40-mile train line and 237 train round trips per year; all data based on Bechtel data with the exception of the turbine generator manufacture (it was assumed that the turbine/generator cost $150/Kw of which 25 percent was labor and that this labor was paid at an average rate of $10/hr); calculations divide the sum of construction manpower and 30-year operating manpower requirements by the total number of megawatt-years of energy produced by the plant.

SOURCE: "Resource Requirements, Impacts, and Potential Constraints Associated with Various Energy Futures," the draft annual report of Bechtel Corp. to ERDA, November 1976 (No. APAE-11735-76-1).

Table VII-2. Labor Requirements of Two Types of Distributed Solar Energy Systems
(Man-hours per megawatt-year)

Type	Total	Construction	Operations and maintenance
I. Solar hot water heaters ($8m^2$ flat plate):			
Manufacture collector...	900 - 1,800	900 - 1,800	0
Install collector.......	2,500	2,500	0
Routine O & M..........	700 - 1,400		700 - 1,400
Total for hot water system[1/]...............	4,100 - 5,700	3,400 - 4,300	700 - 1,400
Total for hot water system including backup................	4,440 - 5,040	3,740 - 4,640	---
II. Tracking silicon photovoltaic system ($50m^2$):			
Manufacture collector & cells...................	3,000	3,000	
Install collector.......	1,700 - 5,500	1,700 - 5,500	---
Operate system..........	1,200	---	1,200
Total for tracking photovoltaic system...	5,900 - 9,700	4,700 - 8,500	1,200
Total for tracking photovoltaic system including backup......	6,240 -10,040	5,040 - 8,840	---

1/ Since electric water heaters are typically only 70 percent efficient, the man-hours per megawatt-year of solar thermal energy applied to hot water can not be compared with the man-hours per megawatt-year of electricity illustrated in the previous table. The man-hours required to produce a megawatt-year of electric hot water would be 42 percent larger than the man-hours displayed in the previous table.

ASSUMPTIONS: 20-year system life; installation includes 75 ft. of piping costing \$0.12 MG/ft to install; flat plates installed for 1.3 MH/m^2 and tracking collector installed for 0.83 to 3.33 MH/m^2; cells assumed to be 18 percent efficient, optical efficiency 80 percent; labor for providing backup power is assumed to be 50 percent of the construction labor (e.g., 340 man-hours/per megawatt-year).

SOURCE: Prepared by Office of Technology Assessment using manufacturer's data.

In another study done by the California Employment Development Department, models have been constructed to compare a solar energy system with two proposed nuclear energy power plants in that State. Their summary conclusion showed that the solar energy equivalent of the two plants would produce many more jobs as indicated in the following table.

Table VII-3. Estimated Total (Direct and Indirect) Man/Years Required to Build and Operate Two Nuclear Power Plants and Solar Equivalents

Project	Man/Years
Sundesert 1900 Mw Plant	36,268
Solar Equivalent	241,055
Potrero 400 Mw Plant	1,237
Solar Equivalent	34,885

NOTE: Information on assumptions and calculations to obtain these data based on twenty years of operations are available in the draft paper.

SOURCE: State of California, Employment Development Department, "A Comparative Analysis of the Employment Effects of Solar Energy in California," draft paper, October 1977.

Yet another model-building study by the Council on Economic Priorities compared employment resulting from continued consumption of electric power on Long Island with consumption under a conservation/solar scenario.[3/] This

3/ Council on Economic Priorities, Jobs and Energy, New York, N.Y., 1979.

study also made a comparison of the employment generated under a conservation electric scenario and under the proposed construction of Jamesport 1 & 2 nuclear electric plants. Details on the assumptions and calculations may be obtained from the full report.

In addition to the models developed for complete systems, there are other studies of man-hour requirements to produce components for solar energy such as solar collector plates. Although data from the labor requirements models have many limitations, they often serve as a basis for decision making until more empirical data become available.

In the 1970's there were a growing number of establishments engaged in the manufacture, sale and installation of products for capturing solar energy for household and commercial use. These were in addition to companies engaged in research and development of solar energy devices and technology.

Recognizing the growing activities in research and development, manufacture of components and systems, marketing and distribution, and installation and maintenance of solar energy technology, the Department of Energy arranged for Battelle Institute to do a survey of the establishments and work force engaged in solar energy activities in 1978. (Table VII-4.) The scope of this study included all types of solar energy technologies and applications (space heating and cooling, water heating, industrial process heat, thermal power, ocean thermal conversion, photo-voltaic conversion, wind conversion and biomass conversion) and all phases of work. This study provides the most comprehensive review of employment and the current structure of the solar energy industry available.

It is estimated that 22,500 persons, both full and part time, were working in solar energy activities in 1978. (Table VII-4.) Engineers were the largest occupational group in R&D work which was slightly larger than commercial and installation activity. Most of the occupations in installation work were skilled while unskilled dominated the commercial activity.

In the 1978 survey, approximately 31 percent of the respondent establishments were involved in the manufacture of solar collectors or other solar products. About 23 percent provided research and development services, and 18 percent provided architectural and engineering services. Twelve percent of the respondent establishments were engaged in installation and 16 percent provided other solar-related services.

The establishments engaged in solar work tended to be small. Forty percent had 10 or fewer employees and only 20 percent had over 400 employees. These larger establishments, however, employed 40 percent of all persons working in solar. The percentage of employees engaged in solar work varied inversely with the size of the establishment. That is, establishments with 10 or fewer employees had over 80 percent of their employees engaged in solar work. In contrast, establishments with more than 400 employees had fewer than 1 percent of their employees engaged in solar work.

Establishment size was also related to the type of solar work performed. Installation, architectural and engineering services, and miscellaneous services were performed mainly by small organizations, whereas R&D work was performed mainly by large organizations. Manufacturing work was performed by both large and small establishments. Approximately 75 percent of the solar work of large establishments was in R&D.

Table VII-4. Estimated Employment in Different Types of Solar Energy, 1978

Type	Number[a/]		
	Total	Research and development	Commercial (including installation)
Total.................	22,500	12,500	10,000
Space heating & cooling, water heating............	14,700	6,800	7,900
Industrial process heat....	300	200	100
Thermal power.............	600	600	b/
Ocean thermal conversion...	400	400	b/
Photovoltaic conversion....	4,400	2,700	1,700
Wind conversion............	1,200	1,000	200
Biomass conversion.........	800	800	b/

a/ Detail may not add to total due to rounding. (Rounded to nearest 100.)
b/ Less than 50.

NOTE: Data are based on responses from 518 establishments that responded, i.e., 27.75 percent of the 1,867 establishments estimated to have been engaged in solar energy activity.

SOURCE: U.S. Department of Energy, Solar Energy Employment and Requirements, 1978-1983, DOE/TIC-11154, 1980.

Employment Projections

Solar employment in R&D activities was projected to increase by 144 percent by 1983 and in commercial activities by 203 percent, as shown in the table below.

Table VII-5. Full-time Equivalent Solar Employment and Projected Changes

Activity	Employment			Percent Change	
	1978	1981	1983	1978-81	1978-83
Total.............	16,407	33,134	44,365	102.1	170.4
Solar R&D...........	9,111	15,852	22,245	74.0	144.2
Solar commercial....	7,296	17,282[a]	22,120[a]	136.9	203.2

a/ Based on the Recent Trends Scenario.

NOTE: The assumptions and projection methodology are available in Appendix D of the report.

SOURCE: U.S. Department of Energy, Solar Energy Employment and Requirements, 1978-1983, DOE/TIC-11154, 1980.

Occupations Engaged in Solar Energy

Engineers comprised the largest occupational group in the R&D firms, while skilled workers made up the largest occupational group in the installation work. (Table VII-6.) The respondents (in the Battelle survey) were asked to report occupations that were difficult to hire in 1978. Engineers and other professionals were most frequently mentioned.

Table VII-6. Occupational Distribution of Employment in Solar Activities

	Number Reported			Reported frequency of difficulty to hire
	Research and development	Commercial (except installation)	Instal-lation	
Total..........	1,327	927	80	84
Engineers...........	482	185	16	15
Scientists..........	249	21	0	18
Other professionals.	176	98	4	10
Technicians.........	263	105	8	21
Skilled crafts and operatives....	157	518	52	20

NOTE: Based on 518 reporting establishments.

SOURCE: U.S. Department of Energy, Solar Energy Employment and Requirements, 1978-1983, DOE/TIC-11154, 1980

One of the purposes of the Battelle survey was to identify new job specialties required in the solar area. The returns indicated that existing occupations with special emphasis on analytical and design skills were needed. The responses from 393 employees indicated that the sources of their special skills were formal training 44.0 percent, practical experience 41.2 percent, and self study 14.8 percent. The subject matter and duration of the most frequent formal training courses are shown in the following table.

Table VII-7. Subject Matter and Average Duration of the Four Most Frequently Taken Training Programs or Courses as Reported by Employees

Subject Matter	Number of training programs or courses taken	Average duration in hours
Solar Energy general...........	154	19.9
Space Heating and Cooling......	40	29.9
Solar System Design............	27	23.8
Thermodynamics/Heat Transfer...	16	37.9

SOURCE: U.S. Department of Energy, Solar Energy Employment and Requirements, 1978-1983, DOE/TIC-11154, 1980.

CHAPTER VIII - GEOTHERMAL ENERGY

Geothermal energy involves the use of natural heat from the earth. Where concentrated near the earth's surface, energy from these resources can be extracted to produce electricity or for direct heating. Although geothermal energy resources have been used for many years in certain geographic areas, the recent search for alternatives to depleting and undependable supplies of conventional fuels has brought greater attention to geothermal energy resources.

The internal heat of the earth is theoretically a virtually inexhaustable energy source; however, only heat concentrations near the earth's surface can be exploited with current technology. Heat in the earth may be available in several forms such as dry steam in geysers, hot water, or dry rock from which the heat has to be extracted by pumping water down and returning hot water for use. Since geothermal energy can not be stored or economically transported, its use involves location of industrial or commercial facilities near the source for direct use or conversion to electricity at a somewhat standard electric power plant.

The production or capture of geothermal energy is not an industry identified in the Standard Industrial Classification (SIC), and therefore practically no data on employment, production and economic significance exist in the usual data systems.[1] As of January 1980 the world electrical generation capacity from geothermal resources was 1,926 megawatts of which the United States was the major producer of 665 megawatts.[2] The only geothermal electric generation facility in operation in the United States is located at Geysers, California where operations have existed since 1960. The oldest hydrothermal facility has been operating at Lardarello, Italy since 1904. The use of geothermal resources for space heating has been developed for a number of years in several locations in the United States and many points of the world.

To encourage the exploration and development of geothermal energy Congress passed the Geothermal Steam Act of 1970 and the Geothermal Energy Research, Development and Demonstration Act of 1974. The latter act provides for loan guarantees for private firms undertaking geothermal developments. As of 1979 four loan guarantee projects had been approved in California and Nevada.[3] The development of geothermal energy involves long leadtimes and is permeated with high technical and economic risks. Therefore, it is not attractive to small business. Despite the technical and economic difficulties facing the development of geothermal energy

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1/ For a discussion of the information needs see U.S. Department of Energy, A Plan For Developing a Comprehensive Energy Manpower Information System, DOE/IR-10233, September, 1979.

2/ GAO, Geothermal Energy: Obstacles and Uncertainties Impede its Widespread Uses, EMD-80-36 January 18, 1980.

3/ GAO, The Geothermal Loan Guarantee Program: Needs for Improvements, EMD 80-26, January 24, 1980.

there are forecasts that geothermal electric capacity may reach 3,000 to 4,000 megawatts by 1985.[4/] In addition to electric power production the research and development efforts offer promise of added direct use of geothermal energy.

A comprehensive study of the geothermal industry for the Department of Energy estimated employment as equivalent to 3,340 full-time workers generated by geothermal activities in 1977.[5/] Many persons and firms devote only part time to geothermal work. Almost 700 private firms, public agencies and educational institutions were found to have employed persons in geothermal activity, but the 20 largest employing firms accounted for 52 percent of the reported employment. Geothermal work comprised a minor proportion of the total activities of most organizations involved. Research and development accounted for over a quarter of the manpower involved in geothermal activities with about half of that being for resource exploration and assessment. The University of Utah study found that 60 percent of the employment was in the scientists and engineers occupational category.

Building on information from the stable core of continuous geothermal activity at the Geysers in Northern California and the Imperial Valley

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4/ GAO, *op. cit.*

5/ Richard L. Hannah, "A Manpower Assessment of the Geothermal Industry," The Institute of Human Resources Management, University of Utah, a report to the U.S. Department of Energy, December 1, 1979.

in Southern California, the University of Utah study attempted to cover firms of all sizes, most of which are only marginally attached to geothermal energy production. Some of the firms (such as drilling) were active in other energy industries. The study forecasts employment in geothermal energy to range from 11,802 to 32,339 by 1985. The assumptions and methodology for the forecasts are provided in the report. The scope of the study ranged from exploration and discovery of geothermal sites to the production of electrical energy. The study concluded that if geothermal activity achieves maximum employment growth, the national impact will be minimal.

According to the Utah study, the most serious manpower problems that are likely to emerge in geothermal activities are in certain scientific and engineering occupations including geologists, geophysicists, reservoir engineers and environmental engineers. Employers indicated that if they were to draw from a pool of college trained manpower that had already been oriented to geothermal activities and had received special training courses, geothermal employers would be in a more competitive position for recruiting relative to other energy industries.

Some firms have indicated shortages of skilled personnel and laborers attributable to remote development sites or areas of heavy development activities which have taxed the local manpower pool, or a combination of the two. The former was viewed as a short-term phenomenon, the latter a more serious long-run problem. In particular, problems exist for drill rig personnel from the lowest to the highest skill levels employed at the drilling site. The acquisition of skills and experience and the progression up the job ladder from roustabout, driller assistant, driller foreman to job foreman is hindered by the nature of drilling work which involves long periods of travel and constant movement to different sites which results in high turnover rates.

CHAPTER IX - ELECTRIC AND GAS UTILITIES

Although not an originating source of energy, the electric power and gas utilities are engaged in the conversion and distribution of energy to users. Being in the public interest it has historically been subject to rate regulation and may be privately or publically owned. It is the largest segment of the energy industries in terms of employment and by its nature is widely distributed geographically. It includes SIC industries 491, 492 and 493 which compose the major part of SIC group 49.

The electric utilities may produce electric power from any of several energy sources. Hydroelectric energy has been one of the oldest sources of electric power but has never been a major source. For many years coal was a major source of power for electric utilities, but prices and environmental factors forced a growth in the use of oil and gas as the major fuel. In the 1970's reconversion of electric plants to the use of coal has been urged under policies of domestic sourcing of supplies. Since 1960 nuclear plants have grown in importance providing about 9 percent of total electric generating capacity by 1977. Although nuclear power was projected to double in importance, environmental and safety concerns have slowed its growth. With emphasis on domestic renewable energy resources higher priority is being given to hydroelectric, solar and geothermal sources.

Employment Trends

Employment in electric power and gas utilities has grown from less than 640,000 in 1970 to nearly 740,000 in 1979. Because of technological developments and improved productivity, employment growth rates in this industry have not kept pace with the industry output or general economic growth. During the 1970's most of the employment growth has been in the electric service industry (SIC 491). (Table A-14.) The gas production and distribution industry (SIC 492) and firms that have combustion electric and gas activities (SIC 493) have remained relatively stable in employment. (Tables A-15 and A-16.)

Employment by Occupation

Technological and other factors are altering to some extent the occupational structure in the electric power and gas industry. One area of change is in the balance of supervisory and nonsupervisory workers with nonsupervisory workers declining. The types of fuel used by generating plants affect occupational requirements. Fuel and ash handlers, for example, are not required for plants using natural gas but are needed in plants that burn coal and, to some extent, in plants that burn oil. Also, nuclear plants require more engineers, technicians and other specialists than any type of fossil-fuel plant. As nuclear plants and coal-fired plants are expected to become the dominant types of power plants over the next decade, the occupations of specialists and fuel and ash handler should become more important.

Employment is projected to increase in six of the eight major occupational groups, with the largest increases expected to occur among professional and technical workers, managers and administrators, and craft workers. Specific occupations in which increases are expected include line and cable workers, and truck drivers. (Tables D-7 and D-8.)

Some decline in the number of power plant operators is anticipated. Larger and more efficient equipment is expected to create increases in output with little or no increase in labor requirements. The same number of people, for instance, can operate a large generator or a small one.

There has been some concern in the electric power industry about possible shortages of skilled construction and operating personnel during the coming decade. Such shortages would have greater impact upon nuclear generating plants because of the many special skills involved. Among the occupations critical for constructing and operating nuclear plants, where shortages are possible, are nuclear, mechanical, and electrical engineers, reactor operators, health physics/radiation monitoring technicians, millwrights, and nuclear-qualified welders. A new labor demand model that forecasts power plant construction employment has been developed by the Departments of Labor and Energy and the Tennessee Valley Authority.[1/] The model covers 1978-81 and breaks employment estimates down by region, occupation, and type of generating plant.

Some increase is expected in occupations concerned with the transmission and distribution of electric power. The number of line and cable workers should increase. Increased use of automatic equipment in substations--allowing more remote control operations--may cause a decline in regular substation operators but an increase in the more highly skilled mobile substation operators, who travel from one remote-controlled substation to another.

Labor Supply and Training

With the slow growth of employment and wide dispersion of the electric power and gas utility industry there is unlikely to be a critical shortage of operating personnel. In the construction of power plants and distribution lines in remote areas, problems of labor supply often occur, particularly in the construction of nuclear power plants.

1/ Willis J. Nordlund and John Mumford, "Estimating Employment Potential in U.S. Energy Industries," Monthly Labor Review, May 1978, pp. 10-13.

Although considerable skills are required for operations, much of the training is provided by the firms. A number of specialized training programs have been developed for the nuclear power industry. (Table H-19.)

Training programs are being established to facilitate adjustment of employees to the requirements of new technology. Control room operators in nuclear generating plants, for example, are licensed by the Nuclear Regulatory Commission (NRC) to manipulate the controls of a nuclear reactor. The training program used in a plant visited by BLS staff to prepare operators for the NRC licensing test requires between 6 months and a year to complete and includes extensive training in nuclear physics, radiation protection, and power plant operations. The NRC operator's license must be renewed every 2 years; since nuclear power generation is a rapidly evolving technology, the power company maintains an ongoing retraining program for its operators. Some utilities are installing simulators that will be used to train nuclear operators. Control room supervisors are required to hold a senior operator's license which, in the company visited, requires an additional 6 months of training.

Hours, Earnings and Labor Turnover

Although the 40 hour week is normal for most of the electric power and gas utility industry, average weekly hours usually exceed 40. The need for scheduling some work for duty at all times and the high requirement of supervisory workers accounts for some of the longer work week.

Weekly earnings in the public utilities are slightly below those for many other energy industries with those for the gas production and distribution industry being the lowest. (Tables A-14, A-15 and A-16.) Earnings and wage rates vary considerably from one area to another and for various types of companies.

A comparison was made of labor costs for various occupations between a group of large generating plants (averaging 2,626 Mw) and a group of smaller plants (340 Mw) in 1975.[2/] Labor costs per net Mw for the smaller plants were approximately 35 percent higher for supervisors, 315 percent higher for operating personnel, 48 percent higher for maintenance personnel, 200 percent higher for fuel and ash handlers, and 188 percent higher for clerks.

Technological Changes and Productivity

Major technological changes are taking place in the electric power and gas industry which directly affect the industry's work force and productivity. These include the more widespread use of electronic computers, nuclear power generation, and coal as a major fuel for electric generating plants. Extra-high-voltage transmission will continue to make possible the economical transmission of large quantities of electric power. In constructing and maintaining transmission lines, labor requirements are being reduced through the more efficient utilization of skilled workers and fleets of mechanized vehicles by computerized scheduling of work assignments. The mechanized fleets, however, require an increase in vehicle maintenance crews. Innovations such as process control computers, being introduced in an already highly instrumented

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[2/] Results from the survey of steam generating plants by Electrical World indicate that the cost of operating and maintenance employees per Mw of net output declined steadily from 1960 to 1970, then rose somewhat in 1972, and declined again in 1974 (although not returning to the 1970 level). In this study, 1960 data are from the 14th Steam Station Cost Survey, Electrical World. Data for 1962-72 are from Leonard M. Olmsted, 19th Steam Station Cost Survey, Electrical World, Nov. 15, 1975, p. 44. The 20th Cost Survey, in 1977, did not have such detailed information for labor cost.

environment, will have a less extensive impact on employment and occupations than such changes as nuclear power installations, which require substantially more scientific and technical staff than conventional installations of similar capacity. Research now underway on coal liquefaction and gasification processes may ultimately provide a clean-burning fuel from an abundant energy source to replace oil and natural gas.[3/]

Output per employee hour nearly doubled between 1960 and 1973, but the rate of increase dropped off to 1.4 percent a year in the period 1973-78. The changes in productivity growth rates are closely related to the rates of increase in output. (Table G-5.)

Electrical World publishes a continuing survey of generating costs for electric utility steam plants that includes data on the number of operating and maintenance employees per Mw of net output. The surveys indicate that labor requirements tend to be lower for larger generating plants and that labor requirements vary by type of generating plant. Nuclear plants have the greatest labor requirements per Mw, needing more people in all occupations (except fuel and ash handlers) than the other types of generating plants. Coal-fired plants have the second highest level of labor requirements, oil-fired plants the next, and gas-fired plants the lowest.

3/U.S. Department of Labor, Bureau of Labor Statistics, Technological Change and its Labor Impact in Five Energy Industries, BLS Bulletin 2005, 1979.

Labor and Industrial Relations

About one-half of the workers in electric and gas utilities are unionized. Of the several unions representing utility industry employees, the largest are the International Brotherhood of Electrical Workers and the Utility Workers Union of America. There were 40 work stoppages in the electric and gas utilities in 1977 with more work days lost than in other major energy industries except for coal. (Table F-1.)

Safety and Industrial Hazards

The electric and gas utilities industry gives considerable attention to safety in handling electricity and natural gas. The occupational injury and illness record for the industry compares closely to that of the total private sector. (Table E-1.)

CHAPTER X - MINING AND OIL FIELD MACHINERY AND EQUIPMENT

While each economic segment is affected to some extent by the availability of energy supplies, those industries whose predominant market are the energy producing industries are influenced in a different manner by activity in the energy-producing industries. Energy production requires goods and services purchased from a wide variety of industries. Directly affected by energy-production activities are the mining machinery and equipment (SIC 3532) and oil field machinery and equipment (SIC 3533) industries. Since the output of these two industries is almost totally consumed by coal mining and oil production activities, manpower data available for these industries has been included in this report.

Employment Trends

With the growth in mining activity in the search for domestic fuel sources in the 1970's, employment in the mining machinery industry has grown from 23,600 in 1972 to 38,900 in 1979. (Table A-11.) The oil field machinery industry had a more pronounced growth in the same period from 41,700 in 1972 to 85,600 in 1979. (Table A-12.) Employment in the latter industry is an indicator of drilling and production activity.

Characteristics of the Work Force

In both the mining machinery and oil field machinery and equipment industries over 10 percent of the employees are women. The percentage of jobs held by women in each industry grew in the expansion period of the 1970's. These are heavy durable goods industries in which many of the workers are skilled operatives. Both industries have a high proportion of non-production managerial, professional and technical employees. (Tables A-11 and A-12.)

Labor Supply and Training

The mining and oil field machinery industries do not appear to have as serious labor supply problems as do the energy producing sectors. Many of the skills are acquired on the job in these or related manufacturing industries such as construction machinery. However, because of the growth in drilling activity, some companies have indicated a concern over future manpower availability as a potential limiting factor to expansion.[1/]

Hours, Earnings and Labor Turnover

Although 40 hours is the normal work week in most of the machinery industries, the average weekly hours in the mining machinery and oil field machinery industries exceeded 40 for most of the 1970's. (Tables A-11 and A-12.) The expansion of average weekly hours in the oil field machinery industry reflects the expansion of oil field activity after 1972.

Average weekly earnings in these two energy-supporting industries did not rise as much as earnings did in the direct energy-producing industries.

Labor turnover in the mining and oil field machinery and equipment industries is greater than for most of the energy industries except for oil and gas extraction. (Tables B-11 and B-12.) The oil field machinery industry experienced generally higher turnover rates than mining machinery.

1/ National Petroleum Council, Availability of Materials, Manpower and Equipment for the Exploration, Drilling and Production of Oil, 1974-76, December 1979.

CHAPTER XI - DATA GAPS AND DEFICIENCIES [1/]

A review of existing data series on manpower in energy production reveals, in general, a mixed situation. For the traditional energy sources, such as bituminous coal mining and petroleum refining, there are traditional, well established data series about employment, production, earnings and productivity. However, the complexities and variety of changing energy demand and supply require that ongoing data collection programs be reviewed for possible revision and supplementation.

For a relatively recent development--nuclear generation of electricity--although some data series have been established, they are not as complete as desired for manpower assessment purposes. Further, data in general are not comparable with those for other energy sectors based on standard industrial designations. Data series for this sector also need to be revised and supplemented, particularly in terms of occupational categories and training requirements.

For the newly emerging energy sectors or technologies--e.g., solar heating and cooling and geothermal--practically no standard data series exist and, in fact, the sectors are not as yet clearly defined. Once these new sectors are delineated and a standard industrial code adopted, it will be possible to establish new data series comparable with those of other energy industries. Meanwhile, manpower data need to be collected and compiled, keeping ultimate standardization in mind.

1/ U.S. Department of Energy, Manpower for the Nation's Energy Programs: A Plan for Developing a Comprehensive Energy Manpower Information System, July, 1979, pp. 111-117.

One of the current problems is that of insufficient disaggregation of manpower data for the traditional, large-scale, energy sectors. This arises partly out of the rigidity of the SIC system. Ordinarily, the SIC system would suffice in producing manpower information, but the emergence of critical problems in the energy sector together with technological and structural changes that are taking place, requires some amendments to the current SIC system.

For example:

-- Under bituminous coal and lignite mining (SIC 12), underground and surface mining are combined in SIC code 1211. A separate code for at least the two major types of mining should be provided. Separation of these two types of coal mining is necessary because the technology, productivity levels and occupational composition of the two types are quite different. As the two components change in relative size, the total for all bituminous coal mining can shift in inexplicable ways unless they are separated. Similarly, mining services for both types of mining are combined under SIC code 1213. However, separation of the two services for SIC is not urgent.

-- For petroleum refining and related industries (SIC 29), all establishments engaged in producing gasoline, kerosene, distillate and residual fuel oils, lubricants and other products are classified under SIC code 2911. Expansion of the coding structure for classifying establishments by type of refinery or major process is suggested.

-- Generation of electricity, electric services (establishments generating, transmitting and distributing energy for sale--SIC 4911) and electric and other services combined (establishments with electric services as the major part--SIC 4931) include all establishments regardless of fuel used--coal, gas, oil fired, hydro, or nuclear. Codification by type of fuel used in the generating plant plus possibly a separation of generation from transmission and distribution should be considered. The difference in fuels used has a significant impact on the occupational composition and on the industries from which purchases are made.

-- For nuclear energy activities (other than reactor operation and maintenance which is under SIC codes 4911 or 4931), selected DOE data series are separated into some 20 categories showing detail such as fuel fabrication or design and manufacture of nuclear facilities. All of these categories are in finer detail than the SIC system and none are strictly comparable to any SIC categories. For at least those sectors in which the nuclear component is a significant proportion of the entire industry, as it is now identified in the SIC system, there should be a separate SIC code for the nuclear component. This would be useful in tracing inter-industry effects of changes in the size and scope of nuclear power programs.

-- For solar heating and cooling, no part of the spread of activities from R&D, through manufacture, installation, and maintenance can presently be identified under the SIC system. However, most if not all of the activities are included within broader SIC groupings, for example: establishments making solar flat plate collectors, which are included under SIC code 3433 (heating equipment, except eletric and warm air furnaces), and those designing solar energy systems are probably coded as SIC 8911--engineering, architectural and surveying services. Maintenance, repair and installation is under plumbing, heating and air conditioning contractors (SIC 171). Usually, however, establishments engaged in solar energy activities are primarily engaged in non-solar work.

The SIC coding system should be changed to meet energy manpower assessment needs through establishment of new four-digit codes or new five-digit codes, etc.

Another general inadequacy for the various energy sectors is the lack of detailed staffing data which can be directly related to specific production levels. There is generalized productivity information for established industries such as petroleum refining or coal mining. These data can reveal overall trends in output per manhour. But, in general, information is not sufficient for analyzing factors contributing to improved productivity. The possibility of measuring the effect of the introduction of equipment or environmental regulations on output should also be investigated.

There is insufficient information on the manpower requirements for the construction of energy facilities. In some cases, this activity is carried out by contract construction firms and in others by "force account" construction (that is, by workers on the payroll of the primary industry, e.g., the coal mining firm or public utility). In any case, a prime requisite for proper manpower assessment is the analysis of construction manpower requirements, whether for drilling for geothermal energy, opening new mines, or building new refineries or nuclear facilities. The Construction Labor Demand System (CLDS), a recently established joint project of the Departments of Labor and Energy and the Tennessee Valley Authority, shows promise in meeting the requirements for such data. However, it is still in its developmental stages, and efforts are required to continue its planned program. Additional types of energy construction projects and occupations may need to be added to the CLDS.

Another general weakness of data required for energy manpower assessment is the scarcity of up-to-date information on demographic characteristics of the labor supply in various energy industries and occupations. Such data should include information on age, sex, race, and ethnic background of employees. Data on age are important in assessing future attrition and replacement needs, and information on the other characteristics is important for assessing the potential for improving manpower supply and identifying barriers to employment.

Occupational data, perhaps the most important in assessing specific manpower requirements, skill shortages, and other barriers to meeting construction and production goals, though improving, still have certain weaknesses. Continued development of the Occupational Employment Survey (OES) conducted by the Bureau of Labor Statistics is important. Now established after many years of development, it is essential that this comprehensive collection of data provide occupational patterns for established and newly emerging energy industries. Further disaggregation of industries and energy-related occupations is also required for the OES data to be useful in energy manpower assessment.

Once disaggregation of data is accomplished by means of separate SIC codes, then established data collection efforts would produce selected data in geographic detail. For example, employment data by state and SMSA can be produced through existing statistical systems. However, in some instances even finer detail might be needed. Labor requirements based on the location of underground or surface coal mines, or the location of refineries having specialized output would vary.

Information on the training of new workers for scientific and technical, as well as most of the managerial positions, is in relatively good shape with established data series on college enrollments and graduations. However, for the technician, skilled crafts and other jobs requiring considerable experience or training, a weakness in data availability is apparent. More information is required on entry patterns and sources of workers, and on training institutions and organizations. Data on vocational and technical training in educational institutions or by employers in formal programs, as well as on apprenticeships, need to be improved.

The measurement of indirect manpower requirements arising from the purchase of goods and services by energy-producing sectors in the supplier industries, as well as the measurement of manpower effects upon energy-consuming industries, is difficult. For energy activities which can be categorized by an SIC code (e.g., coal mining and petroleum refining), ongoing programs of the Bureau of Labor Statistics in economic growth and the industry/occupation matrix based on the input/output model serve fairly well. However, even here the lack of detail in input/output "lines" in the model for separating electricity generation by type of fuel used or separating underground and surface coal mining constitutes a strategic weakness. For those energy sectors not aligned specifically with standard industrial sectors, such as solar heating and cooling, geothermal energy development and production or the various phases of fuel production and processing and design and engineering of nuclear facilities, it is now impossible to determine indirect manpower impacts of energy production through interindustry relationships. Only the delineation of necessary distinctions in the SIC and the subsequent use of the SIC breakdowns in the regular statistics of the census of manufactures, mining and business and the subsequent use of the data tabulated in using the Commerce Department's Input/Output Table will make possible a more complete analysis of indirect impacts of changes in energy activities.

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APPENDIX TABLES (AND TECHNICAL NOTES)

Technical Notes, Tables A-1 through A-17 and B-1 through B-12 [1/]

Payroll reports provide current information on wage and salary employment, hours, earnings and labor turnover in nonagricultural establishments, by industry and geographic location.

Under cooperative arrangements with state agencies, the respondent (employer) fills out a single employment or labor turnover reporting form, which is then used for national, state, and area estimates. State agencies mail the forms to the establishments and examine the returns for consistency, accuracy, and completeness. The state uses the information to prepare state and area series and then sends the establishment data to the BLS (Washington Office) for use in preparing the national series.

Establishments are classified into industries on the basis of their principal product or activity determined from information on annual sales volume.

Employment data refer to persons on establishment payrolls who receive pay for any part of the pay period which includes the 12th of the month. The data exclude proprietors, the self-employed, unpaid volunteer or family workers, farm workers, and domestic workers in households. Salaried officers of corporations are included. Persons on establishment payrolls who are on paid sick leave (when pay is received directly from the firm), on paid holiday or paid vacation, or who work during a part of the pay period even though they are unemployed or on strike during the rest of the period are counted as employed.

1/ Additional detail available in Employment and Earnings, October 1979, pp. 181, 183 and 185, U.S. Department of Labor, Bureau of Labor Statistics.

From a sample composed of establishments reporting for both the previous and current months, the ratio of current month employment to that of the previous month is computed. This is called a "link relative." The estimates of employment for the current month are obtained by multiplying the estimates for the previous month by these "link relatives."

Employment estimates are compared periodically with comprehensive counts of employment which provide "benchmarks" for the various nonagricultural industries, and appropriate adjustments are made as indicated. Normally, benchmark adjustments are made annually.

The primary sources of benchmark information are employment data by industry, compiled quarterly by state agencies from reports of establishments covered under state unemployment insurance laws. These tabulations cover nearly nine-tenths of the total nonagricultural employment in the United States. Benchmark data for the residual are obtained from the records of the Social Security Administration, the Interstate Commerce Commission, and a number of other agencies in private industry or government.

Labor turnover is the gross movement of wage and salary workers into and out of employed status with respect to individual establishments. This movement, which relates to a calendar month, is divided into two broad types--accessions and separations. Each type of action is cumulated for a calendar month and expressed as a rate per 100 employees.

APPENDIX A-EMPLOYMENT AND PAYROLL DATA

Table A-1. Employment and Payroll Data
Coal Mining Industries (SIC codes 11, 12) Selected Years
Annual Averages, 1950-79

	Number (000's)		Production workers		
Year	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-55	NA	NA	NA	NA	NA
1960	186.1	3.0	164.6	$110.41	35.5
1965	141.4	2.3	123.7	137.51	39.9*
1970	145.1	2.6	126.7	184.32	40.6*
1971	145.6	2.9	123.3	192.63	40.3*
1972	160.9	2.8	139.7	214.49	40.9
1973	161.8	3.0	139.5	226.86	39.9*
1974	179.5	3.3	154.2	233.87	37.5*
1975	212.7	4.5	182.1	284.80	39.5*
1976	225.0	5.6	191.8	308.05	39.9*
1977	225.3	6.4	192.0	345.68	41.7*
1978	208.5	7.7	172.2	384.75	40.6*
1979 1/	258.6	9.2	216.3	417.18	41.0*

NA - Not Available.

1/ Preliminary.

*11-month averages, data for July not available.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-2. Employment and Payroll Data
Anthracite Mining Industry (SIC code 11)
Selected Years, Annual Averages, 1950-79

Year	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	3.8	0.2	3.3	$145.48	40.3
1973	3.8	.2	3.4	178.13	44.2
1974	3.5	.1	3.1	193.95	43.1
1975	3.4	.2	3.0	237.15	41.9
1976	3.5	.2	3.0	255.03	41.2
1977	3.4	.2	3.0	282.07	42.1
1978	3.1	.1	2.7	280.52	38.8
1979 2/	3.0	.1	2.7	318.80	39.8

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table A-3. Employment and Payroll Data
Bituminous Coal and Lignite Mining Industry (SIC code 12)
Selected Years, Annual Averages, 1950-79

Year	Number (000's) All employees	Number (000's) Women 1/	Production workers Number (000's)	Production workers Average weekly earnings	Production workers Average weekly hours
1950	367.9	NA	351.4	$ 67.46	34.7
1955	218.7	NA	204.9	92.13	37.3
1960	168.5	NA	149.2	112.41	35.8
1965	131.8	NA	115.2	140.26	40.2*
1970	139.6	NA	121.9	186.41	40.7*
1971	140.4	NA	118.9	175.81	40.3*
1972	157.1	2.8	136.4	216.12	40.9*
1973	158.0	3.0	136.2	228.28	39.8*
1974	176.0	3.3	151.1	234.75	37.4*
1975	209.3	4.5	179.2	285.98	39.5*
1976	221.4	5.6	188.8	309.25	39.9*
1977	221.9	6.4	189.0	346.51	41.7*
1978	205.4	7.7	169.5	385.97	40.6*
1979 2/	255.6	9.1	213.6	418.40	41.1*

NA - Not Available.

1/ Unpublished data from BLS. These data do not meet BLS publication standards and BLS does not certify to their accuracy and reliability.

2/ Preliminary.

*11-month averages, data for July not available.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-4. Employment and Payroll Data
Oil and Gas Extraction Industry (SIC code 13)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	266.1	NA	226.5	NA	NA
1955	331.9	NA	268.9	NA	NA
1960	309.2	25.2	225.6	$103.32	42.0
1965	287.1	24.4	201.8	116.18	42.4
1970	270.1	27.6	178.3	154.22	43.2
1971	264.2	28.3	173.4	163,30	43.2
1972	267.9	29.5	176.5	175.34	43.4
1973	273.9	31.1	182.0	186.19	43.0
1974	300.2	34.7	202.6	213.31	43.8
1975	328.8	39.4	223.1	235.11	43.7
1976	345.7	42.5	237.1	257.99	44.1
1977	381.4	45.5	266.5	284.74	44.7
1978	430.0	54.1	299.2	315.45	45.0
1979 1/	476.5	64.6	327.5	343.21	44.4

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-5. Employment and Payroll Data
Crude Petroleum and Natural Gas, and Gas Liquids Industries (SIC codes 131, 2)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	166.8	NA	130.7	$69.53	40.4
1955	189.0	NA	138.4	88.88	40.4
1960	178.2	18.4	111.2	108.95	40.5
1965	156.6	18.0	88.4	123.62	40.8
1970	144.9	19.4	74.8	155.88	40.7
1971	144.8	20.8	75.0	169.32	40.8
1972	143.3	21.9	73.3	184.87	40.9
1973	139.3	22.3	69.9	195.91	40.9
1974	144.6	24.3	71.3	218.89	41.3
1975	155.4	26.5	77.9	242.20	40.3
1976	161.4	28.2	82.7	271.01	41.0
1977	170.1	30.2	86.8	295.71	41.3
1978	183.9	35.1	90.7	334.49	41.5
1979 1/	201.3	41.5	95.1	364.79	41.5

NA - Not Available.

1/Preliminary

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

A-6. Employment and Payroll Data
Crude Petroleum and Natural Gas Industry (SIC code 131)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	139.7	21.4	71.1	$184.05	40.9
1973	135.6	21.8	67.7	195.02	40.8
1974	140.7	23.7	69.0	217.95	41.2
1975	151.3	25.8	75.7	241.20	40.2
1976	157.3	27.5	80.5	270.35	40.9
1977	165.8	29.5	84.1	294.99	41.2
1978	179.6	34.4	87.4	334.49	41.5
1979 1/	196.7	40.7	92.0	364.32	41.4

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table A-7. Employment and Payroll Data
Natural Gas Liquids Industry (SIC code 132)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	3.7	0.5	2.2	$207.92	41.5
1973	3.7	.5	2.3	218.36	42.4
1974	3.9	.6	2.3	235.64	43.0
1975	4.1	.7	2.2	262.08	42.0
1976	4.1	.8	2.2	285.66	42.7
1977	4.3	.7	2.7	309.03	43.1
1978	4.3	.7	2.8	340.94	42.3
1979 1/	4.6	.7	3.1	361.99	41.8

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table A-8. Employment and Payroll Data
Oil and Gas Services Industry (SIC code 138) Selected
Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-55	NA	NA	NA	NA	NA
1960	131.1	6.8	114.4	$ 98.31	43.5
1965	130.5	6.4	113.4	110.31	43.6
1970	125.2	8.2	103.6	153.00	45.0
1971	119.4	7.5	98.7	158.40	45.0
1972	124.5	7.6	103.2	168.60	45.2
1973	134.6	8.8	112.0	179.86	44.3
1974	155.6	10.4	131.3	210.63	45.2
1975	173.5	12.8	145.3	230.69	45.5
1976	184.3	14.3	154.4	251.44	45.8
1977	211.4	15.3	179.7	279.65	46.3
1978	246.1	18.9	208.5	308.03	46.6
1979 1/	275.2	23.1	232.4	334.70	45.6

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulleting 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and employment and Earnings, March 1980 for final 1979 data.

Table A-9. Employment and Payroll Data
Petroleum Refining Industry (SIC code 291)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	185.4	NA	140.3	$ 77.25	39.9
1955	201.3	NA	136.4	99.54	40.3
1960	177.2	13.8	112.8	123.22	40.8
1965	148.1	12.5	88.7	145.05	41.8
1970	153.7	13.8	91.4	189.93	42.3
1971	152.8	13.6	94.0	202.44	42.0
1972	151.4	14.0	92.4	219.76	42.1
1973	149.2	13.9	91.0	232.13	41.6
1974	153.0	14.1	93.6	247.61	41.2
1975	152.8	14.9	93.1	282.05	40.7
1976	156.6	16.1	96.9	324.43	41.7
1977	159.5	18.8	99.3	359.55	42.4
1978	164.9	20.0	103.8	401.69	43.1
1979 1/	168.6	21.5	106.2	440.06	43.7

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-10. Employment and Payroll Data
Miscellaneous Products of Petroleum and Coal Industry (SIC code 299)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	11.4	1.6	7.9	$155.86	40.8
1973	11.1	1.6	7.7	171.39	41.2
1974	11.6	1.8	7.9	177.72	40.3
1975	11.2	1.8	7.4	192.15	39.7
1976	11.1	1.8	7.4	216.12	40.7
1977	11.2	1.7	7.6	228.10	40.3
1978	11.1	1.8	7.1	257.86	40.8
1979 1/	11.6	2.0	7.2	283.72	41.0

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table A-11. Employment and Payroll Data
Mining Machinery Industry (SIC code 3532)
Selected Years, Annual Averages, 1950-79

	Numbers (000's)		Production workers		
Year	All employees	Women 1/	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	23.6	2.1	15.5	$173.44	41.1
1973	24.9	2.2	16.2	189.20	41.4
1974	27.5	2.5	18.2	208.96	42.3
1975	31.8	2.9	21.1	224.95	41.2
1976	34.1	3.4	22.0	233.63	39.8
1977	34.0	3.5	21.8	259.37	40.4
1978	35.0	3.9	22.2	295.94	41.8
1979 1/	38.9	4.6	24.7	330.06	42.1

NA - Not Available.

1/ Unpublished data from BLS. These data do not meet BLS publication standards and BLS does not certify to their accuracy and reliability.

2/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1311-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-12. Employment and Payroll Data
Oil Field Machinery Industry (SIC code 3533)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	NA	NA	NA	NA	NA
1955	NA	NA	NA	$ 85.45	42.3
1960	33.3	2.8	22.1	99.85	40.1
1965	38.5	3.1	26.4	119.78	43.4
1970	44.8	4.4	30.5	146.78	41.7
1971	41.1	4.1	27.0	156.04	41.5
1972	41.7	4.1	27.6	172.10	42.6
1973	45.4	4.6	30.2	191.83	44.2
1974	51.7	5.2	35.2	208.65	44.3
1975	62.2	6.8	43.3	226.52	43.9
1976	66.1	7.6	45.3	235.20	42.0
1977	69.4	8.1	47.2	265.31	43.0
1978	77.2	9.2	53.3	295.03	44.1
1979 1/	85.6	11.5	58.8	310.60	42.9

NA - Not Available.

1/Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-13. Employment and Payroll Data
Pipe Lines, Except Natural Gas Industry (SIC code 46) Selected
Years, Annual Averages. 1950-79

Year	Number (000's)		Nonsupervisory workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-55	NA	NA	NA	NA	NA
1960	23.1	1.7	19.8	$124.53	40.3
1965	19.5	1.6	16.3	145.85	41.2
1970	17.6	1.4	14.0	189.20	41.4
1971	17.3	1.4	13.5	201.62	41.4
1972	16.7	1.2	13.1	214.65	41.2
1973	16.8	1.2	13.1	228.94	41.4
1974	17.3	1.3	13.5	249.26	41.2
1975	17.5	1.4	13.3	280.42	40.7
1976	17.7	1.8	13.2	309.92	41.6
1977	18.5	1.9	13.6	340.25	41.8
1978	19.5	2.0	14.1	365.62	41.5
1979 1/	19.4	2.1	13.8	399.84	42.0

NA - Not Available.

1/ Preliminary

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-14. Employment and Payroll Data
Electric Service Industry (SIC code 491)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Nonsupervisory workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	238.9	NA	224.5	$65.85	41.6
1955	248.7	NA	223.4	86.32	41.3
1960	252.5	37.9	218.7	109.86	41.3
1965	253.0	38.3	214.6	133.31	41.4
1970	290.2	43.4	247.1	176.40	41.8
1971	300.0	44.8	254.8	188.52	41.8
1972	312.0	46.7	264.7	200.58	41.7
1973	321.0	49.5	269.6	216.15	42.3
1974	330.3	51.5	275.1	231.42	42.0
1975	322.8	50.9	267.2	249.07	41.1
1976	327.4	52.8	269.1	272.83	41.4
1977	336.4	55.2	274.9	298.16	41.7
1978	354.3	58.6	286.3	325.36	42.2
1979 1/	373.1	63.9	301.1	350.69	42.1

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-15. Employment and Payroll Data
Gas Production and Distribution Industry (SIC code 492)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Nonsupervisory workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	117.6	NA	110.9	$ 61.80	41.2
1955	140.8	NA	129.0	80.39	40.6
1960	154.8	25.0	138.5	100.28	40.6
1965	153.6	25.0	134.5	120.83	41.1
1970	161.2	27.8	137.3	157.00	41.1
1971	158.5	27.6	134.4	166.87	40.8
1972	160.7	27.7	135.6	179.96	40.9
1973	162.7	27.9	136.6	193.05	40.9
1974	163.2	29.0	136.0	207.36	40.9
1975	161.9	30.3	134.6	224.40	40.8
1976	159.3	30.6	131.3	247.25	40.6
1977	158.8	31.1	130.6	270.76	40.9
1978	164.0	33.3	134.4	288.97	40.7
1979 1/	169.0	35.2	138.0	311.00	40.6

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table A-16. Employment and Payroll Data
Combination Electric and Gas, and Other Utility Services Industry (SIC code 493)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Nonsupervisory workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950	169.4	NA	156.5	$ 68.53	42.2
1955	172.6	NA	158.0	89.67	42.1
1960	175.0	25.0	159.4	117.26	41.0
1965	176.5	24.6	158.1	143.79	41.8
1970	186.4	25.8	163.2	188.03	41.6
1971	182.5	24.5	158.5	202.29	41.2
1972	183.4	23.7	158.1	226.68	41.9
1973	187.9	25.0	161.9	241.60	41.8
1974	190.3	26.9	163.8	254.20	41.2
1975	186.8	27.4	159.5	277.69	41.2
1976	185.2	28.0	156.9	303.64	41.2
1977	187.9	29.9	156.4	321.50	40.8
1978	192.8	31.3	158.0	354.47	41.9
1979 1/	195.5	33.0	158.5	379.61	41.9

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, _Employment and Earnings, United States, 1909-1978_, Bulletin 1312-11 for 1950-76 data; _Employment and Earnings Supplement_, November 1979 for 1977-78 data; and _Employment and Earnings_, March 1980 for final 1979 data.

Table A-17. Employment and Payroll Data
Steam Supply and Irrigation Systems Industries (SIC code 496, 7)
Selected Years, Annual Averages, 1950-79

Year	Number (000's)		Production workers		
	All employees	Women	Number (000's)	Average weekly earnings	Average weekly hours
1950-71	NA	NA	NA	NA	NA
1972	2.3	0.2	1.8	$165.11	39.5
1973	2.4	.2	1.9	178.32	40.9
1974	2.5	.2	2.0	209.14	43.3
1975	2.6	.2	2.0	233.49	43.0
1976	3.1	.2	2.5	237.44	42.4
1977	3.2	.3	2.6	262.12	42.9
1978	3.2	.3	2.6	273.53	39.3
1979 1/	3.5	.3	2.9	280.92	39.4

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table A-18. Employment in Selected Energy Industries, by State, 1978 1/
(All employees, in thousands)

Technical Notes Follow

State	Industry								
	Bituminous & lignite mining SIC-12	Oil and gas extraction SIC-13	Bituminous mining; oil & gas extraction SIC-12, 13	Bituminous mining & nonmetallic minerals exc. fuel SIC-12, 14	Petroleum refining & related industries SIC-29	Petroleum refining SIC-291	Mining Machinery (mfg) SIC-3532	Oil field machinery (mfg) SIC-3533	Pipe lines, except natural gas SIC-46
Total, U. S. .	208.5 2/	430.0	635.4	324.5	208.7	164.9	35.0	77.2	19.5
Alabama	9.8	-	-	-	-	-	-	-	-
California	-	22.4 3/	27.6	-	26.8	23.5	-	-	-
Colorado	-	13.4	-	4.4	-	-	-	-	-
Illinois	11.8	6.0	-	-	16.4	12.3	-	-	-
Indiana	-	-	-	-	4.6	-	-	-	-
Kansas	-	10.5	-	-	4.5	-	-	-	-
Kentucky	47.9	-	-	-	3.9	-	-	-	-
Louisiana	-	69.0	-	-	11.6	10.6	-	-	-
New Jersey	-	-	-	-	12.2 4/	8.4 4/	-	-	-
New Mexico	-	10.0	-	4.6	-	-	-	-	-
New York	-	-	-	-	8.3	-	-	-	-
Ohio	15.3	-	-	-	15.5	-	-	-	-
Oklahoma	-	51.0	-	-	8.5	7.5	-	9.3	-
Pennsylvania ..	38.3 2/	-	-	-	17.0	13.3	-	-	-
Texas	-	172.8	-	-	42.9	39.5	-	52.2	-
Virginia	17.5	-	-	-	-	-	-	-	-
West Virginia .	53.9	-	-	-	-	-	-	-	-
Wyoming	-	13.8	-	9.2	1.6	-	-	-	-

1/ Unless otherwise noted.
2/ Includes 3.1 in anthracite mining SIC-11.
3/ 1st quarter 1975. Analysis of California Energy Industry, Lawrence Berkeley Laboratory, University of California.
4/ 1977 data; 1978 not yet available.
SORUCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, States and Areas, 1939-78, Bulletin 1370-13, 1979.

Technical Notes, Table A-18.

The employment figures in Table A-18 are compiled by individual states and submitted to the BLS for publication. Each of the States shown here has reported at least two percent of the total national employment in at least one of the energy industries. Where blanks appear in the table it generally means that employment in the industry was too small to be reported separately. The omitted States do not necessarily have zero employment in the energy industries but were omitted because they did not report for the selected industries or did not account for two percent of the employment in any one of those industries. Similarly, blank spaces for the listed states mean that figures were not reported by the state.

There is one exception to the above criteria. Many states reported employment for SIC Industry 49 Electric Gas and Sanitary Services, or for one or more of its SIC components. However, these services are performed in every State and the employment in that industry would be reflective of the States population. Consequently, the data for Industry 49 are not shown.

Table A-19. (Part 1.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977

Technical Notes Follow

Affected industry[2/]	Energy industry				
	Coal mining SIC 11 & 12	Crude petro. & nat. gas SIC 1311, & 1321	New public utils. const. SIC Pt. 15, Pt 16, Pt 17, & Pt. 6561	Oil and gas well drilling & explor. SIC 138	Petroleum refining & related products SIC 29
Total	50,930	29,797	65,859	83,608	34,076
Agriculture, Forestry, Fishery					
Products	151	163	261	152	168
Services	24	40	80	372	36
Mining					
Iron & Ferroalloy Ores Mining	31	24	126	201	22
Copper Ore Mining	27	20	507	120	24
Other Nonferrous Ore Mining	37	38	274	150	64
Coal Mining	38,110	69	172	232	111
Crude Petroleum & Natural Gas	94	13,210	168	228	6,140
Stone, & Clay Mining & Quarrying	59	44	326	127	165
Construction[3/]					
New Public Utility Construction	0	0	32,173	0	0
Oil & Gas Well Drilling & Explor	0	0	0	59,709	0
Maintenance & Repair Contruction	566	1,893	436	393	2,020
Manufacturing					
Ordnance	3	3	7	3	2
Fabrics, Yarn, & Thread Mills	100	25	59	96	44
Apparel	17	21	72	67	37
Misc. Fabricated Textile Products	35	8	19	13	26
Logging	125	12	156	26	25
Sawmills & Planning Mills	34	30	452	85	40

See footnotes at end of table.

Table A-19. (Part 1.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977--continued

Affected industry[2/]	Energy industry				
	Coal mining SIC 11 & 12	Crude petro. & nat. gas SIC 1311, & 1321	New public utils. const. SIC Pt. 15, Pt 16, Pt 17, & Pt. 6561	Oil and gas well drilling & explor. SIC 138	Petroleum refining & related products SIC 29
Millwork, Ply. & Other Wood Prod....	20	28	889	73	35
Paper Products.....................	64	74	169	105	270
Paperboard.........................	26	26	83	43	135
Newspaper Printing & Publishing.....	54	80	119	94	315
Periodicals & Book Print., Pub......	15	22	30	23	61
Misc. Printing & Publishing.........	73	102	144	106	289
Indust. Inorganic & Organic Chem....	115	197	153	178	555
Miscellaneous Chemical Products.....	236	58	76	199	121
Plastic Mat. & Synthetic Rubber.....	21	17	45	28	37
Paints & Allied Products............	22	54	96	53	84
Petroleum Refining & Related Prod...	62	58	116	168	4,958
Tires & Inner Tubes.................	19	22	50	74	26
Miscellaneous Rubber Products.......	239	80	85	87	136
Plastic Products...................	45	47	196	83	96
Glass..............................	16	26	94	23	34
Cement & Concrete Products..........	36	71	1,122	716	98
Structural Clay Products............	6	15	221	8	24
Pottery & Related Products..........	3	6	197	3	6
Miscellaneous Stone & Clay Prod.....	85	135	382	288	141
Blast Furn. & Basic Steel Prod......	465	381	2,063	3,412	322
Iron & Steel Foundries & Forging....	106	73	762	206	84
Primary Copper & Copper Prod........	65	39	1,402	304	45
Primary Aluminum & Aluminum Prod....	32	36	320	94	49
Other Primary Nonferrous Prod.......	36	32	300	122	68
Metal Containers...................	10	12	21	15	83
Heating Appar. & Plbg. Fixtures.....	10	24	53	13	25
Fabricated Structural Metal.........	49	205	3,696	744	157

Table A-19. (Part 1.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977--continued

Affected industry[2/]	Energy industry				
	Coal mining SIC 11 & 12	Crude petro. & nat. gas SIC 1311, & 1321	New public utils. const. SIC Pt. 15, Pt 16, Pt 17, & Pt. 6561	Oil and gas well drilling & explor. SIC 138	Petroleum refining & related products SIC 29
Screw Machine Products..............	386	34	162	118	40
Metal Stampings.....................	27	29	103	53	38
Cutlery, Handtools & Gen. Hardw.....	25	39	102	119	52
Other Fabricated Metal Prod.........	128	145	789	258	149
Engine, Turbines & Generators.......	112	99	197	39	60
Farm Machinery......................	10	6	15	15	7
Const., Mining & Oilfield Mach......	416	77	59	642	50
Material Handling Equipment.........	15	14	98	29	36
Metal Working Machines..............	65	59	161	106	63
Special Industry Machinery..........	19	30	36	23	36
General Industrial Machinery........	111	214	184	149	237
Machine Shop Products...............	165	306	260	169	182
Service Industry Machines...........	20	31	89	35	38
Electric Transmission Equipment.....	20	142	158	45	83
Electrical Industrial Apparatus.....	42	281	167	96	161
Electric Lighting & Wiring..........	107	54	1,015	34	74
Telephone & Telegraph Apparatus.....	10	22	28	12	21
Radio & Communication Equipment.....	3	11	49	5	9
Electronic Components...............	20	49	61	26	47
Miscellaneous Electrical Prod.......	25	22	127	40	21
Motor Vehicles......................	27	27	77	44	30
Aircraft............................	30	32	70	28	28
Railroad Equipment..................	10	11	13	12	9
Scientific & Controlling Instr......	15	43	55	32	67
Medical & Dental Instruments........	4	4	10	7	7
Optical & Ophthalmic Equipment......	2	3	6	5	5
Other Misc. Manufactured Prod.......	26	32	75	47	59

Table A-19. (Part 1.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977--continued

Affected industry[2/]	Energy industry				
	Coal mining SIC 11 & 12	Crude petro. & nat. gas SIC 1311, & 1321	New public utils. const. SIC Pt. 15, Pt 16, Pt 17, & Pt. 6561	Oil and gas well drilling & explor. SIC 138	Petroleum refining & related products SIC 29
Transportation					
Railroad Transportation.............	276	220	585	526	341
Local Transit, Intercity Buses......	38	71	91	46	68
Truck Transportation................	360	323	1,194	1,060	1,017
Water Transportation................	53	103	108	140	730
Air Transportation..................	66	122	182	84	119
Pipe Line Transportation............	5	6	9	13	305
Transportation Services.............	44	74	101	82	162
Communication					
Communication, Except Radio & TV....	131	127	228	186	224
Radio & TV Broadcasting.............	32	46	72	57	194
Public Utilities					
Electric Utilities..................	351	196	161	123	306
Gas Utilities.......................	44	101	105	89	350
Water & Sanitary Services...........	23	36	22	20	67
Wholesale & Retail Trade					
Wholesale Trade.....................	1,081	676	1,995	1,667	1,432
Retail Trade........................	478	1,034	1,932	1,334	926
Finance, Insurance & Real Estate					
Banking.............................	294	468	367	294	751
Credit Agencies & Financial Bkrs....	150	246	103	82	469
Insurance...........................	373	418	454	359	463
Real Estate.........................	616	2,072	332	288	1,481

Table A-19. (Part 1.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand [1/] Selected Energy Industries, 1977--continued

Affected industry [2/]	Energy industry				
	Coal mining SIC 11 & 12	Crude petrol & nat. gas SIC 1311, & 1321	New public utils. const. SIC Pt. 15, Pt 16, Pt 17, & Pt. 6561	Oil and gas well drilling & explor. SIC 138	Petroleum refining & related products SIC 29
Hotels & Lodging Places.............	246	674	376	182	528
Personal & Repair Services..........	47	70	113	81	166
Miscellaneous Business Services......	1,524	1,056	1,839	3,551	2,356
Advertising.........................	30	40	70	56	187
Misc. Professional Services.........	398	872	1,428	517	733
Automobile Repair...................	140	138	367	329	183
Motion Pictures.....................	16	39	23	18	63
Amusements & Recreation Services....	24	56	45	24	66
Educational Services................	59	159	33	29	142
Nonprofit Organizations.............	140	137	278	219	186
Government Enterprises					
Post Office........................	179	167	243	266	326
Other Federal Enterprises..........	86	82	60	46	109
Other State & Local Government.....	206	239	148	125	362

[1/] Employment is a count of jobs (rather then persons). Includes wage and salary employees, self-employed and unpaid-family workers. Final demand is valued at the site of production (in 1972 prices) and represents the value of goods and services sold by the energy indsutries to final demand consumers (excluding transportation and handling charges).

[2/] Includes only those industries which have 50 or more jobs per billion dollars in at least one of the designated energy industries.

[3/] The indirect labor requirements generated in the construction sector are shown as zero, because they are a capital investment input.

SOURCE: See p. 132.

Table A-19. (Part 2.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977

Affected industry[2/]	Energy industry				
	Const., mining & oilfield mach. SIC 3531, 32, 33	Electric trans- mission equipment SIC 361	Pipe line trans- portation SIC 46	Electric utilities SIC 491, Pt. 493	Gas utilities SIC 492, Pt. 493
Total..........................	51,522	67,599	28,846	38,151	32,547
Agriculture, Forestry, Fishery					
Products..........................	135	203	116	80	97
Services..........................	21	27	26	15	19
Mining					
Iron & Ferroalloy Ores Mining.......	160	100	14	12	11
Copper Ore Mining..................	82	386	20	19	10
Other Nonferrous Ore Mining.........	231	345	33	29	17
Coal Mining........................	217	149	177	2,111	64
Crude Petroleum & Natural Gas.......	91	103	546	265	3,955
Stone, & Clay Mining & Quarrying....	56	48	49	39	28
Construction[3/]					
New Public Utility Construction.....	0	0	0	0	0
Oil & Gas Well Drilling & Explor....	0	0	0	0	0
Maintenance & Repair Contruction....	540	575	2,840	2,860	1,865
Manufacturing					
Ordnance...........................	36	54	3	1	1
Fabrics, Yarn, & Thread Mills.......	73	66	156	34	16
Apparel............................	104	117	22	45	25
Misc. Fabricated Textile Products...	30	16	283	11	5
Logging............................	22	37	22	21	10
Sawmills & Planning Mills...........	61	66	43	41	25
Millwork, Ply. & Other Wood Prod....	50	73	37	32	22
Paper Products.....................	134	358	216	108	63

Table A-19. (Part 2.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977--continued

Affected industry[2/]	Energy industry: Const., mining & oilfield mach. SIC 3531, 32, 33	Electric trans- mission equipment SIC 361	Pipe line trans- portation SIC 46	Electric utilities SIC 491, Pt. 493	Gas utilities SIC 492, Pt. 493
Paperboard........................	79	184	41	27	16
Newspaper Printing & Publishing.....	149	164	90	76	56
Periodicals & Book Print., Pub......	34	41	23	20	15
Misc. Printing & Publishing.........	159	273	141	119	85
Indust. Inorganic & Organic Chem....	131	207	83	100	78
Miscellaneous Chemical Products.....	54	88	28	43	23
Plastic Mat. & Synthetic Rubber.....	41	84	16	12	9
Paints & Allied Products...........	67	83	134	58	41
Petroleum Refining & Related Prod...	49	63	105	88	33
Tires & Inner Tubes................	220	21	14	23	12
Miscellaneous Rubber Products.......	236	131	38	50	31
Plastic Products...................	115	348	60	36	28
Glass..............................	37	186	29	25	18
Cement & Concrete Products..........	31	27	39	38	36
Structural Clay Products...........	11	14	21	19	13
Pottery & Related Products..........	8	471	7	7	4
Miscellaneous Stone & Clay Prod.....	252	172	138	32	51
Blast Furn. & Basic Steel Prod......	2,708	1,622	224	180	167
Iron & Steel Foundries & Forging....	2,716	235	118	46	32
Primary Copper & Copper Prod........	193	1,058	47	34	21
Primary Aluminum & Aluminum Prod....	248	378	39	33	17
Other Primary Nonferrous Prod.......	259	474	33	23	14
Metal Containers...................	16	22	14	9	8
Heating Appar. & Plbg. Fixtures.....	97	23	33	31	20
Fabricated Structural Metal.........	400	101	126	112	109
Screw Machine Products.............	314	433	38	41	19
Metal Stampings....................	215	228	36	22	15
Cutlery, Handtools & Gen. Hardw.....	94	62	27	21	18

Table A-19. (Part 2.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1/] Selected Energy Industries, 1977--continued

Affected industry[2/]	Energy industry				
	Const., mining & oilfield mach. SIC 3531, 32, 33	Electric trans-mission equipment SIC 361	Pipe line trans-portation SIC 46	Electric utilities SIC 491, Pt. 493	Gas utilities SIC 492, Pt. 493
Other Fabricated Metal Prod.........	511	326	357	82	65
Engine, Turbines & Generators.......	634	65	86	20	32
Farm Machinery......................	285	10	6	5	3
Const., Mining & Oilfield Mach......	21,429	28	24	34	28
Material Handling Equipment.........	488	21	15	13	9
Metal Working Machines..............	924	372	49	23	24
Special Industry Machinery..........	139	28	20	9	12
General Industrial Machinery........	2,006	147	280	77	73
Machine Shop Products...............	619	257	72	45	103
Service Industry Machines...........	84	66	42	32	23
Electric Transmission Equipment.....	167	35,278	100	82	48
Electrical Industrial Apparatus.....	540	2,316	170	44	92
Electric Lighting & Wiring..........	90	1,371	60	113	39
Telephone & Telegraph Apparatus.....	28	698	48	15	12
Radio & Communication Equipment.....	24	560	13	6	5
Electronic Components...............	78	1,869	102	24	22
Miscellaneous Electrical Prod.......	139	251	19	16	10
Motor Vehicles......................	331	76	26	19	12
Aircraft............................	332	120	30	12	15
Railroad Equipment..................	183	43	8	10	4
Scientific & Controlling Instr......	216	766	215	15	17
Medical & Dental Instruments........	50	29	7	3	2
Optical & Ophthalmic Equipment......	12	69	5	2	2
Other Misc. Manufactured Prod.......	66	80	43	33	25
Transportation					
Railroad Transportation.............	467	414	228	885	115
Local Transit, Intercity Buses......	74	116	52	58	51

Table A-19. (Part 2.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand[1] Selected Energy Industries, 1977--continued

Affected industry[2]	Energy industry				
	Const., mining & oilfield mach. SIC 3531, 32, 33	Electric trans-mission equipment SIC 361	Pipe line trans-portation SIC 46	Electric utilities SIC 491, Pt. 493	Gas utilities SIC 492, Pt. 493
Truck Transportation................	895	791	620	614	185
Water Transportation................	85	76	76	123	40
Air Transportation..................	155	249	100	82	106
Pipe Line Transportation............	4	5	9,532	6	3
Transportation Services.............	81	92	60	75	40
Communication					
Communication, Except Radio & TV....	345	429	410	199	176
Radio & TV Broadcasting.............	91	98	53	45	33
Public Utilities					
Electric Utilities..................	209	211	1,029	14,130	168
Gas Utilities.......................	120	92	304	672	16,867
Water & Sanitary Services...........	22	30	16	35	29
Wholesale & Retail Trade					
Wholesale Trade.....................	2,494	1,990	1,017	774	376
Retail Trade........................	815	1,740	727	604	676
Finance, Insurance & Real Estate					
Banking.............................	334	506	754	298	389
Credit Agencies & Financial Bkrs....	111	162	125	211	179
Insurance...........................	327	284	292	317	228
Real Estate.........................	360	602	671	233	741
Hotels & Lodging Places.............	323	552	319	183	345
Personal & Repair Services..........	155	182	76	136	178
Miscellaneous Business Services.....	1,623	1,760	1,818	1,039	949
Advertising.........................	89	95	50	44	3[illegible]

Table A-19. (Part 2.) Direct and Indirect Employment Requirements per Billion Dollars of Delivery to Final Demand [1/] Selected Energy Industries, 1977--continued

Affected industry [2/]	Energy industry: Const., mining & oilfield mach. SIC 3531, 32, 33	Electric trans-mission equipment SIC 361	Pipe line trans-portation SIC 46	Electric utilities SIC 491, Pt. 493	Gas utilities SIC 492, Pt. 493
Misc. Professional Services	535	567	518	331	447
Automobile Repair	190	197	166	162	82
Motion Pictures	27	32	22	18	18
Amusements & Recreation Services	41	63	33	22	32
Educational Services	36	58	66	51	75
Nonprofit Organizations	231	286	226	121	129
Government Enterprises					
Post Office	276	299	318	400	460
Other Federal Enterprises	59	72	226	2,786	54
Other State & Local Government	154	175	479	5,499	1,234

1/ Employment is a count of jobs (rather than persons). Includes wage and salary employees, self-employed and unpaid family workers. Final demand is valued at the site of production (in 1972 prices) and represents the value of goods and services sold by the energy industries to final demand consumers (excluding transportation and handling charges).

2/ Includes only those industries which have 50 or more jobs per billion dollars in at least one of the designated energy industries.

3/ The indirect labor requirements generated in the construction sector are shown as zero, because they are a capital investment input.

SOURCE: U.S. Department of Labor, Monthly Labor Review, December, 1979, pp 3-10.

Technical Notes, Table 19

Table A-19 shows direct and indirect employment per billion dollars of delivery to final demand by the energy industry named at the head of each column (the 10 energy industries for which data are available). Final demand is valued in 1972 prices at the site of production (producers' value) and excludes transportation and handling charges.

The table is based on 1973 input-output and 1977 employment/output relationships. The basic input-output table is developed from estimates of the value of goods and services purchased from the supplying industries (i.e., the "affected industries") by the producing industries. Goods and services purchased are "intermediate", i.e., they are consumed in the production of final goods and services by the energy industries. They do not include capital investment purchases (of which construction is one category - all construction is a capital investment and therefore would show "zero" intermediate inputs). Values are converted to employment by use of an employment/output ratio for each industry.

The employment numbers are a count of jobs, rather than persons, including full- and part-time jobs with equal weight. Employment includes wage and salary employees, the self-employed, and unpaid family workers.

The employment within an industry (at the head of the column) that is required to produce its own output is shown opposite the corresponding industry in the "affected industry" column (i.e., the "direct" employment). The required employment in supporting industries is shown in the other cells of the column.

BLS is currently developing employment factors for newer energy technologies which will be compatible with the interindustry employment model. Additional information on methodology may be obtained from the Office of Economic Growth, Bureau of Labor Statistics, U.S. Department of Labor.

Table A-20. Construction Employment per Quadrillion Btu Output per Year for the 17 Energy Sectors
Technical Notes Follow Table A-21

Sector	Construction employment per quadrillion Btu: Total	Direct	Indirect
Coal Mining			
Eastern Underground...	22,236	5,399	16,837
Eastern Surface.......	36,560	5,485	31,075
Western Underground...	36,930	8,953	27,977
Western Surface.......	17,734	3,976	13,758
Nuclear			
Fuel Extraction.......	14,132	5,026	9,106
Fuel Preparation......	66,823	19,971	46,852
Power Generation......	883,412	258,125	658,287
Waste Disposal........	814	328	486
Electric Utilities			
Gas...................	323,370	104,189	228,181
Coal..................	612,400	166,036	446,364
Oil...................	538,646	166,099	372,547
Hydropower............	1,022,843	353,145	699,698
Synthetic Fuels			
Low Btu Coal Gasification.........	277,108	88,054	189,054
Oil Shale.............	168,589	62,822	105,767
Coal Liquefaction.....	288,684	76,514	212,170
Solar			
Residential Hot Water................	2,595,981	1,136,000	1,459,981
Residential Space Heat.................	6,604,851	1,361,000	5,243,855
Centralized Photo-voltaics............	8,253,051	2,705,627	5,547,424

SOURCE: CONSAD Research Corporation, Final Report for the Joint DOE-DOL Project to Improve Employment/Energy Economic Analysis, Vienna, Virginia, January, 1980.

Table A-21. Operational Employment Per Quadrillion Btu Output per Year for 17 Energy Sectors
Technical Notes Follow

Sector	Operational employment per quadrillion Btu		
	Total	Direct	Indirect
Coal Mining			
Eastern Underground....	30,741	20,252	10,489
Eastern Surface........	6,614	4,069	2,545
Western Underground....	51,784	33,585	18,199
Western Surface........	6,976	3,947	3,029
Nuclear			
Fuel Extraction.......	13,040	9,305	3,735
Fuel Preparation......	16,912	2,490	14,422
Power Generation......	18,383	5,648	12,735
Waste Disposal........	681	241	467
Electric Utilities			
Gas...................	53,781	8,425	45,356
Coal..................	57,095	8,989	48,106
Oil...................	87,256	10,989	76,267
Hydropower............	12,683	5,045	7,638
Synthetic Fuels			
Low Btu Coal Gasification.........	22,168	8,837	13,331
Oil Shale.............	26,830	14,453	12,377
Coal Liquefaction.....	44,451	18,654	25,797
Solar			
Residential Hot Water.	268,093	118,000	150,093
Residential Space Heat	144,381	40,000	104,381
Centralized Photovoltaics............	131,862	42,979	88,883

SOURCE: CONSAD Research Corporation, Final Report for the Joint DOE-DOL Project to Improve Employment/Energy Economic Analysis, Vienna, Virginia, January, 1980.

Technical Notes, Tables A-20 and A-21

Tables A-20 and A-21 present data on direct and indirect employment requirements per quadrillion Btu's of output per year.

The Economic Growth Model of the Bureau of Labor Statistics, is a macroeconomic model using an input-output (I-O) system. Through the use of input-output and other analytical methods, construction and operating cost estimates for 17 specific energy technologies were converted into a useable I-O format and then introduced into the BLS model.

Through a series of computations, the model then generated a set of employment/energy output ratios for each of the 17 technologies. These ratios were presented in terms of two standard energy output levels: one million barrels of oil per day and quadrillion (10^{15}) Btu output per year. These ratios were used to illustrate the direct, indirect and total employment effects associated with each technology.

It should be noted that the construction-related employment figures are not annualized estimates. These estimates represent the total number of jobs distributed over the length of the construction period; the latter differs considerably by technology. For example, the construction of a nuclear power plant occurs over a nine year period while the different synfuel plants can be built in four or five years.

SOURCE: CONSAD Research Corporation, Final Report for the Joint DOE-DOL Project to Improve Employment/Energy Economic Analysis, Vienna, Virginia, January, 1980.

The cost data on the solar technologies represent a first time effort and are to be revised in the future. Moreover, an estimated 55 million residential solar hot water systems would be required to produce one quad of output per year. This difference in "scale" between a solar system and conventional systems is important to keep in mind in interpreting the ratios. For example, 0.1 million direct jobs per quad would translate to about four hours direct operating labor per system each year.

Table A-22. On-Site Labor Requirement for Constructing Electric Generating Plants
Estimated 1979 and Projected 1983
(Thousands of work years [1])

Technical Notes Follow

Craft	All types 1979	All types 1983	Nuclear 1979	Nuclear 1983	Fossil 1979	Fossil 1983	Hydro 1979	Hydro 1983
Total	200.3	142.8	122.3	69.7	65.4	66.0	12.7	6.9
Asbestos worker/ insulation	3.4	3.8	1.1	1.5	2.4	2.2	-	-
Boilermaker	14.3	12.4	4.1	2.3	9.8	9.8	.3	.2
Bricklayer/ stonemason	.8	.5	.5	.2	.3	.3	-	-
Carpenter	23.7	12.9	16.6	6.2	5.5	5.8	1.6	.9
Cement-concrete finisher	2.8	1.8	1.9	.9	.7	.8	.2	.1
Electrician	27.4	22.5	17.3	12.6	9.5	9.4	.6	.5
Iron worker	17.8	11.2	11.2	4.5	5.8	6.2	.8	.4
Laborer	31.7	19.4	20.2	9.5	7.6	8.0	4.0	1.9
Millwright	5.0	4.3	2.5	2.0	1.9	1.9	.6	.4
Operating engineer	15.7	10.3	8.5	4.0	4.8	5.0	2.4	1.2
Painter	3.7	3.1	2.6	2.1	1.0	1.0	.2	.1
Pipefitter	42.2	32.4	29.3	20.0	12.4	12.0	.5	.3
Sheet metal worker	2.8	2.6	1.4	1.2	1.3	1.3	-	-
Truck driver	7.8	5.0	4.6	2.3	2.1	2.1	1.0	.5
Other workers	1.2	.8	.5	.3	.2	.2	.5	.3

1/Work-years (37 hours/week, 4.345 weeks/month, 12 months) = 1,929.2 work-hours/year.

NOTE: Due to rounding, individual items may not equal totals.

SOURCE: Projections of Cost, Duration, and On-Site Manual Labor Requirements for Constructing Electric Generating Plants, 1979-1983, DOE/IR-0057 and DOL/CLDS/PP2, U.S. Departments of Energy and Labor, September 1979.

Technical Notes, Table A-22

The estimates of labor requirements are based primarily on a special survey of utilities by the Department of Labor conducted in March and April of 1979 as part of an ongoing Construction Labor Demand System. The estimates are based upon power plants already under construction as well as those in advanced planning stages which are expected to be under construction during the 1979-1983 interval. To insure continued usefulness, the projections are revised periodically to reflect new information and changing circumstances. Within each category of power plant (e.g., nuclear, fossil) estimates of on-site labor requirements are provided for 14 separate craft classifications. Projections are also published for each of 10 geographical regions of the United States. The labor requirement forecasts paper covers all new power plant construction in progress or planned for the 1979-1983 period. The craft mix, construction duration, cost, and on-site manual labor per installed kilowatt of electricity (KWe) for specific types and vintages of power plants were estimated by analyzing pooled time series and cross-sectional data collected in a survey of utilities by the Department of Labor as well as from secondary sources.

Labor requirements are forecasted to decline each year through the period, dropping by about 30 percent from 1979 to 1983. The forecasted decline in labor needs will parallel a downward trend in the number of electric generating units under construction or planned during the period.

Requirements for workers in fossil-fueled power plant construction projects are projected to decline by 11 percent in the 1979-1981 period and then rebound, bringing the overall requirement in 1983 to a level about 1 percent higher than the base year of 1979. Labor requirements on nuclear construction jobs, on the other hand, are expected to grow by some 5,000 work-years between 1979 and 1980 and then decline sharply through 1983.

About two-fifths of the labor requirements associated with power plant construction during the 1979-1983 period will be centered in the Southeastern and Midwestern sections of the Nation. However, on-site labor requirements in these areas are forecasted to decline by some 36 percent during this time frame. In only two areas of the country, New York-New Jersey (95 percent) and the Rocky Mountains (7 percent), are increases in labor requirements forecasted between 1979 and 1983.

Technical Notes, Tables A-23 through A-31[1]

Tables A-23 through A-31 are from a report developed from data tabulations provided by the National Academy of Sciences-National Research Council (NAS-NRC).[2] The data were collected in 1977 in a survey conducted by the NAS-NRC with the support of the National Science Foundation, the National Endowment for the Humanities and the National Institutes of Health.

The survey sample was drawn from a universe of doctorate recipients compiled by the NRC. The survey universe included persons who received their doctorates from 1930 through 1976 in science, engineering or the humanities. The data provided are restricted to doctorates who either earned their degree in science or engineering or who were employed as scientists or engineers in February 1977. While the NAS-NRC survey of earned doctorates included employed, unemployed and those not in the labor force, the data presented here are restricted to persons who were employed during the reference week of February 6-12, 1977.

Stratified sampling was used to establish the survey sample base. This permitted collecting relatively larger samples of small subgroups to obtain reliable estimates for all subgroups. The survey sample for all doctoral scientists and engineers was approximately 13 percent of the total

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1/ U.S. Department of Energy. Report prepared by Oak Ridge Associated Universities. (In process.)

2/ Unless otherwise noted, the data tabulations were provided by the Commission on Human Resources, National Research Council.

universe. The sample responses were inflated, according to the stratified sample sizes, to represent the total population of doctoral scientists and engineers and the entire populations for each subgroup.

The survey indicated there were approximately 284,000 employed doctoral scientists and engineers in the United States at the beginning of 1977. The survey included information about doctoral degree specialties, employment fields, types of employers, primary work activities, sources of government support and various biographical data.

The DOE-ORAU report includes a substantial amount of statistical information. A few selected tables are presented here.

The term "energy-related" is used to denote those doctoral scientists and engineers who indicated in the survey that they devoted a significant portion of their professional time to the area of energy and fuel during the week of February 6-12, 1977. The survey did not collect information pertaining to the proportion of time spent on such activities nor to the segment of the energy field in which the respondent was involved (e.g., fossil, nuclear, solar).

The survey indicated that approximately 10 percent of the employed doctoral scientists and engineers devoted a significant portion of their professional time to energy- and fuel-related activities in 1977. However, this number is by no means a complete count of doctoral scientists and engineers with energy- and fuel-related experience or training in the United States in 1977. Survey respondents were asked to indicate only one area of national interest, i.e., the one on which they spent the most time.

Many individuals who indicated another area of national interest, or who did not indicate any area, may have devoted a lesser part of their time to energy-related activities in 1977 or may have engaged in energy-related work in previous years. Moreover, many doctoral scientists and engineers who received funds from energy-related agencies (e.g., ERDA, now D.O.E.) indicated an area other than energy and fuel (e.g., environment, defense). It should also be noted that the data presented here are restricted to persons who were employed in February 1977. It is not known how many persons with training or experience in the energy field were unemployed or out of the labor force at that time.

Some of the subgroups in the energy-related populations were represented by fairly small samples. The accuracy of the count and characteristics of subgroups with small estimated populations should be treated with some caution.

Table A-23. Energy-Related and All Doctoral Scientists and Engineers, by Degree Specialty Employed Population, 1977

Doctoral degree specialty	Doctoral Scientists and Engineers: Energy-Related Number	Energy-Related Percent distri-bution	Total Number	Total Percent distri-bution	Percent Energy-Related in Specialty
Total, all specialties	28,557	100	284,237	100	10.0
Mathematics/computer sciences	653	2	16,495	6	4.0
Physics/astronomy	4,782	17	25,076	9	19.1
Chemistry	5,498	19	41,185	14	13.3
Earth, environmental and marine sciences	2,472	9	9,102	3	27.2
Engineering	11,241	39	42,808	15	26.3
Life sciences	1,376	5	69,113	24	2.0
Psychology	161	1	32,216	11	0.5
Social sciences	2,236	8	40,915	14	5.5
All other and not reported	138	1/	7,327	3	1.9

1/ Less than 0.5 percent.

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientists and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980.

Table A-24. Energy-Related and All Doctoral Scientists and Engineers, by Employment Field Employed Population, 1977

Employment field	Doctoral Scientists and Engineers: Energy-Related Number	Energy-Related Percent distribution	Total Number	Total Percent distribution	Percent Energy-Related in Specialty
Total, all fields	28,557	100	284,237	100	10.0
Mathematics/computer sciences	989	3	19,271	7	5.1
Physics/astronomy	3,617	13	17,984	6	20.1
Chemistry	4,124	14	33,344	12	12.4
Earth, environmental and marine sciences	3,033	11	12,573	4	24.1
Engineering	11,823	41	42,442	15	27.9
Life sciences	1,080	4	68,094	24	1.6
Psychology	145	1	31,303	11	0.5
Social sciences	2,169	8	36,025	13	6.0
Education, business and other	1,191	4	17,165	6	6.9
Not reported	386	1	6,036	2	6.4

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980.

Table A-25. Energy-Related Doctoral Scientists and Engineers, by Engineering Employment Fields and Degree Specialties employed Population, 1977

Field or degree specialty 2/	Number Reporting 1/ Doctoral degree specialty	Employment field
Civil engineering	681	465
Chemical engineering	2,731	2,054
Electrical engineering	1,170	760
Nuclear engineering	711	1,327
Engineering mechanics	650	471
Mechanical engineering	1,967	1,903
Metallurgy and physical metallurgy	1,072	719
Fuel technology, petroleum engineering	106	725
Materials science engineering	289	695

1/ The overlap between the number reporting a doctoral degree specialty and the number reporting an employment field in the same area is not known. That is, it is not possible to estimate, using the survey data, the number of doctoral degree specialty holders who were working in the same employment field.

2/ Each area listed accounted for 5 percent or more of the doctoral degrees in the specialty or 5 percent or more of the employment in the field.

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980.

Table A-26. Energy-Related and All Doctoral Scientists and Engineers, by Age Group Employed Population, 1977

Age group	Doctoral Scientists and Engineers Energy-Related Number	Energy-Related Percent distribution	Total Number	Total Percent distribution
Total, all age groups	28,557	100	284,237	100
Under 30	871	3	8,474	3
30 - 34	5,502	19	53,562	19
35 - 39	6,841	24	66,741	23
40 - 44	5,167	18	45,147	16
45 - 49	3,765	13	37,626	13
50 - 54	2,799	10	30,935	11
55 - 59	2,060	7	22,507	8
60 - 64	1,148	4	12,944	5
Over 64 or not reported	404	1	6,301	2

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980.

Table A-27. Energy-Related and All Doctoral Scientists and Engineers, by Race/Ethnic Group Employed Population, 1977

Employment field	Percentage distribution: Race/Ethnic Group				
	Total	White	Asian	Other	Not Reported
Total, all fields					
Energy-related	100	87.0	8.2	0.8	3.9
All doctorates	100	89.1	5.4	1.5	4.1
Mathematics/computer science					
Energy-related	100	90.4	5.5	1.3	2.8
All doctorates	100	87.8	6.5	1.0	4.7
Physical sciences					
Energy-related	100	90.3	4.9	1.2	3.7
All doctorates	100	89.2	5.9	1.3	3.7
Earth, environmental and marine sciences					
Energy-related	100	91.1	3.7	0.4	4.8
All doctorates	100	92.5	3.9	0.3	3.3
Engineering					
Energy-related	100	82.7	13.3	0.4	3.6
All doctorates	100	85.0	10.9	0.6	3.5
Life sciences					
Energy-related	100	90.9	3.9	1.3	3.9
All doctorates	100	89.5	5.2	1.6	3.7
Psychology and social sciences					
Energy-related	100	91.1	3.4	1.5	3.9
All doctorates	100	91.0	2.1	2.1	4.8

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientists and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980.

Table A-28. Energy-Related and All Doctoral Scientists and Engineers--Percentage Women, by Degree Specialty and Employment Field Employed Population, 1977

Field or degree	Percentage Women: Degree specialty Energy-Related	Degree specialty All doctorates	Employment field Energy-Related	Employment field All doctorates
Total, women	2.1	9.7	2.1	9.7
Mathematics/ computer science	4.4	6.8	3.0	6.3
Physics	1.3	2.4	1.4	2.7
Chemistry	3.0	5.9	2.8	6.1
Earth, environmental and marine sciences	2.5	3.5	1.8	3.4
Engineering	0.4	0.5	0.6	0.7
Life sciences	6.5	12.6	7.2	12.4
Psychology and social sciences	6.4	17.7	6.1	17.9
Other and not reported	5.3	16.4	4.1	11.2

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/0033-T2, April 1980.

Table A-29. Energy-Related and All Doctoral
Scientists and Engineers
Percentage Non-U.S. Citizen, by Employment Field
Employed Population, 1977

Employment field	Percentage Non-U.S. Citizen	
	Energy-Related	All doctorates
Total, all fields	8.3	5.9
Mathematics/computer science	9.5	7.9
Physics	8.3	8.3
Chemistry	6.7	6.6
Earth, environmental and marine sciences	4.4	6.3
Engineering	11.4	9.0
Life sciences	5.8	5.9
Psychology and social sciences	2.1	2.9
All other fields	3.5	2.5
Not reported	16.6	8.6

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/0033-T2, April 1980.

Table A-30, Energy-Related Doctoral Scientists,
by Region and Field of Employment
Employed Population, 1977

Region	Total, Energy-Related: Number	Total, Energy-Related: Percent distribution	Field: Mathematics/computer science	Field: Physics	Field: Chemistry
	Number				
Total, all regions	28,557	100	989	3,617	4,124
New England	1,645	5	97	271	229
Middle Atlantic	5,261	18	228	562	974
East North Central	4,384	15	183	477	694
West North Central	1,205	4	0	114	181
South Atlantic	4,155	14	70	663	586
East South Central	1,091	4	60	119	138
West South Central	3,160	11	128	125	449
Mountain	2,705	9	97	525	272
Pacific	4,925	17	126	755	595
U.S. possessions	26	1/	0	6	6

1/ Less than 0.5 percent.

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/0033-T2, April 1980

Table A-31. Energy-Related and All Doctoral Scientists and Engineers--Percentage of U.S. Government Supported Personnel, by Employment Field 1/ Employed Population, 1977

Employment field	Percent Reporting U.S. Government Support: Energy-Related	All doctorates
Total, all fields	50	42
Mathematics/computer science and physical sciences	57	37
Earth, environmental and marine sciences	44	54
Engineering	48	50
Civil	41	48
Chemical	34	25
Electrical, electronic	44	48
Nuclear	62	64
Mechanical	50	46
Other engineering	52	56
Life sciences	65	57
Psychology and social sciences	41	31
All other and not reported	36	24

1/ Support received from U.S. Government could range from minimal amount to full support.

SOURCE: U.S. Department of Energy, Energy-Related Doctoral Scientist and Engineers in the United States, 1977, DOE/IR/00033-T2, April 1980

Table A-32. Staffing Patterns for Fossil Energy Research by Degree/Employment Field and Fossil Energy Area, 1977-1978
(Percent distribution)

Technical Notes Follow Table A-34

Degree/employment field	Energy research and development area				
	Total, fossil energy	Coal and coal products	Petroleum	Natural gas	Oil shale and tar sands
Total............................	100.0	100.0	100.0	100.0	100.0
Mathematical sciences............	1.4	1.2	0	0	4.2
Physics..........................	1.6	1.6	0	0	5.1
Chemistry........................	28.5	31.8	30.1	0	13.0
Earth sciences...................	12.4	5.7	19.5	99.2	-39.1
Atmospheric and marine sciences...	.6	*	1.4	0	3.7
Chemical engineering.............	32.4	35.1	44.8	0	11.4
All other engineering............	18.6	22.5	3.8	0	12.7
Agricultural sciences............	*	*	0	0	2.0
Biological sciences..............	2.2	2.0	*	0	4.5
Social sciences..................	*	*	0	0	0
Other fields.....................	.5	0	0	0	3.7
Field not reported...............	1.3	1.7	0	.8	0
Number of projects...............	176	135	19.5	3.5	18.0
Dollar value of projects (in $000's).....................	$37,386	$28,815	$3,702	$419	$4,450

* Less than 0.5 percent.
NOTE: Column totals may not add to 100.0 percent because of rounding.
SOURCE: U.S. Department of Energy, University Manpower in Fossil Energy Research and Development: A Data Collection Feasibility Study, September 1979. DOE/TID/0033-1

Table A-33. Faculty and Student Participation in Fossil Energy Research, 1977-1978

Technical Notes Follow Table A-34

Energy research and development area	Total	Faculty	Research associates 1/	Graduate research assistants	Under-graduate assistant	Techni-cians
Total, fossil energy						
Man-months...............	12,301	2,669	2,633	5,151	601	1,247
Percent distribution.....	100.0	21.7	21.4	41.9	4.9	10.1
Coal and coal products						
Man-months...............	9,435	1,798	2,069	3,974	442	1,152
Percent distribution.....	100.0	19.1	21.9	42.1	4.7	12.2
Petroleum						
Man-months.................	1,268	276	204	585	132	71
Percent distribution.......	100.0	21.7	16.1	46.1	10.4	5.6
Natural gas						
Man-months................	137	45	0	81	0	11
Percent distribution......	100.0	32.8	0	59.1	0	8.0
Oil shale and tar sands						
Man-months...............	1,461	550	360	511	27	13
Percent distribution.....	100.0	37.6	24.6	35.0	1.9	.9

1/ Includes postdoctoral fellows.

NOTE: Percentages may not add to 100.0 percent because of rounding.

SOURCE: U.S. Department of Energy, University Manpower in Fossil Energy Research and Development: A Data Collection Feasibility Study, September 1979. DOE/TID/0033-1

Table A-34. Man-Months of Input per Million Dollars of Fossil Energy Research by Manpower Category and Fossil Energy Area, 1977-1978

Technical Notes Follow

Manpower category	Energy research and development area				
	Total, fossil energy	Coal and coal products	Petroleum	Natural gas	Oil shale and tar sands
Total............................	329.1	327.4	342.3	327.1	328.3
Faculty..........................	71.4	62.4	74.4	106.2	123.6
Research associate (includes postdoctoral)........	70.4	71.8	55.1	0	80.9
Graduate research assistant.......	137.8	137.9	158.0	194.6	114.8
Undergraduate research assistant.....................	16.1	15.3	35.7	0	6.1
Technician.......................	33.4	40.0	19.1	26.3	2.9
Number of projects................	176	135	19.5	3.5	18.0
Dollar value of projects (in $000's).....................	$37,387	$28,816	$3,702	$419	$4,450

SOURCE: U.S. Department of Energy, University Manpower in Fossil Energy Research and Development: A Data Collection Feasibility Study, September, 1979. DOE/TID/0033-1

Technical Notes, Tables A-32 - A-34[1/]

Tables A-32 through A-34 present data on manpower engaged in DOE-funded fossil energy research in universities. The full report identifies man-months of graduate student, faculty, and staff inputs to this research effort by discipline and, in most cases, by subdiscipline.

Data presented in the report come primarily from a review of research proposals and contracts in DOE files conducted during the summer of 1978. All of the projects examined were active during the 1977 and/or 1978 calendar years. While all the data come from this source, they were checked and classified by energy area using information from the Oak Ridge National Laboratory Energy Inventory, a compilation of energy research in progress.

[1/] U.S. Department of Energy, University Manpower in Fossil Energy Research and Development: A Data Collection Feasibility Study, September 1979. DOE/TID/0033-1

Appendix B - Labor Turnover Rates,
Annual Averages, 1972-1979

Table B-1. Labor Turnover Rates
Coal Mining Industries (SIC codes 11, 12)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accescions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.8	1.4	NA	1.9	0.8	0.6
1973	1.7	1.3	NA	1.6	.8	.3
1974	1.9	1.7	NA	1.4	.7	.1
1975	2.3	1.9	NA	1.4	.7	.2
1976	2.0	1.5	0.2	1.7	.8	.3
1977	2.1	1.3	.4	1.6	.8	.3
1978	1.9	1.3	.3	1.7	.7	.4
1979 1/	1.6	1.0	.4	2.1	.7	.9

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-2. Labor Turnover Rates
Anthracite Mining Idustry (SIC code 11)
Annual Averages, 1972-79
Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	3.6	1.2	NA	5.7	0.9	3.9
1973	2.4	1.1	NA	2.3	1.1	.5
1974	1.9	1.5	NA	1.3	.9	.1
1975	4.0	1.5	NA	2.3	.6	.3
1976	2.0	.9	0.9	2.0	.5	.9
1977	1.5	.6	.9	2.2	.2	1.0
1978	2.4	.4	1.8	2.4	.3	1.4
1979 1/	2.3	.7	.9	2.3	.4	.8

NA - Not Available.

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table B-3. Labor Turnover Rates
Bituminous Coal and Lignite Mining Industry (SIC code 12)
Annual Averages, 1972-79
Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accescions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.7	1.4	NA	1.8	0.8	0.5
1973	1.7	1.3	NA	1.6	.8	.3
1974	1.9	1.7	NA	1.4	.7	.1
1975	2.3	1.9	NA	1.4	.8	.2
1976	2.1	1.5	0.2	1.7	.8	.3
1977	2.1	1.3	.3	1.6	.8	.2
1978	1.9	1.3	.3	1.6	.7	.4
1979 1/	1.6	1.0	.4	2.1	.7	.9

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-4. Labor Turnover Rates
Oil and Gas Extraction Industry (SIC code 13)
Annual Averages, 1972-79
Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New-hires	Recalls	Separations	Quits	Layoffs
1972	5.1	4.2	NA	4.9	2.8	1.1
1973	5.2	4.4	NA	5.2	3.2	.9
1974	6.4	5.3	NA	5.3	3.7	.6
1975	5.1	4.4	NA	4.6	3.0	.7
1976	5.4	4.3	0.5	5.0	3.1	.8
1977	5.4	4.4	.5	4.7	3.4	.3
1978	6.6	5.3	.6	5.7	4.2	.3
1979 1/	7.1	5.6	.9	5.9	4.2	.5

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-5. Labor Turnover Rates
Crude Petroleum and Natural Gas, and
Gas Liquids Industries (SIC code 131, 2)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees) Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.6	1.2	NA	1.6	0.7	0.2
1973	1.6	1.2	NA	1.7	.8	.2
1974	2.0	1.4	NA	1.5	.8	.1
1975	1.6	1.3	NA	1.3	.7	.1
1976	1.7	1.3	0.2	1.5	.8	.1
1977	2.0	1.5	.2	1.7	1.0	.1
1978	2.3	1.6	.4	1.9	1.1	.2
1979 1/	2.6	1.9	.4	1.8	1.0	.2

NA - Not Available.

1/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-6. Labor Turnover Rates
Crude Petroleum and Natural Gas Industry (SIC code 131)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.6	1.2	NA	1.6	0.7	0.2
1973	1.6	1.2	NA	1.7	.8	.2
1974	2.0	1.4	NA	1.5	.8	.1
1975	1.6	1.2	NA	1.3	.7	.1
1976	1.7	1.3	0.2	1.5	.8	.1
1977	2.0	1.5	.2	1.7	1.0	.1
1978	2.3	1.6	.4	1.9	1.1	.2
1979 1/	2.6	1.9	.4	1.8	1.0	.2

NA - Not Available.

1/ Preliminary

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table B-7. Labor Turnover Rates
Natural Gas Liquids Industry (SIC code 132)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.3	1.1	NA	1.3	0.7	0.1
1973	1.6	1.2	NA	1.6	1.1	.0
1974	1.9	1.4	NA	1.4	.9	.0
1975	1.6	1.5	NA	1.1	.9	.0
1976	1.7	1.5	NA	2.1	1.3	.0
1977	1.9	1.8	.1	1.5	.7	.0
1978	2.4	2.2	.1	2.3	1.7	.0
1979 1/	2.0	1.8	*	1.7	1.2	*

NA - Not Available

1/ Preliminary.

* Less than 0.05.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table B-8. Labor Turnover Rates
Oil and Gas Field Services Industry (SIC code 138)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	9.2	7.6	NA	8.8	5.3	2.1
1973	9.0	7.6	NA	8.8	5.6	1.6
1974	10.5	9.0	NA	9.0	6.4	1.1
1975	8.3	7.2	NA	7.5	5.0	1.2
1976	8.6	7.0	0.8	8.1	5.1	1.5
1977	8.1	6.8	.7	7.1	5.3	.5
1978	9.9	8.1	.7	8.5	6.5	.5
1979 1/	10.4	8.3	1.3	9.0	6.6	.7

NA - Not Available

1/Preliminary

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-9. Labor Turnover Rates
Petroleum Refining Industry (SIC code 291)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	1.3	1.1	NA	1.6	0.5	0.5
1973	1.6	1.4	NA	1.6	.5	.5
1974	1.7	1.5	NA	1.5	.5	.4
1975	1.2	1.0	NA	1.2	.4	.3
1976	1.4	1.2	*	1.4	.4	.5
1977	1.5	1.3	*	1.6	.5	.4
1978	1.5	1.3	*	1.4	.5	.4
1979 1/	1.8	1.6	.1	1.4	.5	.4

NA - Not Available

1/ Preliminary.

*Less than 0.05.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1213-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Table B-10. Labor Turnover Rates
Miscellaneous Products of Petroleum and
Coal Industry (SIC code 299)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	2.9	2.4	NA	2.9	1.7	0.5
1973	3.8	3.4	NA	3.6	2.2	.4
1974	4.0	3.5	NA	3.9	2.4	.4
1975	2.4	1.7	NA	2.8	1.3	.9
1976	2.8	2.1	0.5	2.4	1.3	.4
1977	2.8	2.3	.4	2.8	1.7	.4
1978	2.9	2.4	.4	2.9	1.7	.5
1979 1/	3.1	2.6	.4	3.0	1.9	.5

NA - Not Available

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table B-11. Labor Turnover Rates
Mining Machinery Industry (SIC code 3532)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	2.0	1.5	NA	1.9	0.9	0.5
1973	2.5	2.2	NA	2.2	1.3	.2
1974	2.8	2.6	NA	2.3	1.3	.3
1975	1.8	1.5	NA	1.8	.7	.5
1976	1.6	1.0	0.5	2.1	.7	1.0
1977	1.6	1.0	.4	1.7	.7	.5
1978	2.3	1.6	.6	2.1	.9	.6
1979 1/	2.0	1.6	.2	2.0	1.0	.4

NA - Not Available

1/ Preliminary.

SOURCE: Unpublished data from the Bureau of Labor Statistics. These data do not meet BLS publication standards and the Bureau does not certify to their accuracy and reliability.

Table B-12. Labor Turnover Rates
Oil Field Machinery Industry (SIC code 3533)
Annual Averages, 1972-79

Technical Notes, p.101

Year	Labor turnover rates (per 100 employees)					
	Accessions	New hires	Recalls	Separations	Quits	Layoffs
1972	3.5	2.9	NA	2.7	1.6	0.2
1973	3.9	3.5	NA	3.1	2.1	.1
1974	4.5	4.2	NA	3.1	2.1	*
1975	3.6	3.3	NA	2.8	1.7	.2
1976	2.8	2.3	0.3	2.8	1.6	.4
1977	3.5	3.0	0.3	3.0	1.8	.4
1978	4.0	3.7	.1	3.0	1.9	.1
1979 1/	3.4	3.0	.2	2.9	1.9	.2

NA - Not Available

1/ Preliminary.

*Less than 0.05.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Employment and Earnings, United States, 1909-1978, Bulletin 1312-11 for 1950-76 data; Employment and Earnings Supplement, November 1979 for 1977-78 data; and Employment and Earnings, March 1980 for final 1979 data.

Appendix C

Employment by Age, Sex, and Race/Ethnic Group

Data in Tables C-1 and C-2 are based on the 1970 Census of Population. Some Census items are obtained from a survey of the entire population, others from a sample of the population. The industrial-age characteristics are based on a 5 percent sample.

The 1970 Census was conducted primarily through self-enumeration, i.e., as a substitute for the traditional census direct interview.

Human and mechanical errors occur in any mass statistical operation such as a decennial census. Errors during the data collection phase can include failure to obtain required information from respondents, obtaining incorrect or inconsistent information, and recording information in the wrong places or incorrectly. Errors can also occur during the field review of the enumerator's work, the clerical handling of the questionnaires, and the various stages of the electronic processing of the material. Careful efforts are made in every census to keep the errors in each step at an acceptably low level. Quality control and check measures are utilized throughout the census operation.

Sampling Variability

The estimates from the sample tabulations are subject to sampling variability. The standard errors of these estimates can be obtained from Appendix D of the Bureau of the Census Report, 1970 Census of Population, Industrial Characteristics, PC(2)7B.

Table C-1. Age and Sex of Employed Persons, Total, Black, and Hispanics for all Industries, 1970

Age and Sex	Total, all industries		
	Total	Black	Hispanic 1/
Male			
Total, all ages....................	47,730,661	4,069,397	1,874,396
16-19 years......................	2,983,681	255,154	132,463
20-29 years......................	10,655,926	986,598	519,751
30-39 years......................	9,885,723	911,429	491,086
40-49 years......................	10,559,480	873,184	402,214
50-59 years......................	8,769,681	676,502	219,917
60 years and over................	4,876,170	366,530	108,965
Female			
Total, all ages....................	29,074,510	3,333,659	1,019,234
16-19 years......................	2,333,311	192,754	96,475
20-29 years......................	7,317,153	885,681	314,646
30-39 years......................	5,131,553	756,566	245,408
40-49 years......................	6,288,286	717,159	209,158
50-59 years......................	5,298,493	522,538	111,686
60 years and over................	2,705,714	258,961	41,861

1/ Hispanics may be of any race, thus some persons included here are also included in the "Black" category.

SOURCE: U.S. Department of Commerce, Bureau of the Census, Industrial Characteristics, Subject Report, P(2) - 7B, 1970, Tables 33-36, pp. 267-308.

Table C-2. Age and Sex of Employed Persons for Selected Energy Industries for Total in Industry, Blacks, and Hispanics, 1970

Age and sex	Coal mining, SIC 11, 12		
	Total	Black	Hispanic 1/
Male			
Total, all ages	135,253	4,133	1,260
16-19 years	1,901	103	26
20-29 years	23,173	282	242
30-39 years	26,327	346	202
40-49 years	36,301	1,122	286
50-59 years	36,508	1,556	325
60 years and over	11,043	724	179
Female			
Total, all ages	3,847	115	51
16-19 years	182	-	-
20-29 years	982	50	-
30-39 years	736	18	15
40-49 years	943	22	36
50-59 years	738	25	-
60 years and over	266	-	-

Age and sex	Crude petroleum & natural gas extractions, SIC 13		
	Total	Black	Hispanic 1/
Male			
Total, all ages	241,363	5,137	7,811
16-19 years	6,507	185	209
20-29 years	49,877	1,710	2,429
30-39 years	56,779	789	2,545
40-49 years	66,530	1,010	1,705
50-59 years	44,263	972	722
60 years and over	17,407	471	201
Female			
Total, all ages	35,100	1,550	1,032
16-19 years	1,568	126	43
20-29 years	11,765	792	549
30-39 years	7,493	213	208
40-49 years	8,213	252	94
50-59 years	4,230	58	80
60 years and over	1,831	109	58

See footnotes at end of table.

Table C-2. Age and Sex of Employed Persons for Selected Energy Industries for Total in Industry, Blacks, and Hispanics, 1970 (continued)

Age and sex	Petroleum refining SIC 291		
	Total	Black	Hispanic[1/]
Male			
Total, all ages	155,388	7,791	3,715
16-19 years	1,531	211	50
20-29 years	27,577	2,354	1,058
30-39 years	28,122	1,490	794
40-49 years	45,820	1,469	777
50-59 years	41,354	1,631	832
60 years and over	10,984	636	204
Female			
Total, all ages	26,687	1,991	847
16-19 years	1,752	132	42
20-29 years	9,974	1,341	473
30-39 years	4,267	262	106
40-49 years	5,468	118	92
50-59 years	3,968	115	110
60 years and over	1,258	23	24

Age and sex	Misc. petroleum & coal products, SIC 295, 299[2/]		
	Total	Black	Hispanic[1/]
Male			
Total, all ages	17,289	2,319	836
16-19 years	489	66	23
20-29 years	3,465	428	229
30-39 years	3,593	526	189
40-49 years	4,441	609	208
50-59 years	3,803	486	120
60 years and over	1,498	204	67
Female			
Total, all ages	3,382	179	42
16-19 years	215	31	-
20-29 years	1,109	127	24
30-39 years	657	-	18
40-49 years	592	21	-
50-59 years	522	-	-
60 years and over	287	-	-

See footnotes at end of table.

Table C-2. Age and Sex of Employed Persons for Selected Energy Industries for Total in Industry, Blacks, and Hispanics, 1970 (continued)

Age and sex	Pipelines, except natural gas, SIC 46		
	Total	Black	Hispanic 1/
Male			
Total, all ages	11,104	410	236
16-19 years	74	16	-
20-29 years	1,916	134	73
30-39 years	1,876	56	37
40-49 years	3,187	114	50
50-59 years	2,875	19	53
60 years and over	1,176	71	23
Female			
Total, all ages	1,168	19	-
16-19 years	16	-	-
20-29 years	377	19	-
30-39 years	324	-	-
40-49 years	215	-	-
50-59 years	132	-	-
60 years and over	104	-	-

Age and sex	Electric light and power, SIC 491		
	Total	Black	Hispanic 1/
Male			
Total, all ages	339,442	14,889	6,600
16-19 years	5,040	531	173
20-29 years	78,553	4,288	2,372
30-39 years	78,667	3,605	1,722
40-49 years	90,309	2,925	1,410
50-59 years	59,991	2,523	656
60 years and over	26,882	1,017	267
Female			
Total, all ages	56,979	3,275	1,144
16-19 years	4,021	279	98
20-29 years	18,787	1,645	661
30-39 years	10,524	456	194
40-49 years	11,846	472	107
50-59 years	8,434	368	64
60 years and over	3,367	55	20

See footnotes at end of table.

Table C-2. Age and Sex of Employed Persons for Selected Energy Industries for Total in Industry, Blacks, and Hispanics, 1970 (continued)

Age and sex	Electric-gas utilities, SIC 493		
	Total	Black	Hispanic 1/
Male			
Total, all ages	134,313	8,193	3,619
16-19 years	2,182	477	43
20-29 years	30,583	2,234	1,200
30-39 years	30,858	1,986	1,075
40-49 years	34,111	1,861	703
50-59 years	24,789	1,108	487
60 years and over	11,790	527	111
Female			
Total, all ages	23,386	2,071	621
16-19 years	1,814	272	90
20-29 years	8,257	937	326
30-39 years	3,573	336	78
40-49 years	4,890	376	89
50-59 years	3,692	130	17
60 years and over	1,160	20	21

Age and sex	Gas and steam supply systems, SIC 492, 496		
	Total	Black	Hispanic 1/
Male			
Total, all ages	106,261	6,024	2,623
16-19 years	1,411	206	89
20-29 years	19,654	1,690	798
30-39 years	25,599	1,483	599
40-49 years	31,200	1,307	782
50-59 years	21,225	1,165	336
60 years and over	7,172	173	19
Female			
Total, all ages	20,707	1,365	460
16-19 years	1,481	202	35
20-29 years	7,325	592	219
30-39 years	3,496	250	117
40-49 years	4,671	193	65
50-59 years	2,871	81	24
60 years and over	863	47	-

See footnotes on following page.

Footnotes for Table C-2

[1] Hispanics may be of any race, thus some persons included here are also included in the "Black" category.

[2] Includes paving and roofing materials -- SIC 299 not available separately.

SOURCE: Industrial Characteristics, Subject Report, PC(2)-7B, 1970 Census of Population, U.S. Department of Commerce, Bureau of the Census, Tables 33-36, pp. 267-308.

Table C-3. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excludes Hawaii)
Anthracite Mining Industry SIC 11
Technical Notes Follow Table C-8

Race/ethnic group and sex	Total	Officials and managers	Selected occupational groups 1/ Profes-sionals	Craft workers	Opera-tives	Labor-ers
ALL EMPLOYEES						
Number......	7,775	7,792	178	1,824	3,755	738
Percent.....	100.0	100.0	100.0	100.0	100.0	100.0
White............	94.8	97.6	98.9	97.0	91.6	98.5
Male...........	91.3	96.3	90.4	96.7	90.3	95.7
Female.........	3.5	1.3	8.4	.4	1.4	2.8
Black............	5.1	2.1	1.1	3.0	8.2	1.4
Male...........	4.9	2.1	1.1	2.9	7.9	1.2
Female.........	.2	.0	.0	.1	.3	.1
Hispanic.........	.1	.1	.0	.0	.1	.1
Male...........	.1	.1	.0	.0	.1	.1
Female.........	*	.0	.0	.0	.0	.0
Asian American...	.1	.1	.0	.0	*	.0
Male...........	*	.1	.0	.0	*	.0
Female.........	*	.0	.0	.0	.0	.0
American Indian..	.0	.0	.0	.0	.0	.0
Male...........	.0	.0	.0	.0	.0	.0
Female.........	.0	.0	.0	.0	.0	.0

1/ Tables available from EEOC also show data for technicians, sales, office and clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities And Women in Private Industry, February, 1980.

Table C-4. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excluding Hawaii) Bituminous Coal and Lignite Mining Industry SIC 12

Technical Notes Follow Table C-8

Race/ethnic group and sex	Total	Selected occupational groups 1/				
		Officials and managers	Profes-sionals	Craft workers	Opera-tives	Labor-ers
ALL EMPLOYEES						
Number......	152,203	18,651	3,540	40,759	51,877	22,320
Percent.....	100.0	100.0	100.0	100.0	100.0	100.0
White............	95.3	98.1	96.6	95.0	95.0	93.9
Male...........	91.5	97.1	86.6	94.7	94.1	91.2
Female.........	3.8	1.0	7.0	.3	.9	2.7
Black............	2.7	1.9	1.0	2.2	3.1	4.3
Male...........	2.4	1.9	.8	2.2	3.1	3.9
Female.........	.3	.1	.4	*	.1	.4
Hispanic.........	.9	.5	.9	1.3	.8	1.0
Male...........	.9	.5	.7	1.3	.8	.9
Female.........	.1	*	.1	*	*	*
Asian American...	.1	.1	.9	*	*	*
Male...........	.1	.1	.9	*	*	*
Female.........	*	.0	*	.0	*	*
American Indian..	1.0	.4	.5	1.4	1.1	.8
Male...........	.9	.4	.4	1.4	1.1	.8
Female.........	*	*	.1	*	*	*

1/ Tables available from EEOC also show data for technicians, sales, office and clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities And Women in Private Industry, February, 1980.

Table C-5. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excluding Hawaii)
Oil and Gas Extraction Industry SIC 13
(Technical Notes Follow Table C-8)

Race/ethnic group and sex	Total	Officials and managers	Selected occupational groups 1/ Professionals	Craft workers	Operatives	Laborers
ALL EMPLOYEES						
Number......	217,629	30,814	31,028	38,908	46,775	20,656
Percent.....	100.0	100.0	100.0	100.0	100.0	100.0
White............	86.6	91.1	94.0	88.5	81.0	75.4
Male...........	74.6	92.8	85.5	87.7	79.2	73.4
Female.........	12.0	3.3	8.4	.8	1.8	2.0
Black............	6.5	1.2	2.1	4.8	9.6	12.0
Male...........	5.0	1.1	1.4	4.7	9.0	11.5
Female.........	1.5	.1	.6	.1	.7	.6
Hispanic.........	5.2	1.3	1.8	5.2	8.1	11.0
Male...........	4.4	1.2	1.6	5.1	7.5	10.8
Female.........	.8	.1	.2	.1	.6	.2
Asian American...	.6	.3	1.5	.2	.2	.3
Male...........	.4	.3	1.2	.2	.2	.3
Female.........	.2	*	.3	.0	.1	*
American Indian..	1.1	1.1	.6	1.3	1.0	1.2
Male...........	.9	1.0	.6	1.3	1.0	1.2
Female.........	.2	.1	.1	*	*	*

1/ Tables available from EEOC also show data for technicians, sales, office and clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities And Women in Private Industry, February, 1980.

Table C-6. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excluding Hawaii)
Petroleum Refining Industry SIC 291
(Technical Notes Follow Table C-8)

Race/ethnic group and sex	Total	Selected occupational groups [1/] Officials and managers	Professionals	Craft workers	Operatives	Laborers
ALL EMPLOYEES						
Number......	167,741	27,298	27,197	43,712	25,483	5,420
Percent.....	100.0	100.0	100.0	100.0	100.0	100.0
White............	85.5	96.2	92.2	85.5	75.9	68.8
Male...........	71.6	93.2	80.4	84.5	70.7	61.4
Female.........	13.9	3.0	11.8	1.0	5.2	7.4
Black............	9.0	1.7	3.5	9.5	16.8	23.5
Male...........	6.7	1.6	2.3	9.2	14.7	19.0
Female.........	2.3	.1	1.2	.3	2.1	4.0
Hispanic.........	3.3	1.0	1.5	3.7	5.8	5.6
Male...........	2.7	.9	1.2	3.6	5.5	5.3
Female.........	.6	.1	.3	*	.3	.4
Asian American...	1.1	.4	2.1	.4	.6	.3
Male...........	.7	.4	1.6	.4	.5	.3
Female.........	.3	*	.4	*	*	.0
American Indian..	1.1	.7	.7	1.0	.9	1.8
Male...........	.8	.7	.6	.9	.8	1.6
Female.........	.3	.1	.1	*	.1	.1

[1/] Tables available from EEOC also show data for technicians, sales, office and clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities And Women in Private Industry, February, 1980.

Table C-7. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excluding Hawaii) Pipe Lines (exc. Natural Gas) Industry SIC 46

(Technical Notes Follow Table C-8)

Race/ethnic group and sex	Total	Officials and managers	Selected occupational groups 1/ Profes-sionals	Craft workers	Opera-tives	Labor-ers
ALL EMPLOYEES						
Number..........	12,019	1,995	1,443	2,727	2,058	844
Percent........	100.0	100.0	100.0	100.0	100.0	100.0
White...........	90.9	97.0	95.2	91.8	86.2	81.4
Male..........	81.1	95.3	87.2	91.1	85.1	78.7
Female........	9.8	1.7	8.0	.7	1.1	2.7
Black...........	4.1	.5	1.7	4.4	6.1	10.3
Male..........	3.4	.4	1.5	4.3	5.9	9.7
Female........	.6	.1	.1	.1	.2	.6
Hispanic........	2.3	.5	1.2	2.2	4.3	4.9
Male..........	2.0	.4	1.0	2.2	4.2	4.7
Female........	.3	.1	.1	*	.1	.1
Asian American..	.5	.1	1.2	.1	.1	.0
Male..........	.3	.1	.9	.1	.1	.0
Female........	.1	.0	.3	.0	.0	.0
American Indian.	2.3	2.0	.8	1.4	3.3	3.4
Male..........	2.0	2.0	.7	1.4	3.3	3.3
Female........	.3	.1	.1	*	.0	.1

1/ Tables available from EEOC also show data for technicians, sales, office and, clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities And Women in Private Industry, February, 1980.

Table C-8. Percent Distribution of Employment by Race/Ethnic Group and Sex, by Occupational Group, U.S., 1978 (Excluding Hawaii) Electric, Gas and Sanitary Services Industry SIC 49 (Technical Notes Follow)

Race/ethnic group and sex	Total	Selected occupational groups 1/				
		Officials and managers	Professionals	Craft workers	Operatives	Laborers
ALL EMPLOYEES						
Numbers.....	623,063	88,791	60,769	174,327	91,771	21,243
Percent.....	100.0	100.0	100.0	100.0	100.0	100.0
White............	86.5	96.4	92.8	91.1	76.4	68.2
Male...........	73.1	92.3	83.7	90.8	74.6	65.6
Female.........	13.4	4.2	9.1	.3	1.8	2.6
Black............	9.0	1.9	2.9	5.9	17.0	23.7
Male...........	6.7	1.6	2.1	5.8	16.4	22.8
Female.........	2.3	.3	.9	.1	.5	1.0
Hispanic	3.3	1.1	1.8	2.5	5.6	6.6
Male...........	2.6	1.0	1.6	2.4	5.4	6.2
Female.........	.7	.1	.2	*	.2	.4
Asian American...	.7	.2	2.2	.2	.4	.2
Male...........	.4	.2	1.9	.2	.4	.2
Female.........	.2	*	.3	*	*	*
American Indian..	.5	.4	.3	.4	.6	1.2
Male...........	.4	.4	.3	.4	.6	1.1
Female.........	.1	*	*	*	*	.1

1/ Tables available from EEOC also show data for technicians, sales, office and clerical, and service workers.

* Less than 0.05 percent.

SOURCE: Equal Employment Opportunity Commission, Minorities and Women in Private Industry, February, 1980.

Technical Notes for Tables C-3-through C-8

Tables C-3 through C-8 are based on survey conducted by the Equal Employment Opportunities Commission. [1/]

Every private employer subject to Title VII and having 100 or more employees was required to file an EEO-1, unless that employer was a primary or secondary school system, an institution of higher education, an Indian tribe, or a tax-exempt private membership club other than a labor organization. Those Federal contractors having 50 or more employees and contracts of at least $50,000 were also required to file. While each single-establishment employer submitted only one EEO-1 report, those employers of 100 or more persons whose business was conducted at more than one location were required to submit a company-wide consolidated report, a headquarters report, and individual reports for each establishment with 25 or more workers. Employment figures could be for any pay period in January through May 1978. Some employers were permitted to report 1977 year end figures.

Employers submitted, as appropriate, individual establishment and headquarters reports for 165,000 reporting units with 32.7 million workers. These 32.7 million employees constituted about half of all private, non-farm workers in the Nation. Coverage among industry divisions varied - about 60 percent in mining and 75 percent in manufacturing and utilities.

1/ Equal Employment Opportunity Commission, Minorities and Women in Private Industry, February, 1980.

Appendix D. Employment by Occupation

Tables D-1 through D-9 are from the Bureau of Labor Statistics' industry-occupational matrices available for 1970, 1978 and 1990. The occupational pattern of each industry sector is shown, i.e., the proportion of each occupation to total employment in an industry. 1/

Data for the matrices are brought together from a wide variety of sources. A major source for the development of the 1970 matrix was the Occupation by Industry report from the 1970 Census of Population. The monthly Current Population Survey (CPS) is the source for updating data on total employment, employment for broad occupational groups, and for a few large, specific occupations. Other sources of data include the regulatory agency statistics on employment by occupation in the telephone, railroad, and air transportation industries; U.S. Civil Service Commission statistics on employment by occupation in the Federal Government; statistics on selected professional occupations based on licensing data and membership records of professional societies; and surveys of employers by the Bureau and other agencies to obtain estimates of employment in a limited number of highly important occupations such as scientists, engineers, teachers, and police officers.

The 1970 matrix provided the base for the 1978 and 1990 matrices. Where available, occupational data from other sources, such as those cited above, were incorporated into the updated matrices as fixed cells. For the remaining cells, first approximations of the occupational patterns for 1976 were made by

1/ Source of technical note: Bureau of Labor Statistics. See also tables in Appendix D.

cells, first approximations of the occupational patterns for 1976 were made by interpolating between earlier patterns of the 1974 and the 1985 matrices. The 1990 ratios were based on a continuation of the trends shown from 1976 to 1985. The patterns were then applied to individual industry employment controls and summed to arrive at occupational totals.

Although the occupational patterns of many industries are relatively stable over periods of less than 5 years, it is clear that occupational patterns change with the advance of technology and changes in the supply of workers in each occupation. Hence, information on how technology and labor supply are changing the occupational pattern in each industry is used to modify the initial estimates.

The information obtained from the CPS and other surveys is subject to the response and sampling limitations typical of surveys. In addition, since, in some cases, the occupational definitions and concepts of the surveys frequently differ, data stemming from surveys must be adjusted and are subject to error resulting from analytical adjustments. The matrix data then indicates the general level and position the estimates hold in relation to the other occupational estimates within each major industry group. Consequently, the occupational estimates in the matrices should be used with caution and should not be viewed as precise measurements. In general, the smaller the occupational estimates the less the reliability. In terms of data use, the current National Industry-Occupational Matrix is limited in scope to about 377 specific occupations and 201 industry sectors.

The complete matrix printout (order #PB80-134869) can be obtained from NTIS, 5285 Port Royal Road, Springfield, Virginia 22161.

Tables D-2a, D-2b, D-3a, and D-4a are from the Occupational Employment Statistics Survey. The OES Survey is a periodic mail survey conducted by state employment security agencies of a sample of non-farm establishments to obtain wage and salary employment by occupation. For this survey, employment excludes proprietors, owners and partners of unincorporated firms, unpaid family workers, and workers on extended leave. Data for the survey are requested for the pay period including the twelfth of the month. Sources of data reported by respondents are personnel records and especially for small reporting units, personal knowledge of persons completing the reports. While data are primarily collected by mail, personal visits are made to large employers, especially those employers who experience difficulty in completing the questionnaires. The OES sample is designed to yield reliable industry occupational estimates for the participating states and areas with those states. All establishments employing 100 or more employees are included in the sample.

Differences between these data and the occupational industry matrix figure are due to response error, sampling variability, differences in occupational definitions, coverage, and time period of survey. For example, the Spring 1978 employment in Bituminous Coal (D-2b) is greater than the 1978 total employment figure for all coal mining (D-2). Annual average figures, in 1978, for coal mining were depressed because of the strike which occurred in the early part of the year. Data for individual states and some local areas are available from state employment security agencies.

(Note: The abbreviation "nec" used in these tables means "not elsewhere classified.")

Table D-1. Total Employed and Percent Distribution by Selected Occupations for All Industries, U.S. Total 1970, 1978, and Projected 1990

Occupation	All industries: Actual 1970	All industries: Actual 1978	All industries: Projected 1990
Total, all occupations: Number....	78,627,680	94,372,560	114,000,256
Percent...	100.00	100.00	100.00
Professional, technical, & kindred..	13.88	15.09	14.78
Engineers........................	1.40	1.23	1.24
Life & physical scientists........	.26	.30	.31
Mathematical specialists..........	.04	.04	.05
Engineers, science technicians....	1.04	1.02	1.09
Medical workers, exc. tech........	1.77	2.03	2.36
Health technologists & techn......	.35	.54	.59
Technicians, exc. health..........	.20	.23	.25
Computer specialists..............	.36	.46	.55
Social scientists.................	.15	.28	.32
Teachers.........................	4.11	3.91	3.13
Writers, artists, & entertainers..	1.04	1.32	1.28
Other professional, tech..........	3.15	3.73	3.67
Managers, officials, proprietors....	9.52	10.71	10.70
Sales workers......................	6.38	6.31	6.66
Clerical workers..................	17.46	17.91	19.04
Crafts & kindred workers...........	13.28	13.12	13.04
Construction crafts workers......	3.93	3.98	3.93
Blue collar worker superv, nec...	1.75	1.77	1.69
Metalworking crafts, exc. mech...	1.45	1.27	1.28
Mechanics, repr, installers......	3.37	3.53	3.79
Printing trade crafts workers....	.50	.45	.38
Transp, pub utils craft workers..	.64	.59	.50
Other crafts, kindred workers....	1.64	1.53	1.47
Operatives........................	16.88	15.28	14.58
Operatives, exc. transport.......	13.05	11.52	10.97
Transport equipment operatives...	3.83	3.75	3.61
Service workers...................	13.31	13.60	14.63
Laborers, exc. farm................	5.31	5.01	4.48
Farmers & farm workers............	3.98	2.96	2.06

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-2. Total Employed and Percent Distribution by Occupation
Coal Mining Industries SIC-11, 12
1970, 1978, and Projected 1990

Occupation	Coal mining SIC 11, 12		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number......	144,809	212,694	339,762
Percent.....	100.00	100.00	100.00
Professional, technical, & kindred.....	2.02	2.28	2.66
Engineers, technical................	.87	.91	1.18
Chemical...........................	.02	.02	.03
Civil..............................	.08	.07	.10
Electrical.........................	.07	.06	.04
Industrial.........................	.07	.09	.12
Mechanical.........................	.06	.06	.05
Mining.............................	.57	.60	.83
Other..............................	.02	.02	.02
Life and physical scientists.........	.19	.20	.22
Chemists...........................	.15	.16	.16
Geologists.........................	.04	.04	.06
Engineers, science tech.............	.44	.49	.60
Drafters...........................	.10	.09	.11
Electrical, electronic tech.........	.01	.01	.01
Surveyors..........................	.22	.24	.27
Engineering, science tech, nec......	.12	.15	.20
Medical workers, exc. tech..........	.01	.01	.01
Technicians, exc. health............	.05	.07	.07
Computer specialists................	.03	.04	.05
Programmers........................	.02	.03	.03
Systems analysts...................	.01	.02	.02
Social scientists...................	.01	.02	.02
Economists.........................	.01	.02	.02
Other professional, technical........	.41	.54	.52
Managers, officials, proprietors.......	2.53	2.88	2.54
Buyers, sales, loan managers.........	.26	.25	.23
Other managers, officials, prop......	2.27	2.63	2.31
Sales workers.........................	.11	.13	.13
Clerical workers......................	3.78	3.94	3.56
Stenos, typists, secretaries.........	.76	.83	.82
Office machine operators............	.11	.15	.10
Other clerical workers..............	2.91	2.96	2.6

Table D-2. Total Employed and Percent Distribution by Occupation--continued

Occupation	Coal mining SIC 11, 12		
	Actual		Projected
	1970	1978	1990
Crafts and kindred workers.............	29.87	32.71	34.48
Construction crafts workers..........	13.40	13.97	15.25
Carpenters & apprentices............	3.96	4.27	3.79
Brick & stonemasons & appren........	.23	.19	.11
Bulldozer operators.................	2.58	2.77	4.32
Electricians & apprentices..........	3.40	3.67	3.60
Excav., grad., mach. oper...........	3.09	2.94	3.32
Painters & apprentices..............	.02	.02	.02
Plumbers, pipefitters & appren......	.07	.07	.07
Roofers & slaters...................	.01	.02	.02
Structural metal craft workers......	.02	.01	.02
Blue collar worker superv. nec.......	6.06	6.81	6.49
Metalworking craft wkrs. exc. mech...	.71	.86	1.19
Blacksmiths.........................	.05	.03	-
Boilermakers........................	.02	.03	.04
Forge & hammer operators............	.03	.04	.06
Machinists & apprentices............	.57	.70	1.01
Millwrights.........................	.04	.06	.09
Mechanics, repairers, installers.....	7.17	8.54	9.18
Auto mechanics & apprentices........	.46	.43	.33
Heavy equip mech., incl. diesel.....	6.17	7.53	8.41
Radio, television repairers.........	.03	.02	.01
Railroad, car shop repairers........	.04	.05	.04
Other mechanics & apprentices.......	.48	.51	.38
Transp., pub. utils., craft wkrs.....	.06	.07	.05
Locomotive engineers................	.05	.06	.04
Locomotive engineer helpers.........	.01	.01	.01
Other crafts, kindred workers........	2.47	2.47	2.31
Crane, derrick, & hoist oprs........	.48	.41	.46
Inspectors..........................	.80	.98	1.01
Stationary engineers................	1.17	1.06	.84
Crafts & kindred, nec...............	.02	.01	.01
Operatives............................	52.51	49.53	50.37
Operatives, exc. transport...........	44.03	40.91	41.03
Semiskilled, metalworking...........	1.79	1.87	1.57
Welders & flame cutters............	1.75	1.84	1.55
Others.............................	.03	.02	.02

Table D-2. Total Employed and Percent Distribution by Occupation--continued

Occupation	Coal mining SIC 11, 12		
	Actual		Projected
	1970	1978	1990
Other operatives, exc. transp..	42.24	39.05	39.46
Assemblers..................	.03	.03	.02
Blasters.....................	1.24	1.27	1.06
Surveyor helpers............	.13	.16	.23
Cutting operators, nec.......	2.66	2.85	2.71
Drillers, earth..............	2.46	2.21	1.33
Meat cutters, butch, exc. mfg	.12	.01	.01
Mine operatives, nec.........	34.16	30.97	32.69
Mixing operatives...........	.04	.05	.07
Oilers, greasers, exc., auto.	1.35	1.39	1.25
Sawyers.....................	.17	.07	.06
Furnance tendr stokr, exc metal	.07	.04	.01
Misc machine operatives......	.01	.01	.01
Operatives, nec.............	.01	.01	.01
Transport equipment operatives.	8.48	8.61	9.34
Delivery & route workers.....	.13	.12	.11
Forklift, tow motor operatives	.37	.48	.57
Rail vehicle operators, nec...	3.45	3.24	2.25
Truck drivers................	4.53	4.77	6.42
Service workers....................	.99	.93	.70
Laborers, exc. farm................	8.19	7.60	5.56

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix

Table D-2a. Total Employed and Percent Distribution by Occupation
Anthracite Mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Total, all occupations: Number.........	3,200
Percent........	100.00
Managers and Officers......................	5.37
Professional Occupations...................	2.35
Technical Occupations......................	.34
Service Occupations........................	1.34
Maintenance, Construction, Repair, Material Handling and Powerplant Occupations.........................	85.57
Mechanic, automotive.................	1.68
All other mechanics and repairers.....	4.70
Truck driver.........................	14.77
Driller, machine.....................	2.35
Supervisor, nonworking................	3.69
Heavy equipment operator.............	13.76
Maintenance repairer, general - utility	2.35
Helper, trades.......................	2.01
Oiler................................	5.37
Welder and/or flamecutter............	6.38
All other skilled craft and kindred workers..........................	4.70
All other operatives and semiskilled workers..........................	13.76
All other laborers and unskilled workers	10.07

See footnote at end of table.

Table D-2a.
Total Employed and Percent Distribution by Occupation - Continued

Anthracite Mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Clerical Occupations....................	4.70
Office clerical occupations........	3.36
Production clerical occupations....	1.34
Sales Occupations.......................	.34

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics. Occupational Employment Statistics Survey of Selected Nonmanufacturing, 1978.

Table D-2b. Total Employed and Percent Distribution by Occupation
Bituminous coal and lignite mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Total, all occupations: Number....	244,650
Percent...	100.00
Managers and Officers..................	4.34
Professional Occupations................	2.92
Civil engineer....................	.08
Industrial engineer................	.08
Mechanical engineer................	.04
Mining engineer....................	.63
Safety engineer....................	.38
All other engineers................	.22
Mathematical scientist............	.03
Chemist..........................	.09
Geologist and/or geophysicist......	.07
Systems analyst, electronic data processing.....................	.07
Purchasing agent and/or buyer......	.25
Accountant and/or auditor..........	.51
Lawyer..........................	.05
Personnel and labor relations specialists	.20
All other professional workers.....	.22
Technical Occupations........................	1.11
Computer programmer.....................	.08
Drafter.................................	.33
Surveyor................................	.28
All other engineering technicians........	.23
Science technicians.....................	.10
All other technicians...................	.09
Service Occupations..........................	.91
Janitor, porter, and/or cleaner..........	.27
Guard and/or doorkeeper..................	.56
All other service workers................	.07

See footnotes at end of table.*

Table D-2b.
Total Employed and Percent Distribution by Occupation - Continued

Bituminous coal and lignite mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Maintenance, Construction, Repair, Material Handling and Powerplant Occupations	85.88
Mechanic, automotive	.67
Diesel mechanic	.49
Engineering-equipment mechanic	.65
Mine-machinery mechanic	5.14
Mechanic, maintenance	.98
All other mechanics and repairers	.60
Truck driver	3.62
Auger-machine operator	.20
Blaster, mining and quarrying	1.37
Bonder and/or wirer	.19
Header, bottomer, car dropper and/or cager	.32
Braker, train	.49
Brattice builder	1.27
Carpenter	.34
Cement mason	.17
Coal washer	.82
Continuous-mining-machine operator	3.16
Crane, derrick, and/or hoist operator	.69
Cutting machine operator	.75
Delivery and/or route worker	.02
Dispatcher, mine car	.17
Drier operator, coal or ore	.05
Driller, hand	.29
Driller, machine	1.76
Dump operator	.19
Electrician	2.13
Fire boss	.75
Supervisor, nonworking	7.26
Heavy equipment operator	12.27
Industrial truck operator	.16
Inspector	.06
Lamp keeper and/or repairer	.31

See footnotes at end of table.*

Table D-2b.
Total Employed and Percent Distribution by Occupation - Continued

Bituminous coal and lignite mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Maintenance, Construction, Repair, Material Handling and Powerplant Occupations-Continued	
Loading-machine operator, underground...........	1.35
Long-wall miner operator........................	.13
Long-wall miner operator helper.................	.57
Machinist.......................................	.32
Maintenance repairer, general-utility...........	1.54
Helper, trades..................................	1.75
Dinkey operator.................................	.76
Oiler...	2.08
Painter, maintenance............................	.02
Panelboard operator and/or grinding mill panelboard operator.........................	.16
Plumber and/or pipefitter.......................	.08
Rock-dust sprayer...............................	.38
Roof bolter.....................................	4.68
Shaker tender...................................	.16
Shuttle-car operator............................	4.80
Stationary engineer.............................	.12
Tipple-operator.................................	1.32
Track layer.....................................	.56
Welder and/or flamecutter.......................	2.43
Surveyor helper.................................	.30
Belt repairer...................................	1.25
Separator tender................................	.08
Conveyor operator or tender.....................	.64
Yard engineer...................................	.11
Pump operator...................................	.46
All other skilled craft and kindred workers....................................	.28
All other operatives and semiskilled workers....................................	2.96
All other laborers and unskilled workers........	9.22

See footnotes at end of table.

Table D-2b.
Total Employed and Percent Distribution by Occupation - Continued

Bituminous coal and lignite mining
Spring, 1978

Occupation	Employment and Percent of total Employment
Clerical Occupations....................	4.75
Bookkeeping and/or billing machine operator..........................	.04
Computer operator.....................	.04
Keypunch operator.....................	.08
Stenographer..........................	.08
Accounting clerk......................	.24
Bookkeeper, hand......................	.07
File clerk............................	.08
General clerk, office.................	.88
Order clerk...........................	.05
Payroll and/or timekeeping clerk......	.26
Personnel clerk.......................	.10
Receptionist..........................	.06
Secretary.............................	.83
Switchboard operator - receptionist...	.07
Typist................................	.18
Clerical supervisor, office or plant..	.20
All other office clerical workers.....	.16
Production clerk and/or coordinator...	.10
Shipping and/or receiving clerk.......	.07
Weigher, record-keeper................	.33
Stock clerk, stockroom, warehouse or storage yard.......................	.77
Dispatcher, vehicle, service or work..	.05
All other plant clerical workers......	.04
Sales Occupations......................	.09

1/ The relative standard errors apply equally to data on estimated employment and percent of total employment; relative standard errors estimated at the level of 2 chances out of 3. For further information on sampling variability and other types of errors, consult the section "method".

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics. Occupational Employment Statistics Survey of Selected Nonmanufacturing, 1978.

Table D-3. Total Employed and Percent Distribution by Occupation
Crude Petroleum and Natural Gas Industry SIC-13
1970, 1978, and Projected 1990

Occupation		Crude petroleum & natural gas SIC-13		
		Actual		Projected
		1970	1978	1990
Total, all occupations:	Number...	279,212	421,250	490,965
	Percent..	100.00	100.00	100.00
Professional, technical, & kindred..		18.37	19.38	21.11
Engineers, technical.............		5.08	4.85	5.81
Chemical......................		.31	.28	.22
Civil.........................		.29	.23	.26
Electrical....................		.26	.25	.20
Industrial....................		.20	.22	.20
Mechanical....................		.38	.39	.44
Metalluri gical................		.02	.03	.04
Mining........................		.18	.17	.20
Petroleum.....................		3.15	3.02	4.01
Sales.........................		.14	.12	.13
Other.........................		.15	.13	.12
Life and physical scientists......		4.86	4.42	5.69
Biological scientists..........		-	.01	.01
Chemists......................		.40	.45	.49
Geologists....................		4.41	3.89	5.09
Marine scientists.............		.01	.02	.03
Physicists & astronomers.......		.04	.05	.06
Mathematical specialists..........		.06	.07	.05
Mathematicians.................		.03	.03	.02
Statisticians.................		.04	.03	.02
Engineers, science tech...........		3.15	3.31	3.67
Agric, biolog, tech exc. health		.01	.01	.01
Chemical tehnicians............		.58	.62	.72
Drafters......................		.98	.90	1.00
Electrical, electronic tech....		.22	.26	.26
Surveyors.....................		.32	.29	.19
Engineering, science tech, nec.		1.02	1.22	1.48
Medical workers, exc. tech........		.02	.02	.04
Technicians, exc. health..........		.42	.71	1.04
Computer specialists..............		.84	1.10	1.18
Programmers....................		.54	.63	.66
Systems analysts...............		.26	.41	.49
Other computer specialists.....		.04	.06	.03

Table D-3. Total Employed and Percent Distribution by Occupation--continued

Occupation	Crude petroleum & natural gas SIC-13		
	Actual		Projected
	1970	1978	1990
Social scientists................	.14	.23	.21
Economists....................	.13	.22	.21
Sociologists..................	-	.01	-
Writers, artists, entertainers...	.19	.23	.19
Other professional, technical....	3.62	4.44	3.34
Managers, officials, proprietors...	9.81	10.55	9.55
Buyers, sales, loan managers.....	1.78	1.69	1.67
Other managers, officials, prop..	8.03	8.86	7.88
Sales workers......................	.69	.52	.14
Clerical workers...................	13.37	13.86	12.30
Stenos, typists, secretaries.....	5.53	5.45	5.17
Office machine operators.........	1.20	1.60	.97
Other clerical workers...........	6.63	6.81	6.17
Crafts and kindred workers.........	17.97	18.24	17.39
Construction crafts workers...	2.16	2.26	2.74
Carpenters & apprentices......	.18	.21	.23
Brick & stonemasons & appren..	.01	.01	-
Bulldozer operators...........	.27	.28	.43
Cement & concrete finishers...	.01	.02	.05
Electricians & apprentices....	.56	.65	.80
Excav., grad., mach. oper.....	.42	.38	.36
Floor layers exc. tilesetters.	.02	.02	.02
Painters & apprentices........	.18	.18	.15
Plumbers, pipefitters & appren.	.48	.52	.69
Structural metal craft workers.	.03	.02	.01
Blue collar workers superv. nec...	5.31	6.04	6.09
Metalworking craft wkrs. exc. mech	.54	.70	1.19
Blacksmiths...................	.02	.02	-
Boilermakers..................	.06	.06	.09
Job & die setters, metal.......	.01	.01	.01
Machniists & apprentices.......	.39	.53	.96
Millwrights...................	.02	.03	.06
Sheetmetal workers & appren....	.01	.02	.02
Tool & diemakers & appren......	.03	.03	.05

Table D-3. Total Employed and Percent Distribution by Occupation--continued

Occupation	Crude petroleum & natural gas SIC-13		
	Actual		Projected
	1970	1978	1990
Mechanics, repairers, installers..	3.34	3.94	4.37
Air cond., heating, refrig.....	.09	.13	.13
Aircraft mechanics............	.04	.05	.08
Auto body repairers...........	.01	.01	.01
Auto mechnics & apprentices....	.52	.48	.38
Data process, mach. repairers..	.01	.02	.02
Heavy equip mech., incl. diesel	2.18	2.75	3.39
Radio, television repairers....	.04	.04	.03
Other mechanics & apprentices..	.46	.47	.32
Printing trade crafts workers.....	.07	.08	.07
Transp., pub. utils., craft wkrs..	.09	.09	.08
Elect. pwr line instal., reprs	.06	.04	-
Power station operators........	.02	.02	.04
Telephone installers, repairers	.01	.02	.03
Other crafts, kindred workers.....	6.46	5.13	2.85
Crane, derrick, & hoist oprs...	.50	.48	.75
Inspectors....................	.48	.58	.60
Stationary engineers..........	5.41	4.00	1.43
Crafts & kindred, nec..........	.07	.07	.08
Operatives.......................	36.51	34.39	36.98
Operatives, exc. transport........	32.95	30.65	32.07
Semiskilled, metalworking......	1.43	1.54	1.81
Welders & flame cutters........	1.15	1.32	1.68
Others........................	.28	.22	.13
Other operatives, exc. transp.....	31.52	29.11	30.25
Assemblers....................	.11	.15	.26
Blasters......................	.24	.23	.19
Surveyor helpers...............	.06	.06	.06
Cutting operators, nec.........	.07	.08	.08
Drillers, earth................	5.73	5.96	6.74
Garage wkrs, gas station att...	.05	.03	.02
Mine operatives, nec...........	24.57	21.88	22.03
Mixing operatives.............	.04	.04	.04
Oilers, greasers, exc., auto...	.35	.40	.52
Photographic process workers...	.03	.02	.01
Sailors & deckhands...........	.11	.11	.18
Sawyers.......................	.02	.02	.05
Furnance tendr stokr, exc metal	.08	.06	.07
Winding operatives, nec........	.02	.01	-
Misc. machine operatives.......	.01	.01	-
Operatives, nec................	.01	.01	-

Table D-3. Total Employed and Percent Distribution by Occupation--continued

Occupation	Crude petroleum & natural gas SIC-13		
	Actual		Projected
	1970	1978	1990
Transport equipment operatives..........	3.56	3.74	4.92
Boat operatives......................	.10	.09	.06
Delivery & route workers.............	.18	.17	.17
Forklift, tow motor operatives........	.07	.09	.10
Rail vehicle operators, nec...........	.29	.23	.08
Railroad switch operators............	.01	.01	.01
Taxicab drivers, chauffeurs...........	.04	.04	.03
Truck drivers........................	2.87	3.11	4.45
Service workers........................	1.24	1.17	.95
Laborers, exc. farm....................	2.03	1.87	1.47

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Matrix.

Table D-3a. Total Employed and Percent Distribution by Occupation
Crude Petroleum and Natural Gas
Spring, 1978

Occupation	Employment and Percent of total Employment
Total, all occupations: Number	175,160
Percent	100.00
Managers and Officers	11.80
Manager and/or officer	11.80
Professional Occupations	22.14
Chemical engineer	.35
Civil engineer	.31
Electrical and/or electronic engineer	.21
Mechanical engineer	.24
Petroleum engineer	4.15
Safety engineer	.14
All other engineers	.75
Mathematical scientist	.28
Geologist and/or geophysicist	5.40
All other physical scientist	.33
Systems analyst, electronic data processing	1.12
Purchasing agent and/or buyer	.62
Accountant and/or auditor	4.16
Lawyer	.51
Lease buyer	1.41
Personnel and labor relations specialists	.65
Title clerk	.48
Claim clerk	.03
All other professional workers	1.01
Technical Occupations	6.20
Computer programmer	.59
Computer, prospecting and/or computer, seismograph	.12
Core analyst	.06
Drafter	1.85
Electrical and/or electronic technician	.13
Scout	.07
Surveyor	.09

See footnote at end of table.

Table D-3a.

Total Employed and Percent Distribution by Occupation - Continued

Crude Petroleum and Natural Gas
Spring, 1978

Occupation	Employment and Percent of total Employment
Technical Occupations - Continued	
All other engineering technicians..........	1.74
Science technicians.......................	.80
Airplane pilot............................	.30
All other technicians.....................	.45
Service Occupations.......................	1.10
Janitor, porter, and/or cleaner...........	.70
Guard and/or doorkeeper...................	.10
Food service workers......................	.11
Supervisor, nonworking - service only......	.14
All other service workers.................	.05
Maintenance, Construction, Repair, Material Handling and Powerplant Occupations.......	34.50
Mechanic, automotive......................	.26
Diesel mechanic...........................	.14
Mechanic, maintenance.....................	1.39
All other mechanics and repairers..........	.24
Truck driver..............................	.84
Carpenter.................................	.05
Derrick operator, petroleum and gas extraction.............................	.34
Electrician...............................	.30
Supervisor, nonworking....................	4.27
Formation testing operator................	.18
Gager.....................................	1.43
Natural-gas-treating-unit operator.........	.84
Heavy equipment operator..................	.21
Inspector.................................	.08
Instrument repairer.......................	.41
Liquefication-and-regasification-plant operator...............................	.19
Machinist.................................	.05
Maintenance repairer, general-utility......	1.17

See footnotes at end of table.

Table D-3a.

Total Employed and Percent Distribution by Occupation - Continued

Crude Petroleum and Natural Gas
Spring, 1978

Occupations	Employment and Percent of total Employment
Maintenance, Construction, Repair, Material Handling and Powerplant Occupations - Continued	
Oil pumper	4.94
Painter, maintenance	.02
Pumper, head	3.40
Rotary drill operator	.70
Rotary drill operator helper	.43
Roustabout	7.26
Service unit operator, oil well	.34
Stationary engineer	.37
Welder and/or flamecutter	.27
Well puller	.53
Surveyor helper	.05
All other skilled craft and kindred workers	1.12
All other operatives and semiskilled workers	2.00
All other laborers and unskilled workers	.67
Clerical Occupations	23.91
Computer operator	.61
Keypunch operator	.63
All other office machine operators	.44
Stenographer	.94
Accounting clerk	2.31
Bookkeeper, hand	.89
Cashier	.09
File clerk	.45
General clerk, office	5.18
Loan closer, new Mail clerk	.37
Order clerk	.12
Payroll and/or timekeeping clerk	.22
Personnel clerk	.30
Receptionist	.49
Secretary	5.67
Switchboard operator	.12

See footnotes at end of table.

Table D-3a.

Total Employed and Percent Distribution by Occupation - Continued

Crude Petroleum and Natural Gas
Spring, 1978

Occupations	Employment and Percent of total Employment
Clerical Occupations - Continued	
Switchboard operator - receptionist........	.58
Typist....................................	.88
Clerical supervisor, office or plant.......	1.21
All other office clerical workers..........	1.55
Production clerk and/or coordinator........	.49
stock clerk, stockroom, warehouse or storage yard..........................	.23
Dispatcher, vehicle, service or work.......	.10
All other plant clerical workers...........	.05
Sales Occupations..........................	.35

1/ Estimates of fewer than 50 are generally not shown separately since such estimates are considered unreliable.

2/ The relative standard errors apply equally to data on estimated employment and percent of total employment; relative standard errors estimated at the level of 2 chances out of 3. For further information on sampling variability and other types of errors, consult the section on "method".

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, <u>Occupational Employment Statistics Survey of Selected Nonmanufacturing</u>, 1978.

Table D-4. Total Employed and Percent Distribution by Occupation
Petroleum Refining Industry SIC-291
1970, 1978, and Projected 1990

Occupation	Petroleum refining SIC-291		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number......	153,515	164,492	121,538
Percent.....	100.00	100.00	100.00
Professional, technical, & kindred.....	23.08	23.78	23.15
Engineers, technical.................	5.90	5.49	5.81
Chemical..........................	3.00	2.95	3.15
Civil..............................	.44	.32	.30
Electrical.........................	.31	.27	.22
Industrial.........................	.31	.30	.31
Mechanical.........................	.77	.69	.72
Metallurgical......................	.04	.05	.07
Mining.............................	.01	-	-
Petroleum..........................	.67	.61	.77
Sales..............................	.08	.06	.04
Other..............................	.28	.24	.22
Life and physical scientists.........	2.34	2.20	2.33
Agricultural scientists............	.01	.01	-
Biological scientists..............	.01	.02	.01
Chemists...........................	1.69	1.64	1.67
Geologists.........................	.53	.44	.58
Physicists & astronomers...........	.06	.06	.05
Life, physical scientists, nec......	.03	.03	.02
Mathematical specialists............	.13	.13	.10
Actuaries..........................	.01	.01	.01
Mathematicians.....................	.05	.06	.05
Statisticians......................	.07	.06	.04
Engineers, science tech.............	6.36	6.23	6.76
Agric, biolog, tech exc. health.....	.01	.01	.01
Chemical technicians...............	4.59	4.59	5.21
Drafters...........................	.65	.54	.60
Electrical, electronic tech.........	.13	.12	.07
Industrial engineering tech.........	.05	.06	.05
Mechanical engineering tech.........	.02	.02	.02
Surveyors..........................	.06	.06	.10
Engineering, science tech, nec......	.85	.82	.71
Medical workers, exc. tech..........	.13	.10	.06
Health technologist & technician.....	.04	.05	.02

Table D-4. Total Employed and Percent Distribution by Occupation--continued

Occupation	Petroleum refining SIC-291		
	Actual		Projected
	1970	1978	1990
Technicians, exc. health............	.15	.19	.23
Computer specialists................	1.39	1.69	1.80
Programmers........................	.81	.89	.98
Systems analysts...................	.52	.71	.77
Other computer specialists..........	.05	.09	.05
Social scientists...................	.80	1.12	.77
Economists.........................	.78	1.09	.75
Psychologists......................	.01	.02	.02
Urban and regional planners.........	.01	.01	-
Teachers............................	.02	.02	.01
Writers, artists, entertainers.......	.51	.58	.54
Other professional, technical........	5.30	5.98	4.72
Managers, officials, proprietors......	6.65	7.27	7.15
Buyers, sales, loan managers.........	1.50	1.28	1.08
Other managers, officials, prop......	5.15	6.00	6.07
Sales workers........................	1.45	1.31	1.03
Clerical workers......................	18.09	17.22	15.39
Stenos, typists, secretaries.........	5.84	5.33	5.45
Office machine operators............	2.24	2.52	1.67
Other clerical workers..............	10.01	9.37	8.27
Crafts and kindred workers............	21.31	21.33	23.69
Construction crafts workers..........	5.36	5.03	5.54
Carpenters & apprentices............	.82	.78	.59
Brick & stonemasons & appren........	.08	.06	.03
Bulldozer operators.................	.06	.04	.01
Cement & concrete finishers.........	.03	.04	.09
Electricians & apprentices..........	1.13	1.14	1.22
Excav., grad., mach. oper...........	.10	.08	.07
Painters & apprentices..............	.25	.21	.12
Plumbers, pipefitters & appren......	2.81	2.66	3.40
Structural metal craft workers......	.06	.03	-
Blue collar worker superv. nec.......	5.36	5.77	6.45

Table D-4. Total Employed and Percent Distribution by Occupation--continued

Occupation	Petroleum refining SIC-291		
	Actual		Projected
	1970	1978	1990
Metalworking craft wkrs. exc. mech...	2.40	2.49	3.38
Blacksmiths........................	.01	.01	-
Boilermakers.......................	.83	.75	.78
Job & die setters, metal...........	.01	.01	.01
Machinists & apprentices...........	1.35	1.52	2.33
Millwrights........................	.09	.09	.09
Sheetmetal workers & appren........	.07	.06	.08
Tool & diemakers & appren..........	.04	.05	.09
Mechanics, repairers, installers.....	4.31	4.80	5.74
Air cond., heating, refrig..........	.19	.27	.31
Aircraft mechanics.................	.01	.01	.01
Auto mechanics & apprentices........	.47	.45	.58
Data process. mach. repairers.......	.01	.01	.02
Farm implement mechanics...........	.01	.01	.01
Heavy equip mech., incl. diesel.....	2.09	2.45	3.11
Household appliance mechanics.......	.08	.08	.06
Office machine repairers...........	.02	.02	.07
Radio, television repairers.........	.03	.02	.02
Railroad, car shop repairers........	.02	.02	.04
Other mechanics & apprentices.......	1.39	1.46	1.51
Printing trade crafts workers........	.13	.14	.16
Transp., pub. utils., craft wkrs.....	.14	.13	.08
Elec. pwr line instal., repairers...	.01	.01	.01
Locomotive engineers...............	.01	.02	.01
Power station operators............	.09	.09	.06
Telephone installers, repairers.....	.02	.01	-
Other crafts, kindred workers........	3.61	2.98	2.34
Crane, derrick, & hoist oprs........	.47	.39	.56
Inspectors.........................	.18	.20	.21
Stationary engineers...............	2.55	2.05	1.40
Crafts & kindred, nec..............	.41	.33	.17
Operatives............................	23.82	24.21	25.75
Operatives, exc. transport...........	20.31	21.04	22.64
Semiskilled, metalworking..........	1.67	1.64	1.85
Welders & flame cutters...........	1.49	1.52	1.78
Others...........................	.18	.12	.07
Semiskilled, packaging, insp........	1.76	1.90	2.75

Table D-4. Total Employed and Percent Distribution by Occupation--continued

Occupation	Petroleum refining SIC-291		
	Actual		Projected
	1970	1978	1990
Other operatives, exc. transp......	16.88	17.49	18.05
Asbestos, insulation workers.....	.52	.68	.47
Assemblers......................	.13	.18	.38
Blasters........................	.01	.01	-
Bottling canning operatives......	.10	.09	.07
Cutting operators, nec...........	.09	.08	.07
Drillers, earth..................	.01	.01	.01
Filer, polisher, sander, buffer..	.01	.01	-
Garage wkrs, gas station att.....	.06	.04	.02
Mixing operatives................	.56	.55	.55
Oilers, greasers, exc. auto......	.19	.14	.05
Painters, mfg. articles..........	.40	.31	.23
Photographic process workers.....	.06	.06	.07
Sailors & deckhands..............	.17	.11	.07
Furnace tendr stokr, exc metal...	.87	.59	.59
Winding operatives, nec..........	.01	.01	-
Misc. machine operatives.........	10.40	10.89	11.35
Operatives, nec..................	3.29	3.72	4.14
Transport equipment operatives.....	3.51	3.18	3.10
Boat operatives..................	.01	.01	-
Delivery & route workers.........	.59	.55	.75
Forklift, tow motor operatives...	.36	.41	.41
Railroad switch operators........	.05	.06	.10
Taxicab drivers, chauffeurs......	.10	.05	-
Truck drivers....................	2.39	2.09	1.79
Service workers........................	2.38	1.97	1.26
Laborers, exc. farm...................	3.22	2.90	2.58

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-4a. Total Employment and Percent Distribution by Occupation
Petroleum Refining Industry
Spring, 1977.

Occupation	Employment and Percent of total Employment
Total, all occupations: Number.........	158,420
Percent........	100.00
Managers and Officers........................	6.22
Professional Occupations.....................	14.84
Chemical engineer..........................	2.30
Civil engineer.............................	.57
Electrical and/or electronic engineer......	.37
Industrial engineer........................	.22
Mechanical engineer........................	1.13
Petroleum engineer.........................	.52
Safety engineer............................	.25
All other engineers........................	.89
Statistician...............................	.20
All other mathematical scientists..........	.24
Chemist....................................	1.96
Geologist and/or geophysicist..............	.36
All other physical scientist...............	.05
Systems analyst, electronic data processing............................	.90
Purchasing agent and/or buyer..............	.30
Accountant and/or auditor..................	1.62
Lawyer.....................................	.21
Nurse, professional........................	.12
Personnel and labor relations specialists..	.55
All other professional workers.............	2.07
Technical Occupations........................	4.89
Computer programmer........................	.49
Drafter....................................	.59
Electrical and/or electronic technician....	.34
All other engineering technicians..........	1.02
Science technicians........................	2.18
All other technicians......................	.27

See footnotes at end of table.

Table D-4a.

Total Employment and Percent Distribution by Occupation - Continued

Petroleum Refining Industry
Spring, 1977

Occupation	Employment and Percent of total Employment
Service Occupations....................	1.91
Janitor, porter, and/or cleaner.......	.74
Guard and/or doorkeeper...............	.81
Food Service workers..................	.04
All other service workers.............	.32
Production, Maintenance, Construction, Repair, Material Handling and Powerplant Occupation..........................	56.16
Mechanic, automotive..................	.40
Mechanic, maintenance.................	1.77
All other mechanics and repairers.....	.33
Truck driver..........................	1.86
Asbestos and insulation worker........	.51
Boilermaker...........................	.96
Carpenter.............................	.61
Crane, derrick, and/or hoist operator.	.39
Delivery and/or route worker..........	.06
Electrician...........................	1.16
Supervisor, nonworking................	5.55
Gager.................................	.88
Heavy equipment operator..............	.33
Rigger................................	.19
Industrial truck operator.............	.47
Inspector.............................	.19
Instrument repairer...................	1.32
Loader, tank cars and/or trucks.......	.99
Machinist.............................	1.84
Maintenance repairer, general-utility.	1.80
Helper, trades........................	1.53
Order filler..........................	.21
Painter, maintenance..................	.48
Plumber and/or pipefitter.............	2.61
Production packager, hand or machine..	.50

See footnotes at end of table.

Table D-4a.

Total Employment and Percent Distribution by Occupation - Continued

Petroleum Refining Industry
Spring, 1977

Occupation	Employment and Percent of total Employment
Production, Maintenance, Construction, Repair, Material Handling and Powerplant Occupations - Continued	
Stationary boiler firer....................	.49
Stationary engineer........................	.50
Asphalt blender............................	.13
Chemical operator A........................	.83
Chemical operator B........................	.62
Chemical operator helper...................	.34
Compounder.................................	.28
Control panel operator, petroleum..........	1.05
Dispatcher, refinery.......................	.30
Firer, petroleum refining..................	.24
Instrument fitter..........................	.14
Sampler and/or test preparer...............	.13
Refinery operator, petroleum...............	8.47
Refinery operator, helper petroleum........	4.63
Tester.....................................	1.34
Treater....................................	.27
Chief operator.............................	1.04
Welder and/or flamecutter -a...............	.81
Welder and/or flamecutter -b...............	.30
Filter and/or filter press - operator......	.13
Pump operator..............................	1.16
Pump operator helper.......................	.45
All other skilled craft and kindred workers................................	.67
All other laborers and unskilled workers...	1.84
Clerical Occupations........................	15.43
Bookkeeping and/or billing machine operators..............................	.20

See footnotes at end of table.

Table D-4a.

Total Employment and Percent Distribution by Occupation - Continued

Petroleum Refining Industry
Spring, 1977

Occupation	Employment and Percent of total Employment
Clerical Occupations - Continued	
Computer operator	.33
Keypunch operator	.66
Peripheral EDP equipment operator	.15
All other office machine operators	.30
Stenographer	.94
Accounting clerk	1.70
Bookkeeper, hand	.09
General clerk, office	1.74
Order clerk	.11
Payroll and/or timekeeping clerk	.39
Personnel clerk	.23
Procurement clerk	.18
Receptionist	.12
Secretary	2.84
Statistical clerk	.56
Switchboard operator	.14
Switchboard operator - receptionist	.16
Typist	.13
Clerical supervisor, office of plant	1.10
All other office clerical workers	1.46
Shipping and/or receiving clerk	.26
Stock clerk, stockroom, warehouse or storage yard	.50
Dispatcher, vehicle, service or work	.09
All other plant clerical workers	.32
Sales Occupations	.54
Sales representatives, sales agent, and/or sales associate	.49
All other sales workers	.05

1/ Estimates of fewer than 50 are generally not shown separately since such estimates are considered unreliable.

2/ The relative standard errors apply equally to data on estimated employment and percent of total employment; relative standard errors estimated at the level of 2 chances out of 3. For further information on sampling variability and other types of error, consult the section on "method".

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Employment Statistics Survey of Manufacturing, 1977.

Table D-5. Total Employed and Percent Distribution by Occupation Miscellaneous Petroleum and Coal Products Industries, SIC-295,9 1/ 1970, 1978, and Projected 1990

Occupation	Misc. petroleum and coal products SIC-295,9 1/		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number......	36,609	43,895	56,280
Percent.....	100.00	100.00	100.00
Professional, technical, & kindred.....	8.97	9.01	7.70
Engineers, technical................	2.08	1.89	1.74
Chemical...........................	.39	.34	.21
Civil..............................	.11	.07	-
Electrical.........................	.10	.13	.23
Industrial.........................	.55	.55	.43
Mechanical.........................	.39	.38	.47
Metallurgical......................	.08	.06	-
Petroleum..........................	.04	.03	-
Sales..............................	.25	.18	.17
Other..............................	.17	.16	.23
Life and physical scientists.........	1.59	1.47	1.15
Chemists...........................	1.54	1.43	1.11
Geologists.........................	.05	.04	.04
Engineers, science tech..............	2.50	2.48	2.17
Chemical technicians................	1.73	1.73	1.50
Drafters...........................	.23	.19	.19
Electrical, electronic tech.........	.07	.05	.01
Industrial engineering tech.........	.20	.24	.19
Surveyors..........................	.02	.02	.02
Engineering, science tech, nec......	.24	.24	.26
Medical workers, exc. tech...........	.05	.03	.01
Health technologist & technician.....	.02	.02	-
Technicians, exc. health............	.02	.02	-
Computer specialists................	.18	.23	.18
Programmers........................	.08	.09	.08
Systems analysts...................	.07	.10	.08
Other computer specialists..........	.02	.04	.02
Social scientists...................	.14	.24	.31
Economists.........................	.14	.24	.31

1/ Include roofing and paving materials.

Table D-5. Total Employed and Percent Distribution by Occupation--continued

Occupation	Misc. petroleum and coal products SIC-295,9		
	Actual		Projected
	1970	1978	1990
Teachers	.03	.03	.01
Writers, artists, entertainers	.25	.29	.27
Other professional, technical	2.11	2.30	1.87
Managers, officials, proprietors	11.23	13.12	14.96
Buyers, sales, loan managers	2.01	1.77	1.60
Other managers, officials, prop	9.22	11.35	13.35
Sales workers	4.33	4.34	4.96
Clerical workers	16.44	15.33	14.41
Stenos, typists, secretaries	5.91	5.55	5.78
Office machine operators	.89	.82	.54
Other clerical workers	9.64	8.96	8.09
Crafts and kindred workers	15.74	16.31	17.66
Construction crafts workers	2.87	2.63	2.54
Carpenters & apprentices	.36	.41	.54
Brick & stonemasons & appren	.07	.05	-
Bulldozer operators	.27	.26	.42
Electricians & apprentices	.70	.64	.44
Excav., grad., mach. oper	.80	.64	.49
Painters & apprentices	.14	.11	.05
Plumbers, pipefitters & appren	.43	.41	.50
Roofers & slaters	.07	.08	.06
Tilesetters	.03	.03	.04
Blue collar worker superv. nec	5.77	6.34	7.18
Metalworking craft wkrs. exc. mech	2.02	2.03	2.19
Boilermakers	.08	.05	-
Job & die setters, metal	.03	.02	-
Machinists & apprentices	1.06	1.07	1.12
Millwrights	.66	.68	.64
Sheetmetal workers & appren	.09	.12	.31
Tool & diemakers & appren	.11	.09	.11

Table D-5. Total Employed and Percent Distribution by Occupation--continued

Occupation	Misc. petroleum and coal products SIC-295,9		
	Actual		Projected
	1970	1978	1990
Mechanics, repairers, installers.....	3.84	4.36	5.00
Air cond., heating, refrig..........	.09	.15	.23
Auto mechanics & apprentices........	.50	.48	.56
Heavy equip mech., incl. diesel.....	2.96	3.45	3.99
Household appliance mechanics.......	.09	.07	.02
Radio, television repairers.........	.04	.03	.03
Railroad, car shop repairers........	.03	.03	.03
Other mechanics & apprentices.......	.13	.14	.14
Printing trade crafts workers........	.10	.08	-
Other crafts, kindred workers........	1.13	.87	.75
Crane, derrick, & hoist oprs........	.51	.43	.57
Stationary engineers................	.59	.42	.17
Crafts & kindred, nec...............	.03	.02	.01
Operatives............................	33.78	33.50	33.71
Operatives, exc. transport...........	24.04	23.21	20.20
Semiskilled, metalworking...........	1.05	1.05	1.24
Welders & flame cutters............	.85	.92	1.20
Others.............................	.20	.13	.04
Semiskilled, packaging, insp........	3.05	3.00	3.58
Other operatives, exc. transp.......	19.94	19.17	15.37
Asbestos, insulation workers.......	.07	.12	.16
Assemblers.........................	.65	.80	1.31
Blasters...........................	.03	.03	-
Bottling canning operatives........	.24	.25	.27
Surveyor helpers...................	.02	.02	.03
Cutting operators, nec.............	.73	.67	.48
Drillers, earth....................	.05	.03	-
Dryers.............................	.05	.03	.01
Filer, polisher, sander, buffer....	.11	.08	.02
Garage wkrs, gas station att.......	.07	.04	.02
Mixing operatives..................	2.94	2.71	1.89
Oilers, greasers, exc., auto.......	.39	.42	.60
Painters, mfg. articles............	.46	.36	.28
Riveters & fasteners...............	.03	.03	-
Sawyers............................	.12	.16	.33
Sewers & stitchers.................	.08	.07	.09
Furnace tendr stokr, exc metal.....	1.10	.75	.71
Winding operatives, nec............	.32	.30	.26
Misc. machine operatives...........	9.06	8.98	7.09
Operatives, nec....................	3.43	3.31	1.83

Table D-5. Total Employed and Percent Distribution by Occupation--continued

Occupation	Misc. petroleum and coal products SIC-295,9		
	Actual		Projected
	1970	1978	1990
Transport equipment operatives.....	9.73	10.30	13.51
Delivery & route workers.........	.69	.68	1.04
Forklift, tow motor operatives...	3.91	4.35	4.14
Taxicab drivers, chauffeurs......	.04	.03	.01
Truck drivers....................	5.09	5.24	8.33
Service workers........................	2.25	1.88	1.00
Laborers, exc. farm....................	7.28	6.51	5.59

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-6. Total Employed and Percent Distribution by Occupation
Pipe Lines, Exc. Natural Gas Industry, SIC-46
1970, 1978, and Projected 1990

Occupation	Pipe lines, exc. natural gas, SIC-46		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number......	16,906	19,096	15,967
Percent.....	100.00	100.00	100.00
Professional, technical, & kindred.....	15.77	16.95	18.08
Engineers, technical................	4.24	3.72	3.56
Chemical...........................	.30	.27	.19
Civil..............................	.70	.53	.53
Electrical.........................	1.04	.99	1.06
Industrial.........................	.27	.25	.23
Mechanical.........................	.86	.74	.58
Petroleum..........................	.50	.46	.54
Other..............................	.57	.48	.42
Life and physical scientists.........	.21	.19	.23
Chemists...........................	.12	.12	.09
Geologists.........................	.08	.07	.14
Mathematical specialists............	.08	.08	.11
Statisticians......................	.08	.08	.11
Engineers, science tech.............	3.11	3.02	3.33
Chemical technicians...............	.11	.10	.09
Drafters...........................	1.31	1.16	1.52
Electrical, electronic tech.........	.75	.82	.84
Industrial engineering tech.........	.07	.08	.08
Mechanical engineering tech.........	.08	.08	.07
Surveyors..........................	.27	.24	.21
Engineering, science tech, nec......	.54	.54	.53
Medical workers, exc. tech..........	.07	.08	.13
Technicians, exc. health............	1.27	1.54	1.49
Computer specialists................	.90	1.08	.96
Programmers........................	.67	.77	.71
Systems analysts...................	.23	.31	.25
Social scientists...................	.24	.34	.29
Economists.........................	.24	.34	.29

Table D-6. Total Employed and Percent Distribution by Occupation--continued

Occupation	Pipe lines, exc. natural gas, SIC-46 Actual 1970	1978	Projected 1990
Teachers	.04	.04	-
Writers, artists, entertainers	.30	.29	.24
Other professional, technical	5.32	6.58	7.75
Managers, officials, proprietors	8.97	9.94	10.60
Buyers, sales, loan managers	1.93	1.73	1.83
Other managers, officials, prop	7.04	8.21	8.77
Sales workers	.35	.35	.41
Clerical workers	18.11	18.17	19.33
Stenos, typists, secretaries	4.37	3.94	4.62
Office machine operators	1.47	1.82	1.25
Other clerical workers	12.27	12.41	13.47
Crafts and kindred workers	27.51	27.20	30.60
Construction crafts workers	3.96	3.64	3.87
Carpenters & apprentices	.13	.10	.05
Bulldozer operators	.15	.15	.20
Electricians & apprentices	1.39	1.26	.93
Excav., grad., mach. oper	.59	.56	.80
Painters & apprentices	.26	.21	.14
Plumbers, pipefitters & appren	1.43	1.36	1.76
Blue collar worker superv. nec	5.21	5.60	6.23
Metalworking craft wkrs. exc. mech	.57	.63	.83
Machinists & apprentices	.57	.63	.83
Mechanics, repairers, installers	5.21	5.65	7.02
Air cond., heating, refrig	.07	.10	.13
Aircraft mechanics	.19	.09	.01
Auto mechanics & apprentices	.58	.62	1.01
Data process. mach. repairers	.04	.04	.05
Heavy equip mech., incl. diesel	3.19	3.75	4.78
Household appliance mechanics	.49	.56	.78
Radio, television repairers	.23	.19	.21
Other mechanics & apprentices	.43	.29	.06
Printing trade crafts workers	.07	.06	-
Transp., pub. utils., craft wkrs	.40	.35	.21
Elec. pwr line instal., repairers	.08	.05	.01
Power station operators	.21	.20	.17
Telephone line instal. splicers	.11	.09	.03

Table D-6. Total Employed and Percent Distribution by Occupation--continued

Occupation	Pipe lines, exc. natural gas, SIC-46 Actual 1970	1978	Projected 1990
Other crafts, kindred workers........	12.11	11.29	12.44
Inspectors..........................	2.09	2.45	3.00
Stationary engineers................	9.89	8.76	9.42
Crafts & kindred, nec...............	.12	.08	.03
Operatives..........................	19.22	18.99	15.14
Operatives, exc. transport...........	16.55	16.65	13.06
Semiskilled, metalworking...........	1.64	1.77	2.35
Welders & frame cutters............	1.64	1.77	2.35
Semiskilled, packaging, insp........	.15	.11	-
Other operatives, exc. transp.......	14.75	14.77	10.71
Cutting operators, nec.............	.13	.13	.14
Drillers, earth....................	.04	.03	.01
Mixing operatives..................	.04	.03	.01
Oilers, greasers, exc., auto.......	.40	.27	.06
Photographic process workers.......	.09	.10	.16
Misc. machine operatives...........	1.00	1.07	1.14
Operatives, nec....................	13.05	13.13	9.19
Transport equipment operatives.......	2.67	2.34	2.07
Bus drivers........................	.04	.06	.05
Delivery & route workers...........	.62	.50	.41
Taxicab drivers, chauffeurs.........	.04	.04	.07
Truck drivers......................	1.97	1.74	1.55
Service workers.......................	1.99	1.78	1.37
Laborers, exc. farm...................	8.07	6.63	4.47

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, _National Industry-Occupation Employment Matrix_.

Table D-7. Total Employed and Percent Distribution by Occupation
Electric Light and Power Industry, SIC-491
1970, 1978, and Projected 1990

Occupation	Electric light and power, SIC-491		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number......	327,030	439,687	417,722
Percent.....	100.00	100.00	100.00
Professional, technical, & kindred.....	12.40	13.27	12.08
Engineers, technical.................	5.72	5.87	5.70
Chemical............................	.05	.07	.05
Civil...............................	.46	.48	.41
Electrical..........................	4.20	4.25	4.15
Industrial..........................	.17	.21	.23
Mechanical..........................	.54	.59	.60
Metallurgical.......................	.01	.01	.01
Sales...............................	.12	.08	.06
Other...............................	.18	.17	.19
Life and physical scientists.........	.15	.20	.18
Agricultural scientists.............	.01	.02	-
Biological scientists...............	.01	.02	.01
Chemists............................	.09	.11	.12
Geologists..........................	.01	.02	.03
Marine scientists...................	.01	.01	-
Physicists & astronomers............	.02	.02	.02
Mathematical specialists.............	.06	.07	.05
Mathematicians......................	.01	.01	-
Statisticians.......................	.05	.05	.05
Engineers, science tech..............	2.48	2.56	2.67
Chemical technicians................	.07	.09	.11
Drafters............................	1.02	.90	1.04
Electrical, electronic tech.........	.60	.69	.74
Industrial engineering tech.........	.01	.01	.01
Surveyors...........................	.29	.31	.29
Engineering, science tech, nec......	.49	.55	.48
Medical workers, exc. tech...........	.04	.05	.02
Health technologist & technician.....	.01	.01	-
Technicians, exc. health.............	.27	.33	.25
Computer specialists.................	.44	.57	.50
Programmers.........................	.33	.39	.35
Systems analysts....................	.10	.15	.13
Other computer specialists..........	.02	.04	.02

Table D-7. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric light and power, SIC-491		
	Actual		Projected
	1970	1978	1990
Social scientists....................	.17	.26	.22
Economists..........................	.17	.26	.22
Teachers............................	.01	.02	.01
Writers, artists, entertainers.......	.68	.75	.69
Other professional, technical........	2.36	2.57	1.78
Managers, officials, proprietors.......	5.12	5.78	6.34
Buyers, sales, loan managers.........	.94	.84	.83
Other managers, officials, prop......	4.18	4.94	5.51
Sales workers.........................	1.04	.96	1.27
Clerical workers.......................	20.98	19.83	20.23
Stenos, typists, & secretaries.......	4.28	3.80	3.86
Office machine operators.............	1.13	1.19	.97
Other clerical workers...............	15.57	14.84	15.40
Crafts and kindred workers.............	45.36	45.85	46.05
Construction crafts wkrs.............	7.44	8.05	8.14
Carpenters & apprentices............	.55	.80	.56
Brick & stonemasons & app...........	.05	.05	.05
Bulldozer operators.................	.20	.23	.36
Cement & concrete finishers.........	.04	.05	.02
Electricians & apprentices..........	5.25	5.40	5.56
Excav., grad., mach. oper...........	.36	.38	.42
Painters & apprentices..............	.24	.29	.33
Plumbers, pipefitters...............	.64	.71	.72
Structural metal craft wkrs.........	.10	.14	.11
Blue collar wkr. superv. nec.........	5.36	5.04	3.40
Metalwkng. craft wkrs. exc. mech.....	1.07	1.83	2.48
Blacksmiths........................	.01	.01	.01
Boilermakers.......................	.46	1.04	1.45
Forge & hammer operators............	.01	.01	.01
Machinists & apprentices............	.43	.62	.89
Millwrights........................	.08	.07	.05
Pattern & model makers..............	.01	.01	.01
Sheetmetal wkrs & app...............	.06	.06	.02
Tool & diemakers & app..............	.02	.02	.03

Table D-7. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric light and power, SIC-491		
	Actual		Projected
	1970	1978	1990
Mechanics, repr., installers........	6.20	6.24	6.68
Air cond., heating, refrig.........	.10	.13	.14
Auto mechanics & apprentices.......	.97	.86	.90
Data proces. mach. reprs...........	.01	.01	.01
Heavy equip. mech., incl. diesel...	1.53	1.82	2.22
Household appliance mech...........	2.02	1.94	2.09
Office machine reprs...............	.01	.01	.03
Radio, television reprs............	.10	.06	.02
Other mechanics & app..............	1.46	1.42	1.28
Printing trade crafts workers.......	.09	.08	.04
Transp., pub. utils. craft workers..	21.04	20.83	21.56
Elec. pwr line instal., repr.......	17.82	17.62	19.43
Power station operators............	3.03	3.01	1.96
Telephone installers, reprs........	.11	.11	.11
Telephone line instal. splicers....	.09	.09	.06
Other crafts, kindred wkrs..........	4.16	3.78	3.75
Crane, derrick, & hoist oprs.......	.30	.24	.24
Inspectors.........................	.51	.49	.34
Stationary engineers...............	2.82	2.58	2.57
Crafts & kindred, nec..............	.54	.46	.60
Operatives..........................	6.67	6.42	6.61
Operatives, exc. transport..........	4.70	4.34	3.89
Semiskilled, metalworking..........	.92	1.03	1.00
Welders & flame cutters...........	.84	.95	.92
Others............................	.08	.08	.08
Semiskilled, packng., insp.........	.02	.02	-
Other operatives, exc. transp......	3.76	3.30	2.89
Asbestos, insulation wkrs.........	.05	.07	.03
Blasters..........................	.01	.01	-
Surveyor helpers..................	.03	.03	.03
Cutting operators, nec............	.01	.01	-
Drillers, earth...................	.04	.08	.06
Filer, polisher, sander, buffer...	.01	-	-
Garage wkrs., gas stat. att.......	.08	.06	.06
Oilers, greasers, exc. auto.......	.07	.05	.04
Painters, mfg. articles...........	.02	.02	.04
Photographic process wkrs.........	.04	.04	.02

Table D-7. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric light and power, SIC-491 Actual 1970	1978	Projected 1990
Sawyers............................	.01	.01	-
Furnance tendr., stokr., exc. metal..	1.27	.66	.37
Winding operatives, nec.............	.03	.03	.05
Misc. machine operatives............	.43	.46	.35
Operatives, nec.....................	1.66	1.77	1.85
Transport equipmt. operatives...........	1.97	2.08	2.72
Bus drivers.........................	.04	.05	.01
Delivery & route workers............	.05	.04	.03
Forklift, tow motor operatives.......	.05	.05	.03
Taxicab drivers, chauffeurs..........	.04	.02	.01
Truck drivers.......................	1.79	1.92	2.65
Service workers.........................	2.73	2.52	2.32
Laborers, exc. farm.....................	5.71	5.37	5.10

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-8. Total Employed and Percent Distribution by Occupation
Electric-Gas Utilities SIC-493
1970, 1978, and Projected 1990

Occupation	Electric-gas utilities SIC 493		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number.....	196,031	204,996	233,025
Percent....	100.00	100.00	100.00
Professional, technical, & kindred....	12.46	12.90	13.27
Engineers, technical................	4.54	4.24	4.50
Chemical..........................	.08	.08	.10
Civil.............................	.41	.33	.37
Electrical........................	2.55	2.43	2.44
Industrial........................	.15	.17	.24
Mechanical........................	.70	.67	.77
Petroleum.........................	.01	.01	-
Sales.............................	.13	.10	.09
Other.............................	.51	.46	.51
Life and physical scientists........	.14	.17	.25
Biological scientists.............	.01	.02	.01
Chemists..........................	.09	.10	.14
Geologists........................	.02	.02	.05
Marine scientists.................	.02	.03	.04
Mathematical specialists............	.10	.09	.10
Statisticians.....................	.09	.09	.10
Engineers, science tech.............	2.83	2.83	3.44
Chemical technicians..............	.11	.14	.19
Drafters..........................	1.39	1.21	1.45
Electrical, electronic tech........	.67	.79	.92
Industrial engineering tech........	.02	.02	.02
Mathematical tech..................	.01	-	-
Surveyors..........................	.24	.26	.37
Engineering, science tech, nec.....	.38	.41	.49
Medical workers, exc. tech..........	.07	.05	.01
Health technol. & tech.............	.03	.03	.04
Technicians, exc. health............	.18	.20	.11
Computer specialists................	.66	.82	.73
Programmers.......................	.42	.48	.45
Systems analysts..................	.23	.32	.27
Other computer specialists.........	.01	.02	.01

Table D-8. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric-gas utilities SIC 493 Actual 1970	1978	Projected 1990
Social scientists..................	.22	.33	.31
Economists......................	.21	.32	.31
Teachers.......................	.02	.03	.04
Writers, artists, entertainers.....	.89	1.01	.91
Other professional, technical......	2.79	3.09	2.85
Managers, officials, proprietors.....	5.09	5.89	6.70
Buyers, sales, loan mgrs...........	.98	.88	.94
Other mgrs., officials, prop.......	4.11	5.01	5.76
Sales workers......................	1.21	1.17	1.34
Clerical workers...................	27.12	26.29	24.54
Stenos, typists, & secretaries.....	4.81	4.18	4.03
Office machine operators...........	1.74	1.79	1.21
Other clerical workers.............	20.57	20.32	19.30
Crafts and kindred workers...........	39.34	39.63	39.70
Construction crafts wkrs...........	6.46	6.39	7.44
Carpenters & apprentices..........	.44	.50	.67
Brick & stonemasons & app.........	.01	.02	.02
Bulldozer operators...............	.11	.11	.16
Cement & concrete finishers.......	.04	.03	.01
Electricians & apprentices........	2.83	2.86	3.05
Excav. grad., mach. oper..........	.81	.78	1.02
Painters & apprentices............	.19	.20	.26
Plumbers, pipefitters & app.......	1.97	1.85	2.22
Structural metal craft wkrs.......	.06	.05	.05
Blue collar wkr. superv. nec.......	6.33	5.96	3.65
Metalwkng. craft wkrs. exc. mech...	1.07	1.38	2.85
Blacksmiths.......................	.02	.01	-
Boilermakers......................	.52	.90	2.54
Job & die setters, metal..........	.01	.01	.01
Machinists & apprentices..........	.42	.38	.25
Millwrights.......................	.01	.01	.01
Sheetmetal wkrs & app.............	.05	.03	.02
Tool & diemakers & app............	.02	.02	.03

Table D-8. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric-gas utilities SIC 493		
	Actual		Projected
	1970	1978	1990
Mechanics, repr., installers.......	10.63	11.11	11.53
Air cond., heating, refrig........	.39	.50	.48
Auto body repairers..............	.04	.03	.03
Auto mechanics & apprentices......	1.49	1.33	1.21
Heavy equip. mech., incl. diesel..	1.68	1.94	2.13
Household appliance mech..........	5.14	5.41	6.06
Radio, television reprs...........	.11	.08	.03
Other mechanics & app.............	1.78	1.82	1.59
Printing trade crafts workers.......	.10	.07	-
Transp. pub. utils. craft workers...	9.99	10.36	10.63
Elec. pwr line instal, repr........	8.77	9.15	9.63
Power station operators...........	.87	.88	.80
Telephone installers, reprs........	.21	.18	.12
Telephone line instal. splicers....	.15	.15	.08
Other crafts, kindred wkrs..........	4.76	4.36	3.60
Crane, derrick & hoist oprs........	.29	.22	.18
Inspectors........................	1.80	1.67	.77
Stationary engineers..............	2.10	1.94	2.19
Crafts & kindred nec..............	.56	.54	.45
Operatives..........................	7.79	7.53	8.02
Operatives, exc. transport.........	5.06	4.80	4.38
Semiskilled, metalworking..........	1.37	1.35	1.41
Welders & flame cutters...........	1.31	1.30	1.36
Others............................	.05	.04	.05
Semiskilled, packng, insp..........	.05	.05	04
Other operatives, exc. transp......	3.63	3.41	2.93
Asbestos, insulation wkrs.........	.02	.03	.01
Drillers, earth...................	.01	.01	.01
Garage wkrs., gas stat. att.......	.21	.16	.18
Oilers, greasers, exc. auto.......	.07	.05	.01
Painters, mfg. articles...........	.05	.05	.06
Photographic process wkrs.........	.06	.06	.04
Furnace tendr., stokr., exc. metal	.83	.44	.15
Misc. machine operatives..........	.47	.50	.52
Operatives, nec...................	1.91	2.12	1.95
Transport equipmt. operatives.......	2.73	2.72	3.64
Bus drivers.......................	.11	.13	.02
Delivery & route workers..........	.20	.17	.14

Table D-8. Total Employed and Percent Distribution by Occupation--continued

Occupation	Electric-gas utilities SIC 493		
	Actual		Projected
	1970	1978	1990
Forklift, tow motor operatives....	.06	.06	.06
Railroad switch operators..........	.06	.06	.06
Taxicab drivers, chauffeurs........	.17	.12	.03
Truck drivers......................	2.14	2.18	3.35
Service workers........................	2.18	1.97	1.88
Laborers, exc. farm....................	4.83	4.62	4.55

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-9. Total Employed and Percent Distribution by Occupation
Gas and Steam Supply Systems Industry SIC-492,6
1970, 1978, and Projected 1990

Occupation	Gas & steam supply systems SIC 492,6		
	Actual		Projected
	1970	1978	1990
Total, all occupations: Number.....	166,115	166,288	167,046
Percent....	100.00	100.00	100.00
Professional, tech., & kindred........	9.18	9.73	9.05
Engineers, technical................	2.13	1.95	2.15
Chemical...........................	.13	.14	.18
Civil..............................	.36	.27	.29
Electrical.........................	.23	.22	.23
Industrial.........................	.24	.25	.25
Mechanical.........................	.57	.54	.60
Metallurgical......................	.01	.01	-
Petroleum..........................	.10	.09	.10
Sales..............................	.12	.09	.11
Other..............................	.38	.34	.38
Life and physical scientists........	.16	.15	.20
Chemists...........................	.05	.05	.03
Geologists.........................	.11	.10	.17
Mathematical specialists............	.08	.08	.08
Mathematicians.....................	.01	.01	-
Statisticians......................	.07	.07	.08
Engineers, science tech.............	1.53	1.51	1.91
Chemical technicians...............	.05	.05	.08
Drafters...........................	.82	.72	.87
Electrical, electronic tech........	.22	.24	.26
Industrial engineering tech........	.01	.02	.01
Surveyors..........................	.14	.14	.19
Engineering, science tech., nec....	.28	.33	.51
Medical workers, exc. tech..........	.02	.02	.01
Technicians, exc. health............	.59	.74	.71
Computer specialists................	.68	.82	.70
Programmers........................	.52	.59	.53
Systems analysts...................	.14	.20	.16
Other computer spec................	.02	.04	.02
Social scientists...................	.25	.39	.36
Economists.........................	.25	.39	.36

Table D-9. Total Employed and Percent Distribution by Occupation--continued

Occupation	Gas & steam supply systems SIC 492,6		
	Actual		Projected
	1970	1978	1990
Teachers	.01	.01	.01
Writers, artists, entertainers	.57	.72	.74
Other professional, technical	3.15	3.35	2.19
Managers, officials, proprietors	7.31	8.37	9.21
Buyers, sales, loan mgrs	1.11	1.04	1.22
Other mgrs., officials, prop	6.19	7.33	7.98
Sales workers	1.79	1.33	.65
Clerical workers	28.38	27.71	26.12
Stenos, typists, & secretaries	5.40	5.09	5.81
Office machine operators	1.40	1.52	1.02
Other clerical workers	21.58	21.10	19.29
Crafts and kindred workers	35.62	36.52	39.40
Construction crafts wkrs	5.43	5.26	6.80
Carpenters & apprentices	.20	.21	.23
Brick & stonemasons & app	.04	.03	.01
Bulldozer operators	.20	.19	.28
Cement & concrete finishers	.02	.03	.07
Electricians & apprentices	.44	.47	.60
Excav. grad., mach. oper	.83	.71	.72
Floor layers, exc. tilesetters	.02	.01	-
Painters & apprentices	.13	.12	.08
Plumbers, pipefitters & app	3.53	3.48	4.80
Structural metal craft wkrs	.02	.01	.01
Blue collar wkr. superv. nec	6.30	6.95	8.16
Metalwkng. craft wkrs. exc. mech	.44	.57	1.19
Blacksmiths	.05	.04	.01
Boilermakers	.07	.14	.45
Forge & hammer operators	.02	.01	.01
Machinists & apprentices	.21	.26	.49
Millwrights	.04	.05	.09
Sheetmetal wkrs. & app	.03	.03	.07
Tool & diemakers & app	.02	.03	.08
Mechanics, repr., installers	15.23	16.25	17.04
Air cond., heating, refrig	1.20	1.74	2.10
Auto mechanics & apprentices	1.01	.89	.76
Heavy equip. mech., incl. diesel	2.03	2.47	3.37
Household appliance mech	9.90	10.10	10.08
Radio, television reprs	.09	.08	.10
Other mechanics & app	1.00	.96	.63

Table D-9. Total Employed and Percent Distribution by Occupation--continued

Occupation	Gas & steam supply systems SIC 492,6		
	Actual		Projected
	1970	1978	1990
Printing trade crafts workers....	.09	.10	.11
Transp. pub. utils. craft workers	1.97	1.51	.44
Elec. pwr line instal, repr.....	1.75	1.31	.33
Power station operators.........	.14	.11	.03
Telephone installers, reprs.....	.04	.04	.04
Telephone line instal. splicers	.04	.04	.04
Other crafts, kindred wkrs.......	6.16	5.88	5.65
Crane, derrick & hoist oprs.....	.11	.08	.05
Inspectors......................	2.09	2.44	2.87
Stationary engineers............	3.89	3.29	2.68
Crafts & kindred nec............	.07	.07	.06
Operatives.......................	9.51	9.37	10.72
Operatives, exc. transport.....	6.30	6.15	5.80
Semiskilled, metalworking......	1.72	1.82	2.24
Welders & flame cutters........	1.72	1.82	2.24
Semiskilled, packaging, insp...	.02	.02	-
Other operatives, exc. transp.	4.55	4.31	3.56
Drillers, earth.............	.03	.02	.01
Garage wkrs., gas stat. att..	.14	.09	.07
Mixing operatives...........	.02	.02	-
Oilers, greasers, exc., auto.	.66	.41	.06
Painters, mfg. articles......	.02	.01	-
Photographic process workers.	.02	.02	.01
Furnance tendr., stokr., exc. Metal......................	.40	.29	.33
Misc. machine operatives.....	.98	1.03	1.03
Operatives, nec.............	2.29	2.43	2.05
Transport equipment operatives.	3.21	3.22	4.92
Delivery & route workers.....	.72	.66	.88
Fork lift, tow motor operatives	.05	.06	.08
Truck drivers...............	2.44	2.50	3.96
Service workers....................	2.31	2.03	1.44
Laborers, exc. farm................	5.91	4.95	3.42

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, National Industry-Occupation Employment Matrix.

Table D-10. Occupational Distribution of Nuclear Employment, 1977
(Total and R&D by Type of Establishment)
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Occupations	Total All Sector Total	Total All Sector R&D	Type of Establishment: Non-profit Total	Non-profit R&D	Private Total	Private R&D	GOCO[1/] Total	GOCO[1/] R&D
Total.................	226,954	49,850	2,701	1,979	125,658	7,682	98,595	40,189
Managers...............	13,602	3,006	150	100	8,552	857	4,900	2,049
Chemical engineers.....	2,401	1,147	6	6	822	195	1,573	946
Civil engineers........	3,829	381	9	4	3,345	144	475	233
Electric and electronic engineers............	7,799	3,107	96	89	4,326	522	3,377	2,496
Mechanical engineers...	11,544	4,187	110	74	7,349	899	4,085	3,214
Nuclear and reactor engineers............	5,647	1,517	40	39	4,097	236	1,510	1,242
Metallurgical engineers............	1,153	561	10	9	679	131	464	421
Other engineers........	8,473	1,974	104	83	5,637	421	2,732	1,470
Mathematicians.........	1,906	1,169	19	15	431	127	1,456	1,027
Chemists...............	3,579	2,294	88	87	985	303	2,506	1,904
Geologists and geophysicists........	511	177	2	2	207	18	302	157
Physicists.............	4,198	3,588	174	166	812	404	3,212	3,018
Metallurgists..........	664	406	10	10	290	52	364	344
Other physical scientists...........	810	506	32	1	258	111	520	394
Biological scientists..	1,566	1,237	372	371	423	115	771	751
Medical scientists.....	283	187	21	20	120	39	142	128
Health scientists......	1,000	141	13	4	407	29	580	108
Other life scientists..	453	312	111	110	113	13	229	189
Other professional workers..............	13,455	2,240	69	11	5,942	471	7,444	1,758
Draftsmen..............	9,636	1,290	72	66	7,714	216	1,850	1,008
Electrical and electronic technicians...	6,642	2,792	131	117	2,894	315	3,617	2,360
Other engineering technicians..........	8,298	2,549	352	304	4,722	408	3,224	1,837

Table D-10. Occupational Distribution of Nuclear Employment, 1977--(continued)
(Total and R&D by Type of Establishment)

Occupations	Total: All Sector Total	Total: All Sector R&D	Type of Establishment: Non-profit Total	Non-profit R&D	Private Total	Private R&D	GOCO 1/ Total	GOCO 1/ R&D
Physical science technicians.......	2,708	1,095	45	15	649	140	2,014	940
Life science technicians.......	703	336	56	47	328	120	369	169
Health Physics technicians and radiation monitors	2,391	350	9	5	1,435	19	947	326
Senior nuclear reactors operators..	920	66	3	1	824	17	93	48
Nuclear reactor operators.........	1,674	86	9	0	922	60	743	26
Auxilliary reactor operators........	1,498	65	2	0	1,297	62	199	3
Other technicians..	7,127	2,640	22	19	4,023	238	3,082	2,383
Welders with nuclear certification...........	5,438	43	5	0	4,666	37	767	6
Other skilled craft workers....	32,157	2,939	113	76	17,435	267	14,609	2,596
Clerical workers...	21,519	4,518	344	98	10,297	376	10,878	4,044
All other workers..	43,320	2,944	102	30	23,657	320	19,561	2,594

1/ Government-owned contractor-operated.

SOURCE: U.S. Department of Energy, Employment in Nuclear Energy Activities, 1977, A Highlights Report, DOE/IR-0049, May 1979, p. 19.

Table D-11. Employment in Nuclear Energy Activities, by Occupational Group and Federal Region, 1977

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Region	Total, all groups	Managers	Engineers	Mathematicians	Physical scientists	Life scientists	Other professional workers	Technicians	Skilled craft workers	Clerical workers	All other workers
	Occupational group										
All regions.	226,954	13,602	40,846	1,906	9,762	3,302	13,455	41,647	37,595	21,519	43,320
Region I....	13,768	841	3,509	33	424	223	461	3,164	1,609	1,152	2,352
Region II...	18,967	1,032	4,713	88	762	393	734	3,756	2,427	1,891	3,171
Region III..	27,087	1,870	6,238	204	554	226	1,197	5,648	4,580	2,190	4,380
Region IV...	47,054	2,021	5,989	440	1,357	750	3,130	7,584	10,694	3,932	11,157
Region V....	32,292	1,934	5,303	170	1,335	502	1,555	5,843	6,336	2,531	6,783
Region VI...	19,974	1,242	2,805	357	1,742	240	1,084	4,430	2,172	2,658	3,244
Region VII..	7,545	251	991	21	337	17	765	689	1,033	509	2,932
Region VIII.	4,819	441	324	9	348	30	272	501	1,002	524	1,368
Region IX...	36,581	2,478	7,552	476	2,123	536	2,538	7,128	5,638	3,771	4,341
Region X....	18,867	1,492	3,442	108	708	385	1,719	2,904	2,104	2,361	3,592

Regions consist of the following states:

Region I.......Connecticut, Maine, Massachusetts, New Hampshire, Rhode Island, and Vermont.
Region II......New Jersey and New York.
Region III.....Delaware, District of Columbia, Maryland, Pennsylvania, Virginia, and West Virginia.
Region IV......Alabama, Florida, Georgia, Kentucky, Mississippi, North Carolina, South Carolina, and Tennessee.
Region V.......Illinois, Indiana, Michigan, Minnesota, Ohio, and Wisconsin.
Region VI......Arkansas, Louisiana, New Mexico, Oklahoma, and Texas.
Region VII.....Iowa, Kansas, Missouri, and Nebraska.
Region VII.....Colorado, Montana, North Dakota, South Dakota, Utah, and Wyoming.
Region IX......Arizona, California, Hawaii, and Nevada.
Region X.......Alaska, Idaho, Oregon, and Washington.

SOURCE: U.S. Department of Energy, Employment in Nuclear Activitites, 1977, A Highlights Report, DOE/IR-0049, May 1979, p. 20.

Technical Notes for Tables D-10 and D-11

Since 1960, the Bureau of Labor Statistics surveyed annually through 1970 and biannually up to 1978 the privately-owned establishments and the government-owned facilities operated by private contractors. The survey collected occupational employment data in nuclear energy activities by 21 industrial segments. The survey queried each firm about the portion of the work force in nuclear energy related activities. Classification criteria for some of the industrial segments changed over the life of the survey. Efforts were made to expand the coverage, which may influence the total volume of employment shown from the survey. Excluded from coverage are personnel employed in Federal, state or local governments, medical institutions, uranium mining, construction of nuclear facilities and universities. The survey has been sponsored by the Department of Energy and predecessor agencies. (i.e., Energy Research and Development Administration and the Atomic Energy Commission).

Table D-12. Occupational Distribution of Employment in Solar Activities, 1978

Occupation	Number: Total		Research and development		Commercial (exc. install.)		Installation	
	Reported	Estimated 1/	Reported	Estimated 1/	Reported	Estimated 1/	Reported	Estimated 1/
Total all occupations....	6,257	22,500	3,482	12,500	2,416	8,700	359	1,300
Engineers...............	1,893	6,900	1,398	5,200	440	1,600	55	200
Agricultural...........	30		28		2		0	
Chemical...............	82		54		28		0	
Civil..................	31		26		4		1	
Electrical/electronic...	284		244		35		5	
Mechanical.............	721		509		181		31	
Metallurgical/materials.	62		55		5		2	
Other..................	683		482		185		16	
Scientists..............	529	1,900	469	1,700	54	200	6	2/
Biologists.............	21		20		1		0	
Chemists...............	44		35		8		1	
Computer specialists....	56		48		6		2	
Physicists.............	138		117		18		3	
Other..................	270		249		21		0	
Other professionals......	875	3,200	482	1,800	356	1,300	37	100
Technicians.............	691	2,500	494	1,800	176	600	21	100
Chemical...............	23		21		2		0	
Electrical/electronic...	138		112		23		3	
Mechanical.............	154		98		46		10	
Other..................	376		263		105		8	

See footnotes at end of table.

Table D-12. Occupational Distribution of Employment in Solar Activities, 1978--(continued)

Occupation	Number: Total Reported	Total Estimated 1/	Research and development Reported	Research and development Estimated 1/	Commercial (exc. install.) Reported	Commercial (exc. install.) Estimated 1/	Installation Reported	Installation Estimated 1/
Skilled crafts & operatives..........	1,057	3,900	238	900	649	2,400	170	600
Carpenters..........	43		9		10		27	
HVAC workers........	48		8		18		22	
Machinists..........	29		12		14		3	
Mechanics...........	43		26		13		4	
Plumbers/pipefitters	84		5		37		42	
Sheetmetal workers/ tinsmiths.........	54		9		28		17	
Welders/flame cutters	29		12		11		6	
Other................	727							
Clerical & unskilled..	1,102	4,000	312	1.200	717	2,600	70	300
No occupation given...	110		86		24		0	

1/ Includes allocation of "no occupation given."

2/ Less than 50.

NOTE: Data in this table is based on responses from 518 establishments that represented 27.75 percent of the 1,867 establishment estimated to have been engaged in solar energy activities. Data on other occupations are available in the report shown in the source. The estimated number of employees in major occupational groups, by type of activity, has been computed from the distribution in the reporting sample, rounded to the nearest 100. Detail may not add to totals due to rounding.

SOURCE: U.S. Department of Energy, Solar Energy Employment and Requirements, 1978-1983, DOE/TIC-11154, April 1980.

Technical Notes, Table D-12

Data in Table D-12 were collected by a special survey conducted by Battelle Laboratories under contract with the U.S. Department of Energy. Questionnaires were sent to a universe of over 2,800 establishments, of which 1,314 responded. The study covered eight types of solar energy and encompassed the following five phases of solar and solar related energy work: research and development, manufacturing, marketing and distribution, installation and maintenance, and other commercial activities. From the initial questionnaire mailing a second two-stage questionnaire was used to follow-up for information used in the report. A total of 466 establishments completed a short form and 563 responded to a longer employer questionnaire. To provide more detail about occupations and skills a mail survey was done of nearly 500 employees working in solar energy within respondent firms. The Battelle Laboratories report contains a detailed analysis of the firms surveyed.

Appendix E. Occupational Safety and Health Statistics [1/]

Tables E-1 and E-2 present data compiled under the Occupational Safety and Health Act legislation. Recordkeeping and reporting of occupational safety and health data are mandatory. Recordable cases include all work-related deaths and illnesses and those injuries which result in one or more of the following: Loss of consciousness, restriction of work or motion, transfer to another job, or medical treatment beyond first aid.

The BLS was assigned the responsiblity for the occupational safety and health statistics program. As of January 1, 1978, 41 states and 5 Federal jurisdictions were participating in the survey on a cooperative basis. National data for 5 of the 9 states which did not have operational grants were collected by BLS, and by state agencies under contract for the remaining four.

The survey sample consists of approximately 340,000 establishments in private industry. About 200,000 of these sample units are necessary to produce national estimates. To determine priorities in the development of safety standards and in OSHA compliance activities, data are collected in a prescribed manner, under OSHA definitions.

The sample is selected to respresent private industries in the states and territories. The survey results are used to produce estimates of the incidence rates of occupational injuries and illnesses by industry and employment size for the Nation as a whole. An optimum allocation is achieved by distributing the establishments in the sample to each size group in proportion to the total employment and the variation in the size group.

1/Additional details available in U.S. Department of Labor, Bureau of Labor Statistics, Occupational Safety and Health Statistics Concepts and Methods, Report No. 518, 1978, pp. 1-5.

The quality of the reported data is a major concern in the execution of the survey. Although data are carefully edited and screened, many "errors" caused by misinterpretations of recordkeeping definitions by employers may not be uncovered. For this reason, a quality assurance program is conducted to evaluate the extent of "error" in the records through a program of visits to a sample of establishments which have participated in the annual survey.

Table E-1. Occupational Injury and Illness Incidence Rates, Total Private Sector and Selected Energy Industries, 1977

SIC Code	Industry 1/	Injury and illness incidence rates per 100 full-time workers 1/			
		Total cases 3/	Lost work day cases	Nonfatal cases without lost workdays	Lost work days
	Private sector 4/....	9.3	3.8	5.5	61.6
	Mining 5/................	10.9	6.0	4.9	128.8
11	Anthracite mining 5/......	21.6	10.6	10.6	237.6
12	Bituminous coal & lignite mining.................	12.4	7.8	4.5	167.1
13	Oil & gas extraction......	12.9	6.3	6.5	143.7
291	Petroleum refining........	5.8	2.6	3.2	45.4
299	Misc. petroleum & coal products...............	17.8	7.2	10.6	132.6
35	Machinery, exc. electrical	14.0	4.7	9.3	69.9
3532	Mining machinery..........	20.1	7.5	12.6	109.1
3533	Oil field machinery........	16.5	7.0	9.4	105.9
46	Pipelines, exc. natural gas	5.0	2.0	3.0	32.4
49	Electric, gas, & Sanitary services..............	9.0	4.2	4.8	69.0

1/ Totals for divisions and 2- and 3- digit SIC codes include data for industries not shown separately.

2/ The incidence rates represent the number of injuries and illnesses or lost workdays per 100 full-time workers and were calculated as: (N/EH) x 200,000 where: N=number of injuries and illnesses or lost workdays; EH = total hours worked by all employees during calendar year; 200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per years).

3/ Includes fatalities. Because of rounding, the difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays do not reflect the fatality rate.

4/ Excludes farms with fewer than 11 employees.

5/ Data conforming to Occupational Safety and Health Act definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetallic mining (SIC 10 and 14) were provided by the Mine Safety and Health Administration, U.S. Department of Labor.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Injuries and Illnesses in 1977: Summary, Report 651, Table 1,1979, pp. 2-10.

Table E-2. Occupational Injury Incidence Rates, Total Private Sector and Selected Energy Industries, 1977

SIC Code	Industry 1/	Injury incidence rates per 100 full-time workers 2/			
		Total cases 3/	Lost work day cases	Nonfatal cases without lost workdays	Lost work days
	Private sector 4/........	9.0	3.7	5.3	60.0
	Mining 5/..........................	10.8	5.9	4.8	128.3
11	Anthracite mining 5/.............	21.6	10.6	10.6	237.6
12	Bituminous coal & lignite mining 5/	12.3	7.8	4.4	167.0
13	Oil & gas extraction.............	12.7	6.2	6.4	142.7
291	Petroleum refining.................	5.5	2.5	3.0	44.3
299	Misc. petroleum & coal products....	17.3	7.0	10.3	137.8
35	Machinery, exc. electrical.........	13.5	4.6	8.9	67.4
3532	Mining machinery...................	19.8	7.4	12.4	107.9
3533	Oil field machinery................	16.1	6.9	9.2	104.4
46	Pipelines, exc. natural gas........	4.7	1.9	2.8	31.1
49	Electric, gas, & sanitary services	8.7	4.0	4.6	67.0

1/ Totals for divisions and 2- and 3- digit SIC codes include data for industries not shown separately.

2/ The incidence rates represent the number of injuries or lost workdays per 100 full-time workers and were calculated as: (N/EH) x 200,000 where: N=number of injuries or lost workdays; EH = total hours worked by all employees during calendar year; 200,000 = base for 100 full-time equivalent workers (working 40 hours per week, 50 weeks per year).

3/ Includes fatalities. Because of rounding, the difference between the total and the sum of the rates for lost workday cases and nonfatal cases without lost workdays do not reflect the fatality rate.

4/ Excludes farms with fewer than 11 employees.

5/ Data conforming to Occupational Safety and Health Act definitions for coal and lignite mining (SIC 11 and 12) and metal and nonmetallic mining (SIC 10 and 14) were provided by the Mine Safety and Health Administration, U.S. Department of Labor.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Occupational Injuries and Illnesses in 1977: Summary, Report 651, Table 1, 1979, pp. 2-10.

Table E-3. Occupational Injuries and Illnesses in the Petroleum Industry for the Year 1978
(Covering operations subject to OSHA recordkeeping requirements only)

Technical Notes Follow

Function	SIC	Number of employees	Recordable cases		Fatalities	Extent and outcome of injuries and illnesses		
			Injuries	Illnesses		Lost workday cases: Total cases	Number of--: Days away from work	Number of--: Days of restricted activity
Total............	-	435,524	19,323	578	75	8,722	126,622	28,075
Exploration & production.....	1311	72,749	2,758	51	21	1,157	20,045	1,923
Gas processing....	1321	7,220	318	7	3	100	1,756	240
Drilling..........	1381	2,947	809	1	1	331	9,337	117
Chemicals.........	2800	42,909	2,944	116	3	1,130	16,034	6,092
Refining..........	2911	81,168	4,688	294	19	2,366	27,555	12,995
Marketing-wholesale.........	5171	53,747	2,743	8	10	1,559	23,230	1,724
Marketing-retail..	5541	36,982	1,519	12	7	776	9,140	1,464

Table E-3. Occupational Injuries and Illnesses in the Petroleum Industry for the Year 1978
(Covering operations subject to OSHA recordkeeping requirements only)--continued

			Recordable cases				Extent and outcome of injuries and illnesses	
							Lost workday cases	
							Number of--	
Function	SIC	Number of employees	Injuries	Illnesses	Fatalities	Total cases	Days away from work	Days of restricted activity
Pipeline-crude & products......	4610	13,536	601	21	1	165	2,649	141
Pipeline-gas....	4922	18,551	859	15	1	180	3,245	918
Marine..........	4400	3,906	264	10	2	134	4,259	55
Research & developmnt......	-	17,237	315	15	1	106	584	844
Engineering & gen. service....	-	8,255	195	5	0	49	595	247
Miscellaneous...	-	61,923	687	16	4	347	3,245	487
Combined functions..........	-	14,394	623	7	2	322	4,948	828

SOURCE: American Petroleum Institute, Summary of Occupational Injuries and Illnesses in the Petroleum Industry, August 1979, p. 2.

Technical Notes, Table E-3

Table E-3 is from the 1978 annual API summary of occupational injuries and illnesses in the petroleum industry, recordable under Occupational Safety and Health Administration (OSHA) recordkeeping requirements. The survey shows incidence rates per 100 full-time workers on the same basis as those reported by the Bureau of Labor Statistics.

This report is based on data collected by the API from 109 oil and gas companies employing over 435,000 persons with a work experience of more than 890 million hours. The Incidence Rate (i.e., total recordable cases per 100 full-time workers) was found to be 4.47 for the year 1978 compared with 4.52 for 1977.

The Disabling Injury Frequency Rate (i.e., deaths plus cases involving days away from work) for the year 1978 averaged 7.40 per million hours worked compared with 7.82 for 1977. The ratio of workers to the number of disabling injuries during 1978 averaged 67 per injury as compared with 64 workers per injury in 1977. One death among petroleum workers was reported in 1978 for every 5,807 employees compared with one death for every 5,995 workers employed in 1977.

Appendix F. Work Stoppages [1]

Work stoppages (Table F-1) as reported by BLS include strikes and lockouts, involve six workers or more and continue for the equivalent of a full day or shift or longer.

A strike is defined as a temporary stoppage of work by a group of employees (not necessarily members of a union) to express a grievance or enforce a demand. A lockout is a temporary withholding or denial of employment during a labor dispute to enforce terms of employment upon a group of employees.

The figures on the number of "workers involved" and "days idle" include all workers made idle for one shift or longer in establishments directly involved in a stoppage. They do not account for secondary idleness--that is, the effects of a stoppage on other establishments or industries whose employees may be made idle as a result of material or service shortages.

The total number of workers involved in strikes in a given year may include double counting of individual workers if they are involved in more than one stoppage during that year. (Thus, in 1974, the Bureau recorded some 460,000 bituminous coal and lignite mining workers as participating in strikes, while 165,000 workers were employed in the industry.)

1/ U.S. Department of Labor, Bureau of Labor Statistics, Analysis of Work Stoppages, 1977, Bulletin 2032, 1979.

Although only workdays are used in computing total days of idleness, duration is expressed in calendar days, including nonworkdays.

Information is available separately for the areas that currently comprise the list of Standard Metropolitan Statistical Areas (SMSA's) as defined by the Office of Management and Budget.

Information on the actual or probable existence of work stoppages is collected from a number of sources. Clippings on labor disputes are obtained from a comprehensive coverage of daily and weekly newspapers throughout the country. Information is also received regularly from the Federal Mediation and Conciliation Service. Other sources of information include State boards of mediation and arbitration; research divisions of State labor departments; local offices of State employment security agencies; and trade and union journals. Some employer associations, companies, and unions also furnish the Bureau with work stoppage information on a voluntary cooperative basis, either as stoppages occur or periodically.

A questionnaire is mailed to each of the parties reported as involved in work stoppages to obtain information on the number of workers involved, duration, major issues, location, method of settlement, and other pertinent information.

Although the Bureau seeks to obtain complete coverage, i.e., a "census" of all strikes involving six workers or more and lasting a full shift or more, information is undoubtedly missing on some strikes involving small numbers of workers. Presumably, these missing strikes do not substantially affect the number of workers and days of idleness reported.

Table F-1. Work Stoppages for All Industries and Selected Energy Industries, 1977
(Workers and days idle in thousands)

SIC Code	Industry	Stoppages beginning in year: Number	Mean duration (days) 1/	Workers involved	Number of days idle during year (all stoppages)
	All industries......	5,506 2/	22.8	2,040.1	35,821.8
11	Anthracite mining....	0	0	0	0
12	Bituminous coal & Lignite mining.....	958	9.0	649.8	5,628.3
131	Crude petroleum & natural gas.......	3	19.9	1.9	31.6
132	Natural gas liquids	1	43.0	3/	.8
138	Oil & gas field services..........	3	36.0	.6	14.6
291	Petroleum refining..	14	39.5	5.8	157.6
299	Misc. products of petroleum & coal...	1	23.0	3/	.7
353	Construction, mining & materials handling machinery & equipment.	64	32.5	24.2	601.0
361	Electric transmission and distribution equipment..........	41	7.5	20.2	149.7
46	Pipeline transp.....	0	0	0	0
491	Electric companies & systems..........	31	49.6	8.4	304.9
492	Gas companies & systems............	5	114.6	4.3	390.3
493	Combination companies & systems..........	4	30.5	4.0	85.0

1/ Mean duration is calculated only for stoppages ending in the year, and is weighted by multiplying the duration of each stoppage by the workers involved.

2/ The number of stoppages reported for a major industry group or division may not equal the sum of its components because individual stoppages occurring in two or more groups have been counted in each. Workers involved and days idle have been allocated among the respective groups.

3/ Fewer than 50.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Analysis of Work Stoppages, 1977, Bulletin 2032, 1979.

Appendix G. Indexes of Output per Hour [1/]

The indexes of output per employee hour (Tables G-1 through G-5) are computed by dividing an index of output by an index of aggregate employee hours.

The output indexes are based primarily on the physical quantity of the products of the industry combined with fixed period weights. Unit employee hour weights are used whenever possible to aggregate the data.

For many industries, however, unit labor weights are not available at the detailed product level so substitute weights must be used. The most common substitute weights are unit values. For many manufacturing industries, however, employee hour weights at the product-class level can be developed from the available data. In such cases, a dual level weighting system is used--unit value weights at the product level and unit labor weights at the product-class level.

Although the weights relate to fixed periods, they are updated periodically, usually in conjunction with economic censuses.

Employment and employee hour indexes are developed primarily from basic data compiled by the Bureau of Labor Statistics (BLS) and the Bureau of the Census. In concept, indexes based on employee hour data from the Bureau of the Census relate to plant hours only. Employee hour data from BLS include

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[1/] U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1979 Edition, Bulletin 2054.

not only hours at work but also payroll hours such as vacations, holidays, and sick leave paid by the establishment directly to the employee. In general, because of increases in paid leave during the period, output per employee hour worked would tend to show a somewhat higher rate of gain than output per employee hour paid. However, actual differences may result from statistical limitations in the data as well as from differences in concepts.

Indexes are shown for all employees, production workers, and nonproduction workers.[2/] Although both the BLS and Bureau of the Census provide data on production worker hours, neither source provides annual data by industry on nonproduction worker or all-employee hours. Therefore, the nonproduction worker hours are estimated.

The indexes refer to the standard reference base 1967=100 and, beginning in 1972, conform to the 1972 Standard Industrial Classification (SIC) definitions.

The average annual rates of change are based on the linear least squares trends of the logarithms of the index numbers. Average annual rates of change for any time periods shown in this report are available on request from the Bureau of Labor Statistics.

More detailed information on the methods, limitations, and data sources is contained in the BLS Handbook of Methods, BLS Bulletin 1910 (1976), Chapter 31, and in a number of individual industry reports. Industry reports as well as additional information are available on request from the Bureau of Labor Statistics. The handbook is for sale by the Superintendent of Documents, Washington, D.C. 20402, or at the Bureau of Labor Statistics regional offices.

2/ The term "production workers" covers manufacturing and mining employees who work at the plant or mine and who are generally in nonsupervisory occupations. The remaining employees, such as professional, technical, clerical, supervisory, etc., are identified as "nonproduction workers."

Table G-1. Indexes of Output, Output Per Hour of Production Workers and Output Per Employee 1950-1978, (1967=100) Coal Mining (SIC 111, 121)

Year	Output	Output per hour of production workers1/	Output per employee1/		
			All employees	Production workers	Nonproduction workers
1950	106.9	35.9	32.8	30.8	59.6
1955	91.6	51.2	50.1	48.3	68.4
1960	80.8	66.8	58.6	59.2	54.9
1965	94.7	93.1	91.4	91.0	94.7
1970	105.0	98.1	97.7	98.5	92.2
1975	109.6	72.7	68.5	71.1	54.5
1976	114.6	71.4	67.7	70.6	52.5
1977	116.5	69.5	68.7	71.6	53.4
1978 2/	110.6	75.5	70.5	75.9	47.2
Average annual percent change:					
1947-78	0.2	3.4	3.6	4.0	0.3
1973-78	2.7	-3.5	-3.0	-2.4	-6.3

1/ The output measures underlying the output per hour of production workers and output per employee indexes relate to the total production of the industry. They do not relate to the specific output of any single group of employees.

2/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1978 and 1979 Editions, Bulletins 2002 and 2054.

Table G-2. Indexes of Output, Output Per Hour of Production Workers and Output Per Employee 1950-1978, (1967=100) Bituminous Coal and Lignite Mining (SIC 121)

Year	Output	Output per hour of production workers 1/	Output per employee 1/		
			All employees	Production workers	Nonproduction workers
1950	93.7	35.4	32.6	30.7	58.8
1955	84.7	50.3	50.1	48.1	69.8
1960	76.4	66.2	58.0	58.6	54.1
1965	93.3	93.5	92.0	91.6	95.1
1970	106.3	98.3	97.7	98.6	92.0
1975	112.4	72.1	67.7	70.3	53.6
1976	117.6	70.8	66.9	69.8	51.8
1977	119.8	69.0	68.0	71.1	52.3
1978 2/	113.3	74.7	69.5	74.9	46.1
Average annual percent change:					
1947-78	0.8	3.5	3.6	4.0	0.3
1973-78	2.7	-3.6	-3.1	-2.4	-6.4

1/ The output measures underlying the output per hour of production workers and output per employee indexes relate to the total production of the industry. They do not relate to the specific output of any single group of employees.

2/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1978 and 1979 Editions, Bulletins 2002 and 2054.

Table G-3. Indexes of Output, Output Per Hour and Output Per Employee 1950-78, (1967=100) Petroleum Refining (SIC 2911)

Year	Output	Output per hour[1/] All employees	Output per hour[1/] Production workers	Output per hour[1/] Nonproduction workers	Output per employee[1/] All employees	Output per employee[1/] Production workers	Output per employee[1/] Nonproduction workers
1950	52.0	39.0	36.6	47.4	39.8	37.2	48.3
1955	68.6	48.9	47.1	54.7	48.5	46.3	55.1
1960	78.7	62.7	62.1	64.7	62.2	61.2	65.1
1965	91.2	90.5	89.9	92.1	89.5	88.4	92.7
1970	107.3	104.8	106.6	100.6	106.3	107.6	103.3
1975	115.9	123.7	126.9	115.7	123.0	125.2	118.1
1976	125.1	128.3	130.4	123.1	131.3	133.4	126.4
1977	133.5	136.2	139.5	128.4	138.3	141.7	130.5
1978[2/]	136.3	132.8	134.0	129.7	136.6	138.5	132.1
Average annual percent change:							
1947-78	3.4	5.1	5.5	4.1	5.1	5.5	4.1
1973-78	3.1	1.1	1.1	1.3	1.8	2.1	1.2

1/ The output measures underlying the output per hour of production workers and output per employee indexes relate to the total production of the industry. They do not relate to the specific output of any single group of employees.

2/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1978 and 1979 Editions, Bulletins 2002 and 2054.

Table G-4. Indexes of Output, Output Per Hour and Output Per Employee
1950-78, (1967=100)
Petroleum Pipelines (SIC 4612, 4613)

Year	Output	Output per hour 1/		Output per employee 1/	
		All employees	Production workers 2/	All employees	Production workers 2/
1950	32.1	3/	3/	21.7	3/
1955	49.0	3/	3/	34.8	3/
1960	60.1	50.2	48.9	48.7	47.4
1965	82.0	79.4	79.2	78.6	78.5
1970	114.9	122.6	128.7	122.1	128.1
1975	135.0	147.4	161.9	144.2	158.3
1976	136.8	146.6	164.1	146.6	164.1
1977	153.1	154.0	174.8	154.8	175.6
1978 3/	-	-	-	-	-
Average annual percent change:					
1958-77	5.9	7.8	8.7	7.9	8.9
1973-77	3.0	.5	2.1	.8	2.4

1/ The output measures underlying the output per hour of production workers and output per employee indexes relate to the total production of the industry. They do not relate to the specific output of any single group of employees.

2/ Represents nonsupervisory workers.

3/ Data not available.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1978 and 1979 Editions, Bulletins 2002 and 2054.

Table G-5. Indexes of Output, Output Per Hour
and Output Per Employee
1950-78, (1967=100)
Gas and Electric Utilities (SIC 491, 492, 493)

Year	Output	Output per hour 1/		Output per employee 1/	
		All employees	Production workers 2/	All employees	Production workers 2/
1950	27.7	31.3	28.9	31.5	29.0
1955	44.3	47.2	44.9	47.1	44.7
1960	63.1	65.5	63.8	64.8	63.0
1965	86.8	89.2	88.5	89.0	88.3
1970	125.6	117.4	118.0	117.7	118.3
1975	146.8	131.9	136.2	130.7	134.9
1976	151.6	135.8	141.3	134.9	140.2
1977	156.7	137.8	144.6	137.1	143.8
1978 3/	162.5	135.6	143.8	136.6	144.8
Average annual percent change:					
1947-78	7.0	5.9	6.4	5.9	6.4
1973-78	2.2	1.4	2.1	1.3	2.1

1/ The output measures underlying the output per hour of production workers and output per employee indexes relate to the total production of the industry. They do not relate to the specific output of any single group of employees.

2/ Represents nonsupervisory workers.

3/ Preliminary.

SOURCE: U.S. Department of Labor, Bureau of Labor Statistics, Productivity Indexes for Selected Industries, 1978 and 1979 Editions, Bulletins 2002 and 2054.

Appendix H--Education Statistics

Tables H-1 through H-8 are from the Digest of Education Statistics 1981. Many of the statistics are derived from the annual and biennial surveys of the National Center for Education Statistics. When necessary, these survey data have been supplemented by estimates prepared especially for this volume in order to make the tables as useful as possible. In addition, substantial contributions have been made by statistics received from other agencies, both governmental and non-governmental, as indicated in the source notes in the appropriate tables.

The center surveys are based on data furnished by institutional units (a separately organized campus or branch, which may be independent or part of a larger university or a State system). For more detail on number of institutions and methodology see individual report of the NCES e.g., "Upper Division Enrollment by Degree Field;" "Earned Degrees Conferred," etc.

Only selected items (e.g., fields of study and curriculum) are shown in some of the tables; therefore, details will not add to the total.

Table H-1. Enrollment of Science and Engineering Graduate Students by Field of Study, Level of Enrollment, Attendance Status, and Sex: Aggregate United States, Fall 1980

Field of study	All Students	Level		Attendance		Sex	
		Doctorate	Masters	Full Time	Part Time	Male	Female
Total, all fields	383,210	259,433	123,777	249,111	134,099	249,347	133,863
Engineering..............	77,174	60,427	16,747	43,578	33,596	70,258	6,916
Physical sciences.........	27,063	23,904	3,159	22,958	4,105	22,425	4,638
Environmental sciences....	13,680	10,330	3,350	10,689	2,991	10,560	3,120
Mathematical computer sciences................	28,873	18,589	10,284	16,483	12,390	21,716	7,157
Agricultural sciences.....	12,365	10,038	2,327	10,035	2,330	9,518	2,847
Biological sciences.......	47,643	36,937	10,706	37,571	10,072	29,175	18,468
Health sciences...........	42,693	20,484	22,209	24,798	17,895	12,391	30,302
Psychology................	40,544	25,933	14,611	26,636	13,908	18,990	21,554
Social Sciences...........	93,175	52,791	40,384	56,363	36,812	54,314	38,861

Note: Covers students enrolled at all doctorate and master's-granting institutions in the 50 states, the District of Columbia, and outlying territories

Source: National Science Foundation, Academic Science, Graduate Enrollment and Support, Fall 1980 (in press).

Table H-2. Engineering Enrollment in Institutions of Higher Education, by Level. United States, Selected Years, Fall 1950 to Fall 1979

Fall	Total engineering enrollment	Level of enrollment, for-- First engineering degree	Master's degree 1/	Doctor's degree
1950	179,991	161,321	15,869	2,801
1955	241,657	219,715	18,779	3,163
1960	270,265	232,621	31,199	6,445
1965	309,083	250,928	44,208	13,947
1970	315,721	246,942	49,028	19,751
1975	309,553	245,143	49,664	14,746
1976	337,801	274,530	48,730	14,541
1977	371,277	307,072	48,499 2/	15,706 2/
1978	393,645	331,189	46,909 2/	15,547 2/
1979	430,493	363,408	50,179 2/	16,906 2/

1/ Also includes enrollment for other postgraduate predoctoral degrees.

2/ The distribution of part-time graduate students was estimated by the National Center for Education Statistics.

NOTE: Includes full-time and part-time degree-credit students.

SOURCE: (1) U.S. Department of Health, Education, and Welfare, National Center for Education Statistics, Engineering Degrees (1964-65) and Enrollments (Fall 1965). (2) Engineering Manpower Commission of Engineers Joint Council, reports on Engineering and Technology Enrollments. As published in Digest of Education Statistics, 1981, by the National Center for Education Statistics.

Table H-3. Bachelor's, Master's, and Doctor's Degrees Conferred by Institutions of Higher Education, by Sex of Student and by Selected Fields of Study: Aggregate United States, 1979-80

Major field of Study	Bachelor's degrees requiring 4 or 5 years			Master's degrees			Doctor's degrees (Ph.D., Ed.D., etc.)		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
All fields 1/	940,251	477,750	462,501	299,095	151,159	147,936	32,632	22,950	9,682
Agriculture and natural resources 1/	22,903	16,116	6,787	3,987	3,093	894	991	879	112
Natural resources management	1,936	1,293	643	235	180	55	30	25	5
Architecture and environmental design	9,176	6,628	2,548	3,157	2,257	900	79	66	13
Environmental design, general	986	670	316	135	84	51	2	2	-
Biological sciences 1/	47,111	27,135	19,976	6,536	4,111	2,425	3,638	2,691	947
Biology, general	34,252	19,446	14,806	2,933	1,866	1,067	718	517	201
Business and management	189,224	125,341	63,883	55,322	42,967	12,355	796	681	115
Communications	28,649	13,666	14,983	3,084	1,528	1,556	193	121	72
Computer and information sciences	11,213	7,814	3,399	3,647	2,883	764	240	213	27
Engineering 1/	69,265	62,827	6,438	16,250	15,108	1,142	2,507	2,412	95
Engineering, general	3,977	3,499	478	1,597	1,484	113	282	260	22
Aerospace, aeronautical, astronautical engineering	1,424	1,342	82	382	373	9	99	98	1
Chemical engineering	6,383	5,168	1,215	1,271	1,138	138	284	269	15
Petroleum engineering	893	821	72	122	111	11	25	25	-
Civil, construction, & transportation engineering	10,442	9,451	991	2,683	2,486	197	270	264	6

Table H-3. Bachelor's, Master's, and Doctor's Degrees Conferred by Institutions of Higher Education, by Sex of Student and by Selected Fields of Study: Aggregate United States, 1979-80--continued

Major field of study	Bachelor's degrees requiring 4 or 5 years			Master's degrees			Doctor's degrees (Ph.D., Ed.D., etc.)		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Electrical, electronics, communications engineering.....	13,902	13,000	902	3,842	3,658	184	525	511	14
Mechanical engineering...........	11,863	10,981	882	2,060	1,962	98	281	277	4
Geological engineering...........	222	182	40	36	32	4	2	2	-
Geophysical engineering..........	56	47	9	16	16	-	4	4	-
Industrial and management engineering....................	3,217	2,672	545	1,313	1,180	133	116	109	7
Mining and mineral engineering...	682	631	51	87	84	3	7	6	1
Engineering physics..............	254	236	18	52	49	3	18	16	2
Nuclear engineering..............	495	453	42	365	346	19	101	100	1
Engineering mechanics............	157	146	11	134	125	9	63	61	2
Environmental and sanitary engineering....................	285	231	54	472	408	64	39	37	2
Ocean engineering................	167	151	16	102	97	5	8	8	-
Engineering technologies.........	10,491	10,001	490	339	319	20	5	5	-
Health professions1/...............	64,597	11,446	53,151	15,812	4,387	11,425	786	435	351
Health professions, general......	5,225	1,640	3,585	819	403	416	61	39	22
Radiologic technologies..........	466	207	259	47	37	10	6	6	-
Mathematics........................	11,473	6,625	4,848	2,868	1,832	1,036	724	624	100
Mathematics, general.............	10,587	6,074	4,513	2,095	1,276	819	552	481	71
Statistics, mathematical and theoretical...................	247	143	104	495	362	133	115	91	24
Applied mathematics..............	396	252	144	179	127	52	41	39	2
Other............................	243	156	87	99	67	32	16	13	3

Table H-3. Bachelor's, Master's, and Doctor's Degrees Conferred by Institutions of Higher Education, by Sex of Student and by Selected Fields of Study: Aggregate United States, 1979-80--continued

Major field of study	Bachelor's degrees requiring 4 or 5 years			Master's degrees			Doctor's degrees (Ph.D., Ed.D., etc.)		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Physical sciences 1/	23,661	18,010	5,651	5,233	4,258	975	3,095	2,709	386
Physical sciences, general	1,040	818	222	129	105	24	20	20	-
Physics, general	3,297	2,899	398	1,177	1,063	114	818	756	62
Molecular physics	3	-	3	-	-	-	2	2	-
Nuclear physics	97	64	33	15	11	4	10	9	1
Chemistry, general	11,428	8,154	3,274	1,625	1,201	424	1,419	1,183	236
Inorganic chemistry	10	9	1	7	5	2	19	14	5
Organic chemistry	-	-	-	25	23	2	30	25	5
Physical chemistry	3	3	-	16	13	3	23	18	5
Analytical chemistry	2	-	2	8	6	2	15	15	-
Geology	4,442	3,337	1,105	1,192	973	219	260	238	22
Geochemistry	4	4	-	8	7	1	10	10	-
Geophysics and seismology	154	128	26	95	78	17	43	39	4
Earth sciences, general	931	699	232	183	125	58	46	42	4
Oceanography	252	198	54	142	115	27	79	71	8
Metallurgy	36	32	4	32	31	1	12	12	-
Interdisciplinary studies	34,908	17,377	17,531	4,952	2,861	2,091	401	283	118
General liberal arts & sciences	20,105	9,412	10,693	1,373	540	833	106	82	24
Biological & physical sciences	3,385	2,270	1,115	318	214	104	30	25	5
Humanities and social sciences	3,246	1,310	1,936	1,273	725	548	86	51	35
Engineering & other disciplines	466	400	66	935	867	68	17	16	1
Other	7,706	3,985	3,721	1,053	515	538	162	109	53

SOURCE: U.S. Department of Education, National Center for Education Statistics, Earned Degrees Conferred, 1979-80. As published in Digest of Education Statistics, 1981 by the National Center for Education Statistics.

1/ Subtotals do not add to totals because only selected disciplines shown.

Table H-4. Earned Degrees in the Physical Sciences[1/] Conferred by Institutions of Higher Education, by Level of Degree and by Sex of Student: Aggregate United States, Selected Years, 1959-60 to 1979-80

Year	Bachelor's degrees			Master's degrees			Doctor's degrees		
	Total	Men	Women	Total	Men	Woman	Total	Men	Women
1959-60	16,057	14,041	2,016	3,387	3,060	327	1,838	1,776	62
1969-70	21,551	18,582	2,969	5,948	5,101	847	4,313	4,077	236
1974-75	20,896	17,058	3,838	5,830	4,982	848	3,628	3,326	302
1976-77	22,618	18,067	4,551	5,345	4,458	887	3,344	3,024	320
1977-78	23,175	18,188	4,987	5,576	4,630	946	3,137	2,825	312
1979-80	23,661	18,010	5,651	5,233	4,258	975	3,095	2,709	386

1/ Includes degrees in astronomy, chemistry, geology, metallurgy, meteorology, physics, and other physical sciences.

NOTE: Although a strenuous effort has been made to provide a consistent series of data, minor changes have occurred over time in the way degrees are classified and reported. Any degrees classified in early surveys as "first professional" are included above with bachelor's degrees; any degrees classified as "second professional" or "second level" are included with master's degrees. Data for all years are for 50 States, The District of Columbia, and outlying territories.

SOURCE: U.S. Department of National Center for Education Statistics, reports on Earned Degrees Conferred. As published in Digest for Education Statistics, 1981, by the National Center for Education Statistics.

Table H-5. Earned Degrees in Engineering Conferred by Institutions of Higher Education, by Level of Degree and by Sex of Student: United States, Selected Years, 1949-50 to 1978-79

Year	Bachelor's degrees			Master's degrees			Doctor's degrees		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
1949-50	52,246	52,071	175	4,496	4,481	15	417	416	1
1959-60	37,679	37,537	142	7,159	7,133	26	786	783	3
1969-70	44,479	44,149	330	15,593	15,421	172	3,681	3,657	24
1974-75	46,852	45,838	1,014	15,348	14,973	375	3,108	3,042	66
1976-77	49,283	47,065	2,218	16,245	15,525	720	2,586	2,513	73
1977-78	55,654	51,945	3,709	16,398	15,533	865	2,440	2,383	57
1978-79	62,375	57,201	5,174	15,495	14,544	951	2,506	2,423	83

NOTE: Although a strenuous effort has been made to provide a consistent series of data, minor changes have occurred over time in the way degrees are classified and reported. Any degrees classified in early surveys as "first professional" are included above with bachelor's degrees; any degrees classified as "second professional" or second level" are included with master's degrees. Data for all years are for 50 States and the District of Columbia.

SOURCE: U.S. Department of Education, National Center for Education Statistics, surveys of Earned Degrees Conferred. As published in Digest of Education Statistics by the National Center for Education Statistics (1981)

Table H-6. Statistical Profile of Persons Receiving Doctorate Degrees,[1] by Selected Fields of Study: United States, 1979-80

Item	All fields	Fields of study			
		Engi-neering	Life sciences	Mathe-matics	Physical sciences
Total degrees conferred................	30,982[2]	2,479	5,325	745	3,151
Sex (percents):					
Men..................................	69.7	96.4	74.8	87.2	87.7
Women................................	30.3	3.6	25.2	12.8	12.3
Racial/ethnic group[3] (percents):					
American Indian......................	.4	.2	.2	-	.3
Asian................................	4.2	17.9	5.0	7.3	7.1
Black................................	4.2	1.2	1.5	2.1	.6
Hispanic.............................	1.8	1.8	1.0	.9	1.1
White................................	84.6	73.5	86.7	85.1	83.4
Other and unknown....................	4.9	5.5	5.6	4.6	7.5
Citizenship (percents):					
United States........................	81.0	50.6	80.4	69.8	75.9
Foreign..............................	15.9	46.3	17.6	27.1	21.6
Unknown..............................	3.1	3.1	2.0	3.1	2.4
Median age at doctorate (years)..........	32.2	30.3	30.0	29.3	29.1
Median time lapse from bachelor's degree to doctorate (years)...........	9.3	7.6	7.3	7.0	6.8
Percent with bachelor's degree in same field as doctorate...............	53.8	75.2	40.9	81.9	76.5

Table H-6. Statistical Profile of Persons Receiving Doctorate Degrees,1/ by Field of Study: United States, 1979-80--continued

Item	All fields	Fields of study: Engineering	Life sciences	Mathematics	Physical sciences
Primary postdoctoral work activity (percents):					
Research and development	25.6	64.7	47.5	39.3	70.4
Teaching	40.6	19.8	29.8	50.9	15.9
Administration	14.4	2.0	5.1	.9	2.1
Professional services	11.4	5.3	7.2	4.5	3.7
Other	3.2	3.1	4.7	1.3	3.7
Unknown	5.3	5.1	5.7	3.2	4.1

1/ Includes Ph.D., and comparable degrees at the doctoral level. Excludes first-professional degrees, such as M.D., D.D.S. and D.V.M.

2/ Includes degrees in computer sciences, social sciences, psychology, humanities, education, and other unspecified fields not shown separately.

3/ Excludes non-U.S. citizens with temporary visas.

NOTE: The above classification of degrees by field differs somewhat from that in most publications of the National Center for Education Statistics. The number of degrees also differs slightly from that reported in the NCES survey of earned degrees conferred. Because of rounding, percents may not add to 100.0.

SOURCE: National Academy of Sciences, National Research Council, Summary Report-1980, Doctorate Recipients from United States Universities, 1981.

Table H-7. Associate Degrees and Other Awards Based on Occupational Curriculums, by Length and Type of Curriculum and by Sex of Recipient: United States and Outlying Areas, 1978-79

	All awards			Awards based on organized occupational curriculums of- At least 2 years but less than 4 years			At least 1 year but less than 2 years		
	Total	Men	Women	Total	Men	Women	Total	Men	Women
Occupational curriculums, total...	352,708	190,501	175,656	278,632	132,925	145,707	74,076	30,716	43,360
Science and engineering-related curriculums....................	193,507	96,906	96,601	143,799	71,241	72,552	49,708	25,659	24,049
Data processing technologies....	12,454	6,573	5,881	10,833	6,031	4,802	1,621	542	1,079
Health services and paramedical technologies.................	90,022	11,150	78,872	68,208	9,097	59,111	21,814	2,053	761
Mechanical and engineering technologies.................	71,288	66,998	4,290	49,915	46,833	3,082	21,373	20,165	1,208
Natural-science technologies....	19,743	12,185	7,558	14,843	9,286	5,557	4,900	2,899	2,001
Non-science- and non-engineering-related curriculums............	159,201	66,735	92,466	134,833	61,678	73,155	24,368	5,057	19,311
Business & commerce technologies	121,261	46,652	74,609	100,214	43,129	57,085	21,047	3,523	17,524
Public service related technologies.....................	37,940	20,083	17,857	34,619	18,549	16,070	3,321	1,534	1,787

SOURCE: U.S. Department of Education, National Center for Education Statistics, Associate Degrees and Other Formal Awards Below the Baccalaureate, 1978-79.

Table H-8. Selected Characteristics of Scientists and Engineers, by Field: United States, 1976

Item	Field of science or engineering in 1976: Engineers	Mathematical specialists	Physical scientists	Environmental scientists
Total: Number	658,549	24,831	117,043	26,997
Percent	100.0	100.0	100.0	100.0
Sex: Male	99.6	86.5	92.5	96.8
Female	0.4	13.5	7.5	3.2
Race: White	96.7	93.2	94.3	98.1
Black	0.7	3.8	1.6	0.1
Japanese, Chinese, or Korean	2.2	2.5	3.3	1.4
Other races	0.5	0.5	0.8	0.4
Median age	45.8	41.0	44.0	46.0
Highest degree held:				
Associate	1.5	-	-	-
Bachelor's	68.1	28.6	34.1	42.7
Master's	22.3	30.1	18.5	28.3
Doctorate	5.3	40.7	47.3	28.9
Other degree	0.2	0.5	0.2	0.1
No degree	2.6	-	-	-
Employment status in February 1976:				
In labor force	93.2	93.4	92.9	94.5
Employed	91.3	91.6	91.5	93.6
Full-time	89.9	88.1	87.9	91.3
Part-time	1.2	3.0	2.4	1.3
Full- or part-time not reported	0.2	0.4	1.2	1.1
Unemployed	1.9	1.8	1.4	0.9
Not in labor force	6.8	6.6	7.1	5.5

Table H-8. Selected Characteristics of Scientists and Engineers, by Field: U. S., 1976--continued

Item	Field of science or engineering in 1976			
	Engineers	Mathematical specialists	Physical scientists	Environmental scientists
Primary work activities:[1]				
Research and development	30.1	12.7	42.0	29.4
Management or administration	33.7	22.0	25.1	27.1
Teaching and training	2.3	37.1	14.1	11.1
Production and inspection	15.1	4.0	9.4	6.6
Consulting	5.3	2.1	2.0	7.2
Report writing, statistical work, and computer applications	4.3	17.9	2.4	7.9
Other or not reported	9.2	4.2	5.0	10.8
Type of employer:[1]				
Business or industry	69.0	24.4	52.7	42.6
Educational institution	4.4	46.8	24.3	17.2
Nonprofit organization	1.6	2.4	3.6	1.5
Government	16.1	21.1	14.1	27.4
Self-employed	3.3	1.0	1.1	7.6
Median annual salary[1]	$23,176	$23,551	$23,132	$25,289

[1] Based on employment in February 1976.

NOTE: Because of rounding, details may not add to totals.

SOURCE: U.S. Department of Commerce, Bureau of the Census, "Current Population Reports", Series P-23, No. 76. As published in Digest of Education Statistics by the National Center for Education Statistics (1979).

Table H-9. Nuclear Engineering Degrees as a Percentage of All Engineering Degrees by Degree Level 1970 and 1975-80

Year ending June 30	All engineering	Nuclear engineering	Nuclear as percent of all engineering
		Bachelors	
1970	42,966	424	0.99
1975	38,210	529	1.38
1976	37,970	648	1.71
1977	40,094	758	1.89
1978	46,091	777	1.69
1979	52,598	746	1.42
1980	58,742	656	1.12
		Masters	
1970	15,548	413	2.66
1975	15,549	475	3.05
1976	16,506	468	2.84
1977	16,517	554	3.35
1978	16,182	487	3.00
1979	16,032	453	2.83
1980	17,243	366	2.12
		Doctorate	
1970	3,620	182	5.03
1975	3,138	101	3.22
1976	2,977	145	4.87
1977	2,814	121	4.30
1978	2,573	110	4.27
1979	2,815	117	4.16
1980	2,751	116	4.22

SOURCE: U.S. Department of Energy, Nuclear Engineering Enrollments and Degrees, 1977, DOE/IR-0011, p.7; and 1978, DOE/IR-0053; Oak Ridge Associated Universities, Nuclear Engineering Enrollements and Degrees, 1979 and 1980, ORAU-183.

Technical Notes Table H-9

Data in Table H-9 are based on the tenth annual survey of Nuclear Engineering Enrollments and Degrees. Each year the survey is sent to institutions offering degrees in nuclear engineering or other engineering disciplines with nuclear engineering options. The number of institutions included may vary from one year to the next as new programs are identified and other programs are discontinued.

The 1980 survey includes current data on 69 institutions which reported degrees and/or enrollments. Three institutions reported no students, during the last survey year, and three institutions have discontinued their nuclear engineering program.

Table H-10. Full-Time and Part-Time Graduate Enrollment (Fall 1980) and Degrees Granted (1979-80) in Radiation Protection by Subfield

Subfields	Number of enrollments (Fall 1980) — Master's candidates: Full-time	Master's candidates: Part-time	Master's candidates: Total	Doctoral candidates: Full-time	Doctoral candidates: Part-time	Doctoral candidates: Total	Degrees (1979-80): Bachelor's	Degrees (1979-80): Master's	Degrees (1979-80): Doctorates
Health Physics, Radiation Health, or Radiation Protection......	151	96	247	48	12	60	65	99	13
Radiobiology or Biophysics.....	32	4	36	123	1	124	33	19	23
Medical Radiation Physics or Radiological Physics..	87	20	107	77	11	88	0	35	10
Engineering or Basic Sciences, Health Physics Option.........	10	0	10	2	0	2	3	1	1
Other those listed separately by respondents....	25	2	27	32	11	43	35	20	3
Totals.....	305	122	427	282	35	117	136	174	50

NOTE: Percentages may not add to 100 because of rounding.

SOURCE: Oak Ridge Associated Universities. Radiation Protection Enrollments and Degrees, 1979 and 1980. ORAU-180, July 1981

Appendix H (continued)--Radiation Protection Enrollments and Degrees 1/

Data in Table H-10 are based on the tenth annual survey of Radiation Protection Enrollments and Degrees. Each year the survey is sent to institutions offering degrees in radiation protection and in other closely related fields (health physics, radiation health, radiological physics, radiobiology and similar programs) whose graduate would be prepared to conduct, coordinate, direct, or plan a program for the evaluation and control of radiation hazards in various settings. The number of institutions that are surveyed may change from year to year as new programs are identified and other programs are discontinued.

The 1980 survey included 55 institutions, including three which reported inactive programs.

The number of minorities remained at a low level. Undergraduate females increased in enrollment and degrees received.

Undergraduate enrollment was highest in the Middle Atlantic region, which had 32 percent of the total enrolled. However, the Pacific region contained the largest proportion of graduate students (25 percent of the total). By state, California awarded the largest number of degrees at all levels.

1/ Oak Ridge Associated Universities, Radiation Protection Enrollments and Degrees, 1979 and 1980, ORAU-180, July 1981

Table H-11. Major Field of Study for Highest Degree Held and Occupational Field of 1976 Graduates: Total and Energy-Related in 1978

(Technical Notes p.278)

Major Field of Occupation	Major Field of Study		Occupational Field in 1978	
	Total	Energy-Related	Total	Energy-Related
TOTAL....................	315,910	26,120	313,550	26,110
Total, engineering............	61,300	13,540	61,300	15,010
Chemical....................	4,330	1,840	4,370	1,573
Civil......................	10,460	1,920	8,440	1,484
Electrical or electronic....	14,470	2,040	13,096	1,892
Mechanical..................	9,300	3,230	10,177	3,820
Nuclear, petroleum, or mining	2,530	1,610	4,591	3,261
Other......................	20,210	2,900	20,618	2,992
Total, science................	243,650	12,210	96,100	7,050
Physical....................	13,870	1,590	10,061	1,807
Math and computer...........	24,630	1,860	22,262	1,431
Environmental...............	9,240	2,270	5,792	1,968
Life.......................	66,820	2,490	30,220	640
Psychology and social.......	129,090	4,000	27,773	1,203
Other.........................	10,960	370	156,150	4,050

NOTE: Totals for degree and for occupation may differ slightly since not all respondents answered both questions. Fractional weighting also results in small differences.

SOURCE: U.S.Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR/00033-TI, December 1979.

Table H-12. Activities of Energy-Related 1972 and 1976 Graduates by Major Energy Source in 1978 (Percent distribution)

(Technical Notes p.278)

Major Energy Source	1972 Graduates Scientists	1972 Graduates Engineers	1976 Graduates Scientists	1976 Graduates Engineers
Total, percent................	100.0	100.0	100.0	100.0
Coal and coal products......	11.8	19.2	13.3	16.2
Petroleum 1/................	34.4	27.4	31.0	31.0
Natural gas.................	12.5	11.2	8.6	15.9
Nuclear (fission & fusion)..	15.5	22.8	17.9	20.9
Solar.......................	14.5	5.5	7.7	6.3
Other.......................	9.6	8.3	10.3	6.4
No other....................	1.5	5.6	11.1	3.2

1/ Includes oil shale and tar sands.

NOTE: Figures may not add to 100.0 percent due to independent rounding.

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR-00033-TI, December 1979.

Table H-13. Major Energy-Related Activity of Energy-Related 1972 and 1976 Science and Engineering Graduates in 1978
(Percent distribution)

(Technical Notes, p.278)

Energy-related activity	1972 Graduates Scientists	1972 Graduates Engineers	1976 Graduates Scientists	1976 Graduates Engineers
Total, percent................	100.0	100.0	100.0	100.0
Exploration.................	28.9	3.0	25.3	5.2
Extraction..................	3.7	9.8	4.5	8.6
Manufacturing and processing	7.7	18.6	9.4	18.1
Electric power generation....	8.8	14.0	3.0	15.0
Transportation and storage...	4.9	10.2	5.2	9.0
Conservation.................	3.4	8.4	10.0	10.2
Environmental impact.........	6.3	2.7	7.8	4.8
Other.......................	24.2	14.8	20.8	13.0
No answer...................	12.0	18.5	13.2	16.2

NOTE: Figures may not add to 100.0 percent due to independent rounding.

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR/00033-TI, December, 1979.

Table H-14. Non-White Graduates as Percent of
All Graduates for Total and Energy-Related in 1978

(Technical Notes p.278)

Major field or occupation	Graduates Total 1972	Graduates Total 1976	Energy-Related 1972	Energy-Related 1976
<u>Major field</u>				
Science......................	5.0	6.3	5.0	5.4
Engineering..................	5.5	7.6	7.6	4.4
<u>Occupation</u>				
Science......................	5.6	7.1	3.9	4.9
Engineering..................	5.3	7.2	8.1	4.1

SOURCE: U.S. Department of Energy, <u>Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978</u>, DOE/IR-00033-TI, December 1979.

Table H-15. Female Graduates as Percent of
All Graduates for Total and Energy-Related in 1978

Major field or occupation	Graduates Total 1972	Graduates Total 1976	Energy-Related 1972	Energy-Related 1976
<u>Major field</u>				
Science......................	27.6	35.6	13.3	23.7
Engineering..................	1.0	3.7	.8	4.3
<u>Occupation</u>				
Science......................	23.4	32.4	15.1	18.3
Engineering..................	2.7	6.2	2.1	5.5

SOURCE: U.S. Department of Energy, <u>Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978</u>, DOE/IR-00033-TI, December 1979.

Table H-16. Field of Employment of Energy-Related Recent Science and Engineering Graduates and Experienced Workers in 1978 (Percent)

(Technical Notes p.278)

Field of employment	Scientists and Engineers		
	1972 Graduates	1976 Graduates	Experienced workers
Total	7.0	8.3	12.0
Total, engineering	23.2	24.5	14.3
Chemical	32.0	35.9	23.7
Civil	10.0	17.5	7.5
Electrical or electronic	13.8	14.4	12.0
Mechanical	40.0	37.5	18.8
Other	25.5	24.8	14.6
Total, science	6.8	7.3	8.9
Physical	15.4	18.0	7.4
Environmental	33.2	34.0	48.9
Other	3.7	4.1	3.4
Other	2.0	2.6	9.4

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR-00033-TI, December 1979.

Table H-17. Percent Distribution of Total and Energy-Related 1976 Science and Engineering Graduates, by Type of Employer in 1978

(Technical Notes p.278)

Type of employer	Scientists Total	Scientists Energy-related	Engineers Total	Engineers Energy-related
Total, percent	100.0	100.0	100.0	100.0
Private industry	35.2	59.3	78.5	82.9
Educational institution	27.1	22.9	5.5	7.8
Federal government	7.5	7.0	7.8	5.0
State and local government	12.1	4.8	4.4	0.3
Non-profit organization	6.8	3.6	0.7	1.1
Other	11.4	1.1	3.0	0.5
No answer	0.0	2.3	0.0	2.5

NOTE: Figures may not add to 100.0 percent due to independent rounding.

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR-00033-TI, December 1979.

Table H-18. Primary Work Activity of Energy-Related Recent Science and Engineering Graduates and Experienced Workers in 1978
(Percent distribution)

(Technical Notes p.278)

Primary Work Activity	Scientists 1972 Graduates	Scientists 1976 Graduates	Scientists Experienced Graduates	Engineers 1972 Graduates	Engineers 1976 Graduates	Engineers Experienced Graduates
Total, percent...........	100.0	100.0	100.0	100.0	100.0	100.0
Management.............	8.5	6.2	20.6	21.3	14.5	27.6
Teaching...............	3.3	3.3	1.1	1.7	0.7	0.6
Basic research.........	14.5	17.3	4.5	1.5	2.5	0.4
Applied research.......	14.7	21.8	15.2	6.8	5.4	3.1
Development............	5.0	5.7	11.1	9.4	9.1	10.7
Report, tech. writing....	7.1	5.1	4.7	5.6	7.0	2.6
Design..................	1.1	2.1	1.6	17.1	19.3	18.8
Quality Control..........	6.0	5.1	4.7	5.1	7.6	3.5
Operations...............	2.4	1.5	5.1	15.1	20.4	12.8
Distribution............	0.0	1.9	0.4	2.4	2.2	3.4
Consulting..............	7.1	1.1	10.9	5.7	4.8	8.3
Other...................	30.2	25.6	19.9	8.4	6.5	8.2

NOTE: Figures may not add to 100.0 percent due to independent rounding.

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR-00033-TI, December 1979.

Appendix H (continued)--Energy-Related Scientists and Engineers

A recent report[1/] examines the characteristics of scientists and engineers who graduated during the years 1972, 1974, 1975, and 1976, with special attention to those whose work involves energy. The information is based on the results of the 1976 and 1978 National Survey of Recent Science and Engineering Graduates, sponsored by the National Science Foundation (NSF). The 1978 survey, for the first time, included questions on employment in specific types of energy fields and activities. The sample size was also enlarged in the second survey to include more energyrelated graduates.

The first two sections of the report present data from the 1978 National Survey of Recent Science and Engineering Graduates, conducted by Westat, Inc. for the National Science Foundation and the U.S. Department of Energy. Westat surveyed 14,439 science and engineering graduates; 6,529 earned a bachelor's or master's degree between July 1, 1971 and June 30, 1972 (1972 graduates); and 7,910 received a bachelor's or master's degree between July 1, 1975 and June 30, 1976 (1976 graduates). Responses from these individuals were weighted to represent a total of 376,000 1972 graduates, and 377,000 1976 graduates.

The third section of the report compares the results of the 1976 and 1978 National Survey of Recent Science and Engineering Graduates. The shorter 1976 survey included 9,812 persons who received a bachelor's or master's degree in science or engineering between July 1, 1973 and June 30, 1975.

1/ U.S. Department of Energy, Office of Education, Business and Labor Affairs, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/IR/00033-TI, December 1979.

Data from the 1976 National Survey of Natural Social Scientists conducted for NSF by the Bureau of the Census, are compared with the recent graduates survey data in a fourth section. The sample for this survey was drawn from persons who were identified as scientists and engineers in the work force during the 1970 Census of Population. Although there are differences between this and the Westat surveys, some of the results can be compared.

One of the questions in the 1978 Westat surveys asked respondents to check the area of critical national interest (if any) to which they devoted a significant proportion of professional time. Those who answered this question by checking "energy and fuel" were considered to be energy-related. (The question allows only one choice.) Persons working on the environmental or health effects of energy use may have chosen "health" or "environmental protection, pollution control" instead of "energy and fuel." Persons who selected "energy and fuel" may be considered a core group of energy-related workers; the total number of persons whose work involves some aspect of energy is probably much larger.

The report contains 55 text tables and 42 detailed appendix tables.

Appendix H-19. Fields of Training for Nuclear Power [1/]

The compilation of education, training, and experience programs for nuclear power plant and facility personnel offered by United States private industrial and consulting organizations was prepared at the request of the International Atomic Energy Agency for the Energy Research and Development Administration in the former's Conference on Nuclear Power and Its Fuel Cycle, Salzburg, Austria (May 2-13, 1977). It represents an update and enlargement of the industrial portion of Appendix D to Utility Staffing and Training for Nuclear Power (WASH 1130), published by the United States Atomic Energy Commission in June 1973.

The listing of a program and organization here does not constitute endorsement by the Energy Research and Development Administration (ERDA), nor is the compilation intended to be an exhaustive list of the programs available. The programs listed and described represent responses to a letter sent to all organizations listing "Training" in the 1976 and 1977 Buyers Guide published by the American Nuclear Society. Descriptions are either quoted as submitted or paraphrased from submitter's copy. The opportunities for training listed here supplement the numerous, more formalized programs available in U.S. institutions of higher education. Other nuclear education and training opportunities are available through trade unions, federal agencies and professional societies.

[1/] Energy Research and Development Administration, Office of University Programs, Manpower Assessment Office, Industrial Training for Nuclear Power, January 1977.

FIELDS OF TRAINING FOR NUCLEAR POWER AND FIRMS OFFERING PROGRAM

ACCOUNTING
- Nuclear Associates International, Inc.

AIR CLEANING SYSTEMS
- American Air Filter Co., Inc.
- Ebasco Services, Inc.

CHEMISTRY OR RADIOCHEMISTRY
- Babcock & Wilcox, Lynchburg
- General Electric Co.
- Westinghouse Electric Corp., Pittsburgh

COMPUTERS - Hard & software
- Electronic Associates, Inc.
- Energy Incorporated
- General Electric Co.
- Honeywell
- Nuclear Associates International, Inc.

ENGINEERING AND MANAGEMENT
- Applied Health Physics, Inc.
- Atomics International
- Babcock & Wilcox, Lynchburg
- James J. Barker
- Basic Technology, Inc.
- Black & Veatch
- Combustion Engineering, Inc.
- Energy Incorporated
- General Electric Co.
- General Physics Corp.
- L. Marvin Johnson and Associates, Inc.
- Newport News Industrial Corp.
- Nuclear Plant Services
- NUS Corporation
- NUSAC, Incorporated
- NUTECH
- Science Applications, Inc.
- STAT-A-MATRIX Institute
- Westinghouse Corp., Pittsburgh

EQUIPMENT AND SUBSYSTEMS
- Babcock & Wilcox, Barberton
- Combustion Engineering, Inc.
- Ebasco Services, Inc.
- Electronic Associates, Inc.
- General Physics Corp.
- Newport News Industrial Corp.
- NUS Corporation

INSTRUMENTATION
- Babcock & Wilcox, Lynchburg
- Combustion Engineering, Inc.
- Ebasco Services, Inc.
- Eberline Instrument Corp.
- General Electric Co.
- General Physics Corp.
- Nuclear Plant Services
- NUTECH
- Radiation Management Corp.
- Westinghouse Electric Corp., Baltimore
- Westinghouse Electric Corp., Pittsburgh

INSPECTION AND NONDESTRUCTIVE EXAMINATION
- General Electric Co.
- Energy Incorporated
- Magnaflux Corp.
- Newport News Industrial Corp.
- Nuclear Plant Services
- NUTECH
- STAT-A-MATRIX Institute
- Superintendence Co., Inc.

LICENSING
- EDS Nuclear
- Ebasco Services
- Science Applications, Inc.

PIPING, PUMPS, AND VALVES
- Basic Technology, Inc.
- EDS Nuclear
- NUTECH
- J.D. Stevenson, Consultants

PLANT MAINTENANCE
- Babcock & Wilcox, Barberton
- Babcock & Wilcox, Lynchburg
- General Electric Co.
- General Physics Corp.
- Nuclear Plant Services
- Westinghouse Electric Corp., Baltimore
- Westinghouse Electric Corp., Pittsburgh

PLANT OPERATIONS
- Black & Veatch
- General Electric Co.
- NUS Corporation
- Westinghouse Electric Corp.

PRESSURE VESSELS
- Basic Technology, Inc.
- NUTECH

QUALITY ASSURANCE/CONTROL
- Ebasco Services, Inc.
- Energy Incorporated
- EDS Nuclear
- General Physics Corp.
- L. Marvin Johnson & Associates
- Newport News Industrial Corp.
- Nuclear Plant Services
- NUSAC, Incorporated
- NUTECH
- Science Applications, Inc.
- STAT-A-MATRIX Institute
- J.D. Stevenson, Consultants
- Superintendence Co., Inc.

RADIATION PROTECTION
- Applied Health Physics, Inc.
- Atomics International
- Eberline Instrument Corp.
- General Electric Co.
- General Physics Corp.
- Institute for Resource Management, Inc.
- Magnaflux Corporation
- Newport News Industrial Corp.
- Nuclear Plant Services
- NUSAC, Inc.
- Phoenix Technology Corp.
- Porter-Gertz Consultants, Inc.
- Radiation Management Corp.
- Science Applications, Inc.
- Superintendence Co., Inc.
- Turco Products
- Westinghouse Electric Corp., Pittsburgh

RADWASTE
- Ebasco Services, Inc.
- Energy Incorporated
- Nuclear Plant Services
- Radiation Management Corp.

REACTOR CORE
- Nuclear Associates International, Inc.

REACTOR OPERATION
- Atomics International
- Babcock & Wilcox, Lynchburg
- Combustion Engineering, Inc.
- Electronic Associates, Inc.
- General Electronic Co.
- General Physics Corp.
- Institute for Resource Management, Inc.
- Nuclear Associates International, Inc.
- NUS
- STAT-A-MATRIX Institute
- Westinghouse Electric Corp., Pittsburgh

SAFETY AND SECURITY
- Applied Health Services, Inc.
- Basic Technology, Inc.
- Ebasco Services, Inc.
- Energy Incorporated
- Robert J. Kopp and Associates, Inc.
- Magnaflux Corporation
- Nuclear Associates International, Inc.
- NUSAC, Incorporated
- Porter-Gertz Consultants, Inc.
- Radiation Management Corp.
- STAT-A-MATRIX Institute

SEISMIC AND SHOCK ANALYSIS
- EDS Nuclear
- J.D. Stevenson, Consultants
- Tustin Institute of Technology, Incorporated
- Wyle Laboratories

SODIUM LOOP
- Atomics International

STAFFING
- General Physics Corp.

START-UP AND SHUT-DOWN
- Atomics International
- Babcock & Wilcox, Lynchburg
- Ebasco Services, Inc.
- General Electric Co.
- General Physics Corp.
- Institute for Resource Management, Inc.
- Westinghouse Electric Corp., Pittsburgh

WELDING
- Newport News Industrial Corp.

Appendix H-20

Schools Offering Post-Secondary Coal Mining Technology Programs[1/]

Alabama

Walker State Technical College (Sumiton)

Arizona

Eastern Arizona College (Thatcher)

Northland Community College[2/]

Colorado

Colorado Mountain College (Glenwood Springs)

Illinois

Wabash Valley College (Mt. Carmel)[3/]

Rend Lake College (Ina)

Southeastern Illinois College (Harrisburg)

Indiana

Indiana Vocational Technical College (Terre Haute)

Indiana State University (Evansville)

Kentucky

Hazard Community College (Hazard)

Lees Junior College (Jackson)

Madisonville Community College (Madisonville)

Morehead State University (Morehead)

Murray State (Murray)

Pikeville College (Pikeville)

Southeast Community College (Cumberland)

Ohio

Belmont Technical College (St. Clairsville)

Rio Grande Community College (Rio Grande)

Pennsylvania

Penn State University (Altoona)

Penn State University (Fayette)

University of Pittsburgh (Johnstown)

Utah

College of Eastern Utah (Price)

Virginia

Mountain Empire Community College (Big Stone Gap)

Southwest Va. Community College (Richlands)

West Virginia

Alderson-Broaddus College (Philippi)

Beckley College (Beckley)

Bluefield State College (Bluefield)

Concord College (Athens)

Fairmount State College (Firmount)

Northern W. Va. Community College Wheeling)

Southern W. Va. Community College (Williamson)

W. Va. Intitute of Technology (Montgomery)

West Virginia University (Morgantown)

Wyoming

Casper College (Casper)

Western Wyoming Community College (Sheridan)

1/ This list is not a complete one.
2/ New community college being planned.
3/ and off-site attendance centers in Virden, Carterville, and Belleville.

SOURCE: Manpower for Coal Mining: Supply-Demand-Training, Energy Research and Development Administration, September 1979.

Appendix I. Compensation of Scientists and Engineers Engaged in Research and Development Activities

The information in Tables I-1 through I-4 is based on a Battelle Columbus Laboratories compensation survey of 18 DOE contractor-operated laboratories compared with data from Battelle report, "1978 National Survey of Compensation Paid Scientists and Engineers in Research and Development Activities." The surveys included the following types of establishments:

Type of Establishment	Number of Establish-ments	Number of Scientists & Engineers
Industry..........................	230	57,186
Federal Laboratories..............	17	4,749
Federal Contract Research Centers.	16*	13,053
Non-Profit Research Institutes....	31	5,671
Universities......................	16	3,158
Total Survey.................	310	83,817
DOE Laboratories..................	18	17,829

To present an equitable comparison between DOE Labs and the National Survey, the National Survey average salary for "All Degree Levels" is a composite figure that is calculated by weighting the average salary for each degree level in the National Survey by the DOE Lab population for the corresponding degree level to recognize the higher PhD ratio in DOE Labs.

*Includes 7 DOE Laboratories

Table I-1. Median Salary for Total and Energy-Related 1976 Science and Engineering Graduates by Field of Employment in 1978

Field of Employment	Scientists and Engineers		Ratio of Energy-Related to Total
	Total	Energy-Related	
Total	$12,500	$17,500	1.40
Total, engineering	17,700	18,400	1.04
Chemical	19,000	20,000	1.05
Civil	16,800	18,000	1.07
Electrical or electronic	18,000	18,000	1.00
Mechanical	18,000	18,000	1.00
Nuclear, petroleum, or mining	18,300	19,500	1.07
Other	17,000	18,200	1.07
Total, science	12,000	15,000	1.25
Physical	12,000	14,000	1.17
Math and computer	16,000	17,000	1.06
Environmental	13,500	18,200	1.35
Life	10,400	10,000	0.96
Psychology and social	11,000	15,600	1.42
Other	11,500	13,000	1.04

NOTE: All figures have been rounded to the nearest hundred. Salaries for respondents academically employed for 9 to 10 months have been adjusted by a factor of 11/9.

SOURCE: U.S. Department of Energy, Energy-Related Scientists and Engineers: A Statistical Profile of Recent Entrants into the Work Force, 1978, DOE/OR/00033-TI

Table I-2. Monthly Salaries of Scientists and Engineers Engaged in Research and Development Activities by Degree and Field of Degree*, 1977-78

Degree and field	Total National Survey 1977	Total National Survey 1978	DOE Laboratories 1977	DOE Laboratories 1978
Bachelor's				
All Fields	$1,900	$2,047	$2,004	$2,152
Engineering	1,956	2,116	2,087	2,260
Chemistry	1,782	1,875	1,912	2,004
Physics	1,999	2,168	1,959	2,120
Mathematics-Statistics	1,816	1,925	1,783	1,929
Master's				
All Fields	2,084	2,255	2,066	2,206
Engineering	2,126	2,322	2,117	2,266
Chemistry	1,996	2,100	2,006	2,114
Physics	2,122	2,495	2,097	2,260
Mathematics-Statistics	2,034	2,354	1,963	2,104
PhD				
All Fields	2,329	2,458	2,329	2,483
Engineering	2,397	2,591	2,351	2,523
Chemistry	2,400	2,460	2,380	2,523
Physics	2,348	2,490	2,308	2,473
Mathematics-Statistics	2,326	2,412	2,353	2,509

*Does not include Middle Management.
See source on Table I-4.

Table I-3. Monthly Salaries of Scientists and Engineers Engaged in Research and Development by Degree and Level of Activity, 1977-78

Degree and activity	Total National Survey 1977	Total National Survey 1978	DOE Laboratories 1977	DOE Laboratories 1978
Bachelor's				
Middle Management	$2,689	$3,154	$2,934	$3,283
Unit Head	2,505	2,707	2,647	2,904
Assistant Unit Head	2,150	2,356	2,318	2,568
Non-Supervisory	1,810	1,959	1,920	2,055
Master's				
Middle Management	2,854	3,294	2,931	3,269
Unit Head	2,569	2,806	2,699	2,915
Assistant Unit Head	2,270	2,446	2,391	2,590
Non-Supervisory	1,997	2,169	1,983	2,109
PhD				
Middle Management	3,155	3,349	3,085	3,317
Unit Head	2,665	2,876	2,838	3,017
Assistant Unit Head	2,454	2,595	2,505	2,720
Non-Supervisory	2,252	2,364	2,241	2,388

See source on Table I-4.

Table I-4. Percent Distribution of Expenditures for Supplementary Compensation by DOE Contractors, 1976-77*

Type of expenditure	1976 ALL	1976 R&D	1977 ALL	1977 R&D
TOTAL	100.0	100.0	100.0	100.0
Pay for Working - Straight Time Pay	70.4	72.0	70.6	71.8
Premium Pay	1.4	1.0	1.3	1.0
Paid Leave	9.4	9.7	9.0	9.4
Retirement Programs	11.2	10.5	11.4	11.1
Life Insurance and Health Benefits	6.1	5.6	6.3	5.9
Unemployment Benefits, Non-production Bonuses, Savings and Thrift	1.4	1.1	1.3	1.1

NOTE: Because of rounding, sums of individual items may not equal 100%.

*Covers white collar employees including professionals, executives, administrators, managers, other supervisors, office, clerical, and other non-production workers.

SOURCE: U.S. Department of Energy, Oak Ridge Operations Office <u>Comparison of compensation paid Scientists and Engineers in Research and Development</u>, DOE National Survey of Compensation

Appendix J. Occupational Outlook [1]

The Occupational Outlook Handbook contains information on job duties, educational requirements, employment outlook, and earnings for several hundred occupations and 35 industries. It also includes some information on occupational training, on the movement of workers from one occupation to another and typical paths of advancement within a career field. The Handbook information is based on data received from a variety of sources, including business firms, trade associations, labor unions, professional societies, educational institutions, and government agencies, and represents the most current and comprehensive information available.

Although the discussions of future job prospects contained in the Handbook are written in qualitative terms, the analyses upon which they are based begin with quantitative estimates of projected employment, replacement openings, and--in a few cases--supply.

The projections were developed using the most recent data available on population, industry and occupational employment, productivity, consumer expenditures, and other factors expected to affect employment.

Experts in government, industry, unions, professional societies, and trade associations furnished data and supplied information through interviews. Many of these individuals also reviewed preliminary drafts of the statements.

After the information from these sources was compiled, it was analyzed in conjunction with the BLS model of the economy in 1985. Like other models used

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[1] U.S. Department of Labor, Bureau of Labor Statistics, Occupational Outlook Handbook, 1978-79 Edition, Bulletin 1955, December 1978.

in economic forecasting, it encompasses the major facets of the economy and represents a comprehensive view of its projected structure.

In addition to a projection of employment for each occupation, a projection is made of the number of workers who will be needed as replacements. In most occupations, more workers are needed to replace those who retire, die, or leave the occupation than are needed to fill jobs created by growth. Consequently, even some declining occupations offer employment opportunities.

To estimate replacement openings, the Bureau has developed tables of working life based on actuarial experience for deaths and on decennial census data for general patterns of labor force participation by age and sex. Withdrawals from each occupation are calculated separately for men and women by age group and used to compute an overall separation rate for the occupation. These rates are used to estimate average annual replacement needs for each occupation over the projection period.

Supply estimates used in analysis of certain Handbook occupations represent the numbers of workers who are likely to seek entry to a particular occupation if past trends of entry to the occupation continue. These estimates are developed independently of the demand estimates. Thus, supply and demand are not discussed in the usual economic sense in which wages play a major role in equating supply and demand. Statistics on college enrollments and graduations by field are the chief sources of information on the potential supply of personnel in professional, technical, and other occupations requiring extensive formal education. Data on persons completing apprenticeship programs provide some information on new entrants into skilled trades.

The following is given to illustrate the type of material contained in the Handbook.

PETROLEUM ENGINEERS

(D.O.T. 010.081)

Nature of the Work

Petroleum engineers are mainly involved in exploring and drilling for and producing oil and gas. They work to achieve the maximum profitable recovery of oil and gas from a petroleum reservoir by determining and developing the best and most efficient production methods.

Since only a small proportion of the oil and gas in a reservoir will flow out under natural forces, petroleum engineers develop and use various artificial recovery methods such as flooding the oil field with water to force the oil to the surface. Even when using the best recovery methods, about half the oil is still left in the ground. Petroleum engineers' research and development efforts to increase the proportion of oil recovered in each reservoir can make a significant contribution to increasing available energy resources.

Places of Employment

About 20,000 petroleum engineers were employed in 1976, mostly in the petroleum industry and closely allied fields. Their employers include not only the major oil companies, but also the hundreds of smaller independent oil exploration and production companies. They also work for companies that produce drilling equipment and supplies. Some petroleum engineers work in banks and other financial institutions which need their knowledge of the economic value of oil and gas properties. A small number work for engineering consulting firms or as independent consulting engineers, and for the Federal and State governments.

The petroleum engineer's work is concentrated in places where oil and gas are found. Almost three-fourths of all petroleum engineers are employed in the oil-producing States of Texas, Oklahoma, Louisiana, and California. There are many American petroleum engineers working overseas in oil-producing countries.

Employment Outlook

The employment of petroleum engineers is expected to grow faster than the average for all occupations through the mid-1980's. Economic expansion will require increasing supplies of petroleum and natural gas, even with energy conservation measures. With efforts to attain energy self-sufficiency, and high petroleum prices, increasingly sophisticated and expensive recovery methods will be used. Also, new sources of oil such as oil shale and new offshore oil sources may be developed. All of these factors will contribute to increasing demand for petroleum engineers.

Sources of Additional Information

Society of Petroleum Engineers of AIME,
6200 North Central Expressway
Dallas, Texas 75206

Occupations in Petroleum and Natural Gas Production and Gas Processing[2/]

Nature and Location of the Industry

Occupations in the Industry

Exploration

- Petroleum geologists
- Paleontologists
- Mineralogists
- Stratigraphers
- Photogeologists
- Petrologists
- Drafters
- Surveyors
- Geophysicists
- Prospecting computers
- Observers
- Scouts
- Lease buyers

Drilling

- Rig builders
- Rig-builder helpers
- Tool pushers or drilling supervisors
- Rotary rig engine operators
- Derrick operators
- Rotary drill helpers
- Roustabouts

Well Operation and Maintenance

- Petroleum engineers
- Pumpers
- Switchers
- Gaugers
- Treaters

Natural Gas Processing

- Dehydration-plant operators
- Gas-plant operators
- Gas-compressor operators

Other Oilfield Services

- Cementers
- Acidizers
- Perforator operators
- Sample-taker operators
- Well pullers

Offshore Operations

* * * * * * *

Training, Other Qualifications, and Advancement

Employment Outlook

Earnings and Working Conditions

Sources of Additional Information

[2/] Subheadings only are shown, detailed text is omitted.

Appendix K. Dictionary of Occupational Titles [1/]

Work is organized in a variety of ways. As a result of technological, economic and sociological influences, nearly every job in the economy is performed slightly differently from any other job. Every job is also similar to a number of other jobs.

In order to look at the millions of jobs in the U.S. economy in an organized way, the DOT groups jobs into "occupations" based on their similarities and defines the structure and content of all listed occupations. Occupational definitions are the result of comprehensive studies of how similar jobs are performed in establishments all over the nation and are composites of data collected from diverse sources. The term "occupation," as used in the DOT, refers to this collective description of a number of individual jobs performed, with minor variations, in many establishments.

There are six basic parts to an occupational definition. They present data about a job in a systematic fashion. The parts are listed below in the order in which they appear in every definition:

(1) The Occupational Code Number
(2) The Occupational Title
(3) The Industry Designation
(4) Alternate Titles (if any)
(5) The Body of the Definition
  (a) Lead statement
  (b) Task element statements
  (c) "May" items
(6) Undefined Related Titles (if any)

An example of an energy-related occupation follows:

914.362-010 COAL PIPE LINE OPERATOR (pipe lines)

Controls, from master panel, semiautomatic processing plant that pulverizes and mixes coal with water and introduces resulting slurry into pipeline for transportation. Moves controls to start and regulate conveyors, pumps, grinding mills, tank agitators, and auxillary equipment that convert coal to slurry of specified density and acidity, following standard procedures. Reviews laboratory reports and observes panel lights, flowmeters, and recording instruments to maintain standard conditions in plant and pipeline. Gives directions to assistant to open valves that regulate admission of slurry into pipeline and to make manual adjustments to processing and distribution equipment. Maintains operating log from instrument readings. May control booster pumping stations from panel or direct station operations by telephone.

[1/] U.S. Department of Labor, Employment and Training Administration, Dictionary of Occupational Titles, Fourth Edition, 1977.

Appendix L. Standard Industrial Classification (SIC) Definitions for Selected Energy Industries

Anthracite Mining, SIC 11

This major group includes establishments primarily engaged in producing anthracite (hard coal). Included are mining operations, dredging operations, and preparation plants whether or not such plants are operated in conjunction with the mines served.

Bituminous Coal and Lignite Mining, SIC 12

This major group includes establishments primarily engaged in producing bituminous coal or lignite. Included are mining operations and preparation plants whether or not such plants are operated in conjunction with the mines served.

Oil and Gas Extraction, SIC 13

This major group includes establishments primarily engaged in: (1) producing crude petroleum and natural gas, (2) recovering oil from oil sands and oil shale, and (3) producing natural gasoline and cycle condensate. Types of activities included are exploration, drilling, oil and gas well operation and maintenance, the operation of natural gasoline and cycle plants, and the mining and extraction of oil from oil sands and oil shale. This major group also includes such basic activities as emulsion breaking and desilting of crude petroleum in the preparation of oil and gas customarily done at the field site.

Petroleum Refining, SIC 291

Establishments primarily engaged in producing gasoline, kerosene, distillate fuel oils, residual fuel oils, lubricants and other products from crude petroleum and its fractionation products, through straight distillation of crude oil, redistillation of unfinished petroleum derivatives, cracking or other processes.

Miscellaneous Products of Petroleum and Coal, SIC 299

Establishments primarily engaged in blending, compounding and re-refining lubricating oils and greases from purchased mineral, animal, and vegetable materials; and those engaged in manufacturing fuel briquettes, boulets, packaged fuel, powdered fuel, and other products of petroleum and coal, not elsewhere classified.

Mining Machinery and Equipment, Except Oil Field, SIC 3532

Establishments primarily engaged in manufacturing heavy machinery and equipment used by the mining industries, such as coal breakers, mine cars, mineral cleaning machinery, concentration machinery, core drills, coal cutters, portable rock drills, and rock crushing machinery.

Oil Field Machinery and Equipment, SIC 3533

Establishments primarily engaged in manufacturing machinery and equipment for use in oil and gas fields or for drilling water wells.

Pipe Lines, Except Natural Gas, SIC 46

This major group includes establishments primarily engaged in the pipe line transportation of petroleum and other commodities, except natural gas (Industry 4922). Pipe lines operated by petroleum producing or refining companies and separately reported are included.

Electric, Gas, and Sanitary Services, SIC 49

This major group includes establishments engaged in the generation, transmission and/or distribution of electricity or gas or steam. Such establishments may be combinations of any of the above three services and also include other types of service such as transportation, communication, and refrigeration. Water and irrigation systems, and sanitary systems engaged in the collection and disposal of garbage, sewage, and other wastes by means of destroying or processing materials, are also included.

Electric Services, SIC 491

Establishments engaged in the generation, transmission and/or distribution of electric energy for sale.

Gas Production and Distribution, SIC 492

Establishments engaged in natural gas transmission and distribution and/or storage of natural gas for sale; and mixed, manufactured or liquefied petroleum gas production and/or distribution.

Combination Electric and Gas, and Other Utility Services, SIC 493

Establishments providing electric or gas services in combination with other services. Establishments are classified here only if one service does not constitute 95 percent or more of revenues.

Steam Supply, SIC 496

Establishments engaged in the production and/or distribution of steam and heated or cooled air for sale.

Irrigation Systems, SIC 497

Establishments primarily engaged in operating water supply systems for the purpose of irrigation.

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