

SIGNIFICANT POINTS

- Most establishments employ fewer than 10 workers.
- About 77 percent of the industry's workforce is concentrated in California, Louisiana, Oklahoma, and Texas.
- Although technological innovations have expanded exploration and development worldwide, employment is expected to decline; however, workers with experience in oilfield operations are in demand.
- Earnings are relatively high.

Nature of the Industry

Petroleum, commonly referred to as oil, is a natural fuel formed from the decay of plants and animals buried beneath the ground, under tremendous heat and pressure, for millions of years. Formed by a similar process, natural gas often is found in separate deposits and is sometimes mixed with oil. Because oil and gas are difficult to locate, exploration and drilling are key activities in the oil and gas extraction industry. Oil and natural gas furnish about three-fifths of our energy needs, fueling our homes, workplaces, factories, and transportation systems. In addition, they constitute the raw materials for plastics, chemicals, medicines, fertilizers, and synthetic fibers.

Using a variety of methods, on land and at sea, small crews of specialized workers search for geologic formations that are likely to contain oil and gas. Sophisticated equipment and advances in computer technology have increased the productivity of exploration. Maps of potential deposits now are made using remote-sensing satellites. Seismic prospecting—a technique based on measuring the time it takes sound waves to travel through underground formations and return to the surface—has revolutionized oil and gas exploration. Computers and advanced software analyze seismic data to provide three-dimensional models of subsurface rock formations. This technique lowers the risk involved in exploring by allowing scientists to locate and identify structural oil and gas reservoirs and the best locations to drill. Four-D, or “time-lapsed,” seismic technology tracks the movement of fluids over time and enhances production performance even further. Another method of searching for oil and gas is based on collecting and analyzing core samples of rock, clay, and sand in the earth's layers.

After scientific studies indicate the possible presence of oil, an oil company selects a wellsite and installs a derrick—a tower-like steel structure—to support the drilling equipment. A hole is drilled deep into the earth until oil or gas is found, or the company abandons the effort. Similar techniques are employed in offshore drilling, except that the drilling equipment is part of a steel platform that either sits on the ocean floor, or floats on the surface and is anchored to the ocean floor. Although some large oil companies do their own drilling, most land and offshore drilling is done by contractors.

In rotary drilling, a rotating bit attached to a length of hollow drill pipe bores a hole in the ground by chipping and cutting rock. As the bit cuts deeper, more pipe is added. A stream of drilling “mud”—a mixture of clay, chemicals, and water—is continuously pumped through the drill pipe and through holes in the drill bit. Its purpose is to cool the drill bit, plaster the walls of the hole to prevent cave-ins, carry crushed rock to the surface, and prevent “blowouts” by equalizing pressure inside the hole. When a drill bit wears out, all drill pipe must be removed from the hole a section at a time, the bit replaced, and the pipe returned to the hole. New materials and better designs have advanced drill bit technology, permitting faster, more cost-effective drilling for longer periods.

Advancements in directional or horizontal drilling techniques, which allow increased access to potential reserves, have had a significant impact on drilling capabilities. Drilling begins vertically, but the drill bit can be turned so that drilling can continue at an angle of up to 90 degrees. This technique extends the drill's reach, enabling it to reach separate pockets of oil or gas. Because constructing new platforms is costly, this technique commonly is employed by offshore drilling operations.

When oil or gas is found, the drill pipe and bit are pulled from the well, and metal pipe (casing) is lowered into the hole and cemented in place. The casing's upper end is fastened to a system of pipes and valves called a wellhead, or “Christmas Tree,” through which natural pressure forces the oil or gas into separation and storage tanks. If natural pressure is not great enough to force the oil to the surface, pumps may be used. In some cases, water, steam, or gas may be injected into the oil-producing formation to improve recovery.

Crude oil is transported to refineries by pipeline, ship, barge, truck, or railroad. Natural gas usually is transported to processing plants by pipeline. While oil refineries may be many thousands of miles away from the producing fields, gas processing plants typically are near the fields, so that impurities—water, sulfur, and natural gas liquids—can be removed before the gas is piped to customers. The oil refining industry is considered a separate industry, and its activities are not covered here, even though many oil companies both extract and refine oil.

The oil and gas extraction industry has experienced both “booms” and “busts” over the years, illustrating the cyclical relationship between the price of oil and employment. Generally, the reaction of the labor market lags slightly behind the price fluctuations because oil companies must adjust their production levels accordingly. During the 1970s and early 1980s, the price of crude oil rose sharply, stimulating domestic exploration and production. Between 1978 and 1982—the year in which industry employment peaked—the oil and gas extraction industry grew 65 percent, creating 279,000 jobs, while employment in the economy as a whole remained flat. Starting in 1982, oil-producing countries around the world began pumping much larger volumes of crude oil, driving prices down; this culminated in the collapse of oil prices in the mid-1980s. During this time, the industry experienced a sharp decline in domestic exploration and production and an extended period of downsizing and restructuring, losing more than 415,000 jobs from 1982 to 1999. High oil prices in 2000 through 2003 led to small gains in employment.

Working Conditions

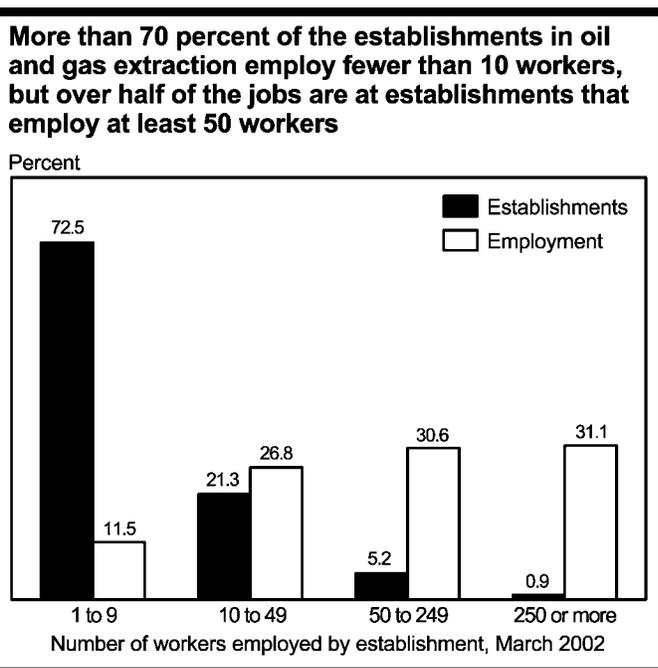
Working conditions in this industry vary significantly by occupation. Roustabout and other construction and extraction occupations may involve rugged outdoor work in remote areas in all kinds of weather. For these jobs, physical strength and stamina are necessary. This work involves standing for long periods, lifting moderately heavy objects, and climbing and stooping to work with tools that often are oily and dirty. Executives generally work in office settings, as do most administrators and clerical workers. Geologists, engineers, and managers may split their time between the office and the jobsites, particularly while involved in exploration work.

Only 1 employee in 12 works fewer than 35 hours a week, because opportunities for part-time work are rare. In fact, a higher percentage of workers work overtime in this industry than in all industries combined. The average nonsupervisory worker worked 39.5 hours per week in 2002, compared with 33.9 hours for all nonsupervisory workers on private nonfarm payrolls.

Oil and gas well drilling and servicing can be hazardous. However, in 2002 the rate of work-related injury and illness in the oil and gas extraction industry, as a whole, was 3.4 per 100 full-time workers, somewhat lower than the 5.3 for the entire private sector. The rate for workers in the oil and gas field services segment, 4.5 per 100 full-time workers, was almost 3 times higher than that for workers in the crude petroleum and natural gas segment, which was only 1.6. However, improvements in drilling technology and oil rig operations, such as remote-controlled drills, have led to fewer injuries.

Drilling rigs operate continuously. On land, drilling crews usually work 6 days, 8 hours a day, and then have a few days off. In offshore operations, workers can work 14 days, 12 hours a day, and then have 14 days off. If the offshore rig is located far from the coast, drilling crew members live on ships anchored nearby or in facilities on the platform itself. Workers on offshore rigs are always evacuated in the event of a storm. Most workers in oil and gas well operations and maintenance or in natural gas processing work 8 hours a day, 5 days a week.

Many oilfield workers are away from home for weeks or months at a time. Exploration field personnel and drilling work-



ers frequently move from place to place as work at a particular field is completed. In contrast, well operation and maintenance workers and natural gas processing workers usually remain in the same location for extended periods.

Employment

The oil and gas extraction industry, with about 123,000 wage and salary jobs in 2002, is the largest industry in the mining division, accounting for one-quarter of employment. Although on-shore oil and gas extraction establishments are found in 32 States, more than 77 percent of the industry’s workers in 2002 were located in just four States—California, Louisiana, Oklahoma, and Texas. While most workers are employed on land, many work at offshore sites. Although they are not included in employment figures for this industry, many Americans are employed by oil companies at locations in Africa, the North Sea, the Far East, the Middle East, South America, and countries of the former Soviet Union.

About 7 out of 10 establishments employ fewer than 10 workers, although more than 60 percent of all workers in this industry are employed in establishments with greater than 50 workers (see chart). As more large domestic oilfields and gasfields are depleted, major oil companies are focusing their exploration and production activity in foreign countries. Consequently, smaller companies with less capital for foreign exploration and production are drilling an increasing share of domestic oil and gas. Technology also has significantly decreased the risk and cost for smaller producers.

Relatively few oil and gas extraction workers are in their teens or early 20s. About 55 percent of the workers in this industry are between 35 and 54 years of age.

Occupations in the Industry

People with many different skills are needed to explore for oil and gas, drill new wells, maintain existing wells, and process natural gas. The largest group is professional and related work-

ers, accounting for about 23.1 percent of industry employment. Managerial, business, and financial workers account for about 20.8 percent of employment, while transportation and material moving workers make up about 11.8 percent, construction and extraction workers make up about 11.4 percent, and production workers make up about 11.3 percent (table 1).

A *petroleum geologist* or a *geophysicist*, who is responsible for analyzing and interpreting the information gathered, usually heads exploration operations. Other geological specialists also may be involved in exploration activities, including *paleontologists*, who study fossil remains to locate oil; *mineralogists*, who study physical and chemical properties of mineral and rock samples; *stratigraphers*, who determine the rock layers most likely to contain oil and natural gas; and *photogeologists*, who examine and interpret aerial photographs of land surfaces. Additionally, exploration parties may include *surveyors* and *drafters*, who assist in surveying and mapping activities.

Some geologists and geophysicists work in district offices of oil companies or contract exploration firms, where they prepare and study geological maps and analyze seismic data. These scientists also may analyze samples from test drillings.

Other workers involved in exploration are *geophysical prospectors*. They lead crews consisting of *gravity* and *seismic prospecting observers*, who operate and maintain electronic seismic equipment; *scouts*, who investigate the exploration, drilling, and leasing activities of other companies to identify promising areas to explore and lease; and *lease buyers*, who make business arrangements to obtain the use of the land or mineral rights from their owners.

Petroleum engineers are responsible for planning and supervising the actual drilling operation, once a potential drillsite has been located. These engineers develop and implement the most efficient recovery method, in order to achieve maximum profitable recovery. They also plan and supervise well operation and maintenance. *Drilling superintendents* serve as supervisors of drilling crews, overseeing one or more drilling rigs.

Rotary drilling crews usually consist of four or five workers. *Rotary drillers* supervise the crew and operate machinery that controls drilling speed and pressure. *Rotary-rig engine operators* are in charge of engines that provide the power for drilling and hoisting. Second in charge, *derrick operators* work on small platforms high on rigs to help run pipe in and out of well holes and operate the pumps that circulate mud through the pipe. *Rotary-driller helpers*, also known as *roughnecks*, guide the lower ends of pipe to well openings and connect pipe joints and drill bits.

Though not necessarily part of the drilling crew, *roustabouts*, or general laborers, do general oilfield maintenance and construction work, such as cleaning tanks and building roads.

Pumpers and their helpers operate and maintain motors, pumps, and other surface equipment that forces oil from wells and regulate the flow, according to a schedule set up by petroleum engineers and production supervisors. In fields where oil flows under natural pressure and does not require pumping, *switchers* open and close valves to regulate the flow. *Gaugers* measure and record the flow, taking samples to check quality. *Treaters* test the oil for water and sediment and remove these impurities by opening a drain or using special equipment. In

Table 1. Employment of wage and salary workers in oil and gas extraction by occupation, 2002 and projected change, 2002-12
(Employment in thousands)

Occupation	Employment, 2002		Percent change, 2002-12
	Number	Percent	
All occupations	123	100.0	-27.8
Management, business, and financial occupations	26	20.8	-26.1
General and operations managers	5	3.9	-28.5
Financial managers	2	1.4	-26.5
Accountants and auditors	6	4.5	-26.8
Professional and related occupations	28	23.1	-25.3
Computer specialists	3	2.6	-21.9
Petroleum engineers	5	4.0	-26.5
Drafters, engineering, and mapping technicians	2	1.8	-25.5
Geoscientists, except hydrologists and geographers	4	3.4	-26.5
Geological and petroleum technicians	2	2.0	-23.3
Office and administrative support occupations	19	15.5	-37.5
Bookkeeping, accounting, and auditing clerks	4	3.1	-37.3
Information and record clerks	2	1.5	-31.1
Office clerks, general	4	3.0	-36.0
Executive secretaries and administrative assistants	3	2.4	-36.2
Secretaries, except legal, medical, and executive	3	2.6	-43.2
Construction and extraction occupations	14	11.4	-26.1
First-line supervisors/managers of construction trades and extraction workers	3	2.1	-26.5
Derrick operators, oil and gas	2	1.5	-26.5
Rotary drill operators, oil and gas	1	1.1	-26.5
Service unit operators, oil, gas, and mining	2	1.9	-26.5
Roustabouts, oil and gas	4	2.9	-26.5
Installation, maintenance, and repair occupations	6	4.5	-24.7
Industrial machinery mechanics	2	1.6	-22.5
Maintenance and repair workers, general ..	1	1.0	-26.5
Production occupations	14	11.3	-26.5
First-line supervisors/managers of production and operating workers	2	1.4	-26.5
Gas plant operators	2	1.4	-26.5
Petroleum pump system operators, refinery operators, and gaugers	8	6.7	-26.5
Transportation and material moving occupations	14	11.8	-27.2
Truck drivers, heavy and tractor-trailer ...	1	1.2	-22.8
Pump operators, except wellhead pumpers	4	3.0	-26.5
Wellhead pumpers	6	4.5	-26.5

NOTE: May not add to totals due to omission of occupations with small employment.

most fields, pumping, switching, gauging, and treating operations are automatic.

Other skilled oilfield workers include *oil well cementers*, who mix and pump cement into the space between the casing and well walls to prevent cave-ins; *acidizers*, who pump acid down the well and into the producing formation to increase oil flow;

perforator operators, who use subsurface “guns” to pierce holes in the casing to make openings for oil to flow into the well bore; *sample-taker operators*, who take samples of soil and rock formations from wells to help geologists determine the presence of oil; and *well pullers*, who remove pipes, pumps, and other subsurface devices from wells for cleaning, repairing, and salvaging.

Many other skilled workers—such as welders, pipefitters, electricians, and machinists—also are employed in maintenance operations to install and repair pumps, gauges, pipes, and other equipment.

In addition to the types of workers required for onshore drilling, crews at offshore locations also need radio operators, cooks, ships’ officers, sailors, and pilots. These workers make up the support personnel who work on or operate drilling platforms, crewboats, barges, and helicopters.

Most workers involved in gas processing are operators. *Gas treaters* tend automatically controlled treating units that remove water and other impurities from natural gas. *Gas-pumping-station operators* tend compressors that raise the pressure of gas for transmission in pipelines. Both types of workers can be assisted by *gas-compressor operators*.

Many employees in large natural gas processing plants—*welders, electricians, instrument repairers, and laborers*, for example—perform maintenance activities. In contrast, many small plants are automated and are checked at periodic intervals by maintenance workers or operators, or monitored by instruments that alert operators if trouble develops. In nonautomated plants, workers usually combine the skills of both operators and maintenance workers.

Training and Advancement

Workers can enter the oil and gas extraction industry with a variety of educational backgrounds. The most common entry-level field jobs are as roustabouts or roughnecks, jobs that usually require little or no previous training or experience. Applicants for these routine laborer jobs must be physically fit and able to pass a physical examination. Companies also may administer aptitude tests and screen prospective employees for drug use. Basic skills usually can be learned over a period of days through on-the-job training. However, previous work experience or formal training in petroleum technology that provides knowledge of oilfield operations and familiarity with computers and other automated equipment can be beneficial. In fact, given the increasing complexity of operations and the sophisticated nature of technology used today, employers now demand a higher level of skill and adaptability, including the ability to work with computers and other sophisticated equipment.

Other entry-level positions, such as engineering technician, usually require at least a 2-year associate degree in engineering technology. Professional jobs, such as geologist, geophysicist, or petroleum engineer, require at least a bachelor’s degree, but many companies prefer to hire candidates with a master’s degree, and may require a Ph.D. for those involved in petroleum research. For well operation and maintenance jobs, companies generally prefer applicants who live nearby, have mechanical ability, and possess knowledge of oilfield processes. Because

this work offers the advantage of a fixed locale, members of drilling crews or exploration parties who prefer not to travel may transfer to well operation and maintenance jobs. Training is acquired on the job.

Promotion opportunities for some jobs may be limited due to the general decline of the domestic petroleum industry. Advancement opportunities for oilfield workers remain best for those with skill and experience. For example, roustabouts may move up to become switchers, gaugers, and pumpers. More experienced roughnecks may advance to derrick operator and, after several years, to driller. Drillers may advance to tool pusher. There should continue to be some opportunities for entry-level field crew workers to acquire the skills that qualify them for higher level jobs within the industry. Due to the critical nature of the work, offshore crews, even at the entry level, generally are more experienced than land crews. Many companies will not employ someone who has no knowledge of oilfield operations to work on an offshore rig, so workers who have gained experience as part of a land crew might advance to offshore operations.

As workers gain knowledge and experience, U.S. or foreign companies operating in other countries also may hire them. Although this can be a lucrative and exciting experience, it may not be suitable for everyone, because it usually means leaving family and friends and adapting to different customs and living standards.

Experience gained in many oil and gas extraction jobs also has application in other industries. For example, roustabouts can move to construction jobs, while machinery operators and repairers can transfer to other industries with similar machinery. Geologists and engineers may become involved with environmental activities, especially those related to this industry.

Earnings

Average wage and salary earnings in the oil and gas extraction industry were significantly higher than the average for all industries. The average hourly earnings of non-supervisory workers in the oil and gas extraction industry were \$19.27, compared with \$14.95 for all workers in private industry. Due to the working conditions, employees at offshore operations generally earn

Table 2. Median hourly earnings of the largest occupations in oil and gas extraction, 2002

Occupation	Oil and gas extraction	All industries
General and operations managers	\$53.87	\$32.80
Geoscientists, except hydrologists and geographers	49.02	32.44
Petroleum engineers	44.96	40.08
Accountants and auditors	25.33	22.60
Petroleum pump system operators, refinery operators, and gaugers	22.78	23.69
Pump operators, except wellhead pumpers	19.08	17.53
Wellhead pumpers	17.29	16.24
Bookkeeping, accounting, and auditing clerks	15.68	13.16
Office clerks, general	13.21	10.71
Roustabouts, oil and gas	12.48	10.71

higher wages than do workers at onshore oil fields. College-educated workers and technical school graduates in professional and technical occupations usually earn the most. Earnings in selected occupations in oil and gas extraction appear in table 2.

Few industry workers belong to unions. In fact, only about 2 percent of workers were union members or were covered by union contracts in 2002, compared with about 15 percent of all workers throughout private industry.

Outlook

Although worldwide demand for oil and gas is expected to grow, overall wage and salary employment in the oil and gas extraction industry is expected to decline by 28 percent through the year 2012, while employment in all industries combined is projected to increase by 16 percent. Employment in establishments that contract work to larger oil companies, such as drilling and operating wells, will likely experience greater fluctuations in employment.

The level of future crude petroleum and natural gas exploration and development and, therefore, employment opportunities, remain contingent upon a number of uncertainties—most importantly, the future price of oil and gas. Sharply higher prices mean that companies, seeking greater profits, can be expected to implement new technologies, expand domestic and international exploration and production, and increase employment. Substantially lower prices, on the other hand, could make exploration and continued production from many existing wells unprofitable, resulting in reduced employment opportunities. Stable and favorable prices are needed to allow companies enough revenue to expand exploration and production projects in order to meet increased global energy demand. Stable oil prices also would allow for more stable employment levels, instead of the boom and bust that has affected the industry for the past few decades. However, maintaining high and stable prices is difficult, especially during economic downturns.

Environmental concerns, accompanied by strict regulation and limited access to protected Federal lands, also continue to have a major impact on this industry. Environmental constraints, especially restrictions on drilling in environmentally sensitive areas, should continue to limit exploration and development, both onshore and offshore. However, changes in policy could expand exploration and drilling for oil and natural gas in currently protected areas, especially in Alaska.

In addition, environmental emissions standards already in place or planned for the future could significantly limit the amount of sulfur and carbon dioxide levels that can be emitted by powerplants. Many new powerplants run on natural gas, as opposed to coal, which emits higher levels of sulfur into the atmosphere. The natural gas exploration and production industry, and its employment, would benefit from the increasing demand for cleaner-burning fuels. However, a lack of proper infrastructure for transporting natural gas, which is found mainly in unpopulated areas or offshore, currently limits natural gas consumption.

While some new oil and gas deposits are being discovered in this country, companies increasingly are moving to more lucrative foreign locations. As companies expand into other areas around the globe, the need for employees in the United States is reduced. However, advances in technology have increased the proportion of exploratory wells that yield oil and gas, enhanced offshore exploration and drilling capabilities, and extended the production of existing wells. As a result, more exploration and development ventures are profitable and provide employment opportunities that otherwise would have been lost.

Despite an overall decline in employment in the oil and gas extraction industry, job opportunities in most occupations should be favorable. The need to replace workers who transfer to other industries, retire, or leave the workforce will be the major source of job openings as more workers in this industry approach retirement age, and others seek more stable employment opportunities in other industries. Employment opportunities will be best for those with previous experience and with strong technical skills. There is strong demand for qualified professionals and extraction workers who have significant experience in oil field operations and who can work with new technology. As employers develop and implement new technologies—such as 3-D and 4-D seismic exploration methods, horizontal and directional drilling techniques, and deepwater and subsea technologies—more workers capable of using sophisticated equipment will be needed.

Sources of Additional Information

Information on training and career opportunities for petroleum engineers or geologists is available from:

- American Association of Petroleum Geologists, Communications Department, P.O. Box 979, Tulsa, OK 74101. Internet: <http://www.aapg.org>
- American Geological Institute, 4220 King St., Alexandria, VA 22302. Internet: <http://www.agiweb.org>
- Society of Petroleum Engineers, P.O. Box 833836, Richardson, TX 75083. Internet: <http://www.spe.org>

Information on some occupations in the oil and gas extraction industry may be found in the 2004-05 *Occupational Outlook Handbook*:

- Construction equipment operators
- Construction laborers
- Engineering and natural sciences managers
- Environmental engineers
- Environmental scientists and geoscientists
- Material-moving occupations
- Petroleum engineers
- Structural and reinforcing iron and metal workers
- Surveyors, cartographers, photogrammetrists, and surveying technicians