Farming, Fishing, and Forestry Occupations

Fishers and Fishing Vessel Operators

Significant Points

- This occupation is characterized by strenuous work, long hours, seasonal employment, and some of the most hazardous conditions in the workforce.
- About 56 percent of all workers are self-employed, among the highest proportions in the workforce.
- Fishers usually begin as deckhands and acquire their occupational skills on the job.
- Employment is projected to decline moderately.

Nature of the Work

Fishers and fishing vessel operators catch and trap various types of marine life for human consumption, animal feed, bait, and other uses. (Aquaculture—the raising and harvesting, under controlled conditions, of fish and other aquatic life in ponds or confined bodies of water—is covered in the *Handbook* statement on farmers, ranchers, and agricultural managers.)

Fishing hundreds of miles from shore with commercial fishing vessels—large boats capable of hauling a catch of tens of thousands of pounds of fish—requires a crew that includes a captain, or skipper, a first mate and sometimes a second mate, a boatswain (called a deckboss on some smaller boats), and deckhands with specialized skills.

The *fishing boat captain* plans and oversees the fishing operation, the fish to be sought, the location of the best fishing grounds, the method of capture, the duration of the trip, and the sale of the catch.

The captain ensures that the fishing vessel is seaworthy; oversees the purchase of supplies, gear, and equipment, such as fuel, netting, and cables; obtains the required fishing permits and licenses; and hires qualified crew members and assigns their duties. The captain plots the vessel's course using compasses, charts, and electronic navigational equipment, such as loran systems or GPS navigation systems. Captains also use radar and sonar to avoid obstacles above and below the water and to detect fish. Sophisticated tracking technology allows captains to better locate schools of fish. The captain directs the fishing operation through subordinate officers' and records daily activities in the ship's log. In port, the captain sells the catch to wholesalers, food processors, or through a fish auction and ensures that each crew member receives the prearranged portion of the proceeds. Captains increasingly use the Internet to bypass processors and sell fish directly to consumers, grocery stores, and restaurants often even before they return to port.

The *first mate* is the captain's assistant and assumes control of the vessel when the captain is off duty. Duty shifts, called watches, usually last 6 hours. In this role, the first mate must be familiar with navigation requirements and the operation of all electronic equipment. The mate's regular duty though, with the help of the boatswain and under the captain's oversight, is to direct the fishing operations and sailing responsibilities of the deckhands, including the operation, maintenance, and repair of the vessel and the gathering, preservation, stowing, and unloading of the catch.

The *boatswain*, a highly experienced deckhand with supervisory responsibilities, directs the *deckhands* as they carry out the sailing and fishing operations. Before departure, the deckhands load equipment and supplies. When necessary, boatswains repair fishing gear, equipment, nets, and accessories. They operate the fishing gear, letting out and pulling in nets and lines, and extract the catch, such as cod, flounder, and tuna, from the nets or the lines' hooks. Deckhands use dip nets to prevent the escape of small fish and gaffs to facilitate the landing of large fish. They then wash, salt, ice, and stow away the catch. Deckhands also must ensure that decks are clear and clean at all times and that the vessel's engines and equipment are kept in good working order. Unless "lumpers" (laborers or longshore workers) are hired, the deckhands unload the catch.

Large fishing vessels that operate in deep water generally have technologically advanced equipment, and some may have facilities on board where the fish are processed and prepared for sale. Such vessels are equipped for long stays at sea and can perform the work of several smaller boats.

Some fishers work on small boats in relatively shallow waters, often in sight of land. Navigation and communication needs are vital and constant for almost all types of boats. On these small boats, crews often consist of one or two members who are involved in all aspects of the fishing operation. Their work might include placing gill nets across the mouths of rivers or inlets, entrapment nets in bays and lakes, or pots and traps for fish or shellfish such as lobsters and crabs. Dredges and scrapes are sometimes used to gather shellfish such as oysters and scallops. A very small proportion of commercial fishing is conducted as diving operations. Depending upon the water's depth, divers wearing regulation diving suits with an umbilical (air line) or a scuba outfit and equipment use spears to catch fish and use nets and other equipment to gather shellfish, coral, sea urchins, abalone, and sponges. In very shallow waters, fish are caught from small boats with an outboard motor, from rowboats, or by wading from shore. Fishers use a wide variety of hand-operated equipment, including nets, tongs, rakes, hoes, hooks, and shovels, to gather fish and shellfish; to catch amphibians and reptiles such as frogs and turtles; and to harvest marine vegetation such as Irish moss and kelp.

Although most fishers are involved in commercial fishing, some captains and deckhands use their expertise in fishing for sport or recreational purposes. For this type of fishing, a group of people charter a fishing vessel with a captain, and possibly several

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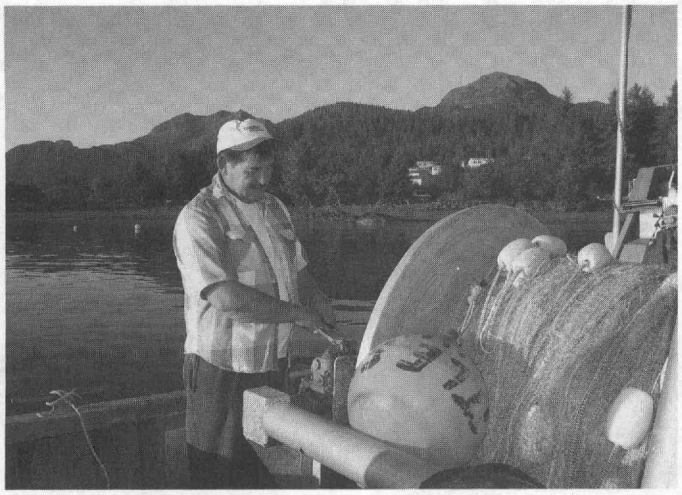

A fisher tends to his equipment on his fishing boat.

deckhands, for periods ranging from several hours to a number of days and embark upon sportfishing, socializing, and relaxation.

Work environment. Fishing operations are conducted under various environmental conditions, depending on the region, body of water, and the kind of species sought. Storms, fog, and wind may hamper fishing vessels or cause them to suspend fishing operations and return to port. In relatively busy fisheries, boats have to take care to avoid collisions.

Fishers and fishing vessel operators work under some of the most hazardous conditions of any occupation, and transportation to a hospital or doctor often is not readily available when injuries occur. The crew must be on guard against the danger of injury from malfunctioning fishing gear, entanglement in fishing nets and gear, slippery decks, ice formation in the winter, or being swept overboard by a large wave. Malfunctioning navigation or communication equipment may lead to collisions or shipwrecks.

Fishers and fishing vessel operators endure strenuous outdoor work and long hours. Commercial fishing trips may require a stay of several weeks, or even months, hundreds of miles away from one's home port. The pace of work may vary, but even during travel between the home port and the fishing grounds deckhands on smaller boats usually try to finish their cleaning and maintenance duties so that there are no chores remaining to be done at port. However, lookout watches are a regular responsibility, and crew members must be prepared to stand watch at prearranged times of the day or night. Although fishing gear has improved, and operations have become more mechanized, netting and processing fish are strenuous activities. Newer vessels have improved living quarters and amenities such as television and shower stalls, but crews still experience the aggravations of confined quarters, continuous close personal contact, and the absence of family.

Training, Other Qualifications, and Advancement

Fishers usually acquire their occupational skills on the job. There are no formal academic training requirements.

Education and training. Most fishers begin as deckhands and learn their trade on the job. Deckhands normally start by finding work through family, friends, or simply walking around the docks and asking for employment. Some larger trawlers and processing ships are run by larger companies, where new workers can apply through the companies' human resources department. Operators of large commercial fishing vessels are required to complete a Coast Guard-approved training course. Students can expedite their entrance into these occupations by enrolling in 2-year vocational-technical programs offered by secondary schools. In addition, some community colleges and universities offer fishery technology and related programs that include courses in seamanship, vessel operations, marine safety, navigation, vessel repair and maintenance, health emergencies, and fishing gear technology. Secondary and postsecondary programs are normally offered in or near coastal areas, and usually include hands-on experience.

Experienced fishers may find short-term workshops especially useful. These generally are offered through various postsecondary institutions and provide a good working knowledge of electronic equipment used in navigation and communication and offer information on the latest improvements in fishing gear.

Licensure. Captains and mates on large fishing vessels of at least 200 gross tons must be licensed. Captains of sportfishing boats used for charter, regardless of the boats' size, must also be licensed. Crew members on certain fish-processing vessels may need a merchant mariner's document. The U.S. Coast Guard issues these documents and licenses to individuals who meet the stipulated health, physical, and academic requirements. (For information about merchant marine occupations, see the section on water transportation occupations elsewhere in the *Handbook*.) States set licensing requirements for boats operating in State waters, defined as inland waters and waters within 3 miles of the coast.

Fishers need a permit to fish in almost any water. Permits are distributed by States for State waters and by regional fishing councils for Federal waters. The permits specify the season when fishing is allowed, the type of fish that may be caught, and sometimes the type of fishing gear that is permissible.

Other qualifications. Fishers must be in good health and possess physical strength. Good coordination, mechanical aptitude, and the ability to work under difficult or dangerous conditions are necessary to operate, maintain, and repair equipment and fishing gear. Fishers need stamina to work long hours at sea, often under difficult conditions. On large vessels, they must be able to work as members of a team. Fishers must be patient, yet always alert, to overcome the boredom of long watches when they are not engaged in fishing operations. The ability to assume any deckhand's functions on short notice is important. As supervisors, mates must be able to assume all duties, including the captain's, when necessary. The captain must be highly experienced, mature, and decisive and also must possess the skills needed to run business operations.

Advancement. On fishing vessels, most fishers begin as deckhands. Experienced, reliable deckhands who display supervisory qualities may become boatswains, who, in turn, may become second mates, first mates, and, finally, captains. Deckhands who acquire experience and whose interests are in ship engineering—the maintenance and repair of ship engines and equipment—can eventually become licensed chief engineers on large commercial vessels after meeting the Coast Guard's experience, physical, and academic requirements. Almost all captains

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become self-employed, and the overwhelming majority eventually own, or have an interest in, one or more fishing ships. Some may choose to run a sport or recreational fishing operation.

Employment

Fishers and fishing vessel operators held an estimated 35,600 jobs in 2008. Over half were self-employed. Most fishing takes place off the coasts, particularly off Alaska, the Gulf Coast, Virginia, California, and New England. Alaska ranks the highest in total volume of fish caught, according to the National Marine Fisheries Service. Many fishers are seasonal workers and positions are usually filled by people who work primarily in other occupations, such as teachers, or by students. For example, salmon season causes employment of fishers in Alaska to more than double during the summer. Because fishing is mostly seasonal and workers are often self-employed, measuring total employment is difficult.

Job Outlook

Employment of fishers and fishing vessel operators is projected to decline moderately as regulations relating to the replenishment of fish stocks reduce allowable fishing.

Employment change. Employment of fishers and fishing vessel operators is expected to decline moderately by 8 percent through the year 2018. Fishers and fishing vessel operators depend on the natural ability of fish stocks to replenish themselves through growth and reproduction, as well as on governmental regulation to promote replenishment of fisheries. As the use of sophisticated electronic equipment for navigation, communication, and locating fish has raised the efficiency of finding fish stocks, the need for setting limits to catches also has risen. Additionally, improvements in fishing gear and the use of highly automated floating processors, where the catch is processed aboard the vessel, have greatly increased fish hauls.

Fisheries councils issue various types of restrictions to prevent over-harvesting and to allow stocks of fish and shellfish to naturally replenish. Fishing councils are shifting to an individual quota system that tends to reduce employment. Nonetheless, such a system is beneficial for those who remain in the industry because it allows for longer fishing seasons, better investment returns, and steadier employment.

In addition, rising seafood imports and increasing competition from farm-raised fish are adversely affecting fishing income and is also causing some fishers to leave the industry. However, competition from farm-raised and imported seafood tends to be concentrated in specific species and thus should have more of an impact in some regions than others.

Governmental efforts to replenish stocks are having some positive results, which should increase the stock of fish in the future. Furthermore, efforts by private fishers' associations on the West Coast to increase government monitoring of the fisheries may help to prevent the type of decline in fish stocks found in waters off the East Coast. Nevertheless, pollution is now being recognized as a new factor affecting the reproduction of fish, a scenario that may take years to mitigate. Consequently, fewer fishers and fishing vessel operators are expected to make their living from the Nation's waters in the years ahead.

Job prospects. The vast majority of job openings will result from the need to replace fishers and fishing vessel operators who leave the occupation because of the strenuous and hazardous nature of the job and the lack of steady, year-round income. The best prospects should be with large fishing operations, while opportunities with small independent fishers are expected to be limited. Sportfishing boats may provide some job opportunities.

Earnings

In May 2008, median annual wages of wage-and-salary fishers were $27,950. The middle 50 percent earned between $19,510 and $33,580. The bottom 10 percent earned less than $16,080, while the top 10 percent earned more than $45,930. Earnings of fishers and fishing vessel operators normally are highest in the summer and fall when demand for their catch and environmental conditions are favorable and lowest during the winter. Many full-time and most part-time workers supplement their income by working in other activities during the off-season.

Earnings of fishers vary widely, depending upon their position, their ownership percentage of the vessel, the size of their ship, and the amount and value of the catch. The costs of the fishing operation such as fuel, repair and maintenance of gear and equipment, and the crew's supplies are deducted from the sale of the catch. Net proceeds are distributed among the crew members in accordance with a prearranged percentage. Generally, the ship's owner, usually its captain, receives half of the net proceeds. From this amount, the owner pays for depreciation, maintenance and repair, and replacement and insurance costs of the ship and its equipment; the money that remains is the owner's profit.

Related Occupations

Other occupations that involve outdoor work with fish and watercraft include:

	Page
Fish and game wardens	473
Water transportation occupations	805

Many ships not only catch the fish but also cut, trim, and preserve it. Seafood processing work done on land is performed by meat, poultry, and fish cutters and trimmers.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Fishers and related fishing workers	45-3011	35,600	32,900	-2,700	-8

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Sources of Additional Information

Information on licensing of fishing vessel captains and mates and on requirements for merchant mariner documentation is available from the U.S. Coast Guard Marine Inspection Office or Marine Safety Office in your State. Or contact either of the following agencies:

➤ National Maritime Center, Coast Guard Headquarters, 2100 Second Street, SW., Washington, DC. 20593-0005. Internet: **http://www.uscg.mil/nmc/**

➤ Commanding Officer (MSC), 2100 Second St. SW, Stop 7102, Washington, DC 20593-7102. Internet: **http://www.uscg.mil/hq/msc/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos177.htm**

Forest and Conservation Workers

Significant Points

- Most forest and conservation workers develop skills through on-the-job training.
- Seasonal demand for forest and conservation workers can vary by region and time of year.
- The best employment opportunities should continue to be in Maine, the Southeast, and the Pacific Northwest.

Nature of the Work

The Nation's forests are a rich natural resource, providing beauty, tranquility, and varied recreational benefits, as well as wood for commercial use. Managing and harvesting the forests and woodlands require many different kinds of workers. Forest and conservation workers help develop, maintain, and protect the forests by growing and planting new seedlings, fighting insects and diseases that attack trees, and helping to control soil erosion.

Forest and conservation workers perform a variety of tasks to reforest and conserve timberlands and to maintain forest facilities, such as roads and campsites. Some forest workers, called tree planters, use digging and planting tools called "dibbles" and "hoedads" to plant seedlings to reforest timberland areas. Forest workers also remove diseased or undesirable trees with power saws or handsaws, spray trees with insecticides and fungicides to kill insects and to protect against disease, and apply herbicides on undesirable brush to reduce competing vegetation. Those who work for State and local governments or who are under contract with them also clear away brush and debris from camp trails, roadsides, and camping areas. Some forest workers clean kitchens and rest rooms at recreational facilities and campgrounds. In private industry, forest workers usually working under the direction of professional foresters, may paint boundary lines, assist with controlled burning, aid in marking and measuring trees, and keep tallies of examined and counted trees.

Other forest and conservation workers work in forest nurseries, sorting out tree seedlings and discarding those not meeting standards of root formation, stem development, and condition of foliage.

Some forest workers are employed on tree farms, where they plant, cultivate, and harvest many different kinds of trees. Their duties vary with the type of farm. Those who work on specialty farms, such as farms growing Christmas or ornamental trees for nurseries, are responsible for shearing treetops and limbs to control the growth of the trees under their care, to increase the density of limbs, and to improve the shapes of the trees. In addition, these workers' duties include planting the seedlings, spraying to control surrounding weed growth and insects, and harvesting the trees.

Other forest workers gather, by hand or with the use of handtools, products from the woodlands, such as decorative greens, tree cones and barks, moss, and other wild plant life. Some may tap trees for sap to make syrup or chemicals.

Work environment. Most of these jobs are physically demanding. Workers spend all their time outdoors, sometimes in poor weather and often in isolated areas. It may be necessary for some forestry aides or forest workers to walk long distances



Forest and conservation workers strive to promote growth of individual trees and entire forests.

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through densely wooded areas to accomplish their work tasks. The increased use of enclosed machines has decreased some of the discomforts caused by inclement weather and has generally made tasks much safer.

Still, workers must be careful and use proper safety measures and equipment such as hardhats, eye protection, safety clothing, and boots to reduce the risk of injury. Data from the U.S. Bureau of Labor Statistics show that full-time forest and conservation workers experienced a work-related injury and illness rate that was higher than the national average. But the jobs of forest and conservation workers generally are much less hazardous than those of logging workers, who work in a similar environment.

Training, Other Qualifications, and Advancement

Most forest and conservation workers develop skills through on-the-job training, learning from experienced workers.

Education and training. Generally, a high school diploma is sufficient for most forest and conservation occupations. Many forest worker jobs offer only seasonal employment during warm-weather months, so students are often hired to perform short-term, labor-intensive tasks, such as planting tree seedlings or conducting pre-commercial tree thinning.

Training programs for forest and conservation workers are common in many States. These training programs typically take place in the field, encouraging the health and productivity of the Nation's forests through programs such as the Sustainable Forest Initiative.

Some vocational and technical schools and community colleges offer courses leading to a 2-year technical degree in forest management technology, wildlife management, conservation, and forest harvesting, all of which are helpful in obtaining a job. A curriculum that includes field trips to observe or participate in forestry or logging activities provides a particularly good background. Additionally, a few community colleges offer training for equipment operators.

Other qualifications. Forest and conservation workers must be in good health and able to work outdoors every day. They also must be able to work as part of a team. Maturity and good judgment are important in making quick, intelligent decisions when hazards arise. Mechanical aptitude and coordination are necessary for operators of machinery and equipment, who often are responsible for repair and maintenance.

Advancement. Advancement generally takes place by obtaining a bachelorís degree in forestry or related field. A bachelorís degree may also qualify candidates to become a forester. (See the section on conservation scientists and foresters elsewhere in the *Handbook*.)

Employment

Forest and conservation workers held about 12,900 jobs in 2008 in the following industries:

State government	5,900
Forestry	2,000
Local government	1,600

About 58 percent of all forest and conservation workers work for government, primarily at the State and local level. Those employed in forest management services may work on a contract basis for the U.S. Department of Agriculture's Forest Service. Self-employed forest and conservation workers make up around 1 percent of the occupation.

Although forest and conservation workers are located in every State, employment is concentrated in the West and Southeast, where many national and private forests and parks are located. Seasonal demand for forest and conservation workers can vary by region and time of year. For northern States, in particular, winter weather can interrupt forestry operations.

Job Outlook

Employment is expected to experience average growth. Most job openings will result from the large number of workers who leave these jobs on a seasonal basis and from an increase in retirements.

Employment change. Employment of forest and conservation workers is expected to grow 9 percent over the 2008-18 decade, as fast as the average for all occupations. Demand for forest and conservation workers will increase as more land is set aside to protect natural resources or wildlife habitats. In addition, more jobs may be created by recent Federal legislation designed to prevent destructive wildfires by thinning the forests and by setting controlled burns in dry regions susceptible to forest fires.

Recent developments in Western forests may result in the conversion of unused roads into forestland, thus creating some new jobs. Additionally, increasing pressure from a growing number of stakeholders for the United States Forest Service to undertake major road repair may also result in higher levels of employment. Employment growth will, nonetheless, be largely determined by each of these programsí ability to obtain necessary funding.

Job prospects. Some opportunities will stem from employment growth, but most openings will arise from the large number of workers who leave these jobs on a seasonal basis and from an increase in retirements expected over the next decade. The best employment opportunities should continue to be in Maine, the Southeast, and the Pacific Northwest.

Employment of forest and conservation workers can sometimes be unsteady. During the muddy spring season and the cold winter months, weather often can curtail the work, depending on the geographic region.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Forest and conservation workers	45-4011	12,900	14,000	1,100	9

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Earnings

In May 2008, median hourly wages of wage and salary forest and conservation workers were $10.98. The middle 50 percent earned between $8.98 and $14.75. The lowest 10 percent earned less than $8.02, and the highest 10 percent earned more than $20.04.

Many beginning or inexperienced workers earn the Federal minimum wage of $7.25 per hour as of July 24, 2009, but many States may set minimum wages higher than the Federal minimum.

Forest and conservation workers who work for State and local governments or for large, private firms generally enjoy more generous benefits than do workers in smaller firms.

Related Occupations

Other occupations concerned with the care of trees and their environment include:

	Page
Conservation scientists and foresters	185
Forest and conservation technicians	230
Grounds maintenance workers	498

Sources of Additional Information

For information about timber-cutting and logging careers and about secondary and postsecondary programs offering training for logging occupations, contact:

➤ Forest Resources Association, Inc., 600 Jefferson Plaza, Suite 350, Rockville, MD 20852-1157. Internet: **http://www.forestresources.org**

For information on the Sustainable Forestry Initiative training programs, contact:

➤ American Forest and Paper Association, 1111 19th St. NW., Suite 800, Washington, DC 20036-3652. Internet: **http://www.afandpa.org**

A list of State forestry associations and other forestry-related State associations is available at most public libraries. Schools of Forestry at State land-grant colleges or universities also can be useful sources of information.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos350.htm**

Logging Workers

Significant Points

- Workers spend all their time outdoors, sometimes in poor weather and often in isolated areas.
- Most jobs are physically demanding and can be hazardous.
- Employment is projected to grow 6 percent, which is slower than the average.
- Despite slower than average employment growth, job opportunities should be good because of the need to replace workers who leave the occupation for other jobs that are less physically demanding, dangerous, and prone to layoffs.

Nature of the Work

Logging workers harvest thousands of acres of forests each year for the timber that provides the raw material for countless consumer and industrial products. The timber-cutting and logging process is carried out by a logging crew. A typical crew might consist of one or two tree fallers or one tree harvesting machine operator to cut down trees, one bucker to cut logs, two logging skidder operators to drag cut trees to the loading deck, and one equipment operator to load the logs onto trucks.

Fallers, commonly known as *tree fallers,* cut down trees with hand-held power chain saws or mobile felling machines. Using gas-powered chain saws, *buckers* trim off the tops and branches and buck (cut) the resulting logs into specified lengths. *Choke setters* fasten chokers (steel cables or chains) around logs to be skidded (dragged) by tractors or forwarded by the cable-yarding system to the landing or deck area, where the logs are separated by species and type of product, such as pulpwood, saw logs, or veneer logs, and loaded onto trucks. *Rigging slingers* and *chasers* set up and dismantle the cables and guy wires of the yarding system. *Log sorters, markers, movers,* and *chippers* sort, mark, and move logs, based on species, size, and ownership, and tend machines that chip up logs.

Logging equipment operators use tree harvesters to fell the trees, shear the limbs off, and then cut the logs into desired lengths. They drive tractors mounted on crawler tracks and operate self-propelled machines called skidders or forwarders, which drag or transport logs from the felling site in the woods to the log landing area for loading. They also operate grapple loaders, which lift and load logs into trucks. Some logging equipment operators, usually at a sawmill or a pulp-mill woodyard, use a tracked or wheeled machine similar to a forklift to unload logs and pulpwood off of trucks or gondola railroad cars. Some newer, more efficient logging equipment has state-of-the-art computer technology, requiring skilled operators with more training.

Log graders and *scalers* inspect logs for defects, measure logs to determine their volume, and estimate the marketable content or value of logs or pulpwood. These workers often use hand-held data collection devices to enter data about individual trees; later, the data can be downloaded to a central computer.



A logging worker cuts a log into smaller lengths.

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Other timber-cutting and logging workers have a variety of responsibilities. Some hike through forests to assess logging conditions. Some clear areas of brush and other growth to prepare for logging activities or to promote the growth of desirable species of trees.

Most crews work for self-employed logging contractors who have substantial logging experience, the capital to purchase equipment, and the skills needed to run a small business successfully. Many contractors work alongside their crews as supervisors and often operate one of the logging machines, such as the grapple loader or the tree harvester. Some manage more than one crew and function as owner-supervisors.

Although timber-cutting and logging equipment has greatly improved and operations are becoming increasingly mechanized, many logging jobs still are dangerous and very labor intensive. These jobs require various levels of skill, ranging from the unskilled task of manually moving logs, branches, and equipment to skillfully using chain saws to fell trees, and heavy equipment to skid and load logs onto trucks. To keep costs down, many timber-cutting and logging workers maintain and repair the equipment they use. A skillful, experienced logging worker is expected to handle a variety of logging operations.

Work environment. Logging jobs are physically demanding and can be hazardous. Workers spend all their time outdoors, sometimes in poor weather and often in isolated areas. The increased use of enclosed machines has decreased some of the discomforts caused by inclement weather and has generally made logging much safer. Workers in some sparsely populated western States and northern Maine commute long distances between their homes and logging sites. A few logging camps in Alaska and Maine house workers in bunkhouses. In the more densely populated eastern and southern States, commuting distances are shorter.

Most logging occupations involve lifting, climbing, and other strenuous activities, although machinery has eliminated some heavy labor. Loggers work under unusually hazardous conditions. Falling branches, vines, and rough terrain are constant hazards, as are the dangers associated with tree-felling and log-handling operations. Special care must be taken during strong winds, which can even halt logging operations. Slippery or muddy ground, hidden roots, or vines not only reduce efficiency, but also present a constant danger, especially in the presence of moving vehicles and machinery. Poisonous plants, brambles, insects, snakes, heat, humidity, and extreme cold are common conditions where loggers work. The use of hearing protection devices is required on logging operations because the high noise level of felling and skidding operations over long periods may impair one's hearing. Workers must be careful and use proper safety measures and equipment such as hardhats, eye and ear protection, safety clothing, and boots to reduce the risk of injury.

Training, Other Qualifications, and Advancement

Most logging workers develop skills through on-the-job training, learning from experienced workers.

Education and training. Generally, a high school diploma is sufficient for most logging occupations. Through on-the-job training, logging workers become familiar with the character and dangers of the forest environment and the operation of logging machinery and equipment.

Safety training is a vital and required part of the instruction of all logging workers. Many State forestry or logging associations provide training sessions for tree fallers, whose job duties require more skill and experience than do other positions on the logging team. Sessions may take place in the field, where trainees, under the supervision of an experienced logger, have the opportunity to practice various felling techniques. Fallers learn how to manually cut down extremely large or expensive trees safely and with minimal damage to the felled or surrounding trees.

Training programs for loggers are common in many States. Although specific coursework may vary by State, most programs usually include classroom or field training in a number of areas, including best management practices, environmental compliance, wetlands, safety, endangered species, reforestation, and business management. Some programs lead to logger certification.

Logging companies and trade associations, such as the Northeastern Loggers Association, the American Loggers Council, and the Forest Resources Association, Inc., also offer training programs for workers who operate large, expensive machinery and equipment. Often, a representative of the equipment manufacturer spends several days in the field explaining and overseeing the operation of newly purchased machinery.

Some vocational and technical schools and community colleges offer courses leading to a 2-year technical degree in forest harvesting, which may be helpful in obtaining a job. A curriculum that includes field trips to observe or participate in logging activities provides a particularly good background. Additionally, a few community colleges offer training for equipment operators.

Other qualifications. Logging workers must be in good health and able to work outdoors every day. They also must be able to work as part of a team. Many logging occupations require physical strength and stamina. Maturity and good judgment are important in making quick, intelligent decisions when hazards arise. Mechanical aptitude and coordination are necessary for machinery and equipment operators, who often are responsible for repair and maintenance. Self-employed loggers need initiative and managerial and business skills to be successful as logging contractors.

Advancement. Logging workers generally advance from tasks requiring a lot of manual labor to those involving the operation of expensive, sometimes complicated logging equipment. Inexperienced entrants usually begin as laborers, carrying tools and equipment, clearing brush, performing equipment maintenance, and loading and unloading logs and brush. For some, familiarization with logging operations may lead to jobs such as log-handling equipment operator. Further experience may lead to jobs involving the operation of more complicated machinery and yarding towers to transport, load, and unload logs. Those who have the skills required for the efficient use of power saws and other equipment may become fallers and buckers.

Some experienced logging workers start their own logging contractor businesses, but to do so they also need some basic business skills, which are essential in logging's difficult business climate.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Logging workers	45-4020	66,100	70,000	3,900	6
Fallers	45-4021	11,000	10,700	-300	-3
Logging equipment operators	45-4022	41,700	44,900	3,200	8
Log graders and scalers	45-4023	5,500	5,400	-100	-2
Logging workers, all other	45-4029	8,000	9,100	1,100	14

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Employment

Logging workers held about 66,100 jobs in 2008 in the following occupations:

Logging equipment operators	41,700
Fallers	11,000
Log graders and scalers	5,500
Logging workers, all others	8,000

About half of all logging workers work for the logging industry. Another 31 percent are self-employed, who mostly work under contract to landowners and the logging industry. About 10 percent work in the wood product manufacturing industry, mainly in sawmills.

Seasonal demand for logging workers can vary by region and time of year. For northern States in particular, winter weather can interrupt logging operations, although some logging can be done in winter.

Job Outlook

Employment of logging workers is projected to grow more slowly than the average over the 2008–18 decade. Despite slower than average employment growth, job opportunities should be good because of the need to replace workers who leave the occupation for jobs that are less hazardous.

Employment change. Employment of logging workers is expected to grow 6 percent from 2008 to 2018, which is slower than the average for all occupations. New policies allowing some access to Federal timberland may result in some logging jobs, and Federal legislation designed to prevent destructive wildfires by proactively thinning forests in susceptible regions also may result in additional jobs. Foreign and domestic demand for new wood products, such as wood pellets, is expected to result in some employment growth as well. Nonetheless, domestic timber producers continue to face increasing competition from foreign producers, who can harvest the same amount of timber at lower cost. The logging industry is expected to continue to consolidate in order to reduce costs, which may offset the creation of most new jobs.

Increased mechanization of logging operations and improvements in logging equipment will continue to depress demand for many manual timber-cutting and logging workers. Employment of fallers, buckers, choke setters, and other workers whose jobs are labor intensive should decline as more laborsaving equipment is used. Employment of machinery and equipment operators, such as tree harvesting, skidding, and log-handling equipment operators, will be less adversely affected and should rise as logging companies switch away from manual tree felling.

Job prospects. Despite slower than average employment growth, job opportunities should be good because of the need to replace workers who leave the occupation for other jobs that are less physically demanding, dangerous, and prone to layoffs. Employment of logging workers can sometimes be unsteady as changes in the level of construction, particularly residential construction, can cause slowdowns in logging activities in the short term. In addition, logging operations must be relocated when timber in a particular area has been harvested. During prolonged periods of inactivity, some workers may stay on the job to maintain or repair logging machinery and equipment, but others are laid off or forced to find jobs in other occupations.

Earnings

Earnings of logging workers vary by size of establishment and by geographic area. Workers in the largest establishments earn more than those in the smallest ones. Workers in Alaska and the Northwest earn more than those in the South, where the cost of living is generally lower. Median hourly wages in May 2008 for logging occupations were as follows:

Log graders and scalers	$15.64
Logging equipment operators	15.18
Fallers	14.66
Logging workers, all others	15.96

Small logging contractor firms generally offer timber-cutting and logging workers few benefits beyond vacation days. However, some employers offer full-time workers basic benefits, such as medical coverage, and provide safety apparel and equipment.

Related Occupations

Other occupations concerned with the care of trees and their environment include:

	Page
Conservation scientists and foresters	185
Forest and conservation workers	604
Grounds maintenance workers	498

Logging equipment operators have skills similar to:

Construction equipment operators	632
Material moving occupations	809

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Sources of Additional Information

For information about timber-cutting and logging careers and about secondary and postsecondary programs offering training for logging occupations, contact:

➤ Forest Resources Association, Inc., 600 Jefferson Plaza, Suite 350, Rockville, MD 20852-1157. Internet: **http://www.forestresources.org**

➤ American Loggers Council, P.O. Box 966, Hemphill, TX 75948-0966. Internet: **http://www.americanloggers.org**

For information on the Sustainable Forestry Initiative training programs, contact:

➤ American Forest & Paper Association, 1111 19th St. NW., Suite 800, Washington, DC 20036-3652. Internet: **http://www.afandpa.org**

A list of State forestry associations and other forestry-related State associations is available at most public libraries. Schools of Forestry at State land-grant colleges or universities also can be useful sources of information.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos351.htm**

Agricultural Workers, Other

Significant Points

- Duties vary widely—from raising plants and livestock to operating large farm equipment.
- The majority of agricultural workers learn their skills on the job in less than a month; animal breeders require more work experience or a college degree.
- Job openings are expected to be numerous; opportunities for agricultural equipment operators, and crop, greenhouse, and nursery farmworkers should be particularly plentiful.

Nature of the Work

Agricultural workers play a large role in getting food, plants, and other agricultural products to market. Working mostly on farms or ranches, but also in nurseries and slaughterhouses, these workers have numerous and diverse duties. Among their activities are planting and harvesting crops, installing irrigation, and delivering animals. While most agricultural workers have relatively few technical skills, some have college degrees that train them to breed animals with specific traits.

Crop, nursery, and greenhouse farmworkers and laborers—the largest specialty by far—perform numerous activities related to growing and harvesting grains, fruits, vegetables, nuts, fiber, trees, shrubs, and other crops. They plant and seed, prune, irrigate, harvest, and pack and load crops for shipment. Farmworkers also apply pesticides, herbicides, and fertilizers to crops and repair fences and some farm equipment. Nursery and greenhouse workers prepare land or greenhouse beds for growing horticultural products, such as trees, plants, flowers, and sod. Their duties include planting, watering, pruning, weeding, and spraying the plants. They may cut, roll, and stack sod; stake trees; tie, wrap, and pack plants to fill orders; and dig up or move field-grown and containerized shrubs and trees.

Farm and ranch animal farmworkers—the second largest specialty—care for live farm, ranch, or water animals that may include cattle, sheep, swine, goats, horses, poultry, finfish, shellfish, and bees. The animals are usually raised to supply meat, fur, skins, feathers, eggs, milk, or honey. Duties may include feeding, watering, herding, grazing, castrating, branding, debeaking, weighing, catching, and loading animals; they also maintain records on animals, examine animals to detect diseases and injuries, assist in delivering animals at their birth, and administer medications, vaccinations, or insecticides. Many workers clean and maintain animal housing areas every day. On dairy farms, farmworkers operate milking machines.

Other agricultural workers known as *agricultural equipment operators* use a variety of farm equipment to plow, sow seeds, and maintain and harvest crops. Equipment may include tractors, fertilizer spreaders, haybines, raking equipment, balers, combines, threshers, and trucks. These workers also operate machines, such as conveyor belts, loading machines, separators, cleaners, and dryers, used in moving and treating crops after their harvest. As part of the job, workers may make adjustments and minor repairs to equipment.

Animal breeders select and breed animals using their knowledge of genetics and animal science to produce offspring with desired traits and characteristics, such as chickens that lay more eggs, pigs that produce leaner meat, and sheep with more desirable wool. Other animal breeders breed and raise cats, dogs, and other household pets. Larger and more expensive animals, such as horses and cattle, are usually bred through artificial insemination, a specialized technique which requires taking semen from the male and then inseminating the female. This process ensures better results than conventional mating and also enables one prized male to sire many more offspring. To know which animals to breed and when, animal breeders keep detailed records, including the health of the animals, their size and weight, and the amount and quality of the product produced by them. They also keep track of the traits of the offspring. Some animal breeders work as consultants for a number of farmers, but others breed and raise their own animals for sale or future breeding. For those who raise animals, tasks might include fixing and cleaning animal shelters, feeding and watering the animals, and overseeing animals' health. Some breeders supervise others who perform these tasks. Animal breeders also read journals and newsletters to learn the latest information on breeding and veterinary practices.

Work environment. Working conditions for agricultural workers vary widely. Much of the work of farmworkers and laborers on farms and ranches is physically strenuous and takes place outdoors in all kinds of weather. Harvesting fruits and vegetables, for example, may require much bending, stooping, and lifting. Workers may have limited access to sanitation facilities while working in the field and drinking water may also be limited. Nevertheless, many agricultural workers enjoy the variety of their work, the rural setting, the satisfaction of working the land, and raising animals.

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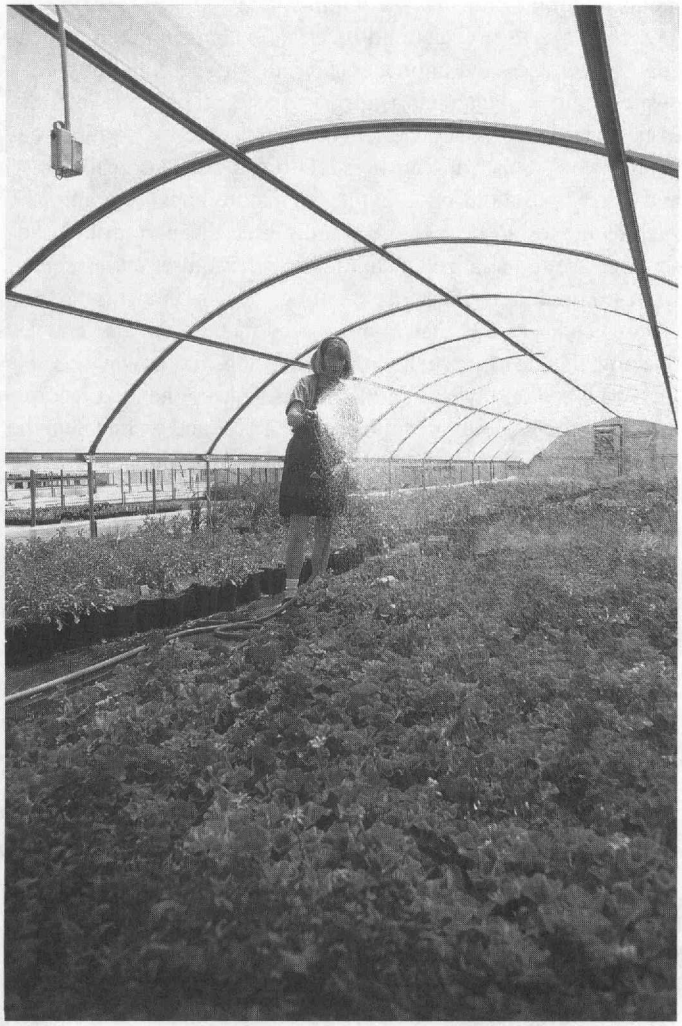
Farm work does not lend itself to a regular 40-hour workweek. In fact, about 16 percent of all agricultural workers have a variable schedule. Work cannot be delayed when crops must be planted or harvested or when animals must be sheltered and fed. Long hours and weekend work is common in these jobs. For example, farmworkers and agricultural equipment operators may work 6 or 7 days a week during planting and harvesting seasons.

Many agricultural worker jobs are seasonal in nature, so some workers also do other jobs during slow seasons. Migrant farmworkers, who move from location to location as crops ripen, live an unsettled lifestyle, which can be stressful. Work also is seasonal for farmworkers in nurseries; spring and summer are the busiest times of the year. Greenhouse workers enjoy relatively comfortable working conditions while tending plants indoors. However, during the busy seasons, when landscape contractors need plants, work schedules may be more demanding, often requiring weekend work. Moreover, the transition from warm weather to cold weather means that nursery workers might have to work overtime with little notice in order to move plants indoors to protect them from frost. Farmworkers who work with animals usually have a more regular schedule; their work is steadier and year round, but they sometimes must come to work on short notice to help handle emergencies.

Farmworkers risk exposure to pesticides and other hazardous chemicals sprayed on crops or plants. However, exposure can be minimal if safety procedures are followed. Those who work on mechanized farms must take precautions to avoid injury when working with tools and heavy equipment. Those who work directly with animals risk being bitten or kicked.



A nursery worker waters flowers in a greenhouse.

Animal breeders spend most of their time outdoors around animals but can also work in offices or laboratories. Breeders who consult may travel from farm to farm. If they need to sell offspring, breeders may travel to attend shows and meet potential buyers. While tending to the animals, breeders may be bitten or kicked.

Training, Other Qualifications, and Advancement

The majority of agricultural workers learn their skills on the job in less than a month; animal breeders require more work experience or a college degree.

Education and training. Most farmworkers learn their jobs quickly as they work; many do not have a high school diploma. People without a high school diploma are particularly common in the crop production sector, which is more labor-intensive and employs numerous migrant farmworkers. Other agricultural workers may require a month to a year of training on the job, depending on their responsibilities.

Other qualifications. Experience working on a farm or around animals is helpful but not necessary to qualify for many jobs. For those who operate equipment on the road or drive a truck as part their job, a driver's license or commercial driver's license is required.

Nursery workers who deal directly with customers must be friendly and tactful. Employers also look for responsible, self-motivated individuals because nursery workers sometimes work with little supervision.

Advancement. Farmworkers who work hard, have good communication skills, and take an interest in the business may advance to crew leader or other supervisory positions. The ability to speak both English and Spanish is quite helpful in supervisory work as well.

Some agricultural workers aspire to become farm, ranch, or other agricultural managers, or own farms or ranches themselves. (Farmers, ranchers, and agricultural managers are discussed elsewhere in the *Handbook*.) In addition, their knowledge of raising and harvesting produce may provide an excellent background for becoming purchasing agents and buyers of farm products. Knowledge of working a farm as a business can also help agricultural workers become farm and home management advisors. Those who earn a college degree in agricultural science could become agricultural and food scientists. (Agricultural and food scientists are discussed elsewhere in the *Handbook*.)

Employment

Agricultural workers held about 821,700 jobs in 2008. About one third was employed in animal production; some found employment in support activities for agriculture and forestry.

Arizona, California, Colorado, Texas, and New Mexico employ approximately one quarter of all crop workers; California, Florida, and Oregon employ the most nursery workers.

Job Outlook

Job opportunities for agricultural workers occupations should be abundant because large numbers of workers leave these jobs due to their low wages and physical demands. Little or no

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Agricultural workers, all other	—	821,700	804,400	17,400	-2
Animal breeders	45-2021	14,700	15,500	800	6
Miscellaneous agricultural workers	45-2090	807,000	788,800	-18,200	-2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

change in employment is expected over the 2008–18 decade, reflecting in large part the outlook for farmworkers in crops, nurseries, and greenhouses, who make up the largest majority of all agricultural workers.

Employment change. Overall employment is expected to show little or no change in employment. Fewer agricultural workers will be needed overall because of continued consolidation of farms and technological advancements in farm equipment that is raising output per farm worker. The agriculture industry also is expected to face increased competition from foreign countries and rising imports, particularly from Central America and China because of trade agreements with those regions. Nursery and greenhouse workers might experience some job growth in this period, if the demand for landscaping plants resumes its growth pattern.

Job prospects. Job openings should be plentiful because of relatively large numbers of workers who leave these jobs for other occupations. This is especially true for jobs as agricultural equipment operators, and crop, greenhouse, and nursery farmworkers. Those who work with animals tend to have a more settled lifestyle, as the work does not require them to follow crops for harvest.

Earnings

Agricultural workers had the following median hourly wages in May 2008:

Animal breeders	$13.02
Agricultural equipment operators	10.92
Farmworkers, farm and ranch animals	10.13
Farmworkers and laborers, crop, nursery, and greenhouse	8.64
Agricultural workers, all others	12.00

Farmworkers in crop production often are paid piece rates, with earnings based on how much they do instead of how many hours they work. Farmworkers tend to receive fewer benefits than those in many other occupations. Some employers supply seasonal workers with room and board.

Related Occupations

The duties of farmworkers who perform outdoor labor are similar to the duties of:

	Page
Fishers and fishing vessel operators	601
Forest and conservation workers	604
Grounds maintenance workers	498

Farmworkers who work with farm and ranch animals perform tasks similar to those of:

Animal care and service workers	504

Animal breeders may perform some work similar to those of:

Veterinarians	402
Veterinary technologists and technicians	443

Sources of Additional Information

Information on agricultural worker jobs is available from:

➤ United Farm Workers, P.O. Box 62, Keene, CA 93531-0062. Internet: **http://www.ufw.org/**

Information on training is available from:

➤ New England Small Farm Institute, 275 Jackson Street, Belchertown, MA 01007-9818. Internet: **http://www.growingnewfarmers.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos349.htm**

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Other Farming, Fishing, and Forestry Occupations

Agricultural Inspectors

Nature of the Work

Agricultural inspectors are employed by Federal and State governments to ensure compliance with laws and regulations governing the health, safety, and quality of agricultural commodities, processing equipment and facilities, and fish and logging operations.

Education and Training

Most jobs require work experience in a related field, such as food processing, or some college coursework in biology, agricultural science, or a related subject.

Job Outlook

Current and projected employment:

2008 Employment	16,600
2018 Employment	18,700
Employment change	2,100
Growth rate	13%

Employment change. Average employment growth is expected as Federal and State governments, the largest employers of these workers, are not expected to hire a significant number of new inspectors. However, demand for agricultural inspectors may increase significantly if pending legislation requiring greater scrutiny of the food industry by the Food and Drug Administration is passed.

Job prospects. Prospects should be good as a large number of government inspectors are expected to retire in the coming decade.

Earnings

Median annual wages of agricultural inspectors were $41,170 in May 2008.

Related Occupations

	Page
Food scientists and technologists	177
Purchasing agents and buyers, farm products	79

Sources of Additional Information

Information on obtaining positions as an agricultural inspector with the Federal Government is available from the Office of Personnel Management through USAJOBS, the Federal Government's official employment information system. This resource for locating and applying for job opportunities can be accessed through the Internet at **http://www.usajobs.opm.gov** or through an interactive voice response telephone system at (703) 724-1850 or TDD (978) 461-8404. These numbers are not toll free, and charges may result.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos347.htm**

Graders and Sorters, Agricultural Products

Nature of the Work

Graders and sorters grade, sort, or classify unprocessed food and other agricultural products by size, weight, color, or condition and discard inferior or defective products.

Education and Training

While some jobs require a high school diploma, simple jobs that need mostly visual inspection might be filled by those with work-related experience.

Job Outlook

Current and projected employment:

2008 Employment	33,400
2018 Employment	33,500
Employment change	100
Growth rate	0%

Employment change. Little or no change in employment is expected. Increased use of electronic sorters, higher levels of imported agricultural products, and growth of produce with less waste will result in decreased demand for these workers.

Job prospects. Most job openings will arise from the need to replace workers who leave the occupation each year. There may be competition for positions.

Earnings

Median hourly wages for graders and sorters of agricultural products were $9.06 per hour in May 2008.

Related Occupations

	Page
Agricultural inspectors	612

Sources of Additional Information

Information on obtaining positions as an agricultural inspector with the Federal Government is available from the Office of Personnel Management through USAJOBS, the Federal Government's official employment information system. This resource for locating and applying for job opportunities can be accessed through the Internet at **http://www.usajobs.opm.gov** or through an interactive voice response telephone system at (703) 724-1850 or TDD (978) 461-8404. These numbers are not toll free, and charges may result.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos348.htm**

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Construction Trades and Related Workers

Boilermakers

Significant Points

- Most boilermakers learn their job through a formal apprenticeship; people with a welding certification or other welding training get priority in selection to boilermaker apprenticeship programs.
- Boilermakers use potentially dangerous equipment and the work is physically demanding.
- Job opportunities are expected to be favorable.

Nature of the Work

Boilermakers and *boilermaker mechanics* make, install, and repair boilers, closed vats, and other large vessels or containers that hold liquids and gases. Boilers heat water or other fluids under extreme pressure for use in generating electric power and to provide heat and power in buildings, factories, and ships. Tanks and vats are used to store and process chemicals, oil, beer, and hundreds of other products.

In addition to installing and maintaining boilers and other vessels, boilermakers also help erect and repair air pollution equipment, blast furnaces, water treatment plants, storage and process tanks, and smoke stacks. Boilermakers also install refractory brick and other heat-resistant materials in fireboxes or pressure vessels. Some install and maintain the huge pipes used in dams to send water to and from hydroelectric power generation turbines.

Boilers and other high-pressure vessels used to hold liquids and gases usually are made in sections by casting each piece out of steel, iron, copper, or stainless steel. Manufacturers increasingly are automating this process to improve the quality of these vessels. Boilermakers weld sections of the boiler together, often using robotic welding systems or automated welding machines. Small boilers may be assembled in the manufacturing plant; larger boilers usually are prefabricated in numerous pieces and assembled on site, although they may be temporarily assembled in a fabrication shop to ensure a proper fit before final assembly at the permanent site.

Because boilers last a long time—sometimes 50 years or more—boilermakers need to regularly maintain them and upgrade components, such as boiler tubes, heating elements, and ductwork, to increase efficiency. They frequently inspect fittings, feed pumps, safety and check valves, water and pressure gauges, boiler controls, and auxiliary machinery. For closed vats and other large vessels, boilermakers clean or supervise cleaning of the vats using scrapers, wire brushes, and cleaning solvents. They repair or replace defective parts using hand and power tools, gas torches, and welding equipment, and may operate metalworking machinery to repair or make parts. They also dismantle leaky boilers, patch weak spots with metal stock, replace defective sections, and strengthen joints.

Before making or repairing a fabricated metal product, a boilermaker studies design drawings and creates full size patterns or templates, using straightedges, squares, transits, and tape measures. After the various sized shapes and pieces are marked out on metal, boilermakers use hand and power tools or flame cutting torches to make the cuts. The sections of metal are then bent into shape and accurately lined up before they are welded together. If the plate sections are very large, heavy cranes are used to lift the parts into place. Boilermakers align sections using plumb bobs, levels, wedges, and turnbuckles. They use metalworking machinery and other tools to remove irregular edges so that metal pieces fit together properly. They then join them by bolting, welding, or riveting. Boilermakers also align and attach water tubes, stacks and liners, safety and check valves, water and pressure gauges, and other parts, and test complete vessels for leaks or other defects.



Boilermakers weld sections of the boiler together.

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Work environment. Boilermakers often use potentially dangerous equipment, such as acetylene torches and power grinders, handle heavy parts and tools, and work on ladders or on top of large vessels. Dams, boilers, storage tanks, and pressure vessels are usually of substantial size, thus a major portion of boilermaker work is performed at great heights, sometimes hundreds of feet above the ground in the case of dams. The work is physically demanding and may be done in cramped quarters inside boilers, vats, or tanks that are often dark, damp, and poorly ventilated. Field construction work is performed outside so exposure to all types of weather conditions, including extreme heat and cold, is common. To reduce the chance of injuries, boilermakers often wear hardhats, harnesses, protective clothing, ear plugs, safety glasses and shoes, and respirators.

Boilermakers may experience extended periods of overtime when equipment is shut down for maintenance. Overtime work also may be necessary to meet construction or production deadlines. However, since most field construction and repair work is contract work, there may be periods of unemployment when a contract is complete. Many boilermakers must travel to a project and live away from home for long periods of time.

Training, Other Qualifications, and Advancement

Most boilermakers learn this trade through a formal apprenticeship. People with a welding certification or other welding training get priority in selection to boilermaker apprenticeship programs.

Education and training. Boilermakers learn their trade through formal apprenticeships offered through unions or employers or from a combination of trade and technical school training and employer-provided training. Training usually includes both boilermaking and structural fabrication. Apprenticeship programs usually consist of 6,000 hours or 4 years of paid on-the-job training, supplemented by a minimum of 144 hours of classroom instruction each year in subjects such as set-up and assembly rigging, plate and pressure welding, blueprint reading, and layout. Those who finish registered apprenticeships are certified as fully qualified journey-level workers.

Most apprentices must be at least 18 years old, a high school graduate or holder of a GED, and be legally authorized to work in the United States. Those with welding training or a welding certification will have an advantage in applying for apprenticeship programs. When an apprenticeship becomes available, the local union usually publicizes the opportunity by notifying local vocational schools and high school vocational programs. Education often continues throughout a boilermaker's career as they often attend classes or seminars to learn about new equipment, procedures, and technology.

Other qualifications. The work of boilermakers requires a high degree of technical skill, knowledge, and dedication. Because the tools and equipment used by boilermakers are typically heavier and more cumbersome than those in other construction trades, having physical strength and stamina is important. Good manual dexterity is also important.

Advancement. Some boilermakers advance to supervisory positions. Because of their extensive training, those qualified through apprenticeships usually have an advantage in getting promoted over those who have not gone through the complete program.

Employment

Boilermakers held about 20,200 jobs in 2008. About 21 percent worked in the nonresidential building construction industry, assembling and erecting boilers and other vessels. Another 21 percent worked in manufacturing.

Job Outlook

Employment is projected to grow faster than average. Favorable job opportunities are expected.

Employment change. Employment of boilermakers is expected to grow by 19 percent between 2008 and 2018. Growth will be driven by the need to maintain and upgrade, rather than replace, the many existing boilers that are getting older, and by the need to meet the growing population's demand for electric power. While boilers historically have lasted over 50 years, the need to replace components, such as boiler tubes, heating elements, and ductwork, is an ongoing process that will continue to spur demand for boilermakers. To meet the requirements of the Clean Air Act, utility companies also will need to continue upgrading their boiler systems.

Federal policies are also encouraging the construction of more environmentally sound and higher efficiency clean-burning coal, wind, and solar power plants, which will spur demand for boilermakers.

Installation of new boilers and pressure vessels, air pollution equipment, water treatment plants, storage and process tanks, electric static precipitators, and stacks and liners, will further drive growth of boilermakers, although to a lesser extent than repairs will.

Job prospects. Job prospects should be favorable because the work of a boilermaker remains hazardous and physically demanding, leading some qualified applicants to seek other types of work. Job growth will generate some new openings, but an even greater number of openings will arise from the numerous boilermakers expected to retire.

People who have welding training or a welding certificate should have the best opportunities for being selected for boilermaker apprenticeship programs.

Many industries that purchase boilers are sensitive to economic conditions. Therefore, during economic downturns, boilermakers in the construction industry may be temporarily laid off. However, maintenance and repairs of boilers must continue even during economic downturns so boilermaker mechanics in

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Boilermakers	47-2011	20,200	24,000	3,800	19

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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manufacturing and other industries generally have more stable employment.

Earnings

In May 2008, the median annual wage and salary of boilermakers was about $52,260. The middle 50 percent earned between $41,210 and $64,300. The lowest 10 percent earned less than $32,480, and the highest 10 percent earned more than $76,160. Apprentices generally start at about half of journey-level wages, with wages gradually increasing to the journey wage as workers gain skills.

Many boilermakers belong to labor unions, most to the International Brotherhood of Boilermakers. Other boilermakers are members of the International Association of Machinists, the United Automobile Workers, or the United Steelworkers of America.

Related Occupations

Workers in other occupations that fabricate, assemble, install, or repair metal equipment or machines include:

	Page
Assemblers and fabricators	723
Industrial machinery mechanics and millwrights	709
Machinists	737
Plumbers, pipelayers, pipefitters, and steamfitters	659
Sheet metal workers	665
Tool and die makers	740
Welding, soldering, and brazing workers	743

Sources of Additional Information

For more information about boilermaking apprenticeships or other training opportunities, contact local offices of the unions previously mentioned, local construction companies and boiler manufacturers, or the local office of your State employment service. You can also find information on the registered apprenticeships together with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/atels_bat.** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

For information on apprenticeships and the boilermaking occupation, contact:

➤ International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers, and Helpers, 753 State Ave., Suite 570, Kansas City, KS 66101. Internet: **http://www.boilermakers.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos221.htm**

Brickmasons, Blockmasons, and Stonemasons

Significant Points

- Job opportunities are expected to be good, especially for those with restoration skills.
- Some entrants learn informally on the job, but apprenticeship programs provide the most thorough training.
- The work is usually outdoors and involves lifting heavy materials and working on scaffolds.
- About 27 percent of brickmasons, blockmasons, and stonemasons were self-employed.

Nature of the Work

Brickmasons, blockmasons, and *stonemasons* create attractive, durable surfaces and structures. For thousands of years, these workers have built buildings, fences, roads, walkways, and walls using bricks, concrete blocks, and natural stone. The structures that they build will continue to be in demand for years to come.

The work varies in complexity, from laying a simple masonry walkway to installing an ornate exterior on a highrise building. Workers cut or break the materials used to create walls, floors, and other structures. Once their building materials are properly sized, they are laid with or without a binding material. Workers use their own perceptions and a variety of tools to ensure that the structure meets the desired standards. After they finish laying the bricks, blocks, or stone, the workers clean the finished product with a variety of cleaning agents.

Brickmasons and blockmasons—who often are called simply *bricklayers*—build and repair walls, floors, partitions, fireplaces, chimneys, and other structures with brick, precast masonry panels, concrete block, and other masonry materials. Some brickmasons specialize in installing firebrick linings in industrial furnaces.

When building a structure, brickmasons usually start in the corners. Because of the precision needed, corners are time-consuming to erect and require the skills of experienced bricklayers. To lay the brick, brickmasons spread a bed of mortar (a mixture of cement, lime, sand, and water) with a trowel (a flat, bladed metal tool with a handle), place the brick on the mortar bed, and press and tap the brick into place. Depending on blueprint specifications, brickmasons either cut bricks with a hammer and chisel or saw them to fit around windows, doors, and other openings. Mortar joints are then finished with jointing tools for a sealed, neat, uniform appearance. Although brickmasons typically use steel supports, or lintels, at window and door openings, they sometimes build brick arches, which support and enhance the beauty of the brickwork.

Refractory masons are brickmasons who specialize in installing firebrick and refractory tile in high-temperature boilers, furnaces, cupolas, ladles, and soaking pits in industrial establishments. Most of these workers are employed in steel mills, where molten materials flow on refractory beds from furnaces to rolling machines. They also are employed at oil refineries,

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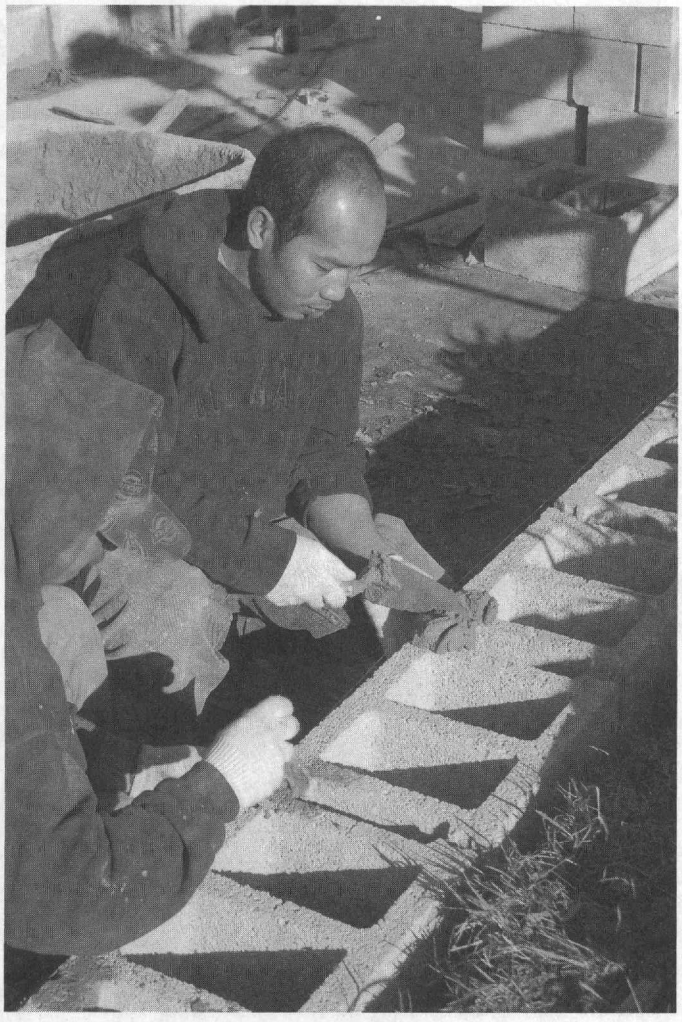
glass furnaces, incinerators, and other locations requiring high temperatures during the manufacturing process.

After a structure is completed there is often work that still needs to be done. *Pointing*, *cleaning*, and *caulking workers* can be the final workers on a job or the primary workers on a restoration project. These workers usually replace bricks or make repairs to brickwork on older structures where mortar has come loose. Special care is taken not to damage the main structural integrity or the bricks, blocks, or stone. Depending on how much mortar is being replaced, it may take several applications to allow the new mortar to cure properly. After laying the new bricks, the workers use chemicals to clean the brick and stone to give the structure a finished appearance.

Stonemasons build stone walls, as well as set stone exteriors and floors. They work with two types of stone—natural-cut stone, such as marble, granite, and limestone; and artificial stone, made from concrete, marble chips, or other masonry materials. Masons use a special hammer and chisel to cut stone. They cut stone along the grain to make various shapes and sizes, and valuable pieces are often cut with a saw that has a diamond blade. Stonemasons often work from a set of drawings in which each stone has been numbered for identification. Helpers may locate and carry these prenumbered stones to the masons. A derrick operator using a hoist may be needed to lift large stone pieces into place.



A blockmason sets concrete blocks.

When building a stone wall, masons set the first course of stones into a shallow bed of mortar. They then align the stones with wedges, plumb lines, and levels, and work them into position with various tools. Masons continue to build the wall by alternating layers of mortar and courses of stone. As the work progresses, masons remove the wedges, fill the joints between stones, and use a pointed metal tool, called a tuck pointer, to smooth the mortar to an attractive finish. To hold large stones in place, stonemasons attach brackets to the stones and weld or bolt these brackets to anchors in the wall. Finally, masons wash the stones with a cleansing solution to remove stains and dry the mortar.

When setting stone floors, which often consist of large and heavy pieces of stone, masons first use a trowel to spread a layer of damp mortar over the surface to be covered. They then use crowbars and hard rubber mallets for aligning and leveling to set the stone in the mortar bed. To finish, workers fill the joints and clean the stone slabs.

Some masons specialize in setting marble, which, in many respects, is similar to setting large pieces of stone. Brickmasons and stonemasons also repair imperfections and cracks and replace broken or missing masonry units in walls and floors.

Most nonresidential buildings are now built with walls made of some combination of any of the following: concrete block, brick veneer, stone, granite, marble, tile, and glass. In the past, masons doing nonresidential interior work mainly built block partition walls and elevator shafts, but because many types of masonry and stone are used in the interiors of today's nonresidential structures, these workers now must be more versatile. For example, some brickmasons and blockmasons now install structural insulated concrete units and wall panels. They also install a variety of masonry anchors and other masonry-associated accessories used in many highrise buildings.

Work environment. Brickmasons, blockmasons, and stonemasons usually work outdoors; in contrast to the past when work slowed down in the winter months, new processes and materials are allowing these masons to work in a greater variety of weather conditions. Masons stand, kneel, and bend for long periods and often have to lift heavy materials. Common hazards include injuries from tools and falls from scaffolds, but these can often be avoided when proper safety equipment, such as a hardhat, is used and when proper safety practices are followed.

Many workers work a standard 40-hour week. Some, however, do work more. Earnings for workers in the construction trades can be reduced on occasion when poor weather and slowdowns in construction activity decrease the amount of time the laborers can work.

Training, Other Qualifications, and Advancement

Some brickmasons, blockmasons, and stonemasons pick up their skills informally, observing and learning from experienced workers. Many others receive initial training in vocational education schools or from industry-based programs common throughout the country. Others complete an apprenticeship, which provides the most thorough training.

Education and training. Individuals who learn the trade on the job usually start as helpers, laborers, or mason tenders. These workers carry materials, move or assemble scaffolds, and mix mortar. When the opportunity arises, they learn from

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experienced craftworkers how to mix and spread mortar, lay brick and block, or set stone. They also may learn restoration skills such as cleaning, pointing, and repointing. As they gain experience, they learn more difficult tasks and make the transition to full-fledged craftworkers. The learning period usually lasts longer for workers who learn the trade on the job than for those who have already been trained in an apprenticeship program. Registered apprenticeship programs usually last between 3 and 4 years.

Some workers learn the trade at technical schools that offer masonry courses. Entrance requirements and fees vary depending on the school and who is funding the program. Some people take courses before being hired, and some take them later as part of on-the-job training.

Apprenticeships for brickmasons, blockmasons, and stonemasons usually are sponsored by local union-management joint apprenticeship and training committees, local contractors, or trade associations. Apprenticeship programs usually require 3 to 4 years of on-the-job training, in addition to a minimum of 144 hours of classroom instruction each year in blueprint reading, mathematics, layout work, sketching, and other subjects. In the coming years, the focus of apprenticeships is likely to change from time served to demonstrated competence. This may result in apprenticeships of shorter average duration. Applicants for apprenticeships must be at least 17 years old and in good physical condition. A high school diploma is preferable, especially with courses in mathematics, mechanical drawing, and general shop.

Apprentices often start by working with laborers: carrying materials, mixing mortar, and building scaffolds for about a month. Next, apprentices learn to lay, align, and join brick and block. They may also learn to work with stone and concrete, which is important when using other masonry materials.

Bricklayers who work in nonresidential construction usually work for large contractors and receive well-rounded training—normally through an apprenticeship in all phases of brick or stone work. Those who work in residential construction usually work for small contractors and specialize in only one or two aspects of the job.

Other qualifications. The most desired qualities in workers are dependability and a strong work ethic. Knowledge of basic math, including measurement, volume, mixing proportions, algebra, plane geometry, and mechanical drawing are important in this trade.

Advancement. With additional training and experience, brickmasons, blockmasons, and stonemasons may become supervisors for masonry contractors. Some eventually become owners of businesses and may spend most of their time as managers. Others move into closely related areas such as construction management or building inspection. Many unionized Joint Apprenticeship and Training Committees offer "lifelong learning" through continuing education courses that help those members who want to advance their technical knowledge and their careers.

Employment

Brickmasons, blockmasons, and stonemasons held 160,200 jobs in 2008. The vast majority were brickmasons and blockmasons. Workers in these crafts are employed in building construction or by specialty trade contractors.

About 27 percent of brickmasons, blockmasons, and stonemasons were self-employed. Many of the self-employed are contractors who work on small jobs, such as patios, walkways, and fireplaces.

Job Outlook

Brickmasons, blockmasons, and stonemasons should see as fast as average growth as the construction industry responds to the needs of a growing population. Job prospects should be better for workers with more thorough training who can work on complex structures.

Employment change. Jobs for brickmasons, blockmasons, and stonemasons are expected to increase by 12 percent over the 2008–18 decade, as fast as the average for all occupations, as the rising population will create a need for schools, hospitals, apartment buildings, and other structures. Also stimulating demand for workers will be the need to build more energy-efficient industrial facilities and office buildings (some of which may be made from brick) and to restore a growing number of old brick buildings. Moreover, the Federal Government has indicated a willingness to spend more on repairing schools and on making government buildings more energy efficient, which should have a positive impact on the construction industry in general.

Because of demographic forces, the residential housing market is expected to eventually pick up again. Brick exteriors and, particularly, stone should remain popular, reflecting a growing preference for durable exterior materials requiring little maintenance. There is also an increased demand for durable homes that incorporate brick or stone in hurricane-prone areas.

Job prospects. Job opportunities for brickmasons, blockmasons, and stonemasons are expected to be in rough balance over the 2008–18 period as laid-off workers and a reduced level of construction help balance out a need for skilled brickmasons, blockmasons, and stonemasons. The masonry workforce is growing older, and a large number of masons are expected to retire over the next decade, which will create many job openings. Applicants who take masonry-related courses at technical schools will improve their job prospects.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Brickmasons, blockmasons, and stonemasons	47-2020	160,200	178,600	18,500	12
Brickmasons and blockmasons	47-2021	135,800	151,500	15,600	12
Stonemasons	47-2022	24,300	27,100	2,800	12

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Employment of brickmasons, blockmasons, and stonemasons, like that of many other construction workers, is sensitive to changes in the economy. When the level of construction activity falls, workers in these trades can experience periods of unemployment. On the other hand, shortages of workers may occur in some areas during peak periods of building activity. Ongoing, however, is the need to repair and restore a large number of aging masonry buildings. This work will increase opportunities for workers with these types of skills.

New concerns over the costs of heating and cooling buildings of all types has led to a need to train construction workers of all types, including brickmasons, blockmasons, and stonemasons, in the emerging field of green construction. Contractors familiar with this burgeoning area will have better job opportunities in the future.

Earnings

Median hourly wages of brickmasons and blockmasons in May 2008 were $21.94. The middle 50 percent earned between $16.77 and $28.46. The lowest 10 percent earned less than $13.26, and the highest 10 percent earned more than $35.63. In the two industries employing the largest numbers of brickmasons and blockmasons in May 2008—the foundation, structure, and building exterior contractors industry and the nonresidential building industry—median hourly wages were $21.71 and $23.84, respectively.

Median hourly wages of wage and salary stonemasons in May 2008 were $18.17. The middle 50 percent earned between $14.31 and $23.72. The lowest 10 percent earned less than $11.63, and the highest 10 percent earned more than $31.87.

Apprentices or helpers usually start at about 50 percent of the wage rate paid to experienced workers. Pay increases as apprentices gain experience and learn new skills. Employers usually increase apprentices' wages about every 6 months on the basis of specific advancement criteria.

About 18 percent of brickmasons, blockmasons, and stonemasons were members of unions, mainly the International Union of Bricklayers and Allied Craftsworkers.

Related Occupations

Brickmasons, blockmasons, and stonemasons combine a thorough knowledge of brick, concrete block, stone, and marble with manual skill to erect attractive, yet highly durable, structures. Workers in other occupations with similar skills include:

	Page
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638

Sources of Additional Information

For details about apprenticeships or other work opportunities in these trades, contact local bricklaying, stonemasonry, or marble-setting contractors; the Associated Builders and Contractors; a local office of the International Union of Bricklayers and Allied Craftsworkers; a local joint union-management apprenticeship committee; or the nearest office of a State employment service or apprenticeship agency. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 872-5627 and online at: **http://www.doleta.gov/OA/eta_default.cfm**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print in many libraries and career centers.

For information on training for brickmasons, blockmasons, and stonemasons, contact:

➤ Mason Contractors Association of America, 33 South Roselle Rd., Schaumburg, IL 60193. Internet: **http://www.masoncontractors.org**

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St. NW., Washington, DC 20005. Internet: **http://www.hbi.org**

For information about training, including a credential in green construction, contact:

➤ International Union of Bricklayers and Allied Craftworkers, 620 F St. NW., Washington, DC 20004. Internet: **http://www.bacweb.org**

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606. Internet: **http://www.nccer.org**

For general information about the work of bricklayers, contact:

➤ International Masonry Institute National Training Center, The James Brice House, 42 East St., Annapolis, MD 21401. Internet: **http://www.imiweb.org**

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201. Internet: **http://www.agc.org**

➤ National Concrete Masonry Association, 13750 Sunrise Valley Dr., Herndon, VA 20171-4662. Internet: **http://www.ncma.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos201.htm**

Carpenters

Significant Points

- About 32 percent of all carpenters are self-employed.
- Job opportunities should be best for those with the most training and skills.
- Carpenters can learn their craft through on-the-job training, vocational schools or technical colleges, or formal apprenticeship programs, which often takes 3 to 4 years.

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Nature of the Work

Carpenters construct, erect, install, and repair structures and fixtures made from wood and other materials. Carpenters are involved in many different kinds of construction, from the building of highways and bridges to the installation of kitchen cabinets.

Each carpentry task is somewhat different, but most involve the same basic steps. Working from blueprints or instructions from supervisors, carpenters first do the layout—measuring, marking, and arranging materials—in accordance with local building codes. They cut and shape wood, plastic, fiberglass, or drywall using hand and power tools, such as chisels, planes, saws, drills, and sanders. They then join the materials with nails, screws, staples, or adhesives. In the last step, carpenters do a final check of the accuracy of their work with levels, rules, plumb bobs, framing squares, and surveying equipment, and make any necessary adjustments. Some materials come prefabricated, allowing for easier and faster installation.

Carpenters may do many different carpentry tasks, or they may specialize in one or two. Carpenters who remodel homes and other structures, for example, need a broad range of carpentry skills. As part of a single job, they might frame walls and partitions, put in doors and windows, build stairs, install cabinets and molding, and complete many other tasks. Well-trained carpenters are able to switch from residential building to commercial construction or remodeling work, depending on which offers the best work opportunities.

Carpenters who work for large construction contractors or specialty contractors may perform only a few regular tasks, such as constructing wooden forms for pouring concrete, or erecting scaffolding. Some carpenters build tunnel bracing, or brattices, in underground passageways and mines to control the circulation of air through the passageways and to worksites. Others build concrete forms for tunnel, bridge, or sewer construction projects.

Carpenters employed outside the construction industry perform a variety of installation and maintenance work. They may replace panes of glass, ceiling tiles, and doors, as well as repair desks, cabinets, and other furniture. Depending on the employer, carpenters install partitions, doors, and windows; change locks; and repair broken furniture. In manufacturing firms, carpenters may assist in moving or installing machinery.



A carpenter uses a pneumatic gun for hammering nails.

(For more information on workers who install machinery, see the discussion of industrial machinery mechanics and millwrights, as well as maintenance and repair workers, general, elsewhere in the *Handbook*.)

Work environment. As is true of other building trades, carpentry work is sometimes strenuous. Prolonged standing, climbing, bending, and kneeling often are necessary. Carpenters risk injury working with sharp or rough materials, using sharp tools and power equipment, and working in situations where they might slip or fall. Consequently, workers in this occupation experience a very high incidence of nonfatal injuries and illnesses. Additionally, carpenters who work outdoors are subject to variable weather conditions.

Many carpenters work a standard 40 hour week; however, some work more. About 7 percent worked part time.

Training, Other Qualifications, and Advancement

Carpenters can learn their craft through on-the-job training, vocational schools or technical colleges, or formal apprenticeship programs, which often takes 3 to 4 years.

Education and training. Learning to be a carpenter can start in high school. Classes in English, algebra, geometry, physics, mechanical drawing, blueprint reading, and general shop will prepare students for the further training they will need.

After high school, there are a number of different ways to obtain the necessary training. Some people get a job as a carpenter's helper, assisting more experienced workers. At the same time, the helper might attend a trade or vocational school, or community college to receive further trade-related training and eventually become a carpenter.

Some employers offer employees formal apprenticeships. These programs combine on-the-job training with related classroom instruction. Apprentices usually must be at least 18 years old and meet local requirements. Apprenticeship programs usually last 3 to 4 years, but new rules may allow apprentices to complete programs sooner as competencies are demonstrated.

On the job, apprentices learn elementary structural design and become familiar with common carpentry jobs, such as layout, form building, rough framing, and outside and inside finishing. They also learn to use the tools, machines, equipment, and materials of the trade. In the classroom, apprentices learn safety, first aid, blueprint reading, freehand sketching, basic mathematics, and various carpentry techniques. Both in the classroom and on the job, they learn the relationship between carpentry and the other building trades.

The number of apprenticeship programs is limited, however, so only a small proportion of carpenters learn their trade through these programs. Most apprenticeships are offered by commercial and industrial building contractors, along with construction unions.

Some people who are interested in carpentry careers choose to receive classroom training before seeking a job. There are a number of public and private vocational-technical schools and training academies affiliated with unions and contractors that offer training to become a carpenter. Employers often look favorably upon these students and usually start them at a higher level than those without this training.

Other qualifications. Carpenters need manual dexterity, good eye-hand coordination, physical fitness, and a good sense

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of balance. The ability to solve mathematical problems quickly and accurately also is required. In addition, military service or a good work history is viewed favorably by employers.

Certification and advancement. Carpenters who complete formal apprenticeship programs receive certification as journeypersons. Some carpenters earn other certifications in scaffold building, high torque bolting, or pump work. These certifications prove that carpenters are able to perform these tasks, which can lead to additional responsibilities.

Carpenters usually have more opportunities than most other construction workers to become general construction supervisors, because carpenters are exposed to the entire construction process. For those who would like to advance, it is increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers; Spanish-speaking workers make up a large part of the construction workforce in many areas. Carpenters may advance to carpentry supervisor or general construction supervisor positions. Others may become independent contractors. Supervisors and contractors need good communication skills to deal with clients and subcontractors. They also should be able to identify and estimate the quantity of materials needed to complete a job and accurately estimate how long a job will take to complete and what it will cost.

Employment

Carpenters are employed throughout the country in almost every community and make up the second largest building trades occupation. They held about 1.3 million jobs in 2008.

About 32 percent worked in the construction of buildings industry, and about 22 percent worked for specialty trade contractors. Most of the rest of wage and salary carpenters worked for manufacturing firms, government agencies, retail establishments, and a wide variety of other industries. About 32 percent of all carpenters were self-employed. Some carpenters change employers each time they finish a construction job. Others alternate between working for a contractor and working as contractors themselves on small jobs, depending on where the work is available.

Job Outlook

As fast as average job growth, coupled with replacement needs, will create a large number of openings each year. Job opportunities should be best for those with the most training and skills.

Employment change. Employment of carpenters is expected to increase by 13 percent during the 2008–18 decade, as fast as the average for all occupations. Population growth over the next decade will stimulate some growth in the construction industry over the long run to meet people's housing and other basic needs. Energy conservation will also stimulate demand for buildings that are more energy efficient, particularly in the industrial sector. The home remodeling market also will create demand for carpenters. Moreover, construction of roads and bridges should increase the demand for carpenters in the coming decade. Much will depend on spending by the Federal and State governments, as they attempt to upgrade and repair existing infrastructure, such as highways, bridges, and public buildings.

Some of the demand for carpenters, however, will be offset by expected productivity gains resulting from the increasing use of prefabricated components and improved fasteners and tools. Prefabricated wall panels, roof assemblies, and stairs, as well as prehung doors and windows can be installed very quickly. Instead of having to be built on the worksite, prefabricated walls, partitions, and stairs can be lifted into place in one operation; beams and, in some cases, entire roof assemblies, are lifted into place using a crane. As prefabricated components become more standardized, builders will use them more often. New and improved tools, equipment, techniques, and materials also are making carpenters more versatile, allowing them to perform more carpentry tasks.

Job prospects. Job opportunities will be good for those with the most training and skills. The need to replace carpenters who retire or leave the occupation for other reasons should result in a large number of openings. Carpenters with specialized or all-around skills will have better opportunities for steady work than carpenters who can perform only a few relatively simple, routine tasks.

Employment of carpenters, like that of many other construction workers, is sensitive to the fluctuations of the economy. Workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Job opportunities for carpenters also vary by geographic area. Construction activity parallels the movement of people and businesses and reflects differences in local economic conditions. The areas with the largest population increases will also provide the best opportunities for jobs as carpenters and for apprenticeships for people seeking to become carpenters.

Earnings

In May 2008, median hourly wages of wage and salary carpenters were $18.72. The middle 50 percent earned between $14.42 and $25.37. The lowest 10 percent earned less than $11.66, and the highest 10 percent earned more than $33.34. Median hourly wages in the industries employing the largest numbers of carpenters were as follows:

Nonresidential building construction	$21.08
Building finishing contractors	19.37
Residential building construction	18.24
Foundation, structure, and building exterior contractors	17.67
Employment services	15.81

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Carpenters	47-2031	1,284,900	1,450,300	165,400	13

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Earnings can be reduced on occasion, because carpenters lose worktime in bad weather and during recessions when jobs are unavailable. Earnings may be increased by overtime during busy periods.

Some carpenters are members of the United Brotherhood of Carpenters and Joiners of America. About 19 percent of all carpenters were members of unions or covered by union contracts, higher than the average for all occupations.

Related Occupations

Carpenters are skilled construction workers. Other skilled construction occupations include:

	Page
Brickmasons, blockmasons, and stonemasons	615
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Construction equipment operators	632
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638
Electricians	641
Plumbers, pipelayers, pipefitters, and steamfitters	659

Sources of Additional Information

For information about carpentry apprenticeships or other work opportunities in this trade, contact local carpentry contractors, locals of the union mentioned above, local joint union-contractor apprenticeship committees, or the nearest office of the State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor toll-free helpline: (877) 872-5627.

For information on training opportunities and carpentry in general, contact:

➤ Associated Builders and Contractors, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201-5426. Internet: **http://www.agc.org**

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL, 32606-8134. Internet: **http://www.nccer.org**

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St. NW., Washington, DC 20005-2842. Internet: **http://www.hbi.org**

➤ United Brotherhood of Carpenters and Joiners of America, Carpenters Training Fund, 101 Constitution Ave. NW, Washington, DC 20001-2192. Internet: **http://www.carpenters.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos202.htm**

Carpet, Floor, and Tile Installers and Finishers

Significant Points

- Most workers learn on the job.
- About 35 percent of carpet, floor, and tile installers and finishers are self-employed.
- Projected job growth varies by specialty; for example, tile and marble setters are expected to grow by 14 percent, while carpet installers is projected to decline by 1 percent.
- Employment of carpet, floor, and tile installers and finishers is less sensitive to fluctuations in construction activity than is employment of workers in other construction trades.

Nature of the Work

Carpet, floor, and tile installers and finishers lay floor coverings in homes, offices, hospitals, stores, restaurants, and many other types of buildings. Tile also may be installed on walls and ceilings. Carpet, tile, and other types of floor coverings not only serve an important basic function in buildings, but their decorative qualities also contribute to the appeal of the buildings.

Before installing carpet, carpet installers first inspect the surface to be covered to determine its condition and, when necessary, correct any imperfections that could show through the carpet or cause the carpet to wear unevenly. They measure the area to be carpeted and plan the layout, keeping in mind likely traffic patterns and placement of seams for best appearance and maximum wear.

When installing wall-to-wall carpet without tacks, installers first fasten a tackless strip to the floor, next to the wall. They then install the padded cushion, or underlay. Next, they roll out, measure, mark, and cut the carpet, allowing for 2 to 3 inches of extra carpet for the final fitting. Using a device called a "knee kicker," they position the carpet, stretching it to fit evenly on the floor and snugly against each wall and door threshold. They then cut off the excess carpet. Finally, using a power stretcher, they stretch the carpet, hooking it to the tackless strip to hold it in place. The installers then finish the edges using a wall trimmer.

Because most carpet comes in 12-foot widths, wall-to-wall installations require installers to join carpet sections together for large rooms. The installers join the sections using heat-taped seams—seams held together by a special plastic tape that is activated by heat.

In commercial installations, carpet often is glued directly to the floor or to padding that has been glued to the floor. For

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special upholstery work, such as installing carpet on stairs, carpet may be held in place with staples.

Carpet installers use hand tools such as hammers, drills, staple guns, carpet knives, and rubber mallets. They also may use carpet-laying tools, such as carpet shears, knee kickers, wall trimmers, loop pile cutters, heat irons, and power stretchers.

Floor installers and *floor layers* lay floor coverings such as laminate, linoleum, vinyl, cork, and rubber for decorative purposes or to reduce noise, absorb shocks, or create air-tight environments. Although these workers also may install carpet, wood, or tile, that is not their main job. Before installing the floor, floor layers inspect the surface to be covered and, if necessary, correct any defects, such as a sub-floor that is unleveled or contains rotted wood, in order to start with a strong, smooth, clean foundation. Then they measure and cut flooring materials. When installing linoleum or vinyl, they may use an adhesive to glue the material directly to the floor. For laminate floor installation, workers may unroll and install a polyethylene film that acts as a moisture barrier, along with a thicker, padded underlayer that helps reduce noise. Cork and rubber floors can often be installed directly on top of the sub-floor without an underlayer. Finally, floor layers install the floor covering to form a tight fit.

After a carpenter installs a new hardwood floor or when a customer wants to refinish an old wood floor, floor sanders and finishers are called in to smooth any imperfections in the wood and apply coats of varnish or polyurethane. To remove imperfections and smooth the surface, they scrape and sand wood floors using floor-sanding machines. After sanding, they then examine the floor and remove excess glue from joints using a knife or wood chisel and may further sand the wood surfaces by hand, using sandpaper. Finally, they apply sealant using brushes or rollers, often applying multiple coats.

Tile installers, *tilesetters*, and *marble setters* apply hard tile and marble to floors, walls, ceilings, countertops, patios, and roof decks. Tile and marble are durable, impervious to water, and easy to clean, making them a popular building material in bathrooms, kitchens, hospitals, and commercial buildings.



Carpet, floor, and tile installers and finishers lay floor coverings in homes and other types of buildings.

Prior to installation, tilesetters use measuring devices, spacers, and levels to ensure that the tile is placed in a consistent manner. Tiles vary in color, shape, and size, with their sides ranging from 1 inch to 24 or more inches in length, so tilesetters sometimes prearrange tiles on a dry floor according to the planned design. This allows them to examine the pattern, check that they have enough of each type of tile, and determine where they will have to cut tiles to fit the design in the available space. Tilesetters cut tiles with a machine saw or a special cutting tool to cover all exposed areas, including corners and around pipes, tubs, and wash basins. To set tile on a flat, solid surface, such as drywall, concrete, plaster, or wood, tilesetters first use a tooth-edged trowel to spread a "thin set"—a thin layer of either cement adhesive or "mastic," which is a very sticky paste. They then properly position the tile and gently tap the surface with the trowel handle, a rubber mallet, or a small block of wood to set the tile evenly and firmly. Spacers are used to maintain exact distance between tiles, and any excess thin set is wiped off the tile immediately after placement.

To apply tile to an area that lacks a solid surface, tilesetters nail a support of metal mesh or tile backer board to the wall or ceiling to be tiled. They use a trowel to apply a cement mortar—called a "scratch coat"—onto the metal screen, and scratch the surface of the soft mortar with a small tool similar to a rake. After the scratch coat has dried, tilesetters apply a brown coat of mortar to level the surface, and then apply mortar to the brown coat and begin to place tile onto the surface. Hard backer board also is used in areas where there is excess moisture, such as a shower stall.

When the cement or mastic has set, tilesetters fill the joints with "grout," which is very fine cement. Grout that is used for joints 1/8th of an inch and larger typically has sand in it. Tilesetters then apply the grout to the surface with a rubber-edged device called a "float" or a grouting trowel to fill the joints and remove excess grout. Before the grout sets, they wipe the tiles and smooth the joints with a wet sponge for a uniform appearance.

Marble setters cut and set marble slabs on floors and walls of buildings. They trim and cut marble to specified sizes using a power wet saw, other electric cutting equipment, or handtools. After setting the marble in place, the workers polish the marble to a high luster using power tools or by hand.

Work environment. Carpet, floor, and tile installers and finishers usually work indoors and have regular daytime hours. However, when floor covering installers need to work in occupied stores or offices, they may work evenings and weekends to avoid disturbing customers or employees. By the time workers install carpets, flooring, or tile in a new structure, the majority of construction has been completed and the work area is relatively clean and uncluttered. Installing these materials is labor intensive; workers spend much of their time bending, kneeling, and reaching—activities that require endurance. The work can be very hard on workers' knees; therefore, safety regulations often require that they wear kneepads. Carpet installers frequently lift heavy rolls of carpet and may move heavy furniture, which requires strength and can be physically exhausting and hard on workers' backs. Carpet and floor layers may be exposed to

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fumes from various kinds of glue and to fibers of certain types of carpet. Tile and floor installers are usually required to wear safety goggles when using certain equipment.

Workers are subject to cuts from tools or materials, falls from ladders, and strained muscles. Data from the U.S. Bureau of Labor Statistics show that full-time carpet, floor, and tile installers and finishers experienced a work-related injury and illness rate that was higher than the national average.

Training, Other Qualifications, and Advancement

The vast majority of carpet, floor, and tile installers and finishers learn their trade informally on the job. Some workers, mostly tile setters, learn through formal apprenticeship programs, which include classroom instruction and paid on-the-job training.

Education and training. Most carpet installers receive short-term on-the-job training, often sponsored by individual contractors; therefore, a high school diploma usually is not required. Workers start as helpers and begin with simple assignments, such as installing stripping and padding, or helping to stretch newly installed carpet. With experience, helpers take on more difficult assignments, such as cutting and fitting.

Tile and marble setters learn their craft mostly through long-term on-the-job training. They start by helping carry materials and learning about the tools of the trade, and later they take on more difficult tasks, such as preparing the subsurface for tile or marble. As tile and marble setters progress, they learn to cut the tile and marble to fit the job. They also learn to apply grout and sealants to give the product its final appearance. Apprenticeship programs and some contractor-sponsored programs provide comprehensive training in all phases of the tilesetting and floor layer trades.

Other floor layers also learn on the job and begin by learning how to use the tools of the trade. As they progress, they learn how to cut and install the various floor coverings.

Other qualifications. Good manual dexterity, eye-hand coordination, physical fitness, and sense of balance and color are some of the skills needed to become carpet, floor, and tile installers and finishers. The ability to solve basic arithmetic problems quickly and accurately also is required. In addition, reliability and a good work history are viewed favorably by contractors.

Advancement. Carpet, floor, and tile installers and finishers sometimes advance to become supervisors, salespersons, or estimators. In these positions, they must be able to estimate the time, money, and quantity of materials needed to complete a job.

Some carpet installers may become managers for large installation firms. For those interested in advancement, it is increasingly important to be able to communicate in both English and Spanish because Spanish-speaking workers make up a large part of the construction workforce in many areas. Workers who want to advance to supervisor jobs or become independent contractors also need good English skills to deal with clients and subcontractors.

Many carpet, floor, and tile installers and finishers who begin working for someone else eventually go into business for themselves as independent contractors.

Employment

Carpet, floor, and tile installers and finishers held about 160,500 jobs in 2008. About 35 percent of all carpet, floor, and tile installers and finishers were self-employed. The following tabulation shows 2008 total employment by specialty:

Tile and marble setters	76,000
Carpet installers	51,100
Floor layers, except carpet, wood, and hard tiles	21,200
Floor sanders and finishers	12,200

Many carpet installers work for flooring contractors or floor covering retailers. Most salaried tilesetters are employed by tilesetting contractors who work mainly on nonresidential construction projects, such as schools, hospitals, and office buildings. Most self-employed tilesetters work on residential projects.

Although carpet, floor, and tile installers and finishers are employed throughout the Nation, they tend to be concentrated in populated areas where there are high levels of construction activity.

Job Outlook

Employment of carpet, floor, and tile installers and finishers is expected to grow as fast as the average for all occupations. Job growth and opportunities, however, will differ among the individual occupations in this category.

Employment change. Overall employment is expected to grow by 7 percent between 2008 and 2018, about as fast as the average. Tile and marble setting, the largest specialty, will experience faster than average employment growth because population and business growth will result in more construction of shopping malls, hospitals, schools, restaurants, and other structures in which tile is used extensively. Tiles, including those made of glass, slate, and mosaic, and other less traditional materials, are also becoming more popular, particularly in the growing number of more expensive homes.

Employment of carpet installers, the second-largest specialty, will decline by 1 percent as residential investors and homeowners increasingly choose hardwood and tile floors because of their durability, neutral colors, and low maintenance, and because owners feel these floors will add to the value of their

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Carpet, floor, and tile installers and finishers	47-2040	160,500	171,900	11,400	7
Carpet installers	47-2041	51,100	50,500	-600	-1
Floor layers, except carpet, wood, and hard tiles	47-2042	21,200	21,000	-200	-1
Floor sanders and finishers	47-2043	12,200	13,600	1,400	11
Tile and marble setters	47-2044	76,000	86,800	10,800	14

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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homes. Carpets, on the other hand, stain and wear out faster than wood or tile, which contributes to the decreased demand for carpet installation. Nevertheless, carpet will continue to be used in nonresidential structures such as schools, offices, and hospitals. Also, many multifamily structures will require or recommend carpet because it provides sound dampening.

Workers who install other types of flooring, including laminate, cork, bamboo, rubber, and vinyl, should have little or no job growth because these materials are used less frequently and are often laid by other types of construction workers. Employment of floor sanders and finishers—a small specialty—is projected to grow by 11 percent because of the increasing use of prefinished hardwood flooring and because their work is heavily concentrated in the relatively small niche market of residential remodeling. There should also be some employment growth resulting from restoration of damaged hardwood floors, a procedure that is typically more cost effective than installing new floors.

Job prospects. In addition to employment growth, numerous job openings are expected for carpet, floor, and tile installers and finishers because of the need to replace workers who leave the occupation. The strenuous nature of the work leads to high replacement needs; many of these workers do not stay in the occupation long.

Few openings will arise for vinyl and linoleum floor installers because the number of these jobs is comparatively small and because homeowners can increasingly take advantage of easy application products, such as self-adhesive vinyl tiles.

Employment of carpet, floor, and tile installers and finishers is less sensitive to changes in construction activity than most other construction occupations because much of the work involves replacing worn carpet and other flooring in existing buildings. However, workers in these trades may still experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

In May 2008, median hourly wages of carpet installers were $17.80. The middle 50 percent earned between $12.82 and $25.35. The lowest 10 percent earned less than $10.23, and the top 10 percent earned more than $34.10. Median hourly wages of carpet installers working for building finishing contractors were $18.25, and $16.92 for those working in home furnishings stores. Carpet installers are paid either on an hourly basis or by the number of yards of carpet installed.

Median hourly wages of wage and salary floor layers except carpet, wood, and hard tiles were $17.50 in May 2008. The middle 50 percent earned between $13.34 and $23.33. The lowest 10 percent earned less than $10.55, and the top 10 percent earned more than $30.84.

Median hourly wages of floor sanders and finishers were $15.41 in May 2008. The middle 50 percent earned between $12.79 and $20.16. The lowest 10 percent earned less than $10.54, and the top 10 percent earned more than $25.96.

Median hourly wages of tile and marble setters were $18.85 in May 2008. The middle 50 percent earned between $13.71 and $25.19. The lowest 10 percent earned less than $10.65, and the top 10 percent earned more than $32.40.

Earnings of carpet, floor, and tile installers and finishers vary greatly by geographic location and by union membership status. Some carpet, floor, and tile installers and finishers belong to the United Brotherhood of Carpenters and Joiners of America. Some tilesetters belong to the International Union of Bricklayers and Allied Craftsmen, and some carpet installers belong to the International Brotherhood of Painters and Allied Trades.

Apprentices and other trainees usually start out earning about half of what an experienced worker earns; their wage rates increase as they advance through the training program.

Related Occupations

Carpet, floor, and tile installers and finishers measure, cut, and fit materials to cover a space. Workers in other occupations involving similar skills, but using different materials, include:

	Page
Brickmasons, blockmasons, and stonemasons	615
Carpenters	618
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638
Painters and paperhangers	656
Roofers	662
Sheet metal workers	665

Sources of Additional Information

For details about apprenticeships or work opportunities, contact local flooring or tilesetting contractors or retailers, locals of the unions previously mentioned, or the nearest office of the State apprenticeship agency or employment service. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: 1 (877) 872–5627.

Additional information on training for carpet installers and floor layers is available from:

➤ Finishing Trades Institute International, 7230 Parkway Drive, Hanover, MD 21076. Internet: **http://www.finishingtradesinstitute.org**

For general information about the work of tile installers and finishers, contact:

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St. NW., Washington, DC 20005. Internet: **http://www.hbi.org** and **http://www.nahb.org**

For more information about tile setting and tile training, contact:

➤ National Tile Contractors Association, P.O. Box 13629, Jackson, MS 39236. Internet: **http://www.tile-assn.com**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos203.htm**

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Cement Masons, Concrete Finishers, Segmental Pavers, and Terrazzo Workers

Significant Points

- Job opportunities are expected to be good, especially for those with the most experience and skills.
- Most workers learn on the job or through a combination of classroom and on-the-job training that can take 3 to 4 years.
- Cement masons often have variable schedules and work overtime, with premium pay, because once concrete has been placed, the job must be completed quickly.

Nature of the Work

Cement masons, concrete finishers, and terrazzo workers all work with concrete, one of the most common and durable materials used in construction. Once set, concrete—a mixture of Portland cement, sand, gravel, and water—becomes the foundation for everything from decorative patios and floors to huge dams or miles of roadways.

Cement masons and *concrete finishers* place and finish concrete. They also may color concrete surfaces, expose aggregate (small stones) in walls and sidewalks, or fabricate concrete beams, columns, and panels. In preparing a site to place concrete, cement masons first set the forms for holding the concrete and properly align them. They then direct the casting of the concrete and supervise laborers who use shovels or special tools to spread it. Masons then guide a straightedge back and forth across the top of the forms to "screed," or level, the freshly placed concrete. Immediately after leveling the concrete, masons carefully float it—which means to smooth the concrete surface with a "bull float," a long-handled tool of about 8 by 48 inches that covers the coarser materials in the concrete and brings a rich mixture of fine cement paste to the surface.

After the concrete has been leveled and floated, concrete finishers press an edger between the forms and the concrete and guide it along the edge and the surface. This produces slightly rounded edges and helps prevent chipping or cracking. Concrete finishers use a special tool called a "groover" to make joints or grooves at specific intervals that help control cracking. Next, they smooth the surface using either a powered or hand trowel, which is a small, smooth, rectangular metal tool.

Sometimes, cement masons perform all the steps of laying concrete, including the finishing. As the final step, they retrowel the concrete surface back and forth with powered or hand trowels to create a smooth finish. For a coarse, nonskid finish, masons brush the surface with a broom or stiff-bristled brush. For a pebble finish, they embed small gravel chips into the surface. They then wash any excess cement from the exposed chips with a mild acid solution. For color, they use colored premixed concrete.

Throughout the entire process, cement masons must monitor how the wind, heat, or cold affects the curing of the concrete. They must have a thorough knowledge of concrete characteristics so that, by using sight and touch, they can determine what is happening to the concrete and take measures to prevent defects.

Segmental pavers lay out, cut, and install pavers—flat pieces of masonry made from compacted concrete or brick. This masonry is typically installed in patios, sidewalks, plazas, streets, crosswalks, parking lots, and driveways. Installers usually begin their work by preparing a base that has been graded to the proper depth and filled and leveled with a layer of sand. Installers then place the pavers in a pattern, normally by hand but sometimes by machine. Sand is then added to fill the joints between the pavers.

Terrazzo workers and *finishers* create attractive walkways, floors, patios, and panels by exposing marble chips and other fine aggregates on the surface of finished concrete. Much of the preliminary work of terrazzo workers is similar to that of cement masons. Depending on the type of terrazzo, they usually first build a solid, level concrete foundation that is 3 to 4 inches deep. Second, after the forms are removed from the foundation, workers add a 1-inch layer of sandy concrete. Terrazzo workers partially embed, or attach with adhesive, metal divider strips in the concrete wherever there is to be a joint or change of color in the terrazzo. For the third and final layer, terrazzo workers blend and place into each of the panels a fine marble chip mixture that may be color-pigmented. While the mixture is still wet, workers add additional marble chips of various colors into each panel and roll a lightweight roller over the entire surface.

When the terrazzo is thoroughly set, helpers grind it with a terrazzo grinder, which is somewhat like a floor polisher, only much heavier. Any depressions left by the grinding are filled with a matching grout material and hand-troweled for a smooth, uniform surface. Terrazzo workers then clean, polish, and seal the dry surface for a lustrous finish.

Work environment. Concrete, segmental paving, and terrazzo work is fast paced and strenuous, and requires continuous physical effort. A work week of 40 hours is the most common, although the number of hours can be increased or decreased by outside factors, such as the need to coordinate work with other jobs being done on the construction site. As a result, about 17 percent of workers have a variable schedule.

Because most finishing is done at floor level, workers must bend and kneel often. Many jobs are outdoors, and work is



Concrete workers direct the concrete to a desired location.

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generally halted during inclement weather. The work, either indoors or outdoors, may be in areas that are muddy, dusty, or dirty. To avoid chemical burns from uncured concrete and sore knees from frequent kneeling, many workers wear kneepads. Workers usually also wear water-repellent boots while working with wet concrete.

Training, Other Qualifications, and Advancement

Most cement masons, concrete finishers, segmental pavers, and terrazzo workers learn their trades through on-the-job training, either as helpers or in apprenticeship programs. Some workers also learn their jobs by attending trade or vocational-technical schools.

Education and training. Many masons and finishers first gain experience as construction laborers. (See the section on construction laborers elsewhere in the *Handbook*.) Most on-the-job training programs consist of informal instruction, in which experienced workers teach helpers to use the tools, equipment, machines, and materials of the trade. Trainees begin with tasks such as edging, jointing, and using a straightedge on freshly placed concrete. As training progresses, assignments become more complex, and trainees can usually do finishing work within a short time.

Some workers train in formal apprenticeship programs usually sponsored by local contractors, trade associations, or local union-management committees. These programs combine on-the-job training with a recommended minimum of 144 hours of classroom instruction each year. In the classroom, apprentices learn applied mathematics, blueprint reading, and safety. Apprentices generally receive special instruction in layout work and cost estimation. Apprenticeships may take 3 to 4 years to complete, although completion times are increasingly variable as apprenticeship progression based on demonstrated competence instead of time is gaining popularity. Applying for an apprenticeship may require a written test and a physical exam.

Many States have technical schools that offer courses in masonry which improve employment and advancement opportunities. Entrance requirements and fees vary depending on the school and who is funding the program. These schools may offer courses before hiring or after hiring as part of the on-the-job training.

Other qualifications. The most important qualities employers look for are dependability and a strong work ethic. When hiring helpers and apprentices, employers prefer high school graduates who are at least 18 years old, possess a driver's license, and are in good physical condition. The ability to get along with others is also important because cement masons frequently work in teams. High school courses in general science, mathematics, and vocational-technical subjects—such as blueprint reading and mechanical drawing—provide a helpful background. Cement masons, concrete finishers, segmental pavers, and terrazzo workers should enjoy doing demanding work. They should take pride in craftsmanship and be able to work without close supervision.

Advancement. With additional training, cement masons, concrete finishers, segmental pavers, or terrazzo workers may become supervisors for masonry contractors or move into construction management, building inspection, or contract estimation. Certification programs offered through the National Concrete Masonry Association may allow workers to advance more quickly as they document higher levels of skill in working with concrete. Some workers eventually become owners of businesses, where they may spend most of their time managing rather than practicing their original trade. For those who want to own their own business, taking business classes will help to prepare.

Employment

Cement masons, concrete finishers, segmental pavers, and terrazzo workers held about 207,800 jobs in 2008; segmental pavers and terrazzo workers accounted for only a small portion of the total. Most cement masons and concrete finishers worked for specialty trade contractors, primarily foundation, structure, and building exterior contractors. They also worked for contractors in nonresidential and residential building construction and in heavy and civil engineering construction on projects such as highways, bridges, shopping malls, or large buildings such as factories, schools, and hospitals. A small number were employed by firms that manufacture concrete products. Most segmental pavers and terrazzo workers worked for specialty trade contractors who install decorative floors and wall panels.

Only about 5 percent of cement masons, concrete finishers, segmental pavers, and terrazzo workers were self-employed, a smaller proportion than in other building trades. Most self-employed masons specialize in small jobs, such as driveways, sidewalks, and patios.

Job Outlook

Average employment growth is expected, and job prospects are expected to be good, especially for those with the most experience and skills.

Employment change. Employment of cement masons, concrete finishers, segmental pavers, and terrazzo workers is

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	–	207,800	234,500	26,700	13
Cement masons, concrete finishers, and terrazzo workers	47-2050	206,600	233,200	26,600	13
Cement masons and concrete finishers	47-2051	201,000	226,800	25,900	13
Terrazzo workers and finishers	47-2053	5,600	6,300	700	13
Segmental pavers	47-4091	1,200	1,300	100	7

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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expected to grow approximately 13 percent over the 2008–18 decade, about as fast as the average for all occupations. Over the long run, more workers will likely be needed to build new highways, bridges, factories, and other residential and nonresidential structures to meet the demands of a growing population. Additionally, cement masons will be needed to repair and renovate existing highways and bridges and other aging structures. Additional funds for these projects are expected to come from the Federal Government, which plans to spend money on construction to stimulate the national economy by addressing necessary infrastructure repairs and renovating schools and other government buildings.

The use of concrete for buildings is increasing because its strength is an important asset in areas prone to severe weather. For example, residential construction in Florida is using more concrete as building requirements are changed in reaction to the increased frequency and intensity of hurricanes. Concrete use is likely to expand into other hurricane-prone areas as the durability of the Florida homes is demonstrated.

Job prospects. Opportunities for cement masons, concrete finishers, segmental pavers, and terrazzo workers are expected to be good, particularly for those with the most experience and skills. Employers report difficulty in finding workers with the right skills, as many qualified jobseekers often prefer work that is less strenuous and has more comfortable working conditions. There are also expected to be a significant number of retirements over the next decade, which will create more job openings. Applicants who take masonry-related courses at technical schools will have better opportunities than those without these courses.

Employment of cement masons, concrete finishers, segmental pavers, and terrazzo workers, like that of many other construction workers, is sensitive to the fluctuations of the economy. Workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

In May 2008, the median hourly wage of cement masons and concrete finishers was $16.87. The middle 50 percent earned between $13.46 and $22.71. The bottom 10 percent earned less than $11.02, and the top 10 percent earned more than $30.30. Median hourly wages in the industries employing the largest numbers of cement masons and concrete finishers were as follows:

Nonresidential building construction	$17.82
Other specialty trade contractors	17.26
Highway, street, and bridge construction	17.12
Residential building construction	16.68
Foundation, structure, and building exterior contractors	16.67

In May 2008, the median hourly wage of terrazzo workers and finishers was $17.25. The middle 50 percent earned between $13.65 and $23.12. The bottom 10 percent earned less than $10.82, and the top 10 percent earned more than $30.12.

In May 2008, the median hourly wage of segmental pavers was $13.17. The middle 50 percent earned between $10.77 and $16.41. The bottom 10 percent earned less than $9.14, and the top 10 percent earned more than $19.33.

Like other construction trades workers who are paid by the hour, earnings of cement masons, concrete finishers, segmental pavers, and terrazzo workers may be reduced on occasion because poor weather and slowdowns in construction activity limit the amount of time they can work. Nonunion workers generally have lower wage rates than union workers. Apprentices usually start at 50 to 60 percent of the rate paid to experienced workers, and increases are generally achieved by meeting specified advancement requirements every 6 months. Cement masons often work overtime, with premium pay, because once concrete has been placed, the job must be completed.

About 14 percent of cement masons, concrete finishers, segmental pavers, and terrazzo workers belong to unions, the largest of which are the Operative Plasterers' and Cement Masons' International Association of the United States and Canada, and the International Union of Bricklayers and Allied Craftworkers. A few terrazzo workers belong to the United Brotherhood of Carpenters and Joiners of the United States.

Related Occupations

Other construction-related occupations requiring similar skills and knowledge include:

	Page
Brickmasons, blockmasons, and stonemasons	615
Carpet, floor, and tile installers and finishers	621
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638

An additional occupation in which workers use cement, segmental pavers, and terazzo in their work is:

Grounds maintenance workers 498

Sources of Additional Information

For information about apprenticeships and work opportunities, contact local concrete or terrazzo contractors, local offices of unions previously mentioned, a local joint union-management apprenticeship committee, or the nearest office of a State employment service or apprenticeship agency. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 872-5627. You may also check the U.S. Department of Labor's Web site for information on apprenticeships and links to State apprenticeship programs. Internet: **http://www.doleta.gov/OA/eta_default.cfm**

For general information about cement masons, concrete finishers, segmental pavers, and terrazzo workers, contact:

➤ Associated Builders and Contractors, Workforce Development Division, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201-5426. Internet: **http://www.agc.org**

➤ International Union of Bricklayers and Allied Craftworkers, International Masonry Institute, The James Brice House, 42 East St., Annapolis, MD 21401-1731. Internet: **http://www.imiweb.org**

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➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606-8127. Internet: **http://www.nccer.org**

➤ National Concrete Masonry Association, 13750 Sunrise Valley Dr., Herndon, VA 20171-4662. Internet: **http://www.ncma.org**

➤ National Terrazzo and Mosaic Association, 201 North Maple, Suite 208, Purcellville, VA 20132-6102. Internet: **http://www.ntma.com**

➤ Operative Plasterers' and Cement Masons' International Association of the United States and Canada, 11720 Beltsville Dr., Suite 700, Beltsville, MD 20705-3104. Internet: **http://www.opcmia.org**

➤ Portland Cement Association, 5420 Old Orchard Rd., Skokie, IL 60077-1083. Internet: **http://www.cement.org**

For more information about careers and training as a mason, contact:

➤ Mason Contractors Association of America, 33 South Roselle Rd., Schaumburg, IL 60193-1646. Internet: **http://www.masoncontractors.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos204.htm**

Construction and Building Inspectors

Significant Points

- About 44 percent of inspectors worked for local governments, primarily municipal or county building departments.
- Many home inspectors are self-employed.
- Training requirements vary widely; some States require a license or certificate.
- Opportunities should be best for those with construction-related work experience; training in engineering, architecture, construction technology, or related fields; or certification as a construction inspector.

Nature of the Work

Construction and building inspectors examine buildings, highways and streets, sewer and water systems, dams, bridges, and other structures. They ensure that their construction, alteration, or repair complies with building codes and ordinances, zoning regulations, and contract specifications. Building codes and standards are the primary means by which building construction is regulated in the United States for the health and safety of the general public. National model building and construction codes are published by the International Code Council (ICC), although many localities have additional ordinances and codes that modify or add to the National model codes. To monitor compliance with regulations, inspectors make an initial inspection during the first phase of construction and follow up with further inspections throughout the construction project. However, no inspection is ever exactly the same. In areas where certain types of severe weather or natural disasters—such as earthquakes or hurricanes—are more common, inspectors monitor compliance with additional safety regulations designed to protect structures and occupants during those events.

There are many types of inspectors. *Building inspectors* inspect the structural quality and general safety of buildings. Some specialize in for example, structural steel or reinforced-concrete structures. Before construction begins, *plan examiners* determine whether the plans for the building or other structure comply with building codes and whether they are suited to the engineering and environmental demands of the building site. To inspect the condition of the soil and the positioning and depth of the footings, inspectors visit the worksite before the foundation is poured. Later, they return to the site to inspect the foundation after it has been completed. The size and type of structure, as well as the rate at which it proceeds toward completion, determine the number of other site visits they must make. Upon completion of the project, they make a final, comprehensive inspection.

In addition to structural characteristics, a primary concern of building inspectors is fire safety. They inspect structures' fire sprinklers, alarms, smoke control systems, and fire exits. Inspectors assess the type of construction, the building's contents, adequacy of fire protection equipment, and any risks posed by adjoining buildings. (For additional information on *fire inspectors*, see the statement on fire inspectors and investigators elsewhere in the *Handbook*.)

Electrical inspectors examine the installation of electrical systems and equipment to ensure that they function properly and comply with electrical codes and standards. They visit worksites to inspect new and existing sound and security systems, wiring, lighting, motors, and generating equipment. They also inspect the installation of the electrical wiring for heating and air-conditioning systems, appliances, and other components.

Elevator inspectors examine lifting and conveying devices such as elevators, escalators, moving sidewalks, lifts and hoists, inclined railways, ski lifts, and amusement rides.

Home inspectors conduct inspections of newly built or previously owned homes, condominiums, town homes, manufactured homes, apartments, and commercial buildings. Home inspection has become a standard practice in the home-purchasing process. Home inspectors are most often hired by prospective home buyers to inspect and report on the condition of a home's systems, components, and structure. Although they look for and report violations of building codes, they do not have the power to enforce compliance with the codes. Typically, they are hired either immediately prior to a purchase offer on a home or as a contingency to a sales contract. In addition to examining structural quality, home inspectors inspect all home

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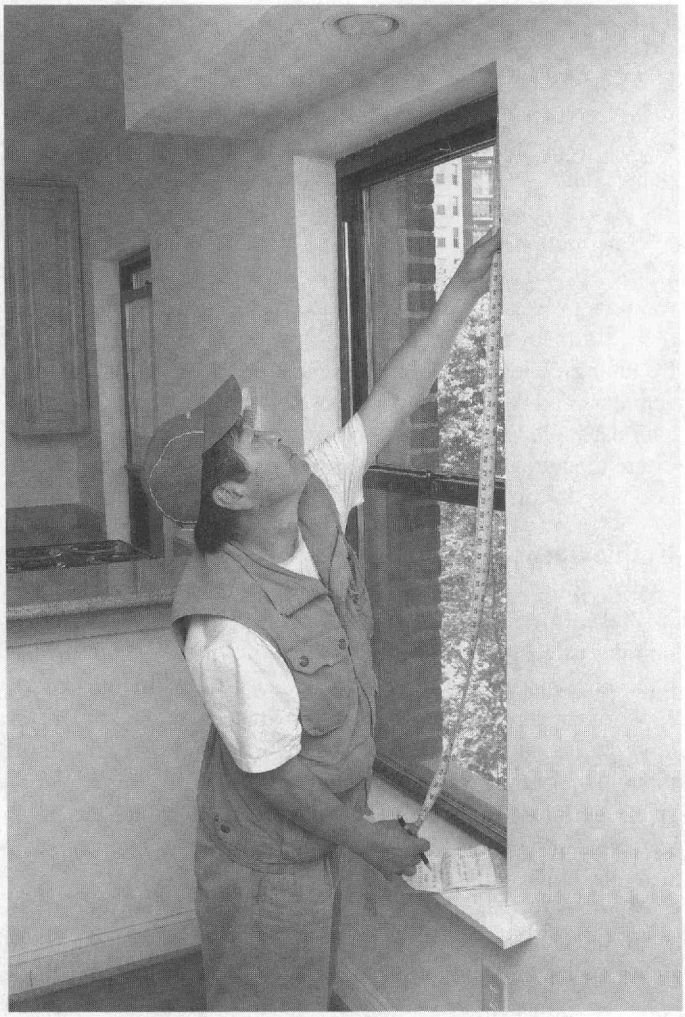
systems and features, including roofing as well as the exterior, attached garage or carport, foundation, interior, plumbing, and electrical, heating, and cooling systems. Some home inspections are done for homeowners who want an evaluation of their home's condition, for example, prior to putting the home on the market or as a way to diagnose problems.

Mechanical inspectors examine the installation of heating, ventilation, air conditioning, and refrigeration systems and equipment to insure they are installed and function properly. This may include the inspection of commercial kitchen equipment, gas-fired appliances, and boilers.

Plumbing inspectors examine the installation of piping systems to insure the safety and health of the drinking water system, chemical process piping for industrial uses, and the sanitary disposal of waste. On most construction sites this will involve at least three inspections, including the piping layout, venting, backflow protection, and setting of fixtures.

Public works inspectors ensure that Federal, State, and local government water and sewer system, highway, street, bridge, and dam construction conforms to detailed contract specifications. They inspect excavation and fill operations, the placement of forms for concrete, concrete mixing and pouring, asphalt paving, and grading operations. They record the work and materials used so that contract payments can be calculated. Public works inspectors may specialize in highways, structural steel, reinforced concrete, or ditches. Others specialize in dredging operations required for bridges and dams or for harbors.



Although inspections are primarily visual, inspectors may use tape measures, survey instruments, and metering devices.

The owner of a building or structure under construction employs *specification inspectors* to ensure that work is done according to design specifications. Specification inspectors represent the owner's interests, not those of the general public. Insurance companies and financial institutions also may use their services.

Details concerning construction projects, building and occupancy permits, and other documentation generally are stored on computers so that they can easily be retrieved and updated. For example, inspectors may use laptop computers to record their findings while inspecting a site. Most inspectors use computers to help them monitor the status of construction inspection activities and keep track of permits issued, and some can access all construction and building codes from their computers on the job site, decreasing the need for paper binders. However, many inspectors continue to use a paper checklist to detail their findings.

Although inspections are primarily visual, inspectors may use tape measures, survey instruments, metering devices, and equipment such as concrete strength measurers. They keep a log of their work, take photographs, and file reports. Many inspectors also use laptops or other portable electronic devices on-site to facilitate the accuracy of their written reports, as well as e-mail and fax machines to send out the results. If necessary, they act on their findings. For example, government and construction inspectors notify the construction contractor, superintendent, or supervisor when they discover a violation of a code or ordinance or something that does not comply with the contract specifications or approved plans. If the problem is not corrected within a reasonable or otherwise specified period, government inspectors have authority to issue a "stop-work" order.

Many inspectors also investigate construction or alterations being done without proper permits. Inspectors who are employees of municipalities enforce laws pertaining to the proper design, construction, and use of buildings. They direct violators of permit laws to obtain permits and to submit to inspection.

Work environment. Construction and building inspectors usually work alone. However, several may be assigned to large, complex projects, particularly because inspectors tend to specialize in different areas of construction. Although they spend considerable time inspecting construction worksites, inspectors also spend time in a field office reviewing blueprints, answering letters or telephone calls, writing reports, and scheduling inspections.

Many construction sites are dirty and may be cluttered with tools, materials, or debris. Inspectors may have to climb ladders or many flights of stairs or crawl around in tight spaces. Although their work generally is not considered hazardous, inspectors, like other construction workers, wear hardhats and adhere to other safety requirements while at a construction site.

Inspectors normally work regular hours. However, they may work additional hours during periods when a lot of construction is taking place. Also, if an accident occurs at a construction site, inspectors must respond immediately and may work additional hours to complete their report. Non-government inspectors—especially those who are self-employed—may have a varied work schedule, at times working evenings and weekends.

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Training, Other Qualifications, and Advancement

Although requirements vary considerably, construction and building inspectors should have a thorough knowledge of construction materials and practices. In some States, construction and building inspectors are required to obtain a special license or certification, so it is important to check with the appropriate State agency.

Education and training. Most employers require at least a high school diploma or the equivalent, even for workers with considerable experience. More often, employers look for persons who have studied engineering or architecture or who have a degree from a community or junior college with courses in building inspection, home inspection, construction technology, drafting, and mathematics. Many community colleges offer certificate or associate degree programs in building inspection technology. Courses in blueprint reading, algebra, geometry, and English also are useful. A growing number of construction and building inspectors are entering the occupation with a college degree, which often can substitute for previous experience.

The level of training requirements varies by type of inspector and State. In general, construction and building inspectors receive much of their training on the job, although they must learn building codes and standards on their own. Working with an experienced inspector, they learn about inspection techniques; codes, ordinances, and regulations; contract specifications; and recordkeeping and reporting duties. Supervised onsite inspections also may be a part of the training. Other requirements can include various courses and assigned reading. Some courses and instructional material are available online as well as through formal venues.

Licensure and certification. Many States and local jurisdictions require some type of license or certification for employment as a construction and building inspector. Requirements may vary by State or local municipality. Typical requirements for licensure or certification include previous experience, a minimum educational attainment level, such as a high school diploma, and passing a State-approved examination. Some States have individual licensing programs for inspectors, while others may require certification by such associations as the International Code Council, International Association of Plumbing and Mechanical Officials, and National Fire Protection Association.

Similarly, some States require home inspectors to obtain a State-issued license or certification. Currently, 34 States have regulations affecting home inspectors. Requirements for a license or certification vary by State, but may include obtaining a minimum level of education, having a set amount of experience with inspections, purchasing liability insurance of a certain amount, and the passing of an examination. Renewal is usually every few years and annual continuing education is almost always required.

Other qualifications. Because inspectors must possess the right mix of technical knowledge, experience, and education, employers prefer applicants who have both formal training and experience. For example, many inspectors previously worked as carpenters, electricians, or plumbers. Home inspectors combine knowledge of multiple specialties, so many of them come into the occupation having a combination of certifications and previous experience in various construction trades.

Construction and building inspectors must be in good physical condition in order to walk and climb about construction and building sites. They also must have a driver's license so that they can get to scheduled appointments.

Advancement. Being a member of a nationally recognized inspection association enhances employment opportunities and may be required by some employers. Even if it is not required, certification can enhance an inspector's opportunities for employment and advancement to more responsible positions. To become certified, inspectors with substantial experience and education must pass examinations on topics including code requirements, construction techniques and materials, standards of practice, and codes of ethics. The International Code Council offers multiple voluntary certifications, as do many other professional associations. Many categories of certification are awarded for inspectors and plan examiners in a variety of specialties, including the Certified Building Official (CBO) certification, for code compliance, and the Residential Building Inspector (RBI) certification, for home inspectors. In a few cases, there are no education or experience prerequisites, and certification consists of passing an examination in a designated field either at a regional location or online. In addition, Federal, State, and many local governments may require inspectors to pass a civil service exam.

Because they advise builders and the general public on building codes, construction practices, and technical developments, construction and building inspectors must keep abreast of changes in these areas. Continuing education is required by many States and certifying organizations. Numerous employers provide formal training to broaden inspectors' knowledge of construction materials, practices, and techniques. Inspectors who work for agencies or firms that do not conduct their own training programs can expand their knowledge and upgrade their skills by attending State-sponsored training programs, by taking college or correspondence courses, or by attending seminars and conferences sponsored by various related organizations, including professional organizations. An engineering or architectural degree often is required for advancement to supervisory positions.

Employment

Construction and building inspectors held about 106,400 jobs in 2008. Local governments—primarily municipal or county building departments—employed 44 percent. Employment of local government inspectors is concentrated in cities and in suburban areas undergoing rapid growth. Local governments in larger jurisdictions may employ large inspection staffs, including many plan examiners or inspectors who specialize in structural steel, reinforced concrete, and boiler, electrical, and elevator inspection. In smaller jurisdictions, only one or a few inspectors with generalist skills in multiple areas may be on staff.

Another 27 percent of construction and building inspectors worked for architectural and engineering services firms, conducting inspections for a fee or on a contract basis. Many of these were home inspectors working on behalf of potential real estate purchasers. Most of the remaining inspectors were employed in other service-providing industries or by State governments.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Construction and building inspectors	47-4011	106,400	124,200	17,900	17

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

About 8 percent of construction and building inspectors were self-employed; many of these were home inspectors.

Job Outlook

Inspectors should experience faster than average employment growth. Opportunities should be best for those with construction-related work experience; training in engineering, architecture, construction technology, or related fields; or certification as a construction inspector.

Employment change. Employment of construction and building inspectors is expected to grow 17 percent over the 2008-2018 decade, faster than the average for all occupations. Concern for public safety and a desire for improvement in the quality of construction should continue to stimulate demand for construction and building inspectors in government as well as in firms specializing in architectural, engineering, and related services. As the result of new technology such as building information modeling (BIM), the availability of a richer set of buildings data in a more timely and transparent manner will make it easier to conduct plan reviews. This will lead to more time and resources spent on inspections. In addition, the growing focus on natural and manmade disasters is increasing the level of interest in and need for qualified inspectors. Issues such as green and sustainable design are new areas of focus that will also drive the demand for construction and building inspectors.

The routine practice of obtaining home inspections is a relatively recent development, causing employment of home inspectors to increase rapidly. Although employment of home inspectors is expected to continue to increase, the attention given to this specialty, combined with the desire of some construction workers to move into less strenuous and potentially higher paying work, may result in reduced growth of home inspectors in some areas. In addition, increasing State regulations are starting to limit entry into the specialty only to those who have a given level of previous experience and who are certified.

Job prospects. Those with construction-related work experience; training in engineering, architecture, construction technology, or related fields; or certification as a construction inspector will have the best prospects. Inspectors are involved in all phases of construction, including maintenance and repair work, and are therefore less likely than many construction workers to lose their jobs when new construction slows during recessions. Those who are self-employed, such as home inspectors, are more likely to be affected by economic downturns or fluctuations in the real estate market. However, those with a thorough knowledge of construction practices and skills in areas such as reading and evaluating blueprints and plans will be better off. In addition to openings stemming from the expected employment growth, some job openings will arise from the need to replace inspectors who transfer to other occupations or leave the labor force.

Earnings

Median annual wages of wage and salary construction and building inspectors were $50,180 in May 2008. The middle 50 percent earned between $39,070 and $63,360. The lowest 10 percent earned less than $31,270, and the highest 10 percent earned more than $78,070. Median annual wages in the industries employing the largest numbers of construction and building inspectors were:

Federal Executive Branch	$62,120
Management, scientific, and technical consulting services	58,520
Local government	50,330
Architectural, engineering, and related services	49,320
State government	45,700

Building inspectors, including plan examiners, generally earn the highest salaries. Salaries in large metropolitan areas are substantially higher than those in small jurisdictions.

Benefits vary by place of employment. Those working for the government and private companies typically receive standard benefits, including health and medical insurance, a retirement plan, and paid annual leave. Those who are self-employed may have to provide their own benefits.

About 25 percent of all construction and building inspectors belonged to a union or were covered by a union contract in 2008.

Related Occupations

Because construction and building inspectors are familiar with construction principles, the most closely related occupations are construction occupations, especially:

	Page
Carpenters	618
Electricians	641
Plumbers, pipelayers, pipefitters, and steamfitters	659

Construction and building inspectors also combine knowledge of construction principles and law with an ability to coordinate data, diagnose problems, and communicate with people. Workers in other occupations using a similar combination of skills include:

Architects, except landscape and naval	151
Appraisers and assessors of real estate	90
Construction managers	38
Cost estimators	100
technicians	173
Engineers	161
Surveyors, cartographers, photogrammetrists, and surveying and mapping technicians	157

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Sources of Additional Information

Information about building codes, certification, and a career as a construction or building inspector is available from:

➤ International Code Council, 500 New Jersey Ave. NW., 6th Floor, Washington, DC 20001-2070. Internet: **http://www.iccsafe.org**

➤ National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471. Internet: **http://www.nfpa.org**

For more information about construction inspectors, contact:

➤ Association of Construction Inspectors, 810N Farrell Dr. Palm Springs, CA 92262. Internet: **http://www.aci-assoc.org**

For more information about electrical inspectors, contact:

➤ International Association of Electrical Inspectors, 901 Waterfall Way, Suite 602, Richardson, TX 75080-7702. Internet: **http://www.iaei.org**

For more information about elevator inspectors, contact:

➤ National Association of Elevator Safety Authorities International, 6957 Littlerock Rd. SW., Ste A, Tumwater, WA 98512. Internet: **http://www.naesai.org**

For more information about education and training for mechanical and plumbing inspectors, contact:

➤ International Association for Plumbing and Mechanical Officials, 5001 E. Philadelphia St., Ontario, CA 91761. Internet: **http://www.iapmo.org**

For information about becoming a home inspector, contact any of the following organizations:

➤ American Society of Home Inspectors, 932 Lee St., Suite 101, Des Plaines, IL 60016. Internet: **http://www.ashi.org**

➤ National Association of Home Inspectors, 4248 Park Glen Rd., Minneapolis, MN 55416. Internet: **http://www.nahi.org**

For information about a career as a State or local government construction or building inspector, contact your State or local employment service.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos004.htm**

Construction Equipment Operators

Significant Points

- Construction equipment operators are trained either through a formal apprenticeship program, through on-the-job training, through a paid training program, or a combination of these programs.
- Job opportunities are expected to be good.
- Hourly pay is relatively high, but operators of some types of equipment cannot work in inclement weather, so total annual earnings may be reduced.

Nature of the Work

Construction equipment operators use machinery to move construction materials, earth, and other heavy materials at construction sites and mines. They operate equipment that clears and grades land to prepare it for construction of roads, buildings, and bridges, as well as airport runways, power generation facilities, dams, levees, and other structures. They use machines to dig trenches to lay or repair sewer and other utilities, and hoist heavy construction materials. They even may work offshore constructing oil rigs. Construction equipment operators also operate machinery that spreads asphalt and concrete on roads and other structures.

These workers also help set up and inspect the equipment, make adjustments, and perform some maintenance and minor repairs. Construction equipment is more technologically advanced than it was in the past. For example, global positioning system (GPS) technology is now being used to help with grading and leveling activities.

Included in the construction equipment operator occupation are operating engineers and other construction equipment operators; paving and surfacing equipment operators; and piledriver operators. *Operating engineers* and *other construction equipment operators* work with one or several types of power construction equipment. They may operate excavation and loading machines equipped with scoops, shovels, or buckets that dig sand, gravel, earth, or similar materials and load it into trucks or onto conveyors. In addition operating to the familiar bulldozers, they operate trench excavators, road graders, and similar equipment. Sometimes, they may drive and control industrial trucks or tractors equipped with forklifts or booms for lifting materials or with hitches for pulling trailers. They also may operate and maintain air compressors, pumps, and other power equipment at construction sites.

Paving and surfacing equipment operators operate machines that spread and level asphalt or spread and smooth concrete for roadways or other structures. *Asphalt spreader operators* turn valves to regulate the temperature and flow of asphalt onto the roadbed. They must take care that the machine distributes the paving material evenly and without voids, and they must make sure that there is a constant flow of asphalt going into the hopper. Concrete paving machine operators control levers and turn handwheels to move attachments that spread, vibrate, and level wet concrete in forms. They must observe the surface of the concrete to identify low spots into which workers must add concrete. They use other attachments to smooth the surface of the concrete, spray on a curing compound, and cut expansion joints. Tamping equipment operators operate tamping machines that compact earth and other fill materials for roadbeds or other construction sites. They also may operate machines with interchangeable hammers to cut or break up old pavement and drive guardrail posts into the earth.

Piledriver operators use large machines mounted on skids, barges, or cranes to hammer piles into the ground. Piles are long, heavy beams of wood or steel driven into the ground to support retaining walls, bulkheads, bridges, piers, or building foundations. Some piledriver operators work on offshore oil rigs. Piledriver operators move hand and foot levers and turn valves to activate, position, and control the pile-driving equipment.

Work environment. Construction equipment operators work outdoors in nearly every type of climate and weather condition, although in many areas of the country some types of

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Construction equipment operators level the surface of a construction site.

construction operations must be suspended in winter. Bulldozers, scrapers, and especially piledrivers are noisy and shake or jolt the operator. Operating heavy construction equipment can be dangerous, and this occupation incurs injuries and illnesses at a higher-than-average rate. As with most machinery, accidents generally can be avoided by observing proper operating procedures and safety practices. Construction equipment operators often get dirty, greasy, muddy, or dusty. Some operators work in remote locations on large construction projects, such as highways and dams, or in factory or mining operations.

Operators may have irregular hours because work on some construction projects continues around the clock or must be performed late at night or early in the morning.

Training, Other Qualifications, and Advancement

Construction equipment operators are trained either through a formal apprenticeship program, through on-the-job training, through a paid training program, or a combination of these programs.

Education and training. Employers of construction equipment operators generally prefer to hire high school graduates, although some employers may train nongraduates to operate some types of equipment. High school courses in automobile mechanics are helpful because workers may perform maintenance on their machines. Also useful are courses in science and mechanical drawing. With the development of GPS, construction equipment operators need more experience with computers than in the past.

On the job, workers may start by operating light equipment under the guidance of an experienced operator. Later, they may operate heavier equipment, such as bulldozers. Technologically advanced construction equipment with computerized controls and improved hydraulics and electronics requires more skill to operate. Operators of such equipment may need more training and some understanding of electronics.

It is generally accepted that formal training provides more comprehensive skills. Some construction equipment operators train in formal operating engineer apprenticeship programs administered by union-management committees of the International Union of Operating Engineers (IUOE). Because apprentices learn to operate a wider variety of machines than do other beginners, they usually have better job opportunities. Apprenticeship programs consist of at least 3 years, or 6,000 hours, of paid on-the-job training together with 144 hours of related classroom instruction each year.

Private vocational schools offer instruction in the operation of certain types of construction equipment. Completion of such programs may help a person get a job. However, people considering this kind of training should check the school's reputation among employers in the area and find out if the school offers the opportunity to work on actual machines in realistic situations. A large amount of information can be learned in classrooms, but to become a skilled construction equipment operator, a worker needs to actually perform the various tasks. Many training facilities, including IUOE apprenticeship programs, incorporate sophisticated simulators into their training, allowing beginners to familiarize themselves with the equipment in a controlled environment.

Certification and other qualifications. Mechanical aptitude and experience operating related mobile equipment, such as farm tractors or heavy equipment, in the Armed Forces or elsewhere is an asset. Construction equipment operators often need a commercial driver's license to haul their equipment to the various jobsites. Commercial driver's licenses are issued by States according to each State's rules and regulations. Operators also need to be in good physical condition and have a good sense of balance, the ability to judge distance, and eye-hand-foot coordination. Some operator positions require the ability to work at heights.

Certification or training from the right school can improve opportunities for jobseekers; some employers may require operators to be certified. While attending some vocational schools, or by fulfilling the requirements of related professional associations, operators can qualify for various certifications. These certifications prove to potential employers that an operator is able to handle specific types of equipment.

Advancement. Construction equipment operators can advance to become supervisors. Some operators choose to pass on their knowledge and teach in training facilities. Other operators start their own contracting businesses, although doing so may be difficult because of high startup costs.

Employment

Construction equipment operators held about 469,300 jobs in 2008. Jobs were found in every section of the country and were distributed among various types of operators as follows:

Operating engineers and other construction equipment operators	404,500
Paving, surfacing, and tamping equipment operators	60,200
Pile-driver operators	4,600

About 63 percent of construction equipment operators worked in the construction industry. Many equipment operators worked in heavy and civil engineering construction, building highways, bridges, or railroads. About 16 percent of construction equipment operators worked in local government. Others—mostly grader, bulldozer, and scraper operators—worked in mining. Some also worked for manufacturing or utility companies. About 3 percent of construction equipment operators were self-employed.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Construction equipment operators	47-2070	469,300	525,500	56,200	12
Paving, surfacing, and tamping equipment operators	47-2071	60,200	67,200	6,900	12
Pile-driver operators	47-2072	4,600	5,200	600	13
Operating engineers and other construction equipment operators	47-2073	404,500	453,200	48,700	12

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job Outlook

Average job growth is projected. The need to fill jobs and replace workers who leave the occupation should result in good job opportunities for construction equipment operators.

Employment change. Employment of construction equipment operators is expected to increase 12 percent between 2008 and 2018, about as fast as the average for all occupations. The likelihood of increased spending by the Federal Government on infrastructure to improve roads and bridges, railroads, the electric transmission system, and water and sewer systems, which are in great need of repair across the country, will generate numerous jobs for construction equipment operators who work primarily in these areas. In addition, population increases and the need for construction projects, such as new roads and sewer lines to service the increased population, will generate more jobs. However, without the extra spending on infrastructure by the Federal Government, employment may be flat as States and localities struggle with reduced taxes and budget shortfalls to pay for road and other improvements.

An expected rise in energy production is expected to increase work on oil rigs, smart grids, windmill farms, pipeline construction, and other types of power-generating facilities. Also, increased output of mines and rock and gravel quarries will generate jobs in the mining industry.

Job prospects. Job opportunities for construction equipment operators are expected to be good because the occupation often does not attract enough qualified candidates to fill jobs. Some workers' reluctance to work in construction makes it easier for willing workers to get operator jobs.

In addition, many job openings will arise from job growth and from the need to replace experienced construction equipment operators who transfer to other occupations, retire, or leave the job for other reasons. Construction equipment operators who can use a wide variety of equipment will have the best prospects. Operators with pipeline experience will have especially good opportunities if, as expected, natural-gas companies expand work on their infrastructure.

Employment of construction equipment operators, like that of many other construction workers, is sensitive to fluctuations in the economy. Workers in these trades may experience periods of unemployment when the overall level of construction falls. However, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

Wages for construction equipment operators vary. In May 2008, median hourly wages of wage and salary operating engineers and other construction equipment operators were $18.88. The middle 50 percent earned between $14.78 and $25.49. The lowest 10 percent earned less than $12.47, and the highest 10 percent earned more than $33.34. Median hourly wages in the industries employing the largest numbers of operating engineers were as follows:

Nonresidential building construction	$21.45
Highway, street, and bridge construction	21.20
Utility system construction	19.79
Other specialty trade contractors	18.61
Local government	17.19

Median hourly wages of wage and salary paving, surfacing, and tamping equipment operators were $16.00 in May 2008. The middle 50 percent earned between $12.94 and $20.75. The lowest 10 percent earned less than $10.77, and the highest 10 percent earned more than $26.70. Median hourly wages in the industries employing the largest numbers of paving, surfacing, and tamping equipment operators were as follows:

Other specialty trade contractors	$16.16
Highway, street, and bridge construction	16.13
Local government	15.94

In May 2008, median hourly wages of wage and salary piledriver operators were $23.01. The middle 50 percent earned between $17.52 and $32.94. The lowest 10 percent earned less than $14.25, and the highest 10 percent earned more than $38.01. Median hourly wages in the industries employing the largest numbers of piledriver operators were as follows:

Other specialty trade contractors	$26.07
Other heavy and civil engineering construction	23.24
Nonresidential building construction	20.46
Utility system construction	19.54

Hourly pay is relatively high, particularly in large metropolitan areas. However, annual earnings of some workers may be lower than hourly rates would indicate because worktime may be limited by bad weather. About 27 percent of construction equipment operators belong to a union.

Related Occupations

Other workers who operate mechanical equipment include the following:

	Page
Agricultural equipment operators	609
Crane and tower operators	809
Logging equipment operators	606
Material moving occupations	809
Truck drivers, heavy and tractor-trailer	797

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Sources of Additional Information

For further information about apprenticeships or work opportunities for construction equipment operators, contact a local of the International Union of Operating Engineers, a local apprenticeship committee, or the nearest office of the State apprenticeship agency or employment service. You also can find information on the registered apprenticeship system, with links to State apprenticeship programs, on the U.S. Department of Labor's Web site: **http://www.doleta.gov/OA/eta_default.cfm.** In addition, apprenticeship information is available from the U.S. Department of Labor's toll free help line: (877) 872-5627.

For general information about the work of construction equipment operators, contact:

- Associated General Contractors of America, 2300 Wilson Blvd., Suite 400, Arlington, VA 22201-5426. Internet: **http://www.agc.org**
- International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036-4786. Internet: **http://www.iuoe.org**
- National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606-8134. Internet: **http://www.nccer.org**
- Pile Driving Contractors Association, P.O. Box 66208, Orange Park, FL 32065-0021. Internet: **http://www.piledrivers.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos255.htm**

Construction Laborers

Significant Points

- Many construction laborer jobs require a variety of basic skills, but others require specialized training and experience.
- Most construction laborers learn on the job, but formal apprenticeship programs provide the most thorough preparation.
- Job opportunities vary by locality, but in many areas there will be competition, especially for jobs requiring limited skills.
- Laborers who have specialized skills or who can relocate near new construction projects should have the best opportunities.

Nature of the Work

Construction laborers can be found on almost all construction sites, performing a wide range of tasks from the very easy to the hazardous. They can be found at building, highway, and heavy construction sites; residential and commercial sites; tunnel and shaft excavations; and demolition sites. Many of the jobs they perform require physical strength, training, and experience. Other jobs require little skill and can be learned quickly. Although most construction laborers specialize in a type of construction, such as highway or tunnel construction, some are generalists who perform many different tasks during all stages of construction. Construction laborers who work in underground construction, such as in tunnels, or in demolition are more likely to specialize in only those areas.

Construction laborers clean and prepare construction sites. They remove trees and debris; tend pumps, compressors, and generators; and erect and disassemble scaffolding and other temporary structures. They load, unload, identify, and distribute building materials to the appropriate location according to project plans and specifications. Laborers also tend machines; for example, they may use a portable mixer to mix concrete or tend a machine that pumps concrete, grout, cement, sand, plaster, or stucco through a spray gun for application to ceilings and walls. They often help other craftworkers, including carpenters, plasterers, operating engineers, and masons.

Construction laborers are responsible for the installation and maintenance of traffic control devices and patterns. At highway construction sites, this work may include clearing and preparing highway work zones and rights-of-way; installing traffic barricades, cones, and markers; and controlling traffic passing near, in, and around work zones. Construction laborers also dig trenches; install sewer, water, and storm drainpipes; and place concrete and asphalt on roads. Other highly specialized tasks include operating laser guidance equipment to place pipes; operating air, electric, and pneumatic drills; and transporting and setting explosives for the construction of tunnels, shafts, and roads.

Some construction laborers help with the removal of hazardous materials, such as asbestos, lead, or chemicals. (Workers who specialize in, and are certified for, the removal of hazardous materials are discussed in the *Handbook* statement on hazardous materials removal workers.)

Construction laborers operate a variety of equipment, including pavement breakers; jackhammers; earth tampers; concrete, mortar, and plaster mixers; electric and hydraulic boring machines; torches; small mechanical hoists; laser beam equipment; and surveying and measuring equipment. They may use computers and other high-tech input devices to control robotic pipe cutters and cleaners. To perform their jobs effectively, construction laborers must be familiar with the duties of other craftworkers and with the materials, tools, and machinery they use, as all of these workers work as part of a team, jointly carrying out assigned construction tasks.

Work environment. Most construction laborers do physically demanding work. Some work at great heights or outdoors in all weather conditions. Some jobs expose workers to harmful materials or chemicals, fumes, odors, loud noises, or dangerous machinery. Some laborers may be exposed to

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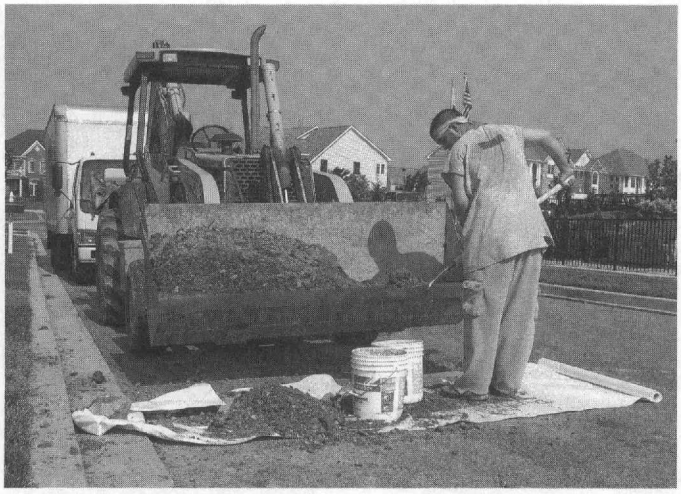

A construction laborer performs work on a scale too small for a large piece of equipment.

lead-based paint, asbestos, or other hazardous substances during their work, especially when they work in confined spaces. Workers in this occupation experience one of the highest rates of nonfatal injuries and illnesses; consequently, the work requires constant attention to safety on the job. To avoid injury, workers in these jobs wear safety clothing, such as gloves, hardhats, protective chemical suits, and devices to protect their eyes, respiratory system, or hearing. While working underground, construction laborers must be especially alert in order to follow procedures safely and must deal with a variety of hazards.

A standard 40 hour work week is the most common work week for construction laborers. About 1 in 7 has a variable schedule, as overnight work may be required in highway work. In some parts of the country, construction laborers may work only during certain seasons. They also may experience weather-related work stoppages at any time of the year.

Training, Other Qualifications, and Advancement

Many construction laborer jobs require a variety of basic skills, but others require specialized training and experience. Most construction laborers learn on the job, but formal apprenticeship programs provide the most thorough preparation.

Education and training. Although some construction laborer jobs have no specific educational qualifications or entry-level training, apprenticeships for laborers usually require a high school diploma or the equivalent. High school classes in English, mathematics, physics, mechanical drawing, blueprint reading, welding, and general shop can be helpful.

Most workers start by getting a job with a contractor who provides on-the-job training. Increasingly, construction laborers are finding work through temporary-help agencies that send laborers to construction sites for short-term work. Entry-level workers generally help more experienced workers, by performing routine tasks such as cleaning and preparing the worksite and unloading materials. When the opportunity arises, they learn from experienced construction trades workers how to do more difficult tasks, such as operating tools and equipment. Construction laborers also may choose or be required to attend a trade or vocational school, association training class, or community college to receive further trade-related training.

Some laborers receive more formal training in the form of an apprenticeship. These programs include between 2 and 4 years of classroom and on-the-job training. In the first 200 hours, workers learn basic construction skills, such as blueprint reading, the correct use of tools and equipment, and safety and health procedures. The remainder of the curriculum consists of specialized skills training in three of the largest segments of the construction industry: building construction, heavy and highway construction, and environmental remediation, such as lead or asbestos abatement and mold or hazardous waste remediation. Training in "green," energy-efficient construction, an area of growth in the construction industry, is now available and can help workers find employment.

Workers who use dangerous equipment or handle toxic chemicals usually receive specialized safety training. Laborers who remove hazardous materials are required to take union- or employer-sponsored Occupational Safety and Health Administration safety training.

Apprenticeship applicants usually must be at least 18 years old and meet local requirements. Because the number of apprenticeship programs is limited, however, only a small proportion of laborers learn their trade in this way.

Other qualifications. Laborers need manual dexterity, eye-hand coordination, good physical fitness, a good sense of balance, and an ability to work as a member of a team. The ability to solve arithmetic problems quickly and accurately may be required. In addition, military service or a good work history is viewed favorably by contractors.

Certification and advancement. Laborers may earn certifications in welding, scaffold erecting, and concrete finishing. These certifications help workers prove that they have the knowledge to perform more complex tasks.

Through training and experience, laborers can move into other construction occupations. Laborers may also advance to become construction supervisors or general contractors. For those who would like to advance, it is increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers with limited understanding of English; Spanish-speaking workers make up a large part of the construction workforce in many areas. Supervisors and contractors need good communication skills to deal with clients and subcontractors.

In addition, supervisors and contractors should be able to identify and estimate the quantity of materials needed to complete a job and accurately estimate how long a job will take to complete and what it will cost. Computer skills also are important for advancement as construction becomes increasingly mechanized and computerized.

Employment

Construction laborers held about 1.2 million jobs in 2008. They worked throughout the country, but like the general population, were concentrated in metropolitan areas. About 62 percent of construction laborers worked in the construction industry, including 27 percent who worked for specialty trade contractors. About 21 percent were self-employed in 2008.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Construction laborers	47-2061	1,248,700	1,504,600	255,900	20

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job Outlook

Employment is expected to grow much faster than the average. In many areas, there will be competition for jobs, especially those requiring limited skills. Laborers who have specialized skills or who can relocate near new construction projects should have the best opportunities.

Employment change. Employment of construction laborers is expected to grow by 20 percent between 2008 and 2018, much faster than the average for all occupations. Because of the large variety of tasks that laborers perform, demand for laborers will mirror the level of overall construction activity. However, some jobs may be adversely affected by automation as they are replaced by new machinery and equipment that improves productivity and quality.

Increasing job prospects for construction laborers, however, is the expected additional government funding for the repair and reconstruction of the Nation's infrastructure, such as roads, bridges, public buildings, and water lines. The occupation should experience an increase in demand because laborers make up a significant portion of workers on these types of projects.

New emphasis on green construction also should help lead to better employment prospects as many green practices require more labor on construction sites. Additional duties resulting from practicing green construction include having to segregate materials that can be used again from those which cannot, and the actual reuse of such materials. In addition, these workers will be needed for the construction of any new projects to harness wind or solar power.

Job prospects. In many geographic areas, construction laborers—especially for those with limited skills—will experience competition because of a plentiful supply of workers who are willing to work as day laborers. Overall opportunities will be best for those with experience and specialized skills and for those who can relocate to areas with new construction projects. Opportunities also will be better for laborers specializing in road construction.

Employment of construction laborers, like that of many other construction workers, is sensitive to the fluctuations of the economy. On the one hand, workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

Median hourly wages of wage and salary construction laborers in May 2008 were $13.71. The middle 50 percent earned between $10.74 and $18.57. The lowest 10 percent earned less than $8.67, and the highest 10 percent earned more than $25.98. Median hourly wages in the industries employing the largest number of construction laborers were as follows:

Nonresidential building construction	$14.95
Other specialty trade contractors	13.81
Residential building construction	13.79
Foundation, structure, and building exterior contractors	13.35
Employment services	10.80

Earnings for construction laborers can be reduced by poor weather or by downturns in construction activity, which sometimes result in layoffs. Apprentices or helpers usually start out earning about 60 percent of the wage paid to experienced workers. Pay increases as apprentices gain experience and learn new skills.

Some laborers—about 14 percent—belong to a union, mainly the Laborers' International Union of North America.

Related Occupations

The work of construction laborers is closely related to that of other construction occupations, as well as that of others who perform similar physical work, such as the following:

	Page
Assemblers and fabricators	723
Brickmasons, blockmasons, and stonemasons	615
Forest and conservation workers	604
Grounds maintenance workers	498
Highway maintenance workers	829
Logging workers	606
Material moving occupations	809
Refractory materials repairers, except brickmasons	830
Roustabouts, oil and gas	829
Structural metal fabricators and fitters	723

Sources of Additional Information

For information about jobs as a construction laborer, contact local building or construction contractors, local joint labor-management apprenticeship committees, apprenticeship agencies, or the local office of your State Employment Service. You also can find information on the registered apprenticeships, together with links to State apprenticeship programs, on the U.S. Department of Labor's Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information also is available from the U.S. Department of Labor's toll-free help line: (877) 872-5627.

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

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For information on education programs for laborers, contact:
➤ Laborers-AGC Education and Training Fund, 37 Deerfield Rd., P.O. Box 37, Pomfret Center, CT 06258-0037.

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606. Internet: **http://www.nccer.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos248.htm**

Drywall and Ceiling Tile Installers, Tapers, Plasterers, and Stucco Masons

Significant Points

- Most workers learn their trade through informal training programs or through an apprenticeship.
- Work is physically demanding.
- Job prospects are expected to be good.
- Workers may be idled when downturns in the economy slow construction activity.

Nature of the Work

Drywall and *ceiling tile installers*, *tapers*, *plasterers*, and *stucco masons* are specialty construction workers who build, apply, or fasten interior and exterior wallboards or wall coverings in residential, commercial, and other structures. Specifically, drywall and ceiling tile installers and tapers work indoors, installing wallboards to ceilings or to interior walls of buildings; plasterers and stucco masons, on the other hand, work both indoors and outdoors—applying plaster to interior walls and cement or stucco to exterior walls. While most work is performed for functionality, such as fireproofing and sound dampening, some applications are intended purely for decorative purposes.

Drywall consists of a thin layer of gypsum between two layers of heavy paper. It is used to make walls and ceilings in most buildings today because it is faster and cheaper to install than plaster.

There are two kinds of drywall workers—installers and tapers—although many workers do both types of work. Installers, also called *framers* or *hangers*, fasten drywall panels to the inside framework of houses and other buildings. Tapers or *finishers*, prepare these panels for painting by taping and finishing joints and imperfections. In addition to drywall workers, ceiling tile installers also help to build walls and ceilings.

Because drywall panels are manufactured in standard sizes—usually 4 feet by 8 feet—drywall installers must measure, cut, fit, and fasten them to the inside framework of buildings. Installers saw, drill, or cut holes in panels for electrical outlets, air-conditioning units, and plumbing. After making these alterations, installers typically screw the wallboard panels to the wood or metal framework, called studs. Because drywall is heavy and cumbersome, another worker usually helps the installer to position and secure the panel. Installers often use a lift when placing ceiling panels.

After the drywall is installed, tapers fill joints between panels with a joint compound, also called spackle or "mud." Using the wide, flat tip of a special trowel, they spread the compound into and along each side of the joint. They immediately use the trowel to press a paper tape—used to reinforce the drywall and to hide imperfections—into the wet compound and to smooth away excess material. Nail and screw depressions also are covered with this compound, as are imperfections caused by the installation of air-conditioning vents and other fixtures. Using increasingly wider trowels, tapers apply second and third coats of the compound, sanding the treated areas after each coat to make them smooth and devoid of seams.

Ceiling tile installers, or *acoustical carpenters*, apply or mount acoustical tiles or blocks, strips, or sheets of shock-absorbing materials to ceilings and walls of buildings to reduce deflection of sound or to decorate rooms. First, they measure and mark the surface according to blueprints and drawings. Then, they nail or screw moldings to the wall to support and seal the joint between the ceiling tile and the wall. Finally, they mount the tile, either by applying a cement adhesive to the back of the tile and then pressing the tile into place, or by nailing, screwing, or wire-tying the lath directly to the structural framework.

Plasterers apply plaster to interior walls and ceilings to form fire-resistant and relatively soundproof surfaces. They also apply plaster veneer over drywall to create smooth or textured abrasion-resistant finishes. In addition, plasterers install prefabricated exterior insulation systems over existing walls—for good insulation and interesting architectural effects—and cast ornamental designs in plaster. Stucco masons apply durable plasters, such as polymer-based acrylic finishes and stucco, to exterior surfaces.

Plasterers can plaster either solid surfaces, such as concrete block, or supportive wire mesh called lath. When plasterers work with hard interior surfaces, such as concrete block and concrete, they first apply a brown coat of gypsum plaster that provides a base, which is followed by a second, or finish coat, also called "white coat." When plastering metal-mesh lath foundations, they apply a preparatory, or "scratch coat" with a trowel. They spread this rich plaster mixture into and over the metal lath. Before the plaster sets, plasterers scratch its surface with a rake-like tool to produce ridges, so that the subsequent brown coat will bond tightly. They then apply the brown coat and the white finish coat.

When plastering on non-solid surfaces, *lathers* are needed to help build supportive walls out of wire. This support base is put on walls, ceilings, ornamental frameworks, and partitions of buildings before plaster and other coatings are added.

Applying different types of plaster coating requires different techniques. When applying the brown coat, plasterers spray or trowel the mixture onto the surface, then smooth it to an even, level surface. For the finish, or white coat, plasterers usually prepare a mixture of plaster and water. They quickly apply this using a "hawk," that is a light, metal plate with a handle, along with a trowel, brush, and water. This mixture, which sets very quickly, produces a very smooth, durable finish.

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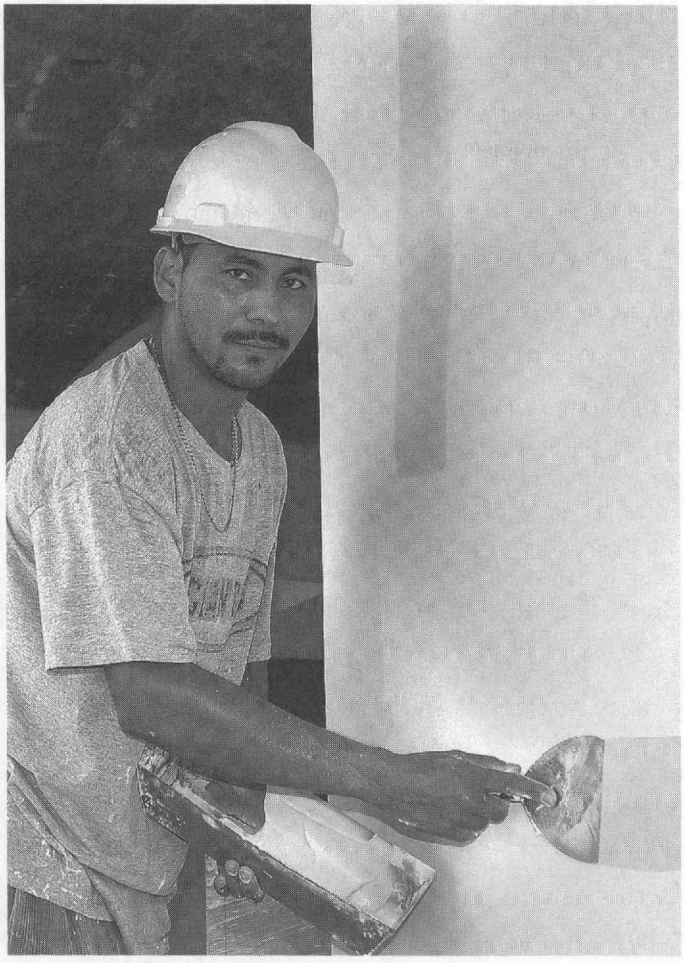

Drywall and ceiling tile installers, tapers, plasterers, and stucco masons learn their trade through informal training programs or through apprenticeships.

Plasterers create decorative interior surfaces as well. One way that they do this is by pressing a brush or trowel firmly against a wet plaster surface and using a circular hand motion to create decorative swirls. Plasterers sometimes do more complex decorative and ornamental work that requires special skill and creativity. For example, they may mold intricate wall and ceiling designs, such as cornice pieces and chair rails. Following an architect's blueprint, plasterers pour or spray a special plaster into a mold and allow it to set. Workers then remove the molded plaster and put it in place, according to the plan.

Stucco masons usually apply stucco—a mixture of Portland cement, lime, and sand—over cement, concrete, masonry or wire lath. Stucco also may be applied directly to a wire lath with a scratch coat, followed by a brown coat, and then a finish coat. Stucco masons may also embed marble or gravel chips into the finish coat to achieve a pebble-like, decorative finish.

When required, stucco masons apply insulation to the exteriors of new and old buildings. They cover the outer wall with rigid foam insulation board and reinforcing mesh, and then trowel on a base coat. They may apply an additional coat of this material with a decorative finish.

Work environment. As in many other construction trades, this work is physically demanding. Drywall and ceiling tile installers, tapers, plasterers, and stucco masons spend most of the day on their feet, either standing, bending, stretching, or kneeling. Some workers need to use stilts; others may have to lift and maneuver heavy, cumbersome materials, such as oversized wallboards. The work also can be dusty and dirty, irritating the skin, eyes, and lungs, unless protective masks, goggles, and gloves are used. Hazards include falls from ladders and scaffolds, and injuries from power tools and from working with sharp tools, such as utility knives.

Most work indoors, except for the relatively few stucco masons who apply exterior finishes.

Training, Other Qualifications, and Advancement

Most workers learn their trade through informal training programs or through an apprenticeship. It can take 3 to 4 years of paid on-the-job training to become a fully skilled worker, but many skills can be learned within the first year. In general, the more formal the training process, the more skilled the individual becomes, and the more in demand by employers.

Education and training. A high school education, or its equivalent, is helpful, as are courses basic math, mechanical drawing, and blueprint reading. The most common way to get a first job is to find an employer who will provide on-the-job training. Entry-level workers generally start as helpers, assisting more experienced workers. Employers may also send new employees to a trade or vocational school or community college to receive classroom training.

Some employers, particularly large nonresidential construction contractors with unionized workforces, offer employees formal apprenticeships. These programs combine on-the-job training with related classroom instruction—at least 144 hours of instruction each year for drywall and ceiling tile installers and tapers, and 166 hours for plasterers and stucco masons. The length of the apprenticeship program, usually 3 to 4 years, varies with the apprentice's skill. Because the number of apprenticeship programs is limited, however, only a small proportion of these workers learn their trade this way.

Helpers and apprentices start by carrying materials, lifting and cleaning up debris. They also learn to use the tools, machines, equipment, and materials of the trade. Within a few weeks, they learn to measure, cut, apply, and install materials. Eventually, they become fully experienced workers. At the end of their training, workers learn to estimate the cost of completing a job.

Other jobseekers may choose to obtain their training before seeking a job. There are a number of vocational-technical schools and training academies affiliated with the industry's unions and contractors that offer training in these occupations. Employers often look favorably upon graduates of these training programs and usually start them at a higher level than those without the training.

Other qualifications. Workers need to be in good physical condition and have good eye-hand coordination, a sense of balance and manual dexterity. For drywall and ceiling tile installers and tapers, the ability to solve basic arithmetic problems quickly and accurately is required. They also should be able to identify and estimate the quantity of materials needed to complete a job, and accurately estimate how long a job will take to complete and at what cost.

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Artistic creativity is helpful for plasterers and stucco masons who apply decorative finishes. In addition, a good work history is viewed favorably by contractors.

Apprentices usually must be at least 18 years old and have a high school diploma or GED. Those who complete apprenticeships registered with the Federal or State Government receive a journey worker certificate that is recognized Nationwide.

Certification and advancement. Some organizations related to masonry trades offer training and certification intended to enhance the skills of their members. For example, the International Union of Bricklayers and Allied Craftworkers International Masonry Institute confers designations in several areas of specialization, including one for plastering. Candidates who complete a 12-week certification program can earn a designation as a "journey level plasterer" by passing a competency-based exam. Experienced candidates can become trainers and earn a designation as "Certified Instructor or Journeyworkers and Apprentices in the Trowel Trades."

Drywall and ceiling tile installers, tapers, plasterers, and stucco masons may advance to supervisor or general construction supervisor positions. However, it is increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers with limited understanding of English because Spanish-speaking workers make up a large part of the construction workforce in many areas. Knowing English well also makes it easier to advance. Many workers become independent contractors. Others become building inspectors.

Employment

Drywall and ceiling tile installers, tapers, plasterers, and stucco masons held about 237,700 jobs in 2008. About 19 percent were self-employed independent contractors. The following tabulation shows 2008 wage-and-salary employment by specialty:

Drywall and ceiling tile installers	151,300
Plasterers and stucco masons	49,000
Tapers	37,400

Most workers are employed in populous areas. In other areas, where there may not be enough work to keep them employed full time, carpenters and painters usually do the work.

Job Outlook

Employment of drywall and ceiling tile installers, tapers, plasterers, and stucco masons is expected to grow about as fast as average for all occupations. Job growth, however, will differ among the individual occupations in this category. Good job prospects are expected overall.

Employment change. Overall employment is expected to grow by 12 percent between 2008 and 2018. Employment of drywall and ceiling tile installers—the largest specialty—is expected to grow 14 percent, reflecting growth of new construction and remodeling projects. New residential construction projects are expected to provide the majority of jobs during the projection decade, but home improvement and renovation projects are also expected to create jobs because existing residential and nonresidential buildings are getting old and need repair.

Employment of tapers is expected to grow 13 percent, which is as fast as the average. Demand for tapers, which often mirrors demand for drywall installers, also will be driven by the overall growth of construction activity.

Employment of plasterers and stucco masons, on the other hand, is expected to grow 7 percent. Despite an increased appreciation for the attractiveness and durability that plaster provides, growing use of cheaper and easier to install alternatives, such as drywall, will impede employment growth for these workers. Nonetheless, stucco masons will experience some employment growth due to demand for new polymer-based exterior insulating finishes that are gaining popularity, particularly in the South and Southwest regions of the country.

Job prospects. Job opportunities for drywall and ceiling tile installers, tapers, plasterers, and stucco masons are expected to be good overall. Many potential workers are not attracted to this occupation because they prefer work that is less strenuous and has more comfortable working conditions. Experienced workers will have especially favorable opportunities.

Besides opportunities resulting from job growth, many drywall and ceiling tile installer and taper jobs will open up each year because of the need to replace workers who transfer to other occupations or leave the labor force. Skilled, experienced plasterers with artistic ability should have excellent opportunities, especially with restoration projects. Decorative custom finishes, expensive homes, and large-scale restoration projects will further result in opportunities for plasterers in the Northeast, particularly in urban areas. For stucco masons, the best employment opportunities should continue to be in Florida, California, and the Southwest, where the use of stucco is expected to remain popular.

Like many other construction workers, employment in these occupations is sensitive to the fluctuations of the economy. Workers in these trades may experience periods of

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	–	237,700	266,200	28,500	12
Drywall installers, ceiling tile installers, and tapers	47-2080	188,700	214,000	25,300	13
Drywall and ceiling tile installers	47-2081	151,300	171,700	20,500	14
Tapers	47-2082	37,400	42,300	4,900	13
Plasterers and stucco masons	47-2161	49,000	52,200	3,200	7

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

The median hourly wages of wage and salary drywall and ceiling tile installers were $18.12 in May 2008. The middle 50 percent earned between $14.23 and $23.80. The lowest 10 percent earned less than $11.64, and the highest 10 percent earned more than $31.72.

Median hourly wages of wage and salary tapers were $21.03 in May 2008. The middle 50 percent earned between $15.45 and $28.27. The lowest 10 percent earned less than $12.62, and the highest 10 percent earned more than $34.91.

Median hourly wages of wage and salary plasterers and stucco masons were $18.01 in May 2008. The middle 50 percent earned between $14.36 and $22.94. The lowest 10 percent earned less than $12.01, and the top 10 percent earned more than $29.59.

Related Occupations

Drywall and ceiling tile installers, tapers, plasterers, and stucco masons combine strength and dexterity with precision and accuracy to make materials fit according to a plan. Other occupations that require similar abilities include:

	Page
Brickmasons, blockmasons, and stonemasons	615
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Insulation workers	653

Sources of Additional Information

For information about work opportunities in this field, contact local drywall installation, ceiling tile installation, plaster and stucco mason contractors, a local joint union-management apprenticeship committee, a State or local chapter of the Associated Builders and Contractors, or the nearest office of the State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/atels_bat.** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 282-5627.

For details about job qualifications and training programs in drywall application and finishing and ceiling tile installation, contact:

➤ Associated Builders and Contractors, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: **http://www.abc.org/**

➤ Association of Wall and Ceiling Industries International, 513 West Broad St., Suite 210, Falls Church, VA 22046. Internet: **http://www.awci.org**

➤ Finishing Trades Institute, International Union of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: **http://www.finishingtradesinstitute.org**

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St. NW., 6th Floor, Washington, DC 20005. Internet: **http://www.hbi.org**

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Building G, Gainesville, FL 32606. Internet: **http://www.nccer.org**

For information about plasterers, contact:

➤ Operative Plasterers' and Cement Masons' International Association of the United States and Canada, 11720 Beltsville Dr., Suite 700, Beltsville, MD 20705. Internet: **http://www.opcmia.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos352.htm**

Electricians

Significant Points

- Job opportunities should be good, especially for those with the broadest range of skills.
- Most electricians acquire their skills by completing an apprenticeship program usually lasting 4 years.
- About 79 percent of electricians work in the construction industry or are self-employed, but there also will be opportunities for electricians in other industries.

Nature of the Work

Electricians install and maintain all of the electrical and power systems for our homes, businesses, and factories. They install and maintain the wiring and control equipment through which electricity flows. They also install and maintain electrical equipment and machines in factories and a wide range of other businesses.

Electricians generally focus on either construction or maintenance, although many do both. Electricians specializing in construction primarily install wiring systems into factories, businesses, and new homes. Electricians specializing in maintenance fix and upgrade existing electrical systems and repair electrical equipment. All electricians must follow State and local building codes and the National Electrical Code when performing their work.

Electricians usually start their work by reading blueprints—technical diagrams that show the locations of circuits, outlets, load centers, panel boards, and other equipment. After determining where all the wires and components will go, electricians install and connect the wires to circuit breakers, transformers, outlets, or other components and systems.

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When installing wiring, electricians use handtools such as conduit benders, screwdrivers, pliers, knives, hacksaws, and wire strippers, as well as power tools such as drills and saws. Later, they use ammeters, ohmmeters, voltmeters, harmonics testers, and other equipment to test connections and ensure the compatibility and safety of components.

Maintenance electricians repair or replace electric and electronic equipment when it breaks. They make needed repairs as quickly as possible in order to minimize inconvenience. They may replace items such as circuit breakers, fuses, switches, electrical and electronic components, or wire.

Electricians also periodically inspect all equipment to ensure that it is operating properly and to correct problems before breakdowns occur.

Maintenance work varies greatly, depending on where an electrician works. Electricians who focus on residential work perform a wide variety of electrical work for homeowners. They may rewire a home and replace an old fuse box with a new circuit breaker box to accommodate additional appliances, or they may install new lighting and other electric household items, such as ceiling fans. These electricians also might do some construction and installation work.

Electricians in large factories usually do maintenance work that is more complex. These kinds of electricians may repair motors, transformers, generators, and electronic controllers on machine tools and industrial robots. They also advise management as to whether the continued operation of certain equipment could be hazardous. When working with complex electronic devices, they may consult with engineers, engineering technicians, line installers and repairers, or industrial machinery mechanics and maintenance workers. (Statements on these occupations appear elsewhere in the *Handbook*.)

Work environment. Electricians work indoors and out, at construction sites, in homes, and in businesses or factories. The work may be strenuous at times and may include bending conduit, lifting heavy objects, and standing, stooping, and kneeling for long periods. Electricians risk injury from electrical shock, falls, and cuts, and must follow strict safety procedures to avoid injuries. Data from the U.S. Bureau of Labor Statistics show that full-time electricians experienced a work-related injury and illness rate that was higher than the national average. When working outdoors, they may be subject to inclement weather. Some electricians may have to travel long distances to jobsites.

Most electricians work a standard 40-hour week, although overtime may be required. Those who do maintenance work may work nights or weekends and be on call to go to the worksite when needed. Electricians in industrial settings may have periodic extended overtime during scheduled maintenance or retooling periods. Companies that operate 24 hours a day may employ three shifts of electricians.

Training, Other Qualifications, and Advancement

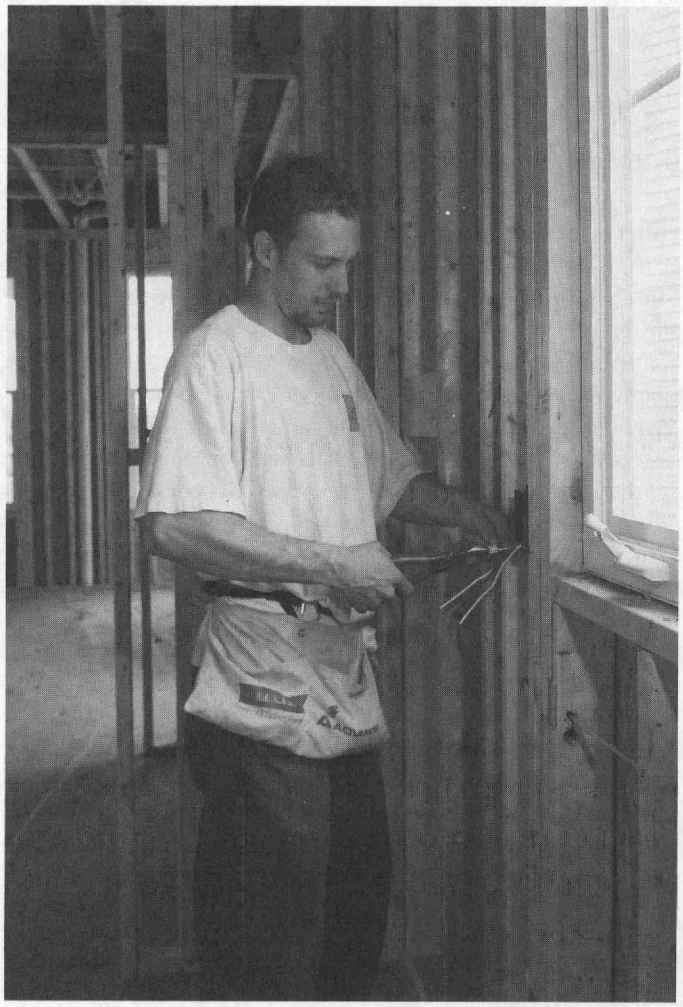
Most electricians learn their trade through apprenticeship programs that combine on-the-job training with related classroom instruction.

Education and training. Apprenticeship programs combine paid on-the-job training with related classroom instruction. Joint training committees made up of local unions of the International Brotherhood of Electrical Workers and local chapters of the National Electrical Contractors Association; individual electrical contracting companies; or local chapters of the Associated Builders and Contractors and the Independent Electrical Contractors Association usually sponsor apprenticeship programs.

Because of the comprehensive training received, those who complete apprenticeship programs qualify to do both maintenance and construction work. Apprenticeship programs usually last 4 years. Each year includes at least 144 hours of classroom instruction and 2,000 hours of on-the-job training. In the classroom, apprentices learn electrical theory, blueprint reading, mathematics, electrical code requirements, and safety and first aid practices. They also may receive specialized training in soldering, communications, fire alarm systems, and cranes and elevators.

On the job, apprentices work under the supervision of experienced electricians. At first, they drill holes, set anchors and attach conduit. Later, they measure, fabricate, and install conduit and install, connect, and test wiring, outlets, and switches. They also learn to set up and draw diagrams for entire electrical systems. Eventually, they practice and master all of an electrician's main tasks.

Some people start their classroom training before seeking an apprenticeship. A number of public and private vocational-technical schools and training academies offer training to become an electrician. Employers often hire students who complete these programs and usually start them at a more advanced level than



An electrician prepares the wiring for an interior room.

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those without this training. A few people become electricians by first working as helpers—assisting electricians by setting up job sites, gathering materials, and doing other nonelectrical work—before entering an apprenticeship program. All apprentices need a high school diploma or a General Equivalency Diploma (G.E.D.). Electricians also may need additional classes in mathematics because they solve mathematical problems on the job.

Education continues throughout an electrician's career. Electricians may need to take classes to learn about changes to the National Electrical Code, and they often complete regular safety programs, manufacturer-specific training, and management training courses. Classes on such topics as low-voltage voice and data systems, telephone systems, video systems, and alternative energy systems such as solar energy and wind energy increasingly are being given as these systems become more prevalent. Other courses teach electricians how to become contractors.

Licensure. Most States and localities require electricians to be licensed. Although licensing requirements vary from State to State, electricians usually must pass an examination that tests their knowledge of electrical theory, the National Electrical Code, and local and State electric and building codes.

Electrical contractors who do electrical work for the public, as opposed to electricians who work for electrical contractors, often need a special license. In some States, electrical contractors need certification as master electricians. Most States require master electricians to have at least 7 years of experience as an electrician or a bachelor's degree in electrical engineering or a related field.

Other qualifications. Applicants for apprenticeships usually must be at least 18 years old and have a high school diploma or a G.E.D. They also may have to pass a test and meet other requirements.

Other skills needed to become an electrician include manual dexterity, eye-hand coordination, physical fitness, and a good sense of balance. Electricians also need good color vision because workers frequently must identify electrical wires by color. In addition, apprenticeship committees and employers view a good work history or military service favorably.

Advancement. Experienced electricians can advance to jobs as supervisors. In construction, they also may become project managers or construction superintendents. Those with sufficient capital and management skills can start their own contracting business, although doing so often requires a special electrical contractor's license. Supervisors and contractors should be able to identify and estimate costs and prices and the time and materials needed to complete a job. Many electricians also become electrical inspectors.

For those who seek to advance, it is increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers with limited understanding of English; Spanish-speaking workers make up a large part of the construction workforce in many areas. Spanish-speaking workers who want to advance in this occupation need very good English skills to understand electrician classes and installation instructions, which are usually written in English and are highly technical.

Employment

Electricians held about 694,900 jobs in 2008. About 65 percent of wage and salary workers were employed by electrical contracting firms, and the remainder worked as electricians in a variety of other industries. In addition, about 9 percent of electricians were self-employed.

Job Outlook

Average employment growth is expected. Job prospects should be good, particularly for workers with the widest range of skills, including voice, data, and video wiring.

Employment change. Employment of electricians should increase 12 percent between 2008 and 2018, about as fast as the average for all occupations. As the population grows, electricians will be needed to wire new homes, restaurants, schools, and other structures that will be built to accommodate the growing population. In addition, older buildings will require improvements to their electrical systems to meet modern codes and accommodate higher electricity consumption due to the greater use of electronic equipment in houses and workplaces.

New technologies also are expected to continue to spur demand for these workers. Robots and other automated manufacturing systems in factories will require the installation and maintenance of more complex wiring systems. In addition, efforts to boost conservation of energy in public buildings and in new construction will boost demand for electricians because electricians are key to installing some of the latest energy savers, such as solar panels and motion sensors for turning on lights.

Job prospects. In addition to jobs created by the increased demand for electrical work, openings are expected over the next decade as electricians retire. This will create good job opportunities, especially for those with the widest range of skills, including voice, data, and video wiring. Job openings for electricians will vary by location and specialty, however, and will be best in the fastest growing regions of the country.

Employment of electricians, like that of many other construction workers, is sensitive to the fluctuations of the economy. On the one hand, workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Although employment of maintenance electricians is steadier than that of construction electricians, those working in the automotive and other manufacturing industries that are sensitive to cyclical swings in the economy may experience layoffs during

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Electricians	47-2111	694,900	777,900	83,000	12

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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recessions. In addition, in many industries opportunities for maintenance electricians may be limited by increased contracting out for electrical services in an effort to reduce operating costs. However, increased job opportunities for electricians in electrical contracting firms should partially offset job losses in other industries.

Earnings

In May 2008, median hourly wages of wage and salary electricians were $22.32. The middle 50 percent earned between $17.00 and $29.88. The lowest 10 percent earned less than $13.54, and the highest 10 percent earned more than $38.18. Median hourly wages in the industries employing the largest numbers of electricians were as follows:

Electric power generation, transmission and distribution	$28.15
Local government	25.66
Nonresidential building construction	22.21
Building equipment contractors	21.72
Employment services	18.32

Apprentices usually start at between 30 and 50 percent of the rate paid to fully trained electricians, depending on experience. As apprentices become more skilled, they receive periodic pay increases throughout their training.

About 32 percent of all electricians are members of a union, especially the International Brotherhood of Electrical Workers. Among unions representing maintenance electricians are the International Brotherhood of Electrical Workers; the International Union of Electronic, Electrical, Salaried, Machine, and Furniture Workers; the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aircraft and Agricultural Implement Workers of America; and the United Steelworkers of America.

Related Occupations

Other occupations that combine manual skill and knowledge of electrical materials and concepts include the following:

	Page
Computer, automated teller, and office machine repairers	672
Electrical and electronics drafters	170
Electrical and electronics Engineering technicians	173
Electrical and electronics installers and repairers	675
Electronic home entertainment equipment installers and repairers	678
Elevator installers and repairers	644
Heating, air-conditioning, and refrigeration mechanics and installers	703
Line installers and repairers	713

Sources of Additional Information

For details about apprenticeships or other work opportunities in this trade, contact the offices of the State employment service, the State apprenticeship agency, local electrical contractors or firms that employ maintenance electricians, or local union-management electrician apprenticeship committees. Apprenticeship information is available from the U.S. Department of Labor's toll free help line: (877) 872-5627. Internet: **http://www.doleta.gov/OA/eta_default.cfm**

Information may be available as well from local chapters of the Independent Electrical Contractors, Inc.; the National Electrical Contractors Association; the Home Builders Institute; the Associated Builders and Contractors trade association; and the International Brotherhood of Electrical Workers.

For information about union apprenticeship and training programs, contact:

➤ National Joint Apprenticeship Training Committee, 301 Prince George's Blvd., Upper Marlboro, MD 20774-7410. Internet: **http://www.njatc.org**

➤ National Electrical Contractors Association, 3 Bethesda Metro Center, Suite 1100, Bethesda, MD 20814-6302. Internet: **http://www.necanet.org**

➤ International Brotherhood of Electrical Workers, 900 Seventh St. NW., Washington, DC 20001-3886. Internet: **http://www.ibew.org**

For information about independent apprenticeship programs, contact:

➤ Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Independent Electrical Contractors, Inc., 4401 Ford Ave., Suite 1100, Alexandria, VA 22302-1464. Internet: **http://www.ieci.org**

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St. NW, 6th Floor, Washington, DC 20005-2842. Internet: **http://www.hbi.org**

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606-8134. Internet: **http://www.nccer.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos206.htm**

Elevator Installers and Repairers

Significant Points

- Most workers belong to a union and enter the occupation through a 4-year apprenticeship program.
- Excellent employment opportunities are expected.
- Elevator installers and repairers are less affected by seasonality and downturns in the economy than most other construction trades workers because much of the work involves maintenance and repair.

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Nature of the Work

Elevator installers and repairers—also called *elevator constructors* or *elevator mechanics*—assemble, install, and replace elevators, escalators, chairlifts, dumbwaiters, moving walkways, and similar equipment in new and old buildings. Once the equipment is in service, they maintain and repair it as well. They also are responsible for modernizing older equipment.

To install, repair, and maintain modern elevators, which are almost all electronically controlled, elevator installers and repairers must have a thorough knowledge of electronics, hydraulics, and electricity. Many elevators are controlled with microprocessors, which are programmed to dispatch elevators in the most efficient manner. With these controls, it is possible to get the greatest amount of service with the smallest number of cars.

Elevator installers and repairers usually specialize in installation, maintenance, or repair work. Maintenance and repair workers generally need greater knowledge of electronics and electricity than do installers because a large part of maintenance and repair work is troubleshooting.

When installing a new elevator, installers and repairers begin by studying blueprints to determine the equipment needed to install rails, machinery, car enclosures, motors, pumps, cylinders, and plunger foundations. Then, they begin equipment installation. Working on scaffolding or platforms, installers bolt or weld steel rails to the walls of the shaft to guide the elevator.

Elevator installers put in electrical wires and controls by running tubing, called conduit, along a shaft's walls from floor to floor. Once the conduit is in place, mechanics pull plastic-covered electrical wires through it. They then install electrical components and related devices required at each floor and at the main control panel in the machine room.

Installers bolt or weld together the steel frame of an elevator car at the bottom of the shaft; install the car's platform, walls, and doors; and attach guide shoes and rollers to minimize the lateral motion of the car as it travels through the shaft. They also install the outer doors and door frames at the elevator entrances on each floor.

For cabled elevators, workers install geared or gearless machines with a traction drive wheel that guides and moves heavy steel cables connected to the elevator car and counterweight. (The counterweight moves in the opposite direction from the car and balances most of the weight of the car to reduce the weight that the elevator's motor must lift.) Elevator installers also install elevators in which a car sits on a hydraulic plunger that is driven by a pump. The plunger pushes the elevator car up from underneath, similar to a hydraulic lift in an auto service station.

Installers and repairers also install escalators. They place the steel framework, the electrically powered stairs, and the tracks and install associated motors and electrical wiring. In addition to elevators and escalators, installers and repairers also may install devices such as dumbwaiters and material lifts—which are similar to elevators in design—as well as moving walkways, stair lifts, and wheelchair lifts.

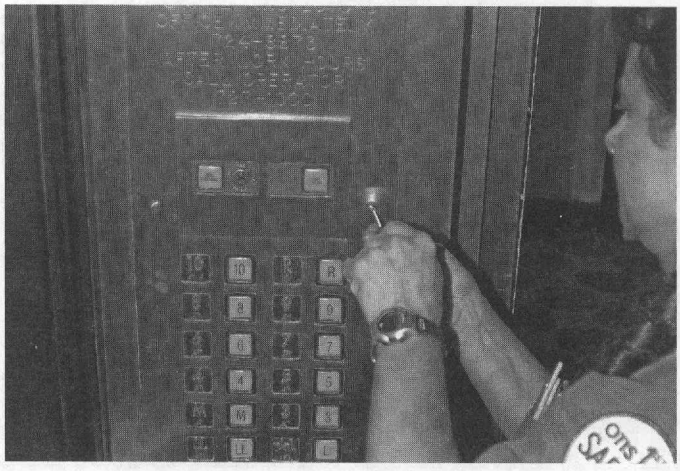
Once an elevator is operating correctly, it must be maintained and serviced regularly to keep it in safe working condition. Elevator installers and repairers generally do preventive maintenance—such as oiling and greasing moving parts, replacing worn parts, testing equipment with meters and gauges, and adjusting equipment for optimal performance. They ensure that the equipment and rooms are clean. They also troubleshoot and may be called to do emergency repairs. Unlike most elevator installers, people who specialize in elevator maintenance work independently most of the day and typically service many of the same elevators on multiple occasions over time.

A service crew usually handles major repairs—for example, replacing cables, elevator doors, or machine bearings. These tasks may require the use of cutting torches or rigging equipment—tools that an elevator repairer would not normally carry. Service crews also do major modernization and alteration work, such as moving and replacing electrical motors, hydraulic pumps, and control panels.

The most highly skilled elevator installers and repairers, called "adjusters," specialize in fine-tuning all the equipment after installation. Adjusters make sure that an elevator works according to specifications and stops correctly at each floor within a specified time. Adjusters need a thorough knowledge of electronics, electricity, and computers to ensure that newly installed elevators operate properly.

Work environment. Elevator installers lift and carry heavy equipment and parts, and they may work in cramped spaces or awkward positions. Potential hazards include falls, electrical shock, muscle strains, and other injuries related to handling heavy equipment. To prevent injury, workers often are required to wear hardhats, harnesses, ear plugs, safety glasses, protective clothing and shoes, and occasionally, respirators. Data from the U.S. Bureau of Labor Statistics show that full-time elevator installers and repairers experienced a work-related injury and illness rate that was much higher than the national average.

Most elevator installers and repairers work a 40-hour week. However, overtime is required when essential equipment must be repaired, and some workers are on 24-hour call. Because most of their work is performed indoors in buildings, elevator installers and repairers lose less work time because of inclement weather than do most other workers in the construction trades.



Employment of elevator installers and repairers is less affected by economic downturns and seasonality than employment in other construction trades.

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Training, Other Qualifications, and Advancement

Most elevator installers receive their education through an apprenticeship program. High school classes in mathematics, science, and shop may help applicants compete for apprenticeship openings.

Education and training. Most elevators installers and repairers learn their trade in an apprenticeship program administered by local joint educational committees representing the employers and the union—the International Union of Elevator Constructors. In nonunion shops, workers may complete training programs sponsored by independent contractors.

Apprenticeship programs teach a range of skills and usually last 4 years. Programs combine paid on-the-job training with classroom instruction in blueprint reading, electrical and electronic theory, mathematics, applications of physics, and safety.

Most apprentices assist experienced elevator installers and repairers. Beginners carry materials and tools, bolt rails to walls, and assemble elevator cars. Eventually, apprentices learn more difficult tasks, such as wiring.

Applicants for apprenticeship positions must have a high school diploma or the equivalent. High school courses in electricity, mathematics, and physics provide a useful background. As elevators become increasingly sophisticated, workers may need to get more advanced education—for example, a certificate or associate degree in electronics. Workers with education beyond high school usually advance more quickly than their counterparts without a degree.

Many elevator installers and repairers receive additional training on their particular company's equipment.

Licensure. Many cities and States require elevator installers and repairers to pass a licensing examination. However, other requirements for licensure may vary.

Certification and other qualifications. Workers who also complete an apprenticeship registered by the U.S. Department of Labor or their State board earn a journeyworker certificate recognized nationwide. Applicants for apprenticeship positions must be at least 18 years old, have a high school diploma or equivalent, and pass an aptitude test and a drug test. Good physical condition and mechanical skills also are important.

Jobs with many employers require membership in the union. To be considered fully qualified by the union, workers must complete an apprenticeship and pass a standard exam administered by the National Elevator Industry Educational Program.

The National Association of Elevator Contractors also offers certification as a Certified Elevator Technician (CET) or Certified Accessibility and Private Residence Lift Technician (CAT).

Advancement. Ongoing training is very important for a worker to keep up with technological developments in elevator repair. In fact, union elevator installers and repairers typically receive training throughout their careers, through correspondence courses, seminars, or formal classes. This training greatly improves one's chances for promotion and retention.

Some installers may receive additional training in specialized areas and advance to the position of mechanic-in-charge, adjuster, supervisor, or elevator inspector. Adjusters, for example, may be picked for their position because they possess particular skills or are electronically inclined. Other workers may move into management, sales, or product-design jobs.

Employment

Elevator installers and repairers held about 24,900 jobs in 2008. Most were employed by specialty trades contractors, particularly other building equipment contractors.

Job Outlook

Even with average job growth, excellent job opportunities are expected in this occupation.

Employment change. Employment of elevator installers and repairers is expected to increase 9 percent during the 2008–18 decade. Demand for additional elevator installers depends greatly on growth in nonresidential construction, such as commercial office buildings and stores that have elevators and escalators. This sector of the construction industry is expected to grow during the decade as the economy expands. In addition, the need to continually maintain, update and repair old equipment, provide access to the disabled, and install increasingly sophisticated equipment and controls should add to the demand for elevator installers and repairers. Another factor causing the demand for elevator installers and repairers to increase is a growing number of elderly people who require easier access to their homes through stair lifts and residential elevators.

Job prospects. Workers who seek to enter this occupation should have excellent opportunities. Elevator installer and repairer jobs have relatively high earnings and good benefits. However, it is the dangerous and physically challenging nature of this occupation and the significant training it requires that reduce the number of applicants and create better opportunities for those who apply. Job prospects should be best for those with postsecondary education in electronics or experience in the military.

Elevators, escalators, lifts, moving walkways, and related equipment need to be kept in good working condition year round every year, so employment of elevator repairers is less affected by economic downturns and seasonality than employment in other construction trades. Although elevator installers and repairers are employed throughout the Nation, the majority of positions tend to be concentrated in the Northeast because of its high concentration of tall office and residential structures.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Elevator installers and repairers	47-4021	24,900	27,100	2,300	9

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Earnings

Wages of elevator installers and repairers are among the highest of all construction trades. Median hourly wages of elevator installers and repairers were $33.35 in May 2008. The middle 50 percent earned between $25.79 and $39.41. The lowest 10 percent earned less than $19.38, and the top 10 percent earned more than $46.78. Median hourly wages in the building equipment contractors industry were $33.46.

Wages for members of the International Union of Elevator Constructors vary on the basis of locale and specialty. Check with a local chapter in your area for average wages.

Over half of all elevator installers and repairers were members of unions or covered by a union contract, one of the highest proportions of all occupations. Of those in a union, the largest number were members of the International Union of Elevator Constructors. In addition to free continuing education, elevator installers and repairers receive the basic benefits enjoyed by most other workers.

Related Occupations

Elevator installers and repairers combine electrical and mechanical skills with construction skills, such as welding, rigging, measuring, and blueprint reading. Other occupations that require many of these skills are:

	Page
Boilermakers	613
Electrical and electronics installers and repairers	675
Electricians	641
Industrial machinery mechanics and millwrights	709
Sheet metal workers	665
Structural and reinforcing iron and metal workers	668

Sources of Additional Information

For information about apprenticeships or job opportunities as an elevator mechanic, contact local contractors, a local chapter of the International Union of Elevator Constructors, a local joint union-management apprenticeship committee, or the nearest office of your State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/atels_bat.** Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 872–5627.

For further information on opportunities as an elevator installer and repairer, contact:

➤ International Union of Elevator Constructors, 7154 Columbia Gateway Dr., Columbia, MD 21046. Internet: **http://www.iuec.org**

For additional information about the Certified Elevator Technician (CET) program or the Certified Accessibility and Private Residence Lift Technician (CAT) program, contact:

➤ National Association of Elevator Contractors, 1298 Wellbrook Circle, Conyers, GA 30012. Internet: **http://www.naec.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos189.htm**

Glaziers

Significant Points

- Glaziers generally learn the trade by helping experienced workers, sometimes with supplemental classroom training.
- Job opportunities are expected to be good.
- Employment is expected to grow 8 percent, about as fast as the average for all occupations.

Nature of the Work

Glass serves many uses in modern life. Insulated and specially treated glass keeps in warmed or cooled air and provides good condensation and sound control. Tempered and laminated glass makes doors and windows more secure. In large commercial buildings, glass panels give office buildings a distinctive look, while reducing the need for artificial lighting. The creative use of large windows, glass doors, skylights, and sunroom additions makes homes bright, airy, and inviting.

Glaziers are responsible for selecting, cutting, installing, replacing, and removing all types of glass. They generally work on one of several types of projects.

Residential glazing involves work, such as replacing glass in home windows; installing glass mirrors, shower doors, and bathtub enclosures; and fitting glass for tabletops and display cases. On commercial interior projects, glaziers install items such as heavy, often etched, decorative room dividers or security windows. Glazing projects also may involve replacement of storefront windows for establishments such as supermarkets, auto dealerships, or banks. In the construction of large commercial buildings, glaziers, after reading and interpreting blueprints and specifications, build metal framework extrusions and install glass panels or curtain walls. (Workers who replace and repair glass in motor vehicles are not covered in this statement. See the statement on automotive body and related repairers elsewhere in the *Handbook*.)

Besides working with glass, glaziers also may work with plastics, granite, marble, and other similar materials used as glass substitutes and with films or laminates that improve the durability or safety of the glass. They may mount steel and aluminum sashes or frames and attach locks and hinges to glass doors.

For most jobs, the glass is precut and mounted in frames at a factory or a contractor's shop. It arrives at the jobsite ready for glaziers to position and secure it in place. They may use a crane or hoist with suction cups to lift large, heavy pieces of glass. They then gently guide the glass into position by hand.

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Once glaziers have the glass in place, they secure it with mastic, putty, or other paste-like cement, or with bolts, rubber gaskets, glazing compound, metal clips, or metal or wood moldings. When they secure glass using a rubber gasket—a thick, molded rubber half-tube with a split running its length—they first secure the gasket around the perimeter within the opening, then set the glass into the split side of the gasket, causing it to clamp to the edges and hold the glass firmly in place.

When they use metal clips and wood moldings, glaziers first secure the molding to the opening, place the glass in the molding, and then force springlike metal clips between the glass and the molding. The clips exert pressure and keep the glass firmly in place.

When a glazing compound is used, glaziers first spread it neatly against and around the edges of the molding on the inside of the opening. Next, they install the glass. Pressing it against the compound on the inside molding, workers screw or nail outside molding that loosely holds the glass in place. To hold it firmly, they pack the space between the molding and the glass with glazing compound and then trim any excess material with a glazing knife.

For some jobs, the glazier must cut the glass manually at the jobsite. To prepare the glass for cutting, glaziers rest it either on edge on a rack, or "A-frame," or flat against a cutting table. They then measure and mark the glass for the cut.

Glaziers cut glass with a special tool that has a small, very hard metal wheel. Using a straightedge as a guide, the glazier presses the cutter's wheel firmly on the glass, guiding and rolling it carefully to make a score just below the surface. To help the cutting tool move smoothly across the glass, workers brush a thin layer of oil along the line of the intended cut or dip the cutting tool in oil. Immediately after cutting, the glazier presses on the shorter end of the glass to break it cleanly along the cut.

In addition to handtools such as glasscutters, suction cups, and glazing knives, glaziers use power tools such as saws, drills, cutters, and grinders. An increasing number of glaziers use computers in the shop or at the jobsite to improve their layout work and reduce the amount of wasted glass.

Work environment. Glaziers often work outdoors, sometimes in inclement weather. They typically work with sharp tools and are often around broken glass. As a result, the rate of nonfatal injuries and illnesses for glaziers is among the highest of any occupation. For these reasons, constant attention to safety is crucial in this occupation.

Glaziers' work is quite physical, and so they must be prepared to lift heavy glass panels and work on scaffolding, sometimes at great heights. In addition, glaziers do a considerable amount of bending, kneeling, lifting, and standing during the installation process.

Most glaziers work a standard 40 hour workweek. During construction boom times, however, they may be required to work 50 or even 60 hours per week.

Training, Other Qualifications, and Advancement

Glaziers generally learn their trade by helping experienced workers, sometimes with supplemental classroom training. A few formal apprenticeship programs are available.

Education and training. Glaziers learn their trade through formal and informal training programs. Usually 3 years of classroom and on-the-job training are required to become a skilled glazier. There are a number of different avenues that one can take to obtain the necessary training. Most glaziers start by obtaining a job with a contractor who then provides on-the-job training. Entry-level workers generally start as helpers, assisting more experienced workers. During this time, employers may send the employee to a trade or vocational school or community college to receive further classroom training.

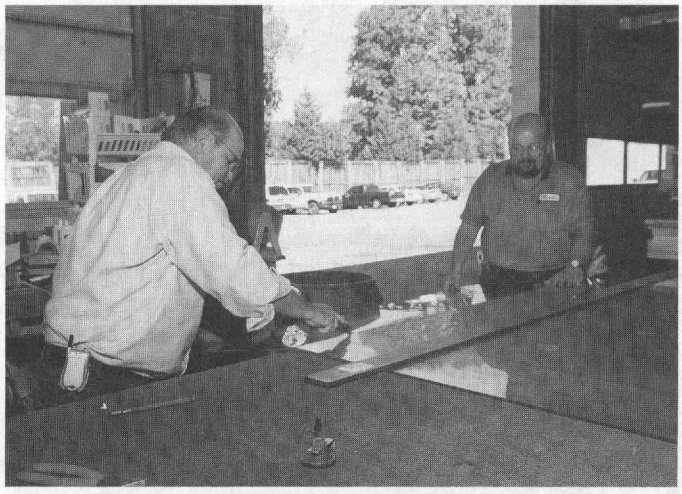
Some employers offer formal apprenticeships. These programs combine paid on-the-job training with related classroom instruction. Apprenticeship applicants usually must be at least 18 years old and meet local requirements. The length of the program is usually 3 years but varies with the apprentice's skill. Because the number of apprenticeship programs is limited, however, only a small proportion of glaziers learn their trade through these programs.

On the job, apprentices or helpers often start by carrying glass and cleaning up debris in glass shops. They often practice cutting on discarded glass. Later, they are given an opportunity to cut glass for a job and assist experienced workers on simple installation jobs. By working with experienced glaziers, they eventually acquire the skills of a fully qualified glazier. On the job, they learn to use the tools and equipment of the trade; handle, measure, cut, and install glass and metal framing; cut and fit moldings; and install and balance glass doors. In the classroom, they are taught about glass and installation techniques as well as basic mathematics, blueprint reading and sketching, general construction techniques, safety practices, and first aid.

Manufacturers have often worked with unions to ensure that workers know everything they need to know in order to install manufacturers' products safely and properly. In line with the architectural push for green construction, trade associations, unions, and partnerships between the two are now offering training to construction workers on the latest energy efficient products and green building techniques.

Licensure. Only the State of Connecticut currently requires glaziers to have a license. In addition to passing a test, workers need education, experience, and an apprenticeship to be licensed. There is a voluntary license in Florida. Other States may require licenses in the future.

Other qualifications. Skills needed to become a glazier include manual dexterity, good eye-hand coordination, physical



Glaziers cut class to lengths specified by the customer.

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fitness, and a good sense of balance. The ability to solve arithmetic problems quickly and accurately also is required. In addition, a good work history or military service is viewed favorably by employers.

Certification and advancement. Glaziers who learn the trade through a formal registered apprenticeship program become certified journeyworkers. Some associations offer other certifications. The National Glass Association, for example, offers a series of written examinations that certify an individual's competency to perform glazier work at three progressively difficult levels of proficiency: Level I Glazier; Level II Commercial Interior or Residential Glazier, or Storefront or Curtainwall Glazier; and Level III Master Glazier.

Advancement for glaziers generally consists of increases in pay; some advance to glazier supervisors, general construction supervisors, independent contractors, or cost estimators. For those who would like to advance, it is increasingly important to be able to communicate in both English and Spanish to relay instructions and safety precautions to workers with limited understanding of English, because Spanish-speaking workers make up a large part of the construction workforce in many areas. Supervisors and contractors need good communication skills to deal with clients and subcontractors and should be able to identify and estimate the quantity of materials needed to complete a job and accurately estimate how long a job will take to complete and at what cost.

Employment

Glaziers held 54,100 jobs in 2008. About 61 percent of glaziers worked for foundation, structure, and building exterior contractors. About 14 percent of glaziers worked in building material and supplies dealers that install or replace glass. A small amount—about 7 percent—were self-employed.

Job Outlook

Average employment growth is projected. Good job opportunities are expected, especially for those with a range of skills.

Employment change. Employment is expected to grow 8 percent from 2008-2018, about as fast as average for all occupations. Job growth will stem from increasing demand for new commercial construction emphasizing glass exteriors. As manufacturers of glass products continue to improve the energy efficiency of glass windows, architects are designing more buildings with glass exteriors, especially in the South. In addition, the continuing need to modernize and repair existing structures, including residences, often involves installing new windows. Demand for specialized safety glass and glass coated with protective laminates is also growing, in response to a higher need for security and the need to withstand hurricanes, particularly in many commercial and government buildings.

Counteracting these factors, however, is the ability of other workers, such as carpenters to install windows of simple design and low cost, which reduces employment growth for glaziers.

Job prospects. In addition to growth, job openings will arise from the need to replace glaziers who leave the occupation, resulting in good job opportunities. Since employers prefer workers who can do a variety of tasks, glaziers with a range of skills will have the best opportunities.

Like other construction trades workers, glaziers employed in the construction industry should expect to experience periods of unemployment, because of the limited duration of construction projects and the cyclical nature of the construction industry. During downturns in the economy, job openings for glaziers are reduced, as the level of construction declines. However, construction activity varies from area to area, so job openings fluctuate with local economic conditions. Employment opportunities should be greatest in metropolitan areas, where most glazing contractors and glass shops are located.

Earnings

In May 2008, median hourly wages of wage and salary glaziers were $17.11. The middle 50 percent earned between $13.37 and $22.66. The lowest 10 percent earned less than $10.65, and the highest 10 percent earned more than $30.47. Median hourly wages in the foundation, structure, and building exterior contractors industry were $17.79. Median hourly wages for glaziers employed by building materials and supply dealers, where most glass shops are found, were $14.90.

Glaziers covered by union contracts generally earn more than their nonunion counterparts. Apprentice wage rates usually start at 40 to 50 percent of the rate paid to experienced glaziers and increase as workers gain experience. Because glaziers can lose work time because of weather conditions and fluctuations in construction activity, their overall earnings may be lower than their hourly wages suggest.

Related Occupations

Glaziers use their knowledge of construction materials and techniques to install glass. Other construction workers whose jobs also involve skilled, custom work include:

	Page
Brickmasons, blockmasons, and stonemasons	615
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Painters and paperhangers	656
Sheet metal workers	665

Other workers who repair and install automobile glass are:

Automotive body and related repairers	687

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Glaziers	47-2121	54,100	58,300	4,200	8

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Sources of Additional Information

For more information about glazier apprenticeships or work opportunities, contact local glazing or general contractors, a local of the International Union of Painters and Allied Trades, a local joint union-management apprenticeship agency, or the nearest office of the State employment service or State apprenticeship agency. You can also find information on the registered apprenticeships together with links to State apprenticeship programs on the U.S. Department of Labor Web site: **http://www.doleta.gov/atels_bat.** Apprenticeship information is also available from the U.S. Department of Labor toll-free helpline: 1 (877) 872-5627.

For general information about the work of glaziers, contact:

➤ International Union of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: **http://www.iupat.org**

For information concerning training for glaziers, contact:

➤ Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Finishing Trades Institute, 7230 Parkway Dr., Hanover, MD 21076-1307. Internet: **http://www.finishingtradesinstitute.org**

➤ National Glass Association, Education and Training Department, 8200 Greensboro Dr., Suite 302, McLean, VA 22102-3881. Internet: **http://www.glass.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos207.htm**

Hazardous Materials Removal Workers

Significant Points

- Formal education beyond high school is not required, but government standards require specific types of on-the-job training.
- Good job opportunities are expected, mainly due to the need to replace workers who leave the occupation.
- Working conditions can be hazardous.

Nature of the Work

Hazardous materials removal workers identify, remove, package, transport, and dispose of asbestos, radioactive and nuclear waste, arsenic, lead, and mercury—or any materials that typically possess at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity. These workers often respond to emergencies where harmful substances are present, and are sometimes called abatement, remediation, or decontamination specialists. Increased public awareness and Federal and State regulations are resulting in the removal of hazardous materials from buildings, facilities, and the environment to prevent contamination of natural resources and to promote public health and safety.

Hazardous materials removal workers use a variety of tools and equipment, depending on the work at hand. Equipment ranges from brooms to personal protective suits that completely isolate workers from the hazardous material. Because of the threat of contamination, workers often wear disposable or reusable coveralls, gloves, hardhats, shoe covers, safety glasses or goggles, chemical-resistant clothing, face shields, and devices to protect one's hearing. Most workers are also required to wear respirators while working, to protect them from airborne particles or noxious gases. The respirators range from simple versions that cover only the mouth and nose to self-contained suits with their own air supply. Recent improvements to respiratory equipment allows for greater comfort, enabling workers to wear the equipment for a longer period of time.

Asbestos and lead are two of the most common contaminants that hazardous materials removal workers encounter. Through the 1970s, asbestos was used to fireproof roofing and flooring, for heat insulation, and for a variety of other purposes. It was durable, fire retardant, corrosion resistant, and insulated well, making it ideal for such applications. Embedded in materials, asbestos is fairly harmless; airborne as a particulate, however, can cause several deadly lung diseases, including lung cancer and asbestosis. Today, asbestos is rarely used in buildings, but there are still structures that contain this material that must be remediated. Similarly, lead was a common building element found in paint and plumbing fixtures and pipes until the late 1970s. Because lead is easily absorbed into the bloodstream, often from breathing lead dust or from eating chips of paint containing lead, it can cause serious health risks, especially in children. Due to these risks, it has become necessary to remove lead-based products from buildings and structures.

Asbestos abatement workers and *lead abatement workers* remove asbestos, lead, and other materials from buildings scheduled to be renovated or demolished. Using a variety of hand and power tools, such as vacuums and scrapers, these workers remove the asbestos and lead from surfaces. A typical residential lead abatement project involves the use of a chemical to strip the lead-based paint from the walls of the home. Lead abatement workers apply the compound with a putty knife and allow it to dry. Then they scrape the hazardous material into an impregnable container for transport and storage. They also use sandblasters and high-pressure water sprayers to remove lead from larger structures. The vacuums utilized by asbestos abatement workers have special, highly efficient filters designed to trap the asbestos, which later is disposed of or stored. During the abatement, special monitors measure the amount of asbestos and lead in the air, to protect the workers; in addition, lead abatement workers wear a personal air monitor that indicates the amount of lead to which a worker has been exposed. Workers also use monitoring devices to identify the

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asbestos, lead, and other materials that need to be removed from the surfaces of walls and structures.

Transportation of hazardous materials is safer today than it was in the past, but accidents still occur. *Emergency and disaster response workers* clean up hazardous materials after train derailments and trucking accidents. These workers also are needed when an immediate cleanup is required, as would be the case after an attack by biological or chemical weapons.

Some hazardous materials removal workers specialize in radioactive substances. These substances range from low-level-contaminated protective clothing, tools, filters, and medical equipment, to highly radioactive nuclear reactor fuels. *Decontamination technicians* perform duties similar to those of janitors and cleaners, but the items and areas they clean are radioactive. They use brooms, mops, and other tools to clean exposed areas and remove exposed items for decontamination or disposal. Some of these jobs are now being done by robots controlled by people away from the contamination site. Increasingly, many of these remote devices are being used to automatically monitor and survey surfaces, such as floors and walls, for contamination.

With experience, decontamination technicians can advance to *radiation-protection technician* jobs and use radiation survey meters and other remote devices to locate and assess radiated materials, operate high-pressure cleaning equipment for decontamination, and package radioactive materials for transportation or disposal.



Some hazardous materials removal workers specialize in radioactive substances.

Decommissioning and decontamination workers remove and treat radioactive materials generated by nuclear facilities and power plants. With a variety of handtools, they break down contaminated items such as "gloveboxes," which are used to process radioactive materials. At decommissioning sites, the workers clean and decontaminate the facility, as well as remove any radioactive or contaminated materials.

Treatment, storage, and disposal workers transport and prepare materials for treatment or disposal. To ensure proper treatment of materials, laws enforced by the U.S. Environmental Protection Agency (EPA) or Occupational Safety and Health Administration (OSHA) require these workers to be able to verify shipping manifests. At incinerator facilities, treatment, storage, and disposal workers transport materials from the customer or service center to the incinerator. At landfills, they follow a strict procedure for the processing and storage of hazardous materials. They organize and track the location of items in the landfill and may help change the state of a material from liquid to solid in preparation for its storage. These workers typically operate heavy machinery, such as forklifts, earthmoving machinery, and large trucks and rigs.

To help clean up the Nation's hazardous waste sites, a Federal program, called Superfund, was created in 1980. Under the Superfund program, abandoned, accidentally spilled, or illegally dumped hazardous waste that poses a current or future threat to human health or the environment is cleaned up. In doing so, the EPA along with potentially responsible parties, communities, local, State, and Federal authorities, identify hazardous waste sites, test site conditions, devise cleanup plans, and clean up the sites.

Mold remediation is a new aspect of some hazardous materials removal work. Some types of mold can cause harsh allergic reactions, especially in people who are susceptible to them. Although mold is present in almost all structures and is not usually defined as a hazardous material, some mold—especially the types that cause allergic reactions—can infest a building to such a degree that extensive efforts must be taken to remove it safely. Molds are fungi that typically grow in warm, damp conditions both indoors and outdoors year round. They can be found in heating and air-conditioning ducts, within walls, and in showers, attics, and basements. Although mold remediation is often undertaken by other construction workers, large scale mold removal is usually handled by hazardous materials removal workers, who take special precautions to protect themselves and surrounding areas from being contaminated.

Hazardous materials removal workers may also be required to construct scaffolding or erect containment areas prior to abatement or decontamination. In most cases, government regulation dictates that hazardous materials removal workers be closely supervised on the worksite. The standard usually is 1 supervisor to every 10 workers. The work is highly structured, sometimes planned years in advance, and usually team oriented. There is a great deal of cooperation among supervisors and workers. Because of the hazard presented by the materials being removed, work areas are restricted to licensed hazardous materials removal workers, thus minimizing exposure to the public.

Work environment. Hazardous materials removal workers function in a highly structured environment to minimize the danger they face. Each phase of an operation is planned in advance,

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and workers are trained to deal with hazardous situations. Crews and supervisors take every safety measure to ensure that the worksite is safe. Whether they work with asbestos, mold, lead abatement, or in radioactive decontamination, hazardous materials removal workers must stand, stoop, and kneel for long periods. Some must wear fully enclosed personal protective suits for several hours at a time; these suits may be hot and uncomfortable and may cause some individuals to experience claustrophobia.

Hazardous materials removal workers face different working conditions, depending on their area of expertise. Although many work a standard 40-hour week, overtime and shift work are common, especially for emergency and disaster response workers. Asbestos and lead abatement workers usually work in structures such as office buildings, schools, or historic buildings under renovation. Because they are under pressure to complete their work within certain deadlines, workers may experience fatigue. Completing projects frequently requires night and weekend work, because hazardous materials removal workers often work around the schedules of others. Treatment, storage, and disposal workers are employed primarily at facilities such as landfills, incinerators, boilers, and industrial furnaces. These facilities often are located in remote areas, due to the kinds of work being done, so workers may have to commute long distances to their jobs.

Decommissioning and decontamination workers, decontamination technicians, and radiation protection technicians work at nuclear facilities and electric power plants. Like treatment, storage, and disposal facilities, these sites are often far from urban areas. Workers who perform jobs in cramped conditions may need to use sharp tools to dismantle contaminated objects. A hazardous materials removal worker must have great self-control and a level head to cope with the daily stress associated with handling hazardous materials.

Hazardous materials removal workers may be required to travel outside their normal working areas in order to respond to emergency cleanups, which sometimes take several days or weeks to complete. During the cleanup, workers may be away from home for the entire time.

Training, Other Qualifications, and Advancement

No formal education beyond a high school diploma is required for a person to become a hazardous materials removal worker. However, Federal, State, and local government standards require specific types of on-the-job training. Regulations vary by specialty and sometimes by State or locality. Employers are responsible for employee training.

Education and training. Hazardous materials removal workers usually need at least 40 hours of formal on-the-job training. For most specialties, this training must meet specific requirements set by the Federal Government or individual States.

Licensure. Workers who treat asbestos and lead, the most common contaminants, must complete a training program through their employer that meets Occupational Safety and Health Administration (OSHA) standards. Employer-sponsored training is usually performed in-house, and the employer is responsible for covering all technical and safety subjects outlined by OSHA.

To become an emergency and disaster response worker and treatment, storage, and disposal worker, candidates must obtain a Federal license as mandated by OSHA. Employers are responsible for ensuring that employees complete a formal 40-hour training program, given either in house or in OSHA-approved training centers. The program covers health hazards, personal protective equipment and clothing, site safety, recognition and identification of hazards, and decontamination.

In some cases, workers may discover one hazardous material while abating another. If workers are not licensed to handle the newly discovered material, they cannot continue to work with it. Many experienced workers opt to take courses in additional types of hazardous material removal to avoid this situation.

Mold removal is not regulated by OSHA, but is regulated by each State. For decommissioning and decontamination workers employed at nuclear facilities, training is most extensive. In addition to obtaining licensure through the standard 40-hour training course in hazardous waste removal, workers must take courses dealing with regulations governing nuclear materials and radiation safety as mandated by the Nuclear Regulatory Commission. These courses add up to approximately 3 months of training, although most are not taken consecutively. Many agencies, organizations, and companies throughout the country provide training programs that are approved by the U.S. Environmental Protection Agency, the U.S. Department of Energy, and other regulatory bodies. To maintain their license, workers in all fields are required to take continuing education courses as a refresher, every year.

Other qualifications. Workers must be able to perform basic mathematical conversions and calculations when mixing solutions that neutralize contaminants and should have good physical strength and manual dexterity. Because of the nature of the work and the time constraints sometimes involved, employers prefer people who are dependable, prompt, and detail-oriented. Since much of the work is done in buildings, a background in construction is helpful.

Employment

Hazardous materials removal workers held about 42,500 jobs in 2008. About 79 percent were employed in waste management and remediation services. Another 5 percent were employed in construction.

Job Outlook

Employment is expected to grow faster than average. Good job opportunities are expected because of the need to replace the large number of workers who leave the occupation each year.

Employment change. Employment of hazardous materials removal workers is expected to grow 15 percent between 2008 and 2018, faster than the average for all occupations. The need for decontamination technicians, radiation safety technicians, and decommissioning workers, in response to increased pressure for cleaner electric generation facilities, is expected to drive employment growth. Furthermore, renewed interest in nuclear power production could lead to the reactivation of additional facilities, resulting in the need for many new remediation workers.

Numerous Superfund projects will require cleanup of hazardous materials waste sites, also spurring demand for hazardous materials removal workers. However, employment growth will largely be determined by Federal funding.

Since the 1970s, asbestos and lead-based paints and plumbing fixtures and pipes have not been used and much of the re-

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Hazardous materials removal workers	47-4041	42,500	48,800	6,300	15

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

mediation stemming from those products has taken place. With the continuing decline in the number of structures that contain asbestos and lead, demand for asbestos and lead abatement workers will be somewhat limited. Some demand, however, will result from the need to abate lead and asbestos from Federal and historic buildings.

Job prospects. In addition to job openings from employment growth, many openings are expected for hazardous materials removal workers because of the need to replace workers who leave the occupation, leading to good opportunities. Job opportunities for radiation safety technicians and decontamination workers should be plentiful as a number of new workers will be needed to replace those who retire or leave the occupation for other reasons. Additional openings may result for remediation workers if nuclear power is more widely adopted in the next decade.

Lead and asbestos workers will have some opportunities at specialty remediation companies as restoration of Federal buildings and historic structures continues, although at a slower pace than in the past. The best employment opportunities for mold remediation workers will be in Southeast, and parts of the Northeast and Northwest, where mold tends to thrive.

Many of these workers are not greatly affected by economic fluctuations because the facilities in which they work must operate, regardless of the state of the economy.

Earnings

Median hourly wages of hazardous materials removal workers were $17.94 in May 2008. The middle 50 percent earned between $14.09 and $24.09 per hour. The lowest 10 percent earned less than $11.41 per hour, and the highest 10 percent earned more than $30.42 per hour. Median hourly wages in remediation and other waste management services, the largest industry employing hazardous materials removal workers, were $18.10.

Related Occupations

Workers who perform similar tasks to those of hazardous materials removal workers include:

	Page
Insulation workers	653
Painters and paperhangers	656
Power plant operators, distributors, and dispatchers	760
Sheet metal workers	665
Water and liquid waste treatment plant and system operators	765

Other workers who commonly respond to emergencies involving hazardous materials include:

Fire fighters	470
Police and detectives	473

Sources of Additional Information

For more information on hazardous materials removal workers in the construction industry, including information on training, contact:

➤ Laborers-AGC Education and Training Fund, 37 Deerfield Rd., Pomfret, CT 06259.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos256.htm**

Insulation Workers

Significant Points

- Workers must follow strict safety guidelines to protect themselves from insulating irritants.
- Most insulation workers learn their work informally on the job; mechanical insulators usually complete formal apprenticeship programs.
- Job opportunities are expected to be excellent.

Nature of the Work

Properly insulated buildings reduce energy consumption by keeping heat in during the winter and out in the summer. Vats, tanks, vessels, boilers, steam and hot-water pipes, and refrigerated storage rooms also are insulated to prevent the wasteful loss of heat or cold and to prevent burns. Insulation also helps to reduce the noise that passes through walls and ceilings. Insulation workers install the materials used to insulate buildings and mechanical equipment.

Insulation workers, mechanical, apply insulating materials to pipes and ductwork, or other mechanical systems, in order to help control and maintain temperature. When covering a steam pipe, for example, these insulation workers measure and cut sections of insulation to the proper length, stretch it open along a cut that runs the length of the material, and slip it over the pipe. They then fasten the insulation with adhesive, staples, tape, or wire bands. Sometimes, they wrap a cover of aluminum, plastic, or canvas over the insulation and cement or band the cover in place. Finally, mechanical insulation workers may screw on metal around insulated pipes to protect the insulation from the weather or physical abuse.

Insulation workers, floor, ceiling, and wall, apply or blow in insulation in attics and exterior walls. When blowing-in loose-fill insulation, a helper feeds a machine with fiberglass, cellulose, or rock-wool insulation, while another worker blows the insulation with a compressor hose into the space being filled.

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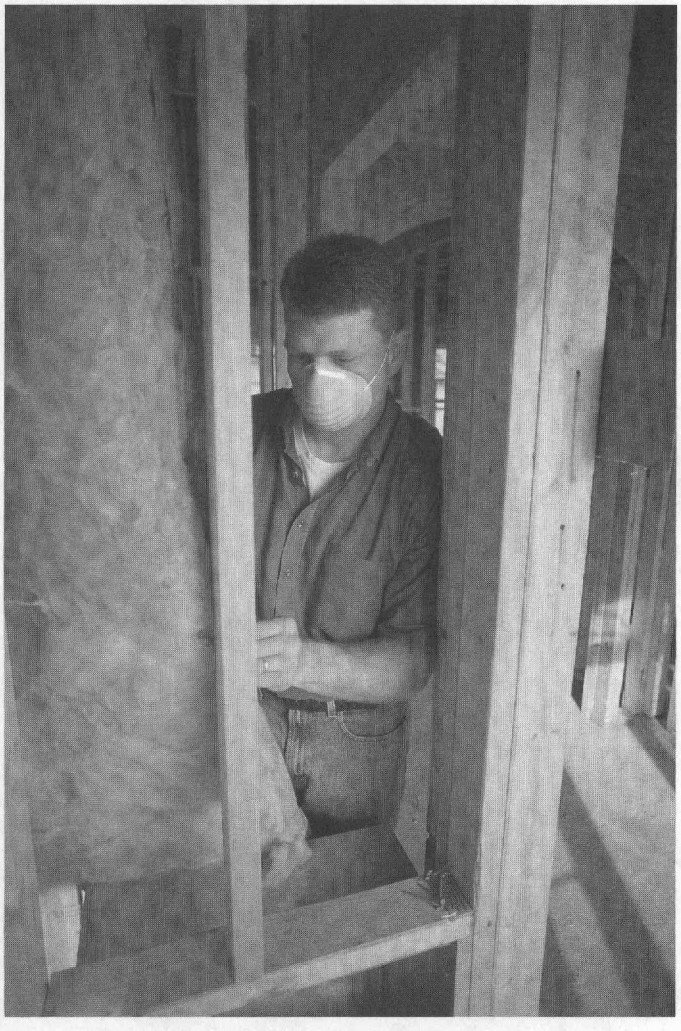
When covering a wall or other flat surface, these insulation workers may use a hose to spray foam insulation onto a wire mesh that provides a rough surface to which the foam can cling and that adds strength to the finished surface. Workers may then install drywall or apply a final coat of plaster for a finished appearance. In new construction or on major renovations, insulation workers staple fiberglass or rock-wool batts to exterior walls and ceilings before drywall, paneling, or plaster walls are put in place.

In making major renovations to old buildings or when putting new insulation around pipes and industrial machinery, insulation workers often must first remove the old insulation. In the past, asbestos—now known to cause cancer in humans—was used extensively in walls and ceilings and to cover pipes, boilers, and various industrial equipment. Because of this danger, U.S. Environmental Protection Agency regulations require that asbestos be removed before a building undergoes major renovations or is demolished. When asbestos is present, specially trained workers must remove it before insulation workers can install the new insulating materials. (See the statement on hazardous materials removal workers elsewhere in the *Handbook*.)

Insulation workers use common handtools, including trowels, brushes, knives, scissors, saws, pliers, and stapling guns. They may use power saws to cut insulating materials, welding machines to join metal or secure clamps, and compressors to blow or spray insulation.



Insulation workers should have excellent job opportunities.

Work environment. Insulation workers generally work indoors in residential and industrial settings. They spend most of the workday on their feet, either standing, bending, or kneeling. They also work from ladders or in confined spaces. Their work usually requires more coordination than strength. In industrial settings, these workers often insulate pipes and vessels at temperatures that may cause burns. Minute particles from insulation materials, especially when blown, can irritate the eyes, skin, and respiratory system.

Insulation workers who install insulation on floors, ceilings, and walls experience a high rate of injuries and illnesses. Consequently, workers must follow strict safety guidelines to protect themselves from insulating irritants. They must keep work areas well ventilated; wear protective suits, masks, and respirators; and take decontamination showers when necessary. Most insulation is applied after buildings are enclosed, so weather conditions have less effect on the employment of insulation workers than some other construction workers.

Training, Other Qualifications, and Advancement

Most insulation workers learn their trade informally on the job, although most mechanical insulators complete formal apprenticeship programs.

Education and training. Employers prefer to hire high school graduates. High school courses in blueprint reading, shop mathematics, science, pattern layout, woodworking, and general construction provide a helpful background.

Most new workers receive instruction and supervision from experienced insulation workers. Trainees begin with simple tasks, such as carrying insulation or holding material while it is fastened in place. On-the-job training can take up to 4 years. Learning to install insulation in homes generally requires less training than does learning to apply insulation in commercial and industrial settings. As they gain experience, trainees receive less supervision, more responsibility, and higher pay.

Trainees in formal apprenticeship programs receive in-depth instruction in all phases of insulation. Apprenticeships are generally offered by contractors that install and maintain mechanical industrial insulation. Apprenticeship programs may be provided by a joint committee of local insulation contractors and the local union of the International Association of Heat and Frost Insulators and Allied Workers, to which some insulation workers belong. Programs normally consist of 4 or 5 years of on-the-job training coupled with classroom instruction, and apprentices must pass practical and written tests to demonstrate their knowledge of the trade.

Licensure. The Environmental Protection Agency offers mandatory certification for insulation workers who remove and handle asbestos.

Other qualifications. For entry-level jobs, insulation contractors prefer to hire workers who are in good physical condition and licensed to drive. Applicants seeking apprenticeship positions are advised to have a high school diploma or its equivalent and be at least 18 years old. Supervisors and contractors, especially, need good communication skills to deal with clients and subcontractors.

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Certification and advancement. Voluntary certification programs have been developed by insulation contractor organizations to help workers prove their skills and knowledge of residential and industrial insulation. The National Insulation Association also offers a certification in performing an energy appraisal to determine if and how insulation can benefit industrial customers.

Skilled insulation workers may advance to supervisor, shop superintendent, or insulation contract estimator, or they may set up their own insulation business.

For those who would like to advance, it is increasingly important to be able to relay instructions and safety precautions to workers in both English and Spanish because Spanish-speaking workers make up a large part of the construction workforce in many areas.

Employment

Insulation workers held about 57,300 jobs in 2008. About 92 percent were employed in the construction industry, with 50 percent working for drywall and insulation contractors. In less populated areas, plumbers and pipefitters, carpenters, heating and air-conditioning installers, or drywall installers may do insulation work.

Job Outlook

Insulation workers should have excellent opportunities due to faster than average job growth, coupled with the need to replace many workers who leave this occupation.

Employment change. Employment of insulation workers is expected to increase 17 percent during the 2008-18 decade, faster than the average for all occupations. Demand for insulation workers will be spurred by the need to make existing buildings more energy efficient, as well as to the anticipated construction of new power plants—a big user of piping and equipment. Modest increases in the housing stock over the decade will also generate jobs for insulation workers.

Job prospects. Job opportunities for insulation workers are expected to be excellent. In addition to opportunities created by growth, job openings will arise from the need to replace workers who retire or leave the labor force for other reasons. The irritating nature of many insulation materials, combined with the often difficult working conditions, causes many insulation workers to leave the occupation each year.

Insulation workers in the construction industry may experience periods of unemployment because of the short duration of many construction projects and the cyclical nature of construction activity. However, as the occupation focuses more and more on weatherization, energy efficiency, and green house gas reduction, the occupation should become more protected against such cyclical ups and downs in construction overall. Workers employed to perform industrial plant maintenance generally have more stable employment because maintenance and repair must be done continually.

Earnings

In May 2008, median hourly wages of wage and salary insulation workers, floor, ceiling, and wall, were $15.34. The middle 50 percent earned between $12.04 and $19.64. The lowest 10 percent earned less than $9.61, and the highest 10 percent earned more than $26.53. Median hourly wages of insulation workers, mechanical, were $17.95. The middle 50 percent earned between $14.01 and $24.58. The lowest 10 percent earned less than $11.46, and the highest 10 percent earned more than $32.82. Median hourly wages in the industries employing the largest numbers of insulation workers were:

Insulation workers, mechanical	
Building equipment contractors	$17.87
Building finishing contractors	17.53
Insulation workers, floor, ceiling, and wall	
Building finishing contractors	15.11

Union workers tend to earn more than nonunion workers. Apprentices start at about one-half of the journey worker's wage. Insulation workers doing commercial and industrial work earn substantially more than those working in residential construction, which does not require as much skill.

Related Occupations

Insulation workers combine their knowledge of insulation materials with the skills of cutting, fitting, and installing materials. Workers in occupations involving similar skills include:

	Page
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638
Roofers	662
Sheet metal workers	665

Sources of Additional Information

For information about training programs or other work opportunities in this trade, contact a local insulation contractor, the nearest office of the State employment service or apprenticeship agency, or the following organizations:

➤ National Insulation Association, 12100 Sunset Hills Rd., Suite 330, Reston, VA 20190-3295. Internet: **http://www.insulation.org**

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Insulation workers	47-2130	57,300	67,300	9,900	17
Insulation workers, floor, ceiling, and wall	47-2131	27,600	31,700	4,200	15
Insulation workers, mechanical	47-2132	29,800	35,500	5,800	19

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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➤ International Association of Heat and Frost Insulators and Allied Workers, 9602 Martin Luther King, Jr. Highway, Lanham, MD 20706-1839. Internet: **http://www.insulators.org**

➤ North American Insulation Manufacturers' Association, 44 Canal Center Plaza, Suite 310, Alexandria, VA 22314-1548. Internet: **http://www.naima.org/pages/resources/training.html**

You can also find information on the registered apprenticeships together with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos208.htm**

Painters and Paperhangers

Significant Points

- Most workers learn informally on the job as helpers, but some experts recommend completion of an apprenticeship program.
- Employment prospects for painters should be excellent due to the large numbers of workers who leave the occupation for other jobs; paperhangers will face very limited opportunities.
- About 45 percent of painters and paperhangers are self-employed.

Nature of the Work

Paint and indoor wall coverings make surfaces clean, attractive, and vibrant. In addition, paints and other sealers protect exterior surfaces from erosion caused by exposure to the weather.

Painters apply paint, stain, varnish, and other finishes to buildings and other structures. They select the right paint or finish for the surface to be covered, taking into account durability, ease of handling, method of application, and customers' wishes. Painters first prepare the surfaces to be coated, so that the paint will adhere properly. This may require removing the old coat of paint by sanding, wire brushing, burning, or water and abrasive blasting. Painters also fill nail holes and cracks, sandpaper rough spots, and wash walls and trim to remove dirt, grease, and dust. On new surfaces, they apply a primer or sealer to prepare the surface for the top coat. Painters also mix paints and match colors, relying on knowledge of paint composition and color harmony. In most paint shops or hardware stores, mixing and matching are automated.

There are several ways to apply paint and similar coverings. Therefore, painters must be able to choose the appropriate paint applicator for each job, depending on the surface to be covered, the characteristics of the finish, and other factors. Some jobs need only a good bristle brush with a soft, tapered edge; others require a dip or fountain pressure roller; still, others are best done using a paint sprayer. Many jobs need several types of applicators. In fact, painters may use an assortment of brushes, edgers, and rollers for a single job. The right tools speed the painter's work and produce the most attractive finish.

Some painting artisans specialize in creating distinctive finishes by using one of many decorative techniques. These techniques frequently involve "broken color," a process created by applying one or more colors in broken layers over a different base coat to produce a speckled or textured effect. Often these techniques employ glazes or washes applied over a solid colored background. Glazes are made of oil-based paints and give a sleek glow to walls. Washes are made of latex-based paints that have been thinned with water which adds a greater sense of depth and texture. Other decorative painting techniques include sponging, rag-rolling, stippling, sheen striping, dragging, distressing, color blocking, marbling, and faux finishes.

Some painters specialize in painting industrial structures to prevent deterioration. One example is applying a protective coating to oil rigs or steel bridges to fight corrosion. The coating most commonly used is a waterborne acrylic solvent that is easy to apply and environmentally friendly, but other specialized and sometimes difficult-to-apply coatings may be used. Painters may also coat interior and exterior manufacturing facilities and equipment such as storage tanks, plant buildings, lockers, piping, structural steel, and ships.

When painting any industrial structure, workers must take necessary safety precautions depending on their project. Those who specialize in interior applications such as painting the inside of storage tanks, for example, must wear a full-body protective suit. When working on bridges, painters are often suspended by cables and may work at extreme heights. When working on tall buildings, painters erect scaffolding, including "swing stages," scaffolds suspended by ropes, or cables attached to roof hooks. When painting steeples and other pointed structures, they use a bosun's chair, a swing-like device.

Paperhangers cover walls with decorative coverings made of paper, vinyl, or fabric. They first prepare the surface to be covered by applying a compound, which seals the surface and makes the covering adhere better. When redecorating, they may first remove the old covering by soaking, steaming, or applying solvents. When necessary, they patch holes and take care of other imperfections before hanging the new wall covering.

After preparing the surface, paperhangers mix the adhesive unless they are using pretreated paper. They then measure the area to be covered, check the covering for flaws, cut the covering into strips of the proper size, and closely examine the pattern in order to match it when the strips are hung. A great deal of this process can now be handled by specialized equipment.

The next step is to brush or roll the adhesive onto the back of the covering, if needed, and to then place the strips on the

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wall, making sure the pattern is matched, the strips are straight, and the edges are butted together to make tight, closed seams. Finally, paperhangers smooth the strips to remove bubbles and wrinkles, trim the top and bottom with a utility knife, and wipe off any excess adhesive.

Work environment. Most painters and paperhangers work 40 hours a week or less; about 25 percent have variable schedules or work part time. Painters and paperhangers must stand for long periods, often working from scaffolding and ladders. Their jobs also require a considerable amount of climbing, bending, kneeling, and stretching. These workers must have good stamina because much of the work is done with their arms raised overhead. Painters, especially industrial painters, often work outdoors, almost always in dry, warm weather. Those who paint bridges or building infrastructure may be exposed to extreme heights and uncomfortable positions; some painters work suspended with ropes or cables.

Some painting jobs can leave a worker covered with paint. Drywall dust created by electric sanders prior to painting requires workers to wear protective safety glasses and a dust mask. Painters and paperhangers occasionally work with materials that are hazardous or toxic, such as when they are required to remove lead-based paints. In the most dangerous situations, painters work in a sealed self-contained suit to prevent inhalation of or contact with hazardous materials. Data from the U.S. Bureau of Labor Statistics show that full-time painters and paperhangers experienced a work-related injury and illness rate that was higher than the national average.



Painters and paperhangers must stand for long periods, often working from scaffolding and ladders.

Training, Other Qualifications, and Advancement

Painting and paperhanging is learned mostly on the job, but some experts recommend completion of an apprenticeship program.

Education and training. Most painters and paperhangers learn through on-the-job training and by working as a helper for an experienced painter. However, there are a number of formal and informal training programs that provide more thorough instruction and a better career foundation. In general, the more formal the training received, the more likely the individual will enter the profession at a higher level and earn a higher salary. There are limited informal training opportunities for paperhangers because there are fewer paperhangers and helpers are usually not required.

A high school education or its equivalent usually is required to enter an apprenticeship program. Apprenticeships for painters and paperhangers consist of 2 to 4 years of paid on-the-job training, supplemented by a minimum of 144 hours of related classroom instruction each year. Apprentices receive instruction in color harmony, use and care of tools and equipment, surface preparation, application techniques, paint mixing and matching, characteristics of different finishes, blueprint reading, wood finishing, and safety.

Besides apprenticeships, some workers gain skills by attending technical or vocational schools that offer training prior to employment. These schools can take about a year to complete.

Whether a painter learns the trade through a formal apprenticeship or informally as a helper, on-the-job instruction covers similar skill areas. Under the direction of experienced workers, trainees carry supplies, erect scaffolds, and do simple painting and surface preparation tasks while they learn about paint and painting equipment. As they gain experience, trainees learn to prepare surfaces for painting and paperhanging, to mix paints, and to apply paint and wall coverings efficiently and neatly. Near the end of their training, they may learn decorating concepts, color coordination, and cost-estimating techniques. In addition to learning craft skills, painters must become familiar with safety and health regulations so that their work complies with the law.

Other qualifications. Painters and paperhangers should have good manual dexterity, vision, and color sense. They also need physical stamina and balance to work on ladders and platforms. Apprentices or helpers generally must be at least 18 years old, in addition to the high school diploma or GED that most apprentices need.

Certification and advancement. Some organizations offer training and certification to enhance the skills of their members. People interested in industrial painting, for example, can earn several designations from the National Association of Corrosion Engineers in several areas of specialization, including one for coating applicators, called

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Protective Coating Specialist. Courses range from 1 day to several weeks depending on the certification program and specialty, and applicants must usually satisfy work experience requirements.

Painters and paperhangers may advance to supervisory or estimating jobs with painting and decorating contractors. Many establish their own painting and decorating businesses. For those who would like to advance, it is increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers with limited English skills; Spanish-speaking workers make up a large segment of the construction workforce in many areas. Painting contractors need good English skills to deal with clients and subcontractors.

Employment

Painters and paperhangers held about 450,100 jobs in 2008 of which 98 percent were painters. Around 36 percent of painters and paperhangers work for painting and wall covering contractors engaged in new construction, repair, restoration, or remodeling work. In addition, organizations that own or manage large buildings—such as apartment complexes—may employ painters, as do some schools, hospitals, factories, and government agencies.

Job Outlook

Overall employment is expected to grow 7 percent, reflecting as fast as average growth among painters but a rapid decline in the number of paperhangers. Excellent employment opportunities are expected for painters due to the need to replace the large number of workers who leave the occupation; paperhangers will have very limited opportunities.

Employment change. Overall employment is expected to grow by 7 percent between 2008 and 2018, about as fast as the average for all occupations. Employment of painters will grow 7 percent, as retiring baby boomers either purchase second homes or otherwise leave their existing homes that then require interior painting. Investors who sell properties or rent them out will also require the services of painters prior to completing a transaction. The relatively short life of exterior paints in residential homes as well as changing color and application trends will continue to support demand for painters. Painting is labor-intensive and not susceptible to technological changes that might make workers more productive and slow employment growth.

Growth of industrial painting will be driven by the need to prevent corrosion and deterioration of the many industrial structures by painting or coating them. Applying a protective coating to steel bridges, for example, is cost-effective and can add years to the life expectancy of a bridge.

Employment of paperhangers, on the other hand, should decline rapidly as many homeowners take advantage of easy application materials and resort to cheaper alternatives, such as painting.

Job prospects. Job prospects for painters should be excellent because of the need to replace workers who leave the occupation for other jobs. There are no strict training requirements for entry into these jobs, so many people with limited skills work as painters or helpers for a relatively short time and then move on to other types of work with higher pay or better working conditions.

Opportunities for industrial painters should be excellent as the positions available should be greater than the pool of qualified individuals to fill them. While industrial structures that require painting are located throughout the Nation, the best employment opportunities should be in the Gulf Coast region, where strong demand and the largest concentration of workers exists.

Very few openings will arise for paperhangers because the number of these jobs is comparatively small and cheaper, more modern decorative finishes such as faux effects and sponge painting have gained in popularity at the expense of paper, vinyl, or fabric wall coverings.

Jobseekers considering these occupations should expect some periods of unemployment, especially until they gain experience. Many construction projects are of short duration, and construction activity is cyclical in nature. Remodeling, restoration, and maintenance projects, however, should continue as homeowners undertake renovation projects and hire painters even in economic downturns. Nonetheless, workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, a shortage of these workers may occur in some areas during peak periods of building activity.

Earnings

In May 2008, median hourly wages of wage and salary painters, construction and maintenance, were $15.85, not including the earnings of the self-employed. The middle 50 percent earned between $13.13 and $20.55. The lowest 10 percent earned less than $10.75, and the highest 10 percent earned more than $27.16. Median hourly wages in the industries employing the largest numbers of painters were as follows:

Nonresidential building construction	$16.72
Building finishing contractors	15.48
Residential building construction	14.87

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Painters and paperhangers	47-2140	450,100	479,900	29,800	7
Painters, construction and maintenance	47-2141	442,800	473,600	30,900	7
Paperhangers	47-2142	7,400	6,300	-1,100	-14

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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In May 2008, median hourly wages for wage and salary paperhangers were $16.76. The middle 50 percent earned between $13.64 and $23.08. The lowest 10 percent earned less than $10.82, and the highest 10 percent earned more than $33.48.

Earnings for painters may be reduced on occasion because of bad weather and the short-term nature of many construction jobs. Hourly wage rates for apprentices usually start at 40 to 50 percent of the rate for experienced workers and increase periodically.

Some painters and paperhangers are members of the International Brotherhood of Painters and Allied Trades. Some painters are members of other unions.

Related Occupations

Painters and paperhangers apply various coverings to decorate and protect wood, drywall, metal, and other surfaces. Other construction workers who do finishing work include:

	Page
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638
Painting and coating workers, except construction and maintenance	778

Sources of Additional Information

For details about painting and paperhanging apprenticeships or work opportunities, contact local painting and decorating contractors, local trade organizations, a local of the International Union of Painters and Allied Trades, a local joint union-management apprenticeship committee, or an office of the State apprenticeship agency or employment service.

For information about the work of painters and paperhangers and training opportunities, contact:

➤ Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: **http://www.trytools.org**

➤ International Union of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: **http://www.iupat.org**

➤ National Center for Construction Education and Research, 3600 NW 43rd St., Bldg. G, Gainesville, FL 32606. Internet: **http://www.nccer.org**

➤ Painting and Decorating Contractors of America, 1801 Park 270 Dr., Suite 220, St. Louis, MO 63146. Internet: **http://www.pdca.org**

For general information about the work of industrial painters and opportunities for training and certification as a protective coating specialist, contact:

➤ National Association of Corrosion Engineers, 1440 South Creek Dr., Houston, TX 77084. Internet: **http://www.nace.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos209.htm**

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Plumbers, Pipelayers, Pipefitters, and Steamfitters

Significant Points

- Job opportunities should be very good.
- These workers constitute one of the largest and highest paid construction occupations.
- Most States and localities require plumbers to be licensed.
- Most workers train in apprenticeship programs and in career or technical schools or community colleges.

Nature of the Work

Most people are familiar with plumbers who come to their home to unclog a drain or fix a leaking toilet. Plumbers, pipelayers, pipefitters, and steamfitters install, maintain, and repair many different types of pipe systems. Some of these systems move water from reservoirs to municipal water treatment plants and then to residential, commercial, and public buildings. Other systems dispose of waste, supply gas to stoves and furnaces, or provide for heating and cooling needs. Pipe systems in powerplants carry the steam that powers huge turbines. Pipes also are used in manufacturing plants to move material through the production process. Specialized piping systems are very important in both pharmaceutical and computer-chip manufacturing.

Although plumbing, pipelaying, pipefitting, and steamfitting are sometimes considered a single trade, workers generally specialize in one of five areas. *Plumbers* install and repair the water, waste disposal, drainage, and gas systems in homes and commercial and industrial buildings. Plumbers also install plumbing fixtures—bathtubs, showers, sinks, and toilets—and appliances such as dishwashers, waste disposers, and water heaters. *Pipelayers* lay clay, concrete, plastic, or cast-iron pipe for drains, sewers, water mains, and oil or gas lines. Before laying the pipe, pipelayers prepare and grade the trenches either manually or with machines. After laying the pipe, they weld,



Pipelayers install pipe to be buried underground on huge construction projects.

glue, cement, or otherwise join the pieces together. *Pipefitters* install and repair both high-pressure and low-pressure pipe systems used in manufacturing, in the generation of electricity, and in the heating and cooling of buildings. They also install automatic controls that are increasingly being used to regulate these systems. *Steamfitters* install pipe systems that move liquids or gases under high pressure. *Sprinklerfitters* install automatic fire sprinkler systems in buildings. Plumbers, pipelayers, pipefitters, and steamfitters use many different materials and construction techniques, depending on the type of project. Residential water systems, for example, incorporate copper, steel, and plastic pipe that can be handled and installed by one or two plumbers. Municipal sewerage systems, by contrast, are made of large cast-iron pipes; installation normally requires crews of pipefitters. Despite these differences, all plumbers, pipelayers, pipefitters, and steamfitters must be able to follow building plans or blueprints and instructions from supervisors, lay out the job, and work efficiently with the materials and tools of their trade. When plumbers working construction install piping in a new house, they work from blueprints or drawings that show the planned location of pipes, plumbing fixtures, and appliances. Recently, plumbers have become more involved in the design process. Their knowledge of codes and the operation of plumbing systems can cut costs. First they lay out the job to fit the piping into the structure of the house with the least waste of material. Then they measure and mark areas in which pipes will be installed and connected. Construction plumbers also check for obstructions such as electrical wiring and, if necessary, plan the pipe installation around the problem.

Sometimes, plumbers have to cut holes in walls, ceilings, and floors of a house. With some systems, they may hang steel supports from ceiling joists to hold the pipe in place. To assemble a system, plumbers—using saws, pipe cutters, and pipe-bending machines—cut and bend lengths of pipe. They connect the lengths of pipe with fittings, using methods that depend on the type of pipe used. For plastic pipe, plumbers connect the sections and fittings with adhesives. For copper pipe, they slide a fitting over the end of the pipe and solder it in place with a torch.

After the piping is in place in the house, plumbers install the fixtures and appliances and connect the system to the outside water or sewer lines. Finally, using pressure gauges, they check the system to ensure that the plumbing works properly.

Work environment. Plumbers work in commercial and residential settings where water and septic systems need to be installed and maintained. Pipefitters and steamfitters most often work in industrial and power plants. Pipelayers work outdoors, sometimes in remote areas, laying pipes that connect sources of oil, gas, and chemicals with the users of these resources. Sprinklerfitters work in all buildings that require the use of fire sprinkler systems.

Because plumbers, pipelayers, pipefitters, and steamfitters frequently must lift heavy pipes, stand for long periods, and sometimes work in uncomfortable or cramped positions, they need physical strength and stamina. They also may have to work outdoors in inclement weather. In addition, they are subject to possible falls from ladders, cuts from sharp tools, and burns from hot pipes or soldering equipment. Consequently, this occupation experiences rates of nonfatal injuries and illnesses that are much higher than average.

Plumbers, pipelayers, pipefitters, and steamfitters often work more than 40 hours per week and can be on call for emergencies nights and weekends. Some pipelayers may need to travel to and from worksites.

Training, Other Qualifications, and Advancement

Most plumbers, pipelayers, pipefitters, and steamfitters train on the job through jointly administered apprenticeships and in career or technical schools or community colleges.

Education and training. Plumbers, pipelayers, pipefitters, and steamfitters enter into the occupation in a variety of ways. Most plumbers, pipefitters, and steamfitters get their training in jointly administered apprenticeships or in technical schools and community colleges. Pipelayers typically receive their training on the job.

Apprenticeship programs generally provide the most comprehensive training available for these jobs. Such programs are, for the most part, administered jointly by union locals and their affiliated companies or by nonunion contractor organizations. Organizations that sponsor apprenticeships include the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada; local employers of either the Mechanical Contractors Association of America or the National Association of Plumbing-Heating-Cooling Contractors; a union associated with a member of the National Fire Sprinkler Association; the Associated Builders and Contractors; the National Association of Plumbing-Heating-Cooling Contractors; the American Fire Sprinkler Association; and the Home Builders Institute of the National Association of Home Builders.

Apprenticeships—both union and nonunion—consist of 4 or 5 years of paid on-the-job training and at least 144 hours of related classroom instruction per year. Classroom subjects include drafting and blueprint reading, mathematics, applied physics and chemistry, safety, and local plumbing codes and regulations. On the job, apprentices first learn basic skills, such as identifying grades and types of pipe, using the tools of the trade, and unloading materials safely. As apprentices gain experience, they learn how to work with various types of pipe and how to install different piping systems and plumbing fixtures. Apprenticeship gives trainees a thorough knowledge of all aspects of the trade. Although most plumbers, pipefitters, and steamfitters are trained through apprenticeships, some still learn their skills informally on the job or by taking classes on their own.

Licensure. Although there are no uniform national licensing requirements, most States and communities require plumbers to be licensed. Licensing requirements vary, but most localities require workers to have 2 to 5 years of experience and to pass an examination that tests their knowledge of the trade and of local plumbing codes before they are permitted to work independently. Several States require a special license to work on gas lines. A few States require pipefitters to be licensed. Licenses usually require a test, experience, or both.

Other qualifications. Applicants for union or nonunion apprentice jobs must be at least 18 years old and in good physical condition. A drug test may be required. Apprenticeship committees may require applicants to have a high school diploma or its equivalent. For jointly administered apprenticeships approved

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by the U.S. Department of Labor, a high school diploma is mandatory, because these programs can earn credit from community colleges and, in some cases, from 4-year colleges. Armed Forces training in plumbing, pipefitting, and steamfitting is considered very good preparation. In fact, people with this background may be given credit for previous experience when they enroll in a civilian apprenticeship program. High school or postsecondary courses in shop, plumbing, general mathematics, drafting, blueprint reading, computers, and physics also are good preparation.

Certification and advancement. With additional training, some plumbers, pipefitters, and steamfitters become supervisors for mechanical and plumbing contractors. Others, especially plumbers, go into business for themselves, often starting as a self-employed plumber working from home. Some eventually become owners of businesses employing many workers and may spend most of their time as managers rather than as plumbers. Others move into closely related areas such as construction management or building inspection.

For those who would like to advance, it is becoming increasingly important to be able to communicate in both English and Spanish in order to relay instructions and safety precautions to workers with limited understanding of English; Spanish-speaking workers make up a large part of the construction workforce in many areas. Supervisors and contractors need good communication skills to deal with clients and subcontractors.

In line with new opportunities arising from the growing need to conserve water, the Plumbing-Heating-Cooling Contractors—National Association has formed a partnership with GreenPlumbers USA to train and certify plumbers across the Nation on water-saving technologies and energy efficiency. Attainment of this certification may help people trained in this area to get more jobs and advance more quickly.

Employment

Plumbers, pipelayers, pipefitters, and steamfitters constitute one of the largest construction occupations, holding about 555,900 jobs in 2008. About 56 percent worked for plumbing, heating, and air-conditioning contractors engaged in new construction, repair, modernization, or maintenance work. Others were employed by a variety of industrial, commercial, and government employers. Pipefitters, for example, were employed in the petroleum and chemical industries to maintain the pipes that carry industrial liquids and gases. About 12 percent of plumbers, pipelayers, pipefitters, and steamfitters were self-employed.

Job Outlook

Faster than average employment growth is projected. Job opportunities are expected to be very good.

Employment change. Employment of plumbers, pipelayers, pipefitters, and steamfitters is expected to grow 16 percent between 2008 and 2018, faster than the average for all occupations. Demand for plumbers will stem from new construction and from renovation of buildings. In addition, repair and maintenance of existing residential systems will keep plumbers employed. A growing emphasis on water conservation, particularly in dryer parts of the country, that will require retrofitting in order to conserve water in new ways will increase demand for plumbers. Demand for pipefitters and steamfitters will be driven by maintenance and construction of places such as powerplants, water and wastewater treatment plants, office buildings, and factories, all of which have extensive pipe systems. The stimulus package aimed at repairing the Nation's infrastructure should help the employment picture immediately; long-term growth of pipelayer jobs will stem from the building of new water and sewer lines and of pipelines to new oil and gas fields. Demand for sprinklerfitters also should also increase, because of proposed changes to construction codes, set to take effect in 2011, that will require the installation of fire sprinkler systems in residential buildings where these systems had previously never been required.

Job prospects. Job opportunities are expected to be very good, with demand for skilled plumbers, pipelayers, pipefitters, and steamfitters expected to outpace the supply of well-trained workers in this craft. Some employers report difficulty finding workers with the right qualifications. In addition, many people currently working in these trades are expected to retire over the next 10 years, which will create additional job openings. Workers with welding experience should have especially good opportunities.

Traditionally, many organizations with extensive pipe systems have employed their own plumbers or pipefitters to maintain equipment and keep systems running smoothly. But, to reduce labor costs, a large number of these firms no longer employ full-time, in-house plumbers or pipefitters. Instead, when they need a plumber, they increasingly are relying on workers provided under service contracts by plumbing and pipefitting contractors.

Construction projects generally provide only temporary employment. When a project ends, some plumbers, pipelayers, pipefitters, and steamfitters may be unemployed until they can begin work on a new project, although most companies are trying to limit these periods of unemployment in order to retain workers. In addition, the jobs of plumbers, pipelayers, pipefitters, and steamfitters are generally less sensitive to changes in economic conditions than are jobs in other construction trades. Moreover, the coming emphasis on conservation of energy and water is opening up opportunities for those

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Pipelayers, plumbers, pipefitters, and steamfitters	47-2150	555,900	642,100	86,300	16
Pipelayers	47-2151	61,200	71,700	10,500	17
Plumbers, pipefitters, and steamfitters	47-2152	494,700	570,500	75,800	15

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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plumbers, pipefitters, and steamfitters who become proficient in new green technologies.

Earnings

Plumbers, pipelayers, pipefitters, and steamfitters are among the highest paid workers in construction occupations. Median hourly wages of wage and salary plumbers, pipefitters, and steamfitters were $21.94 in May 2008. The middle 50 percent earned between $16.63 and $29.66. The lowest 10 percent earned less than $13.22, and the highest 10 percent earned more than $37.93. Median hourly wages in the industries employing the largest numbers of plumbers, pipefitters, and steamfitters were as follows:

Natural gas distribution	$26.27
Nonresidential building construction	23.14
Building equipment contractors	21.86
Utility system construction	21.15
Local government	20.65

In May 2008, median hourly wages of wage and salary pipelayers were $15.72. The middle 50 percent earned between $12.84 and $20.85. The lowest 10 percent earned less than $10.74, and the highest 10 percent earned more than $27.43.

Apprentices usually begin at about 50 percent of the wage rate paid to experienced workers. Wages increase periodically as skills improve. After an initial waiting period, apprentices receive the same benefits as experienced plumbers, pipelayers, pipefitters, and steamfitters.

About 31 percent of plumbers, pipelayers, pipefitters, and steamfitters belonged to a union. Many of these workers are members of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada.

Related Occupations

Other workers who install and repair mechanical systems in buildings include the following:

	Page
Boilermakers	613
Electricians	641
Elevator installers and repairers	644
Heating, air-conditioning, and refrigeration mechanics and installers	703
Industrial machinery mechanics and millwrights	709
Sheet metal workers	665
Stationary engineers and boiler operators	763

Other construction-related workers who need to know plumbing requirements include the following:

Construction and building inspectors	628
Construction managers	38

Sources of Additional Information

For information about apprenticeships or work opportunities in plumbing, pipelaying, pipefitting, and steamfitting, contact local plumbing, heating, and air-conditioning contractors; a local or State chapter of the Plumbing-Heating-Cooling Contractors; a local chapter of the Mechanical Contractors Association; a local chapter of the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada; or the nearest office of your State employment service or apprenticeship agency.

Apprenticeship information also is available from the U.S. Department of Labor's toll-free help line: (877) 872-5627.

For information about apprenticeship opportunities for plumbers, pipefitters, and steamfitters, contact:

➤ United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry, Three Park Place, Annapolis, MD 21401-3687. Internet: **http://www.ua.org**

For general information about the work of pipelayers, plumbers, and pipefitters, contact:

➤ Mechanical Contractors Association of America, 1385 Piccard Dr., Rockville, MD 20850-4329. Internet: **http://www.mcaa.org**

➤ National Center for Construction Education and Research, 3600 NW. 43rd St., Bldg. G, Gainesville, FL 32606-8134. Internet: **http://www.nccer.org**

➤ Plumbing-Heating-Cooling Contractors—National Association, 180 S. Washington St, Falls Church, VA 22046-2935. Internet: **http://www.phccweb.org**

For general information about the work of sprinklerfitters, contact:

➤ American Fire Sprinkler Association, Inc., 12750 Merit Dr., Suite 350, Dallas, TX 75251-1273. Internet: **http://www.firesprinkler.org**

➤ National Fire Sprinkler Association, 40 Jon Barrett Rd., Patterson, NY 12563-2164. Internet: **http://www.nfsa.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos211.htm**

Roofers

Significant Points

- Most roofers learn their skills on the job; some train through 3-year apprenticeships.
- Demand for roofers is less vulnerable to downturns in the economy than demand for other construction trades because most roofing work consists of repair and reroofing.
- Most job openings will occur from the need to replace those who leave the occupation because the work can be hot, strenuous, and dirty, causing many people to switch to jobs in other construction trades.

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Nature of the Work

Roofers repair and install roofs made from a combination of some of the following: tar, asphalt, gravel, rubber, thermoplastic, metal, and shingles—all of which protect buildings and their contents from water damage. A leaky roof can damage ceilings, walls, and furnishings. Repair and reroofing—replacing old roofs on existing buildings—make up the majority of work for roofers.

There are two types of roofs—low-slope and steep-slope. Low-slope roofs rise 4 inches or less per horizontal foot and are installed in layers. Steep-slope roofs rise more than 4 inches per horizontal foot and are usually covered in shingles. Most commercial, industrial, and apartment buildings contain low-slope roofs, while the majority of residential houses have steep-slope roofs. Some roofers work on both types; others specialize.

Most low-slope roofs are covered with several layers of materials. Roofers begin by installing a layer of insulation on the roof deck, followed by applying a tarlike substance called molten bitumen on top of it. Next, they install overlapping layers of roofing felt—a fabric soaked in bitumen—over the surface. Roofers use a mop to spread hot bitumen over the felt before adding another layer of felt. This seals the seams and makes the surface waterproof. Roofers repeat these steps to build up the desired number of layers, called "plies." The top layer is then glazed to make a smooth finish or has gravel embedded in the hot bitumen to create a rough surface.

An increasing number of low-slope roofs are covered with single-ply membranes of waterproof rubber or thermoplastic compounds. Roofers roll these sheets over the roof's insulation and seal the seams. Adhesive, mechanical fasteners, or stone ballast hold the sheets in place. Roofers must make sure the building is strong enough to hold the stone ballast.

A small but increasing number of buildings now have "green" roofs that incorporate landscape roofing systems. A landscape roofing system begins with a single or multiply waterproof layer. After it is proven to be leak free, roofers put a root barrier over it, and then layers of soil, in which trees and grass are planted. Roofers are responsible for making sure the roof is watertight and can endure the weight and water needs of the plants.

Most residential steep-slope roofs are covered with shingles. To apply shingles, roofers first lay, cut, and tack 3-foot strips of roofing felt over the entire roof. Starting from the bottom edge, roofers then nail overlapping rows of shingles to the roof. Roofers measure and cut the felt and shingles to fit intersecting roof surfaces and to fit around vent pipes and chimneys. Wherever two sections of the roof meet each other at an angle or where shingles reach a vent pipe or chimney, roofers cement or nail flashing-strips of metal or shingle over the joints to make them watertight. Finally, roofers cover exposed nail-heads with roofing cement or caulking to prevent water leakage. A similar process is used when installing tile, metal shingles, or shakes (rough wooden shingles).

Some roofers specialize in waterproofing or dampproofing masonry and concrete walls, floors, and foundations. To prepare surfaces for waterproofing, they hammer and chisel away rough spots or remove them with a rubbing brick before applying a coat of liquid waterproofing compound. They also may paint or spray surfaces with a waterproofing material or attach waterproofing membrane to surfaces. Roofers usually spray a bitumen-based coating on interior or exterior surfaces when dampproofing.

Work environment. Roofing work is strenuous. It involves heavy lifting, as well as climbing, bending, and kneeling. Roofers work outdoors in all types of weather, particularly when making repairs. However, they rarely work when it rains or in very cold weather because ice can be dangerous. In northern States, roofing work is generally not performed during winter months. During the summer, roofers may work overtime to complete jobs quickly, especially before forecasted rainfall.

Workers risk slips or falls from scaffolds, ladders, or roofs, and burns from hot bitumen, but safety precautions can prevent most accidents. In addition, roofs can become extremely hot during the summer, causing heat-related illnesses. Data from the U.S. Bureau of Labor Statistics show that full-time roofers experienced a work-related injury and illness rate that was much higher than the national average.

Training, Other Qualifications, and Advancement

Most roofers learn their skills on the job by working as helpers for experienced roofers and by taking classes, including safety training offered by their employers; some complete 3-year apprenticeships.

Education and training. A high school education, or its equivalent, is helpful and so are courses in mechanical drawing and basic mathematics. Although most workers learn roofing as helpers for experienced workers, some roofers train through 3-year apprenticeship programs administered by local union-management committees representing roofing contractors and locals of the United Union of Roofers, Waterproofers, and Allied Workers. Apprenticeship programs usually include at least 2,000 hours of paid long-term on-the-job training each year, plus a minimum of 144 hours of classroom instruction a year in tools and their use, arithmetic, safety, and other topics. On-the-job training for apprentices is similar to the training given to helpers, but an apprenticeship program is more structured and comprehensive. Apprentices, for example, also learn to dampproof and waterproof walls.

Trainees start by carrying equipment and material and erecting scaffolds and hoists. Within 2 or 3 months, they are taught to measure, cut, and fit roofing materials and, later, to lay asphalt or fiberglass shingles. Because some roofing materials are used infrequently, such as solar tiles, it can take several years to get experience working on all types of roofing.

Other qualifications. Physical condition and strength, along with good balance, are essential for roofers. They cannot be afraid of heights. Experience with metal-working is helpful for workers who install metal roofing. Usually, apprentices must be at least 18 years old.

Advancement. Roofers may advance to become supervisors or estimators for a roofing contractor or become independent contractors themselves.

Employment

Roofers held about 148,900 jobs in 2008. About 70 percent of all salaried roofers worked for roofing contractors, while only

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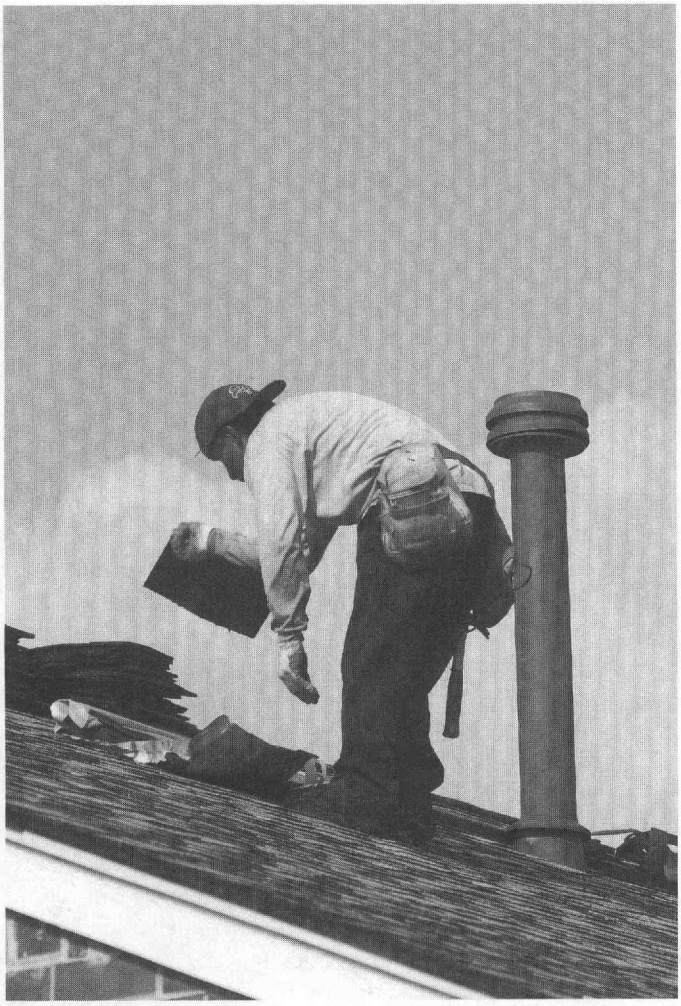

Roofers need good physical condition, strength, and balance.

21 percent were self-employed. Many self-employed roofers specialized in residential work.

Job Outlook

Most job openings will occur from turnover because the work is hot, strenuous, and dirty, causing many people to switch to jobs in other construction trades. Employment is projected to grow slower than the average.

Employment change. Employment of roofers is expected to grow 4 percent between 2008 and 2018, slower than the average for all occupations. Roofs deteriorate faster than most other parts of buildings and, as a result, they need to be repaired or replaced more often. In addition to repair work, the need to install roofs on new buildings may result in some job growth. So as building construction increases, some demand for roofers can be expected.

Employment growth, nonetheless, may be impeded because a greater proportion of roofing work may be completed by other construction workers as opposed to traditional roofing contractors.

Job prospects. Job opportunities for roofers will occur primarily because of the need to replace workers who leave the occupation. The proportion of roofers who leave the occupation each year is higher than in most construction trades—roofing work is hot, strenuous, and dirty, and a considerable number of workers treat roofing as a temporary job until they find other work. Some roofers leave the occupation to go into other construction trades. Jobs should be easier to find during spring and summer.

Employment of roofers who install new roofs, like that of many other construction workers, is sensitive to fluctuations of the economy. Workers may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity. Nevertheless, roofing work is more heavily concentrated in repair and replacement rather than new installation, making demand for roofing less vulnerable to downturns than demand for some other construction trades.

Earnings

In May 2008, median hourly wages of roofers were $16.17. The middle 50 percent earned between $12.97 and $21.98. The lowest 10 percent earned less than $10.63, and the highest 10 percent earned more than $28.46. Median hourly wages of roofers in the foundation, structure, and building exterior contractors industry were $16.26. Earnings may be less on occasions when poor weather limits the time roofers can work.

Apprentices usually begin earning about 40 percent to 50 percent of the rate paid to experienced roofers. They receive periodic raises as they master the skills of the trade.

Some roofers are members of United Union of Roofers, Waterproofers, and Allied Workers. Hourly wages and fringe benefits are generally higher for union workers.

Related Occupations

Roofers use shingles, tile, bitumen and gravel, single-ply plastic or rubber sheets, or other materials to protect and waterproof building surfaces. Workers in other occupations who cover surfaces with special materials for protection and decoration include:

	Page
Carpenters	618
Carpet, floor, and tile installers and finishers	621
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Drywall and ceiling tile installers, tapers, plasterers, and stucco masons	638
Sheet metal workers	665

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Roofers	47-2181	148,900	154,600	5,700	4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Sources of Additional Information

For information about apprenticeships or job opportunities in roofing, contact local roofing contractors, a local chapter of the roofers union, a local joint union-management apprenticeship committee, or the nearest office of your State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site at **http://www.doleta.gov/atels_bat.** Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: 1 (877) 872–5627.

For information about the work of roofers, contact:

➤ National Roofing Contractors Association, 10255 W. Higgins Rd., Suite 600, Rosemont, IL 60018-5607. Internet: **http://www.nrca.net**

➤ United Union of Roofers, Waterproofers, and Allied Workers, 1660 L St. NW., Suite 800, Washington, DC 20036. Internet: **http://www.unionroofers.com**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos212.htm**

Sheet Metal Workers

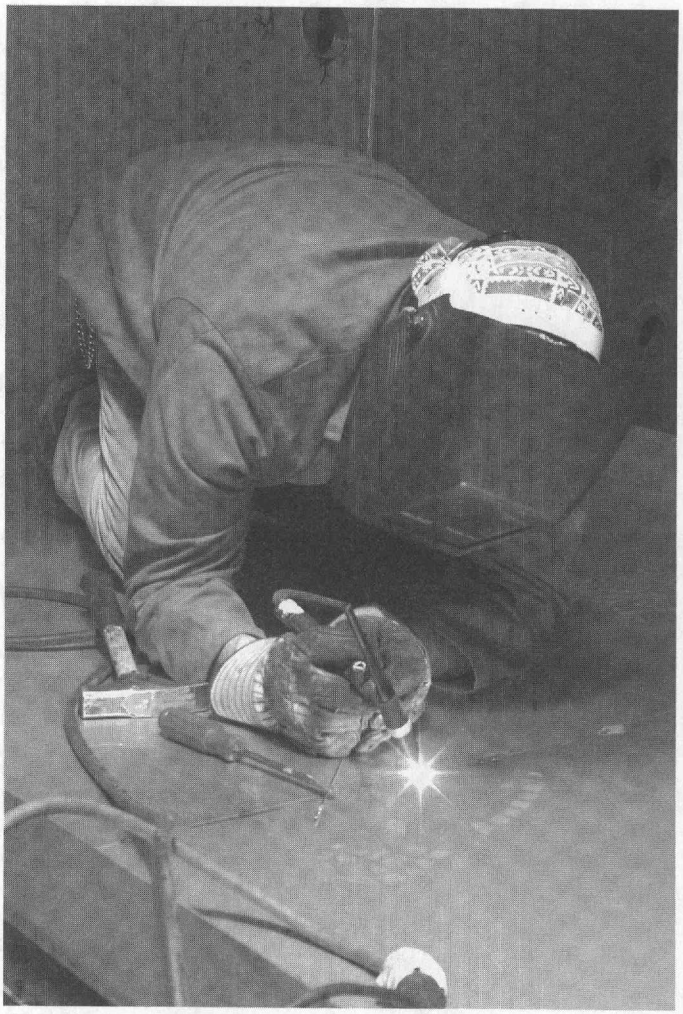
Significant Points

- Sheet metal workers are primarily employed in construction and manufacturing industries.
- Workers learn through informal on-the-job training or formal apprenticeship programs.
- Job opportunities in construction should be good, particularly for individuals who have apprenticeship training or who are certified welders; applicants for jobs in manufacturing will experience competition.

Nature of the Work

Sheet metal workers make, install, and maintain heating, ventilation, and air-conditioning duct systems; roofs; siding; rain gutters; downspouts; skylights; restaurant equipment; outdoor signs; railroad cars; tailgates; customized precision equipment; and many other products made from metal sheets. They also may work with fiberglass and plastic materials. Although some workers specialize in fabrication, installation, or maintenance, most do all three jobs. Sheet metal workers do both construction-related work and mass production of sheet metal products in manufacturing.

Sheet metal workers first study plans and specifications to determine the kind and quantity of materials they will need. They measure, cut, bend, shape, and fasten pieces of sheet metal to make ductwork, countertops, and other custom products. Sheet metal workers program and operate computerized metalworking equipment. They cut, drill, and form parts with computer-controlled saws, lasers, shears, and presses.



A sheet metal worker is using a torch to heat a sheet of metal.

In shops without computerized equipment, and for products that cannot be made with such equipment, sheet metal workers make the required calculations and use tapes, rulers, and other measuring devices for layout work. They then cut or stamp the parts with machine tools.

Before assembling pieces, sheet metal workers use measuring instruments such as tape measures, calipers, and micrometers to check each part for accuracy. If necessary, they use hand, rotary, or squaring shears and hacksaws to finish pieces. After inspecting the pieces, workers fasten seams and joints together with welds, bolts, cement, rivets, solder, or other connecting devices. They then take the parts constructed in the shop and assemble the pieces further as they install them. These workers install ducts, pipes, and tubes by joining them end to end and hanging them with metal hangers secured to a ceiling or a wall. They also use shears, hammers, punches, and drills to make parts at the worksite or to alter parts made in the shop.

Some jobs are done completely at the jobsite. When installing a metal roof, for example, sheet metal workers usually measure and cut the roofing panels onsite. They secure the first panel

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in place and interlock and fasten the grooved edge of the next panel into the grooved edge of the first. Then they nail or weld the free edge of the panel to the structure. This two-step process is repeated for each additional panel. Finally, the workers fasten machine-made molding at joints, along corners, and around windows and doors, for a neat, finished effect.

In addition to installation, some sheet metal workers specialize in testing, balancing, adjusting, and servicing existing air-conditioning and ventilation systems to make sure they are functioning properly and to improve their energy efficiency. Properly installed duct systems are a key component of heating, ventilation, and air-conditioning (HVAC) systems; sometimes duct installers are called HVAC technicians. A growing activity for sheet metal workers is the commissioning of a building—a complete mechanical inspection of the building's HVAC, water, and lighting systems.

Sheet metal workers in manufacturing plants make sheet metal parts for products such as aircraft or industrial equipment. Although some of the fabrication techniques used in large-scale manufacturing are similar to those used in smaller shops, the work may be highly automated and repetitive. Sheet metal workers doing such work may be responsible for reprogramming the computer control systems of the equipment they operate.

Work environment. Sheet metal workers usually work a 40-hour week. Those who fabricate sheet metal products work in small shops and manufacturing plants that are usually well lighted and well ventilated. However, they stand for long periods and lift heavy materials and finished pieces. Those performing installation at construction sites or inside buildings do considerable bending, lifting, standing, climbing, and squatting, sometimes in close quarters or awkward positions. Working outdoors exposes sheet metal workers to various kinds of weather.

Sheet metal workers must follow safety practices, because this occupation has a relatively high rate of nonfatal injuries. Some sheet metal workers work around high-speed machines, which can be dangerous. Others are subject to cuts from sharp metal, burns from soldering or welding, and falls from ladders or scaffolds. They often are required to wear safety glasses and must not wear jewelry or loose-fitting clothing that could easily be caught in a machine. To avoid repetitive-type injuries, they may work at a variety of different production stations.

Training, Other Qualifications, and Advancement

Sheet metal workers learn their trade through both formal apprenticeships and informal on-the-job training programs. Formal apprenticeships are more likely to be found in construction.

Education and training. To become a skilled sheet metal construction worker usually takes between 4 and 5 years of both classroom and on-the-job training. Although there are a number of different ways to obtain this training, generally the more formalized the training received by an individual, the more thoroughly skilled the person becomes and the more likely he or she is to be in demand by employers. For some, this training begins in a high school, where classes in English, algebra, geometry, physics, mechanical drawing and blueprint reading, and general shop are recommended.

After high school, there are a number of different ways to train. One way is to get a job with a contractor who will provide training on the job. Entry-level workers generally start as helpers, assisting more experienced workers. Most begin by carrying metal and cleaning up debris in a metal shop, learning about materials, tools, and their uses as they go about their tasks. Later, they learn to operate machines that bend or cut metal. In time, helpers go to the jobsite to learn installation. Employers may send their employees to a trade or vocational school to take courses or to a community college to receive further formal training. Helpers may be promoted to the journeyman level if they show the requisite knowledge and skills. Most sheet metal workers in large-scale manufacturing receive on-the-job training, with additional classwork or in-house training as necessary. The training needed to become proficient in manufacturing takes less time than the training for proficiency in construction.

Apprenticeship programs combine paid on-the-job training with related classroom instruction. Usually, apprenticeship applicants must be at least 18 years old and meet local requirements. The length of the program, typically 4 to 5 years, varies with the apprentice's skill. Apprenticeship programs provide comprehensive instruction in both sheet metal fabrication and sheet metal installation. They may be administered by local joint committees composed of the Sheet Metal Workers' International Association and local chapters of the Sheet Metal and Air-Conditioning Contractors National Association.

Sheet metal workers can choose one of many specialties. Workers can specialize in commercial and residential HVAC installation and maintenance, industrial welding and fabrication, exterior or architectural sheet metal installation, sign fabrication, service and refrigeration, and testing and balancing of building systems.

On the job, apprentices receive first safety training and then training in tasks that allow them to begin work immediately. They use materials such as fiberglass, plastics, and other nonmetallic materials. Workers focus on a particular sheet metal career path. In the classroom, apprentices learn computer aided drafting; reading of plans and specifications; trigonometry and geometry applicable to layout work; welding; the use of computerized equipment; the principles of heating, air-conditioning, and ventilation systems. In addition, apprentices learn the relationship between sheet metal work and other construction work.

Other qualifications. Sheet metal workers need to be in good physical condition and have mechanical and mathematical aptitude and good reading skills. Good eye-hand coordination, accurate perception of spaces and forms, and manual dexterity also are important. Courses in algebra, trigonometry, geometry, mechanical drawing, and shop provide a helpful background for learning the trade, as does related work experience obtained in the U.S. Armed Services.

Certification and advancement. It is important for experienced sheet metal workers to keep abreast of new technological developments, such as the use of computerized layout and laser-cutting machines. In addition, new software, called B.I.M., which stands for "building information modeling," allows contractors, architects, and engineers to coordinate their efforts and increase efficiency at worksites.

Certifications in one of the specialties also can be beneficial to workers. Certifications related to sheet metal specialties are

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offered by a wide variety of associations, several of which are listed in the sources of additional information at the end of this statement.

Sheet metal workers in construction may advance to supervisory jobs. Some of these workers take additional training in welding and do more specialized work. Workers who perform building and system testing are able to move into construction and building inspection. Others go into the contracting business for themselves. Because a sheet metal contractor must have a shop with equipment to fabricate products, this type of contracting business is more expensive to start than other types of construction contracting.

Sheet metal workers in manufacturing may advance to positions as supervisors or quality inspectors. Some of these workers may move into other management positions.

Employment

Sheet metal workers held about 170,700 jobs in 2008. About 63 percent of all sheet metal workers were in the construction industry, including 46 percent who worked for plumbing, heating, and air-conditioning contractors; most of the rest in construction worked for roofing contractors and for building finishing contractors. Some worked for general contractors engaged in residential and commercial building and for other special trade contractors.

About 23 percent of all sheet metal workers were in manufacturing industries, such as the fabricated metal products, machinery, and aerospace products and parts industries. Some sheet metal workers work for the Federal Government.

Compared with workers in most construction craft occupations, relatively few sheet metal workers are self-employed.

Job Outlook

Slower than average employment growth is projected. Job opportunities should be best for individuals who have apprenticeship training or who are certified welders. Applicants for jobs in manufacturing will experience competition.

Employment change. Employment of sheet metal workers is expected to increase by 6 percent between 2008 and 2018, slower than the average for all occupations. This change reflects anticipated growth in the number of industrial, commercial, and residential structures to be built over the decade. In addition, it reflects the need to install energy-efficient air-conditioning, heating, and ventilation systems in older buildings and to perform other types of renovation and maintenance work on these systems. Also, the popularity of decorative sheet metal products and increased architectural restoration are expected to add to the demand for sheet metal workers.

Sheet metal workers in manufacturing, however, are expected to experience a moderate decline in employment as the industry becomes more automated and some of the work is done in other countries.

Job prospects. Job opportunities are expected to be good for sheet metal workers in the construction industry, reflecting both employment growth and openings arising each year as experienced sheet metal workers leave the occupation. Opportunities should be particularly good for individuals who have apprenticeship training or who are certified welders. Applicants for jobs in manufacturing will experience competition.

Sheet metal workers in construction may experience periods of unemployment, particularly when construction projects end and economic conditions dampen construction activity. However, because maintenance of existing equipment makes up a large part of the work done by sheet metal workers, they are less affected by construction downturns than are some other construction occupations. Installation of new air-conditioning and heating systems in existing buildings is expected to continue as individuals and businesses adopt more energy-efficient equipment to cut utility bills. In addition, a large proportion of sheet metal installation and maintenance is done indoors, so sheet metal workers usually lose less worktime because of bad weather than do other construction workers.

Earnings

In May 2008, median hourly wages of sheet metal workers were $19.37. The middle 50 percent earned between $14.39 and $27.03. The lowest 10 percent of all sheet metal workers earned less than $11.43, and the highest 10 percent earned more than $35.36. The median hourly wages of the largest industries employing sheet metal workers were as follows:

Federal Government	$23.37
Building finishing contractors	21.35
Building equipment contractors	19.98
Foundation, structure, and building exterior contractors	17.67
Architectural and structural metals manufacturing	17.32

Apprentices normally start at about 40 to 50 percent of the rate paid to experienced workers. As apprentices acquire more skills, they receive periodic pay increases, until their pay approaches that of experienced workers.

About 32 percent of all sheet metal workers belong to a union. Union workers in some areas receive supplemental wages from the union when they are laid off or experience shortened workweeks.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Sheet metal workers	47-2211	170,700	181,800	11,100	6

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Related Occupations

To fabricate and install sheet metal products, sheet metal workers combine metalworking skills and knowledge of construction materials and techniques. Other occupations in which workers lay out and fabricate metal products include the following:

	Page
Assemblers and fabricators	723
Machine setters, operators, and tenders—metal and plastic	734
Machinists	737
Tool and die makers	740

Construction occupations requiring similar skills and knowledge include the following:

Glaziers	647
Heating, air-conditioning, and refrigeration mechanics and installers	703

Sources of Additional Information

For more information about apprenticeships or other work opportunities, contact local sheet metal contractors or heating, refrigeration, and air-conditioning contractors; a local of the Sheet Metal Workers International Association; a local of the Sheet Metal and Air-Conditioning Contractors National Association; a local joint union-management apprenticeship committee; or the nearest office of your State employment service or apprenticeship agency. You also can find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is available as well from the U.S. Department of Labor's toll-free help line: (877) 872-5627.

For general and training information about sheet metal workers, contact:

➤ Fabricators and Manufacturers Association, International, 833 Featherstone Road, Rockford, IL 61107-6301. Internet: **http://www.fmanet.org**

➤ International Training Institute for the Sheet Metal and Air-Conditioning Industry, 601 North Fairfax St., Suite 240, Alexandria, VA 22314-2083. Internet: **http://www.sheetmetal-iti.org**

➤ National Center for Construction Education and Research, 3600 NW 43rd St., Bldg. G, Gainesville, FL 32606-8134. Internet: **http://www.nccer.org**

➤ Sheet Metal and Air Conditioning Contractors' National Association, 4201 Lafayette Center Dr., Chantilly, VA 20151-1209. Internet: **http://www.smacna.org**

➤ Sheet Metal Workers International Association, 1750 New York Ave. NW., 6th Floor, Washington, DC 20006-5301. Internet: **http://www.smwia.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos214.htm**

Structural and Reinforcing Iron and Metal Workers

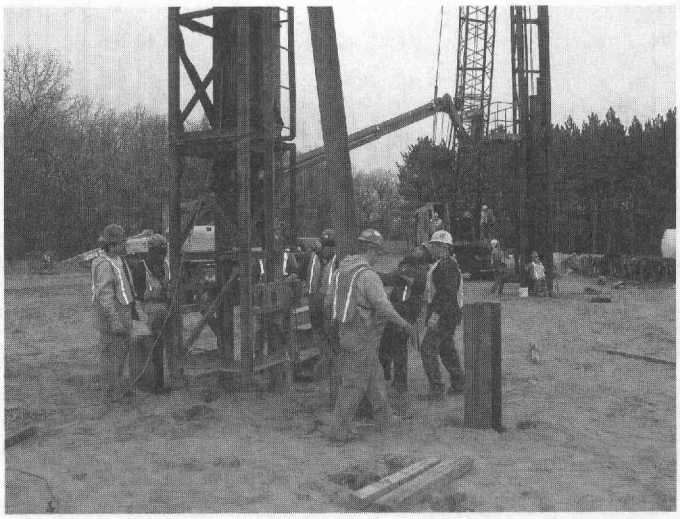
Significant Points

- Workers must be in good physical condition and have no fear of heights.
- Most employers recommend completion of a formal 3-year or 4-year paid apprenticeship, but some workers learn on the job.
- In most areas of the country, job opportunities should be favorable.

Nature of the Work

Structural and reinforcing iron and metal workers place and install iron or steel girders, columns, and other construction materials to form buildings, bridges, and other structures. They also position and secure steel bars or mesh in concrete forms in order to reinforce the concrete used in highways, buildings, bridges, tunnels, and other structures. In addition, they repair and renovate older buildings and structures. Even though the primary metal involved in this work is steel, these workers often are known as *ironworkers* or *erectors*. Some ironworkers make structural metal in fabricating shops, which are usually located away from the construction site. (These workers are covered in the statement on assemblers and fabricators found elsewhere in the *Handbook*.)

Before construction can begin, ironworkers must erect steel frames and assemble the cranes and derricks that move structural steel, reinforcing bars, buckets of concrete, lumber, and other materials and equipment around the construction site. Once this job has been completed, workers begin to connect



Workers hammer large structural steel into the ground at a construction site.

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steel columns, beams, and girders according to blueprints and instructions from supervisors and superintendents. Structural steel, reinforcing rods, and ornamental iron generally come to the construction site ready for erection—cut to the proper size, with holes drilled for bolts and numbered for assembly.

Ironworkers at the construction site unload and stack the prefabricated steel so that it can be hoisted easily when needed. To hoist the steel, ironworkers attach cables (slings) to the steel and to the crane or derrick. One worker directs the hoist operator with hand signals while another worker holds a rope (tag line) attached to the steel to prevent it from swinging. The crane or derrick hoists steel into place in the framework, whereupon two ironworkers, called connectors, position the steel with connecting bars and spud wrenches—a long wrench with a pointed handle. Workers using driftpins or the handle of a spud wrench align the holes in the steel with the holes in the framework. Ironworkers check vertical and horizontal alignment with plumb bobs, laser equipment, transits, or levels; then they bolt or weld the piece permanently in place.

Reinforcing iron and rebar workers, sometimes called *rod busters*, set reinforcing bars (often called rebar) in the forms that hold concrete, following blueprints showing the location, size, and number of bars. They then fasten the bars together by tying wire around them with pliers. When reinforcing floors, ironworkers place spacers under the rebar to hold the bars off the deck. Although these materials usually arrive ready to use, ironworkers occasionally must cut bars with metal shears or acetylene torches, bend them by hand or machine, or weld them with arc-welding equipment. Some concrete is reinforced with welded wire fabric that ironworkers put into position using hooked rods. Post-tensioning is another technique used to reinforce concrete. In this technique, workers substitute cables for rebar. When the concrete is poured, the ends of the cables are left exposed. After the concrete cures, ironworkers tighten the cables with jacking equipment specially designed for the purpose. Post-tensioning allows designers to create larger open areas in a building, because supports can be placed further apart. This technique is commonly employed in parking garages and arenas.

Ornamental ironworkers install stairs, handrails, curtain walls (the nonstructural walls and window frames of many large buildings), and other miscellaneous metal after the structure of the building has been completed. As they hoist pieces into position, ornamental ironworkers make sure that the pieces are properly fitted and aligned before bolting or welding them for a secure fit.

Work environment. Structural and reinforcing iron and metal workers usually work outside in all kinds of weather. However, those who work at great heights do not work during wet, icy, or extremely windy conditions. Because the danger of injuries from falls is great, ironworkers use safety devices such as safety harnesses, scaffolding, and nets to reduce risk. Nevertheless, this occupation does experience an above average rate of nonfatal injuries.

Training, Other Qualifications, and Advancement

Many workers learn to be ironworkers through formal apprenticeships, but others learn on the job. Certifications in welding and rigging can increase a worker's usefulness on the job site.

Education and training. Most employers recommend a 3-year to 4-year apprenticeship consisting of a combination of paid on-the-job training and classroom instruction as the best way to learn this trade. Apprenticeship programs are administered by committees made up of representatives of local unions of the International Association of Bridge, Structural, Ornamental and Reinforcing Iron Workers or the local chapters of contractors' associations. To be accepted into an apprenticeship program, most employers and local apprenticeship committees prefer that applicants have a high school diploma. In addition, high school courses in general mathematics, mechanical drawing, English, and welding are considered helpful.

Classroom study for apprentices consists of blueprint reading; mathematics, the basics of structural erecting, rigging, reinforcing, welding, assembling, and safety training. Apprentices also study the care and safe use of tools and materials. On the job, apprentices work in all aspects of the trade, such as unloading and storing materials at the job site, rigging materials for movement by crane, connecting structural steel, and welding.

Some ironworkers learn the trade informally on the job, without completing an apprenticeship. On-the-job trainees usually begin by assisting experienced ironworkers on simple jobs, such as carrying various materials. With experience, trainees perform more difficult tasks, such as cutting and fitting different parts.

Other qualifications. Ironworkers must be at least 18 years old. Because materials used in iron working are heavy and bulky, ironworkers must be in good physical condition. They also need good agility, balance, eyesight, and depth perception to work safely at great heights on narrow beams and girders. Ironworkers should not be afraid of heights or suffer from dizziness.

Certification and advancement. Ironworkers who complete apprenticeships are certified at the journey level, which often make them more competitive candidates for jobs and promotions. Those who meet education and experience requirements can become welders certified by the American Welding Society. Apprenticeship programs often provide trainees the opportunity to become welder-certified as part of their coursework because welding skills are useful for many ironworker tasks.

Some experienced workers are promoted to supervisor. Others may go into the contracting business for themselves. The ability to communicate in both English and Spanish will improve opportunities for advancement.

Employment

Ironworkers held about 97,800 jobs in 2008; structural iron and steel workers held about 70,200 jobs, and reinforcing iron and rebar workers held about 27,700 jobs. About 88 percent worked in construction, with 51 percent working for foundation, structure, and building exterior contractors. Most of the remaining ironworkers worked for contractors specializing in the construction of various structures, such as bridges, buildings, and factories.

Structural and reinforcing iron and metal workers are employed in all parts of the country, but most work in metropolitan areas, where the bulk of commercial and industrial construction takes place.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Structural and reinforcing iron and metal workers	–	97,800	110,000	12,200	12
Reinforcing iron and rebar workers	47-2171	27,700	31,100	3,500	13
Structural iron and steel workers	47-2221	70,200	78,900	8,700	12

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job Outlook

Average job growth is projected. In most areas of the country, job opportunities should be favorable.

Employment change. Employment of structural and reinforcing iron and metal workers is expected to grow 12 percent between 2008 and 2018, about as fast as the average for all occupations. The rehabilitation, maintenance, and replacement of a growing number of older buildings, powerplants, highways, and bridges also are expected to create employment opportunities. State and Federal legislatures will likely continue to call for road construction and related infrastructure projects, which will secure jobs for the near future. However, a lack of qualified applicants challenges the education and retraining needs of the industry to meet the demands of employment growth.

Job prospects. In addition to new jobs from employment growth, many job openings will result from the need to replace experienced ironworkers who leave the occupation or retire. In most areas, job opportunities should be favorable, although the number of job openings can fluctuate from year to year with economic conditions and the level of construction activity.

Employment of structural and reinforcing iron and metal workers, like that of many other construction workers, is sensitive to the fluctuations of the economy. Workers in these trades may experience periods of unemployment when the overall level of construction falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity. Similarly, job opportunities for ironworkers may vary widely by geographic area. Population growth in the South and West should create more job opportunities than elsewhere as bridges, buildings, and roads are constructed. Job openings for ironworkers usually are more abundant during the spring and summer months, when the level of construction activity increases. Workers who are willing to relocate are often able to find work in another area.

Earnings

In May 2008, median hourly wages of structural iron and steel workers were $20.68. The middle 50 percent earned between $15.18 and $29.15. The lowest 10 percent earned less than $12.25, and the highest 10 percent earned more than $37.04.

In May 2008, median hourly wages of reinforcing iron and rebar workers were $19.18. The middle 50 percent earned between $14.35 and $27.29. The lowest 10 percent earned less than $11.78, and the highest 10 percent earned more than $35.26.

In May 2008, median hourly wages of structural iron and steel workers in foundation, structure, and building exterior contractors were $21.51 and in nonresidential building construction, $18.53. Reinforcing iron and rebar workers earned median hourly wages of $19.37 in foundation, structure, and building exterior contractors.

About 40 percent of the workers in this trade are union members. According to International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers, average hourly compensation, including benefits, for structural and reinforcing metal workers who belonged to a union and worked full time were higher than the hourly earnings of nonunion workers. Structural and reinforcing iron and metal workers in New York, Boston, San Francisco, Chicago, Los Angeles, Philadelphia, and other large cities received the highest wages.

Apprentices generally start at about 60 percent of the rate paid to experienced journey level workers. Throughout the course of the apprenticeship program, as they acquire skills they receive periodic increases until their pay approaches that of experienced workers.

Earnings for ironworkers may be reduced on occasion because work can be limited by bad weather and economic downturns.

Related Occupations

Structural and reinforcing iron and metal workers play an essential role in erecting buildings, bridges, highways, power lines, and other structures. Others who work on these construction jobs include:

	Page
Assemblers and fabricators	723
Boilermakers	613
Carpenters	618
Cement masons, concrete finishers, segmental pavers, and terrazzo workers	625
Construction equipment operators	632
Construction laborers	635
Construction managers	38
Engineers	161
Welding, soldering, and brazing workers	743

Sources of Additional Information

For more information on apprenticeships or other work opportunities, contact local general contractors; a local of the International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers Union; a local ironworkers' joint union-management apprenticeship committee; a local or State chapter of the Associated Builders and Contractors or the Associated General Contractors; or the nearest office of your State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's

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Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

For apprenticeship information, contact:

➤ International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers, Apprenticeship Department, 1750 New York Ave. NW., Suite 400, Washington, DC 20006-5315. Internet: **http://www.ironworkers.org/organization/Apprenticeship.aspx**

For general information about ironworkers, contact:

➤ Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400., Arlington, VA 22201-5426. Internet: **http://www.agc.org**

For general information on apprenticeships and how to get them, see the *Occupational Outlook Quarterly* article "Apprenticeships: Career training, credentials—and a paycheck in your pocket," online at **http://www.bls.gov/opub/ooq/2002/summer/art01.pdf** and in print at many libraries and career centers.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos215.htm**

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Installation, Maintenance, and Repair Occupations

Electrical and Electronic Equipment Mechanics, Installers, and Repairers

Computer, Automated Teller, and Office Machine Repairers

Significant Points

- Employment is expected to decline slowly.
- Job prospects will be best for applicants with knowledge of electronics, certification, formal training, and repair experience.
- Workers qualify for these jobs by receiving training in electronics from associate degree programs, the military, vocational schools, equipment manufacturers, or employers.

Nature of the Work

Computer, automated teller, and office machine repairers install, fix, and maintain many of the machines that are used by businesses, households, and consumers. For large or stationary machines, repairers frequently perform the work on site. These workers—known as *field technicians*—often have assigned areas where they perform preventive maintenance on a regular basis. *Bench technicians* commonly repair smaller equipment and often work in repair shops located in stores, factories, or service centers. In small companies, repairers may work both in repair shops and at customer locations.

Computer repairers, also known as *computer service technicians* or *data processing equipment repairers*, service mainframe, server, and personal computers; printers; and auxiliary computer equipment. These workers primarily perform hands-on repair, maintenance, and installation of computers and related equipment. Workers who provide technical assistance, in person or by telephone, to computer system users are known as computer support specialists or computer support technicians. (See the section on computer support specialists and systems administrators elsewhere in the *Handbook*.)

Computer repairers typically replace subsystems instead of repairing them. Commonly replaced subsystems include video cards, which transmit signals from the computer to the monitor; hard drives, which store data; and network cards, which allow communication over the network. Replacement is common because subsystems are usually inexpensive and businesses are reluctant to shut down their computers for time-consuming repairs. Defective modules may be given to bench technicians, who use software programs to diagnose the problem and who may repair the modules, if possible.

Office machine and *cash register servicers* work on photocopiers, cash registers, and fax machines. Newer models of office machinery include computerized components that allow them to function more reliably than earlier models and, therefore, require less maintenance.

Office machine repairers usually work on machinery at the customer's workplace. However, if the machines are small enough, customers may bring them to a repair shop for repair. Common malfunctions include paper jams caused by worn or dirty parts, and poor-quality copy resulting from problems with lamps, lenses, or mirrors. These malfunctions often can be resolved simply by cleaning the relevant components. Breakdowns also may result from the general wear and tear of commonly used parts. For example, heavy use of a photocopier may wear down the printhead, which applies ink to the final copy. In such cases, the repairer usually replaces the part instead of repairing it.

Automated teller machine servicers install and repair automated teller machines (ATMs) and, increasingly, electronic kiosks. In addition to performing bank transactions without the assistance of a teller, electric kiosks are being used for a variety of non-traditional services, including stamp, phone card, and ticket sales. A growing number of electronic kiosks also allow consumers to redeem movie tickets or airline and train boarding passes.

When ATMs malfunction, computer networks often recognize the problem and alert repairers. Common problems include worn magnetic heads on card readers, which prevent the equipment from recognizing customers' bankcards, and "pick failures," which prevent the equipment from dispensing the correct amount of cash. In such cases, field technicians travel to the locations of ATMs and repair equipment by removing and replacing defective components. Broken components may be taken to a repair shop, where bench technicians make the necessary repairs. Field technicians perform routine maintenance on a regular basis, replacing worn parts and running diagnostic tests to ensure that the equipment operates properly.

To install large equipment, such as mainframe computers and ATMs, repairers connect the equipment to power sources and communication lines that allow the transmission of information over computer networks. For example, when an ATM dispenses cash, it transmits the withdrawal information to the customer's bank. Workers may also install operating software and peripheral equipment, checking that all components are configured to operate together correctly.

Computer, automated teller, and office machine repairers use a variety of tools for diagnostic tests and repair. To

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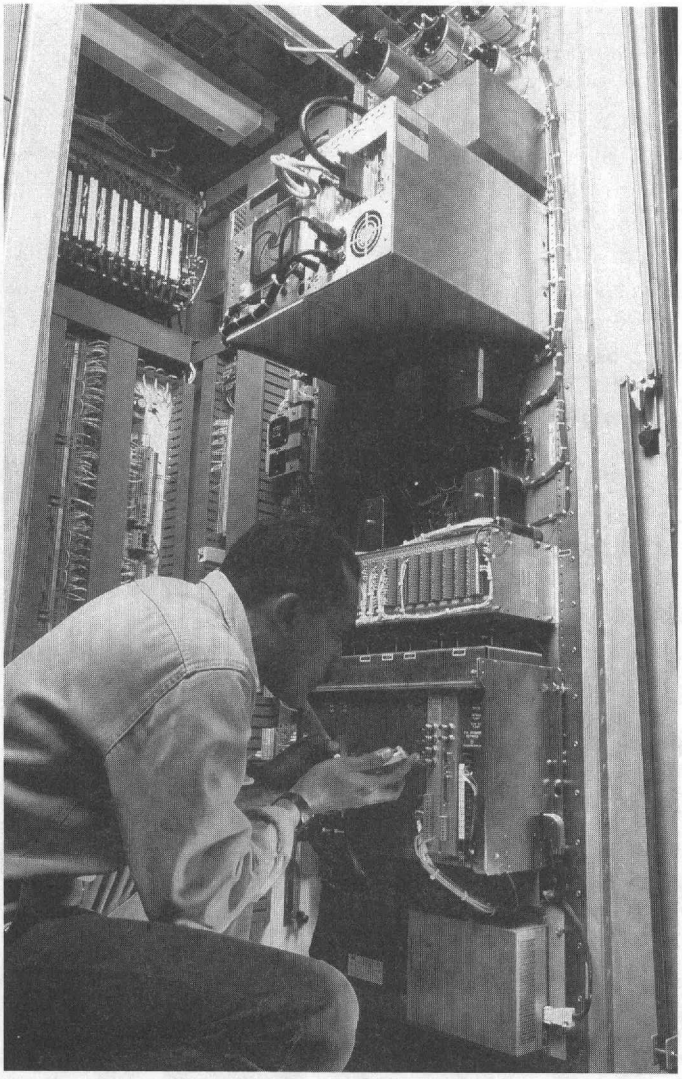

Computer, automated teller, and office machine repairers use a variety of tools for diagnostic tests and repair.

diagnose malfunctions, they use multimeters to measure voltage, current, resistance, and other electrical properties; signal generators to provide test signals; and oscilloscopes to monitor equipment signals. To diagnose computerized equipment, repairers use software programs. To repair or adjust equipment, workers use handtools, such as pliers, screwdrivers, and soldering irons.

Work environment. Repairers usually work in clean, well-lighted surroundings. Because computers and office machines are sensitive to extreme temperatures and humidity, repair shops usually are air-conditioned and well ventilated. Field repairers must travel frequently to various locations to install, maintain, or repair customers' equipment. ATM repairers may have to perform their jobs in small, confined spaces that house the equipment.

Because computers and ATMs are critical for many organizations to function efficiently, data processing equipment repairers and ATM field technicians often work around the clock. Their schedules may include evening, weekend, and holiday shifts, sometimes assigned on the basis of seniority. Office machine and cash register servicers usually work regular business hours because the equipment they repair is not as critical. Most repairers work about 40 hours per week, but about 9 percent work more than 50 hours per week. Although their jobs are not strenuous, repairers often must lift equipment and work in a variety of postures. Repairers of computer monitors need to discharge voltage from the equipment to avoid electrocution.

Training, Other Qualifications, and Advancement

Knowledge of electronics is required, and employers prefer workers with formal training. Office machine and ATM repairers usually have an associate degree. Certification is available for entry-level workers and experienced workers seeking advancement.

Education and training. Knowledge of electronics is necessary for employment as a computer, automated teller, or office machine repairer. Employers prefer workers who are certified or who have training in electronics from an associate degree program, the military, a vocational school, or an equipment manufacturer. Employers generally provide some training to new repairers on specific equipment; however, workers are expected to arrive on the job with a basic understanding of equipment repair. Employers may send experienced workers to training sessions to keep up with changes in technology and service procedures.

Most office machine and ATM repairer positions require an associate degree in electronics. A basic understanding of mechanical equipment is also important because many of the parts that fail in office machines and ATMs, such as paper loaders, are mechanical. Entry-level employees at large companies normally receive on-the-job training lasting several months. Such training may include a week of classroom instruction, followed by a period of 2 weeks to several months assisting an experienced repairer.

Other qualifications. Field technicians work closely with customers and must have good communications skills and a neat appearance. Employers may require that field technicians have a driver's license.

Certification and advancement. Various organizations offer certification. For instance, the Electronics Technicians Association (ETA) offers more than 50 certification programs in numerous electronics specialties for varying levels of competence. The International Society of Certified Electronics Technicians also offers certification for several levels of competence, focusing on a broad range of topics, including basic electronics, multimedia systems, electronic systems, and appliance service. To become certified, applicants must meet several prerequisites and pass a comprehensive written or online examination. Certification demonstrates a level of competency. It can make an applicant more attractive to employers or increase an employee's opportunities for advancement.

Newly hired computer repairers may possibly work on personal computers or peripheral equipment. With experience, they can advance to positions maintaining more sophisticated systems, such as networking equipment and servers. Field repairers of ATMs may advance to bench technician positions responsible for more complex repairs. Experienced workers may become specialists who assist other repairers diagnose difficult problems or who work with engineers in designing equipment

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and developing maintenance procedures. Experienced workers may also move into management positions responsible for supervising other repairers.

Because of their familiarity with equipment, experienced repairers may also move into customer service or sales positions. Some experienced workers open their own repair shops or become wholesalers or retailers of electronic equipment.

Employment

Computer, automated teller, and office machine repairers held about 152,900 jobs in 2008. Wholesale trade establishments employed about 29 percent of the workers in this occupation; most of these establishments were wholesalers of professional and commercial equipment and supplies. Many workers also were employed in electronics and appliance stores and office supply stores. Others worked in electronic and precision equipment repair shops and computer systems design firms. About 20 percent of computer, automated teller, and office machine repairers were self-employed.

Job Outlook

Employment is expected to decline slowly. Opportunities will be best for applicants with knowledge of electronics, formal training, and repair experience. Employers increasingly prefer applicants who are certified.

Employment change. Employment of computer, automated teller, and office machine repairers is expected to decline by 4 percent from 2008 to 2018. Less expensive and more reliable computer equipment is expected to result in fewer computer repairers. Nonetheless, some computer repairers will be needed as malfunctions still occur and can cause severe problems for users, most of whom lack the knowledge to make repairs. Additionally, computers are critical to most businesses today and will become even more so as companies increasingly engage in electronic commerce, and as individuals continue to bank, shop, and pay bills online.

Employment growth of ATM repairers will be impeded as a result of newer technology which allows for the testing and resetting of machines remotely. The relatively slow rate at which new ATMs are installed will also limit demand for ATM repairers, despite a greater reliance on these machines by consumers.

Fewer office machine repairers will be needed as office equipment is often inexpensive and increasingly replaced instead of repaired. However, digital copiers and some newer office machines are more costly and complex. This equipment is often computerized, designed to work on a network, and capable of performing multiple functions. But because this equipment is becoming more reliable, the need for repairers will continue to decline.

Job prospects. Job prospects are expected to be limited as newer equipment continues to require less maintenance and repair. As a result, the vast majority of job openings will stem from the need to replace workers who retire or leave the occupation for other reasons. Those with knowledge of electronics, certification, formal training, and repair experience will have the best prospects.

A growing number of new ATMs called electronic kiosks offer non-traditional retail services, such as employee information processing and ticket redemption, in addition to banking transactions. Candidates who have expertise in the installation, maintenance, and repair of such equipment will also have better job prospects.

Earnings

Median hourly wages of computer, automated teller, and office machine repairers were $18.18 in May 2008. The middle 50 percent earned between $14.17 and $23.20. The lowest 10 percent earned less than $11.14, and the highest 10 percent earned more than $28.41. Median hourly wages in the industries employing the largest numbers of computer, automated teller, and office machine repairers in May 2008 were:

Computer systems design and related services	$19.87
Professional and commercial equipment and supplies merchant wholesalers	19.12
Office supplies, stationery, and gift stores	17.40
Electronic and precision equipment repair and maintenance	17.03
Electronics and appliance stores	15.67

Related Occupations

Workers in other occupations who repair and maintain electronic equipment include:

	Page
Broadcast and sound engineering technicians and radio operators	337
Coin, vending, and amusement machine servicers and repairers	720
Electrical and electronics installers and repairers	675
Electricians	641
Electronic home entertainment equipment installers and repairers	678
Home appliance repairers	707
Maintenance and repair workers, general	716
Radio and telecommunications equipment installers and repairers	680

Sources of Additional Information

For information on electronics careers and certification, contact:

➤ Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: **http://eta-i.org/**

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Computer, automated teller, and office machine repairers	49-2011	152,900	146,200	-6,700	-4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107-4527. Internet: **http://www.iscet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos186.htm**

Electrical and Electronics Installers and Repairers

Significant Points

- Knowledge of electrical equipment and electronics is necessary for employment; employers often prefer applicants with an associate degree in electronics, and professional certification often is required.
- Job opportunities will be best for applicants with an associate degree, certification, or related experience.
- Overall employment is projected to grow more slowly than the average for all occupations.

Nature of the Work

Businesses and other organizations depend on complex electronic equipment for a variety of functions. Industrial controls automatically monitor and direct production processes on the factory floor. Transmitters and antennae provide communication links for many organizations. Electric power companies use electronic equipment to operate and control generating plants, substations, and monitoring equipment. The Federal Government uses radar and missile control systems to provide for the national defense and to direct commercial air traffic. Such complex pieces of electronic equipment are installed, maintained, and repaired by *electrical and electronics installers and repairers*.

Installers and repairers, known as *field technicians*, often travel to factories or other locations to repair equipment. These workers usually have assigned areas in which they perform preventive maintenance on a regular basis. When equipment breaks down, field technicians go to a customer's site to repair the equipment. *Bench technicians* work in repair shops located in factories and service centers, fixing components that cannot be repaired on the factory floor.

Electrical and electronic equipment are two distinct types of industrial equipment, although a great deal of equipment contains both electrical and electronic components. In general, electrical parts provide the power for the equipment, whereas electronic components control the device.

Some industrial electronic equipment is self-monitoring and alerts repairers to malfunctions. When equipment breaks down, repairers will first check for common causes of trouble, such as loose connections or obviously defective components. If routine checks do not locate the trouble, repairers may refer to schematics and manufacturers' specifications that show connections and provide instructions on how to trace problems. Automated electronic control systems are becoming increasingly complex, making diagnosis more challenging. With these systems, repairers use software programs and testing equipment to diagnose malfunctions. Among their diagnostic tools are multimeters, which measure voltage, current, and resistance, and advanced multimeters, which measure capacitance, inductance, and current gain of transistors. Repairers also use signal generators, which provide test signals, and oscilloscopes, which display signals graphically. Finally, repairers use handtools such as pliers, screwdrivers, soldering irons, and wrenches to replace faulty parts and adjust equipment.

Because repairing components is a complex activity and factories cannot allow production equipment to stand idle, repairers on the factory floor usually remove and replace defective units, such as circuit boards, instead of fixing them. Defective units are discarded or returned to the manufacturer or a specialized shop for repair. Bench technicians at these locations have the training, tools, and parts needed to thoroughly diagnose and repair circuit boards or other complex components. These workers also locate and repair circuit defects, such as poorly soldered joints, blown fuses, or malfunctioning transistors.

Electrical and electronics installers often retrofit older manufacturing equipment with new automated control devices. Older manufacturing machines are frequently in good working order, but are limited by inefficient control systems for which replacement parts are no longer available. As a result, installers sometimes replace old electronic control units with new programming logic controls (PLCs). Setting up and installing a new PLC involves connecting it to different sensors and electrically powered devices (electric motors, switches, and pumps) and writing a computer program to operate the PLC. Electronics installers often coordinate their efforts with those of other workers who are installing and maintaining equipment. (See the section on industrial machinery mechanics and millwrights elsewhere in the *Handbook*.)

Electrical and electronics installers and repairers, transportation equipment install, adjust, or maintain mobile electronic communication equipment, including sound, sonar, security, navigation, and surveillance systems on trains, watercraft, or other vehicles. *Electrical and electronics repairers, powerhouse, substation, and relay* inspect, test, maintain, or repair electrical equipment used in generating stations, substations, and in-service relays. These workers may be known as powerhouse electricians, relay technicians, or power transformer repairers. *Electric motor, power tool, and related repairers*—such as armature winders, generator mechanics, and electric golf cart repairers—specialize in installing, maintaining, and repairing electric motors, wiring, or switches.

Electronic equipment installers and repairers, motor vehicles have a significantly different job. They install, diagnose, and repair communication, sound, security, and navigation equipment in motor vehicles. Most installation work involves either new alarm or sound systems. New sound systems vary significantly in cost and complexity of installation. For instance, replacing a head unit (radio) with a new CD player is simple, requiring the removal of a few screws and the connection of a few wires. Installing a new sound system with a subwoofer, amplifier, and fuses is far more complicated. The

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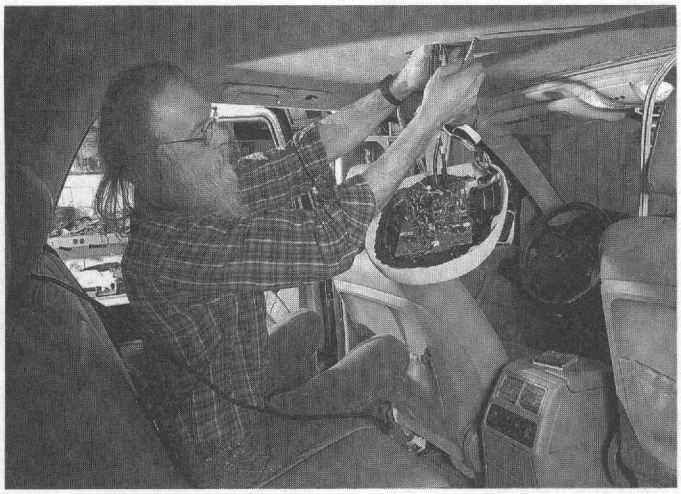

Motor vehicle electronic equipment installers and repairers normally work indoors in well-ventilated and well-lighted repair shops.

installer builds a custom fiberglass or wood box designed to hold the subwoofer and to fit inside the unique dimensions of the automobile. Installing sound-deadening material, which often is necessary with more powerful speakers, requires an installer to remove many parts of a car (for example, seats, carpeting, or interiors of doors), add sound-absorbing material in empty spaces, and reinstall the interior parts. The installer also runs new speaker and electrical cables. The new system may require additional fuses, a new electrical line to be run from the battery through a newly drilled hole in the firewall into the interior of the vehicle, or a more powerful alternator or battery. Motor vehicle installers and repairers work with an increasingly complex range of electronic equipment, including DVD players, satellite navigation equipment, passive security systems, and active security systems.

Work environment. Many electrical and electronics installers and repairers work on factory floors, where they are subject to noise, dirt, vibration, and heat. Bench technicians primarily work in repair shops, where the surroundings are reasonably quiet, comfortable, and well lighted.

Installers and repairers may have to do heavy lifting and work in a variety of positions. They must follow safety guidelines and often wear protective goggles and hardhats. When working on ladders or on elevated equipment, repairers must wear harnesses to avoid falls. Before repairing a piece of machinery, these workers must follow procedures to ensure that others cannot start the equipment during the repair process. They also must take precautions against electric shock by locking off power to the unit under repair.

Motor vehicle electronic equipment installers and repairers normally work indoors in well-ventilated and well-lighted repair shops. Minor cuts and bruises are common, but serious accidents usually are avoided when safety practices are observed.

Training, Other Qualifications, and Advancement

Applicants with an associate degree in electronics are preferred, and professional certification often is required.

Education and training. Knowledge of electrical equipment and electronics is necessary for employment. Employers often prefer applicants with an associate degree from a community college or technical school, although a high school diploma may be sufficient for some jobs. Entry-level repairers may begin by working with experienced technicians who provide technical guidance, and work independently only after developing the necessary skills.

Other qualifications. Installers and repairers should have good eyesight and color perception to work with the intricate components used in electronic equipment. Field technicians work closely with customers and should have good communication skills and a neat appearance. Employers also may require that field technicians have a driver's license.

Certification and advancement. Various organizations offer certification. For instance, the Electronics Technicians Association (ETA) offers over 50 certification programs in numerous electronics specialties for varying levels of competence. The International Society of Certified Electronics Technicians also offers certification for several levels of competence, focusing on a broad range of topics, including basic electronics, electronic systems, and appliance service. To become certified, applicants must meet several prerequisites and pass a comprehensive written or online examination. Certification demonstrates a level of competency and can make an applicant more attractive to employers, as well as increase one's opportunities for advancement.

Experienced repairers with advanced training may become specialists or troubleshooters who assist other repairers diagnose difficult problems. Workers with leadership skills may become supervisors of other repairers. Some experienced workers open their own repair shops.

Employment

Electrical and electronics installers and repairers held about 160,900 jobs in 2008. The following tabulation breaks down their employment by occupational specialty:

Electrical and electronics installers and repairers, commercial and industrial equipment	78,000
Electric motor, power tool, and related repairers	23,700
Electrical and electronics repairers, powerhouse, substation, and relay	23,400
Electrical equipment installers and repairers, motor vehicles	19,700
Electrical and electronics installers and repairers, transportation equipment	16,100

Many repairers worked for repair and maintenance establishments.

Job Outlook

Overall employment is expected to grow more slowly than the average through the year 2018. Job prospects should be best for applicants with an associate degree, certification, and related experience.

Employment change. Overall employment of electrical and electronics installers and repairers is expected to grow by 5 percent through the year 2018, which is slower than the average for all occupations. Growth rates, however, will vary by occupational specialty.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Electrical and electronics installers and repairers	–	160,900	168,400	7,500	5
Electric motor, power tool, and related repairers	49-2092	23,700	24,900	1,200	5
Electrical and electronics installers and repairers, transportation equipment	49-2093	16,100	16,700	700	4
Electrical and electronics repairers, commercial and industrial equipment	49-2094	78,000	81,000	2,900	4
Electrical and electronics repairers, powerhouse, substation, and relay	49-2095	23,400	26,100	2,700	12
Electronic equipment installers and repairers, motor vehicles	49-2096	19,700	19,700	0	0

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Employment of electrical and electronics installers and repairers of commercial and industrial equipment is expected to grow 4 percent, which is slower than the average for all occupations. As equipment becomes more sophisticated, businesses will strive to lower costs by increasing and improving automation. Companies will install electronic controls, robots, sensors, and other equipment to automate processes such as assembly and testing. Improved reliability of equipment, however, may constrain employment growth of installers; on the other hand, companies will increasingly rely on repairers because malfunctions that idle commercial and industrial equipment will continue to be costly.

Little or no employment change is expected for motor vehicle electronic equipment installers and repairers. As motor vehicle manufacturers install more and better sound, security, entertainment, and navigation systems in new vehicles, and as newer electronic systems require progressively less maintenance, employment growth for aftermarket electronic equipment installers will be limited.

Employment of electric motor, power tool, and related repairers is expected to grow 5 percent, which is slower than the average for all occupations. Retrofitting electrical generators in public buildings to reduce emissions and energy consumption will spur some employment growth. However, improvements in electrical and electronic equipment design, as well as the increased use of disposable tool parts should suppress job growth.

Employment of electrical and electronic installers and repairers of transportation equipment is expected to grow 4 percent, which is slower than the average for all occupations. Declining employment in the rail transportation industry will dampen growth in this occupational specialty.

Employment of electrical and electronics installers and repairers, powerhouse, substation, and relay is also expected to grow 12 percent, about as fast as the average for all occupations. While privatization in utilities industries should improve productivity and hinder employment growth, installation of newer, energy efficient green technologies will spur demand for employment.

Job prospects. Job opportunities should be best for applicants with an associate degree in electronics, certification, and related experience. In addition to employment growth, the need to replace workers who transfer to other occupations or leave the labor force will result in some job openings.

Earnings

Median hourly wages of electrical and electronics repairers, commercial and industrial equipment were $23.29 in May 2008. The middle 50 percent earned between $18.40 and $28.73. The lowest 10 percent earned less than $14.39, and the highest 10 percent earned more than $33.81. In May 2008, median hourly wages were $25.31 in the Federal Government and $22.46 in building equipment contractors, the industries employing the largest numbers of electrical and electronics repairers, commercial and industrial equipment.

Median hourly wages of electric motor, power tool, and related repairers were $16.96 in May 2008. The middle 50 percent earned between $13.48 and $21.57. The lowest 10 percent earned less than $10.47, and the highest 10 percent earned more than $26.40. In May 2008, median hourly wages were $16.57 in commercial and industrial machinery and equipment (except automotive and electronic) repair, the industry employing the largest number of electronic motor, power tool, and related repairers.

Median hourly wages of electrical and electronics repairers, powerhouse, substation, and relay were $29.34 in May 2008. The middle 50 percent earned between $25.68 and $33.72. The lowest 10 percent earned less than $20.91, and the highest 10 percent earned more than $38.43. In May 2008, median hourly wages were $29.66 in electric power generation, transmission, and distribution, the industry employing the largest number of these repairers.

Median hourly wages of electronics installers and repairers, motor vehicles were $13.29 in May 2008. The middle 50 percent earned between $10.79 and $16.89. The lowest 10 percent earned less than $8.85, and the highest 10 percent earned more than $21.07.

Median hourly wages of electrical and electronics repairers, transportation equipment were $21.37 in May 2008. The middle 50 percent earned between $16.86 and $25.73. The lowest 10 percent earned less than $13.42, and the highest 10 percent earned more than $30.32.

Related Occupations

Workers in other occupations who install and repair electronic equipment include:

	Page
Aircraft and avionics equipment mechanics and service technicians	684
Broadcast and sound engineering technicians and radio operators	337

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Coin, vending, and amusement machine servicers and repairers 720
Computer, automated teller, and office machine repairers 672
Electricians 641
Electronic home entertainment equipment installers and repairers 678
Elevator installers and repairers 644
Maintenance and repair workers, general 716
Radio and telecommunications equipment installers and repairers 680

Sources of Additional Information

For information on careers and certification, contact any of the following organizations:

➤ ACES International, 5381 Chatham Lake Drive, Virginia Beach, VA 23464. Internet: **http://www.acesinternational.org**

➤ Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: **http://eta-i.org/**

➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107. Internet: **http://www.iscet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos184.htm**

Electronic Home Entertainment Equipment Installers and Repairers

Significant Points

- Employers increasingly prefer applicants who are certified.
- Job opportunities will be best for applicants with knowledge of electronics, related hands-on experience, and good customer service skills.
- Employment is expected to grow as fast as average, due in large part to the rising sales of home entertainment equipment.

Nature of the Work

Electronic home entertainment equipment installers and repairers—also called *service technicians*—repair a variety of audio and video equipment. They may specialize in one type of product, or may be trained in many different ones. The most common products include televisions and radios, stereo components, digital video disc players, and video cameras. They also install and repair satellite television dishes and home theater systems, which consist of large-screen televisions and sophisticated surround-sound audio components.

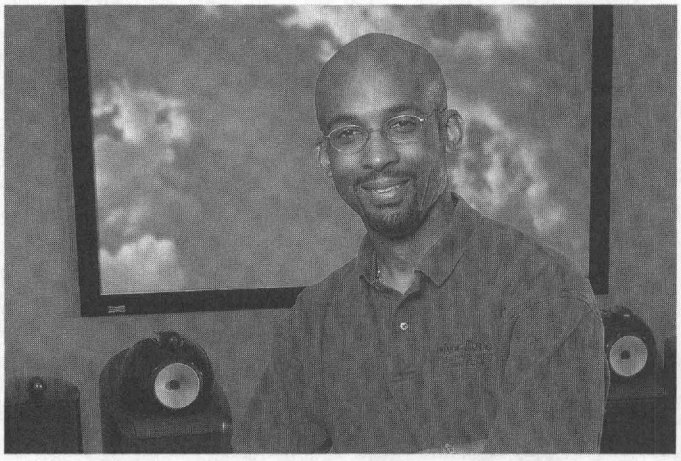
Customers usually bring small, portable equipment to repair shops for servicing. Repairers at these locations, known as *bench technicians*, are equipped with a full array of electronic tools and parts. When larger, less mobile equipment breaks down, customers may pay repairers to come to their homes. These repairers, known as *field technicians*, travel with a limited set of tools and parts, and attempt to complete the repair at the customer's location. If the job is complex, technicians may bring defective components back to the shop for diagnosis and repair.

When equipment breaks down, repairers check for defective components. If routine checks fail to locate the trouble, repairers may refer to schematics and manufacturers' specifications that provide instructions on how to locate problems. Repairers may also use a variety of test equipment to diagnose and identify malfunctions. For example, multimeters detect short circuits, failed capacitors, and blown fuses by measuring voltage, current, and resistance. Color-bar and dot generators provide onscreen test patterns, and oscilloscopes and digital storage scopes measure complex waveforms produced by electronic equipment. Repairs may involve removing and replacing a failed transistor or fuse, often with hand tools, such as pliers, screwdrivers, soldering irons, and wrenches. Repairers also make adjustments to equipment, such as fine tuning the picture quality of a television set or the sound on a surround-sound system.

Improvements in technology have miniaturized and digitized many audio and video recording devices. Miniaturization has made repair work significantly more difficult because both the components and the acceptable tolerances are smaller. Also, components now are mounted on the surface of circuit boards, instead of plugged into slots, requiring more precise soldering when a new part is installed. Improved technologies have lowered the price of electronic home entertainment equipment to the point where customers often replace broken equipment instead of repairing it.

Work environment. Most repairers work in well-lighted electrical repair shops. Field technicians, however, spend much time traveling in service vehicles and working in customers' residences.

Repairers may have to work in a variety of positions and carry heavy equipment. Although the work of repairers is comparatively safe, they must take precautions against minor burns and electric shock. Because television monitors carry high voltage even when they are turned off, repairers need to discharge the voltage before servicing such equipment.



When equipment breaks down, electronic home entertainment equipment installers and repairers check for defective components.

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Training, Other Qualifications, and Advancement

Employers prefer applicants who have knowledge of electronics, good problem-solving skills, and previous repair experience. Good customer service skills are essential for field technicians, as they spend a majority of their time working in customers' homes. Certification is available for entry-level workers and experienced workers seeking advancement.

Education and training. Employers prefer applicants who have knowledge and skills in electronics as well as previous repair experience. Many applicants gain these skills at vocational training programs and community colleges. Training programs should include both hands-on experience and theoretical education in digital consumer electronics. Entry-level repairers may work closely with more experienced technicians, who provide technical guidance.

Other qualifications. Field technicians work closely with customers and must have good communication skills and a neat appearance. Repairers also must have good problem solving skills, as their main duty is to diagnose and solve problems. For home entertainment system installers, excellent vision and a keen sense of sound are important for fine-tuning the installed product. Employers usually require that field technicians have a driver's license.

Certification and advancement. A growing number of employers require applicants to be certified. Various organizations offer certification for electronic home entertainment equipment installers and repairers. For instance, the Electronics Technicians Association (ETA) offers certification programs in numerous electronics specialties, including Residential Electronics Systems Integrator. The International Society of Certified Electronics Technicians also offers certification in multimedia systems and electronic systems. To become certified, applicants must meet several prerequisites and pass a comprehensive written or online examination. Certification demonstrates a level of competency. It can make an applicant more attractive to employers or increase an employee's opportunities for advancement. Experienced repairers with advanced training may become specialists or troubleshooters, helping other repairers to diagnose difficult problems. Workers with leadership ability may become supervisors of other repairers. Some experienced workers open their own repair shops.

Employment

Electronic home entertainment equipment installers and repairers held about 51,200 jobs in 2008. Many repairers—about 33 percent—worked in the retail trade industry. About 26 percent of electronic home entertainment equipment installers and repairers were self-employed.

Job Outlook

Employment is expected to increase about as fast as average for all occupations. Job prospects will be best for applicants with certification, knowledge of electronics, related work experience, and good customer service skills.

Employment change. Employment of electronic home entertainment equipment installers and repairers is expected to grow by 11 percent from 2008 to 2018, which is as fast as the average for all occupations. Demand will be driven by the rising sales of home entertainment equipment.

Employment growth of home entertainment installers will be driven by consumer demand for sophisticated digital equipment, such as high definition televisions, video recorders, cameras, and camcorders. Home entertainment systems continue to grow in popularity and consumers' desire for state-of-the-art sound and picture quality will further spur the need for installers.

The need for repairers, however, is expected to grow slowly because home entertainment equipment is less expensive than in the past. As technological developments have lowered the price and improved the reliability of equipment, the demand for repair services has decreased. When a malfunction does occur, it is often cheaper for consumers to replace equipment than to pay for repairs.

Job prospects. Job openings will arise from employment growth and from the need to replace workers who retire or who leave the occupation. Opportunities will be best for applicants with certification, knowledge of electronics, related hands-on experience, and good customer-service skills.

Earnings

Median hourly wages of wage-and-salary electronic home entertainment equipment installers and repairers were $15.42 in May 2008. The middle 50 percent earned between $12.09 and $19.64. The lowest 10 percent earned less than $9.90, and the highest 10 percent earned more than $24.13. In May 2008, median hourly wages of electronic home entertainment equipment installers and repairers in electrical and electronic goods merchant wholesalers were $17.19, and $16.17 in building equipment contractors.

Related Occupations

Other workers who install, repair, and maintain electronic equipment include:

	Page
Coin, vending, and amusement machine servicers and repairers	720
Computer, automated teller, and office machine repairers	672
Electrical and electronics installers and repairers	675
Electricians	641
Home appliance repairers	707
Maintenance and repair workers, general	716
Radio and telecommunications equipment installers and repairers	680

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Electronic home entertainment equipment installers and repairers	49-2097	51,200	56,800	5,500	11

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Sources of Additional Information

For information on careers and certification, contact:

➤ Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: **http://www.eta-i.org**

➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107. Internet: **http://www.iscet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos187.htm**

Radio and Telecommunications Equipment Installers and Repairers

Significant Points

- Little or no change in employment is projected.
- Job opportunities vary by specialty; good opportunities are expected for central office installers and repairers, but station installers and repairers can expect keen competition.
- Applicants with computer skills and postsecondary electronics training should have the best opportunities.
- Repairers may be on-call around the clock in case of emergencies; therefore, night, weekend, and holiday hours are common.

Nature of the Work

Telephones, computers, and radios depend on a variety of equipment to transmit communications signals and connect to the Internet. From electronic and optical switches that route telephone calls and packets of data to their destinations to radio transmitters and receivers that relay signals from radios in airplanes, boats, and emergency vehicles, complex equipment is needed to keep the country communicating. The workers who set up and maintain this sophisticated equipment are called radio and telecommunications equipment installers and repairers.

Telecommunications equipment installers and repairers have a range of skills and abilities, which vary by the type of work they do and where it is performed. Most work indoors. (Equipment installers who work mainly outdoors are classified as telecommunications line installers and repairers—a separate occupation discussed elsewhere in the *Handbook*.)

Central office installers and repairers—telecommunications equipment installers and repairers who work at switching hubs called central offices—do some of the most complex work. Switching hubs contain the switches and routers that direct packets of information to their destinations. Installers and repairers set up those switches and routers, as well as cables and other equipment.

Although most telephone lines connecting houses to central offices and switching stations are still copper, the lines connecting central hubs to each other are fiber optic. Fiber optic lines, along with newer packet switching equipment, have greatly increased the transmission capacity of each line, allowing an ever increasing amount of information to pass through the lines. Switches and routers are used to transmit, process, amplify, and direct a massive amount of information. Installing and maintaining this equipment requires a high level of technical knowledge.

Nonetheless, the increasing reliability of switches and routers has simplified maintenance as new self-monitoring telecommunications switches can now alert central office repairers to malfunctions. Some switches allow repairers to diagnose and correct problems from remote locations. When faced with a malfunction, the repairer may refer to manufacturers' manuals that provide maintenance instructions.

As cable television and telecommunications technology converge, the equipment used in both technologies is becoming more similar. The distribution centers for cable television companies, which are similar to central offices in the telecommunications sector, are called headends. *Headend technicians* perform essentially the same work as central office technicians, but they work in the cable television industry.

When problems with telecommunications equipment arise, telecommunications equipment repairers diagnose the source of the problem by testing each part of the equipment—a process that requires understanding how the software and hardware interact. To locate the problem, repairers often use spectrum analyzers, network analyzers, or both, to detect any distortion in the signal. To fix the equipment, repairers may use small hand tools, including pliers and screwdrivers, to remove and replace defective components such as circuit boards or wiring. Newer equipment is easier to repair because whole boards and parts are designed to be quickly removed and replaced. Repairers also may install updated software or programs that maintain existing software.

Another type of telecommunications installer and repairer, *PBX installers and repairers*, set up private branch exchange (PBX) switchboards, which relay incoming, outgoing, and interoffice telephone calls within a single location or organization. To install switches and switchboards, installers first connect the equipment to power lines and communications cables and install frames and supports. They test the connections to ensure that adequate power is available and that the communication links work properly. They also install equipment such as power systems, alarms, and telephone sets. New switches and switchboards are computerized and workers often need to install software or program the equipment to provide specific features. Finally, the installer performs tests to verify that the newly installed equipment functions properly. If a problem arises, PBX repairers determine whether it is located within the PBX system or whether it stems from the telephone lines maintained by the local telephone company. Newer installations may use voice-over Internet protocol (VoIP) systems—systems that operate like PBX, but they use a company's computer wiring to run Internet access, network applications, and telephone communications.

Station installers and repairers, telephone—commonly known as *home installers and repairers* or *telecommunications service technicians*—install and repair telecommunications wiring and equipment in customers' home or business premises. They install telephone, VoIP, Internet, and other communications services by installing wiring inside the home or connecting existing wiring to outside service lines. Depending on the service required, they

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may set up television capability or connect modems and install software on a customer's computer. To complete the connection to an outside service line, the installer may need to climb telephone poles or ladders and test the line. Later on, if a maintenance problem occurs, station repairers test the customer's lines to determine if the problem is located in the customer's premises or in the outside service lines and attempt to fix the problem if it is inside. If the problem is with the outside service lines, telecommunications line repairers usually are called to fix it.

Radio mechanics install and maintain radio transmitting and receiving equipment, excluding cellular communications systems. This includes stationary equipment mounted on transmission towers or tall buildings and mobile equipment, such as two-way radio communications systems in taxis, airplanes, ships, and emergency vehicles. Aviation and marine radio mechanics also may work on other electronic equipment, in addition to radios. Newer radio equipment is self-monitoring and may alert mechanics to potential malfunctions. When malfunctions occur, these mechanics examine equipment for damaged components and either fix them, replace the part, or make a software modification. They may use electrical measuring instruments to monitor signal strength, transmission capacity, interference, and signal delay, as well as hand tools to replace defective components and adjust equipment so that it performs within required specifications.

Work environment. Radio and telecommunications equipment installers and repairers generally work in clean, well-lighted, air-conditioned surroundings, such as a telecommunications company's central office, a customer's location, or an electronic service center. Traveling to the site of the installation or repair is common among station installers and repairers, PBX and VoIP installers and repairers, and radio mechanics. Installation may require access to rooftops, attics, ladders, and telephone poles to complete the repair. Radio mechanics may need to work on transmission towers, which may be located on top of tall buildings or mountains, as well as aboard airplanes and ships.

The work of most repairers involves lifting, reaching, stooping, crouching, and crawling. Adherence to safety precautions is important in order to guard against work hazards. These hazards include falls, minor burns, and electrical shock. Data from the U.S. Bureau of Labor Statistics show that telecommunications equipment installers and repairers, except line installers, experienced a work-related injury and illness rate that was higher than the national average.

Nearly all radio and telecommunications equipment installers and repairers work full time during regular business hours to meet the demand for repair services during the workday. Schedules are more irregular at employers that provide repair services 24 hours a day, such as for police radio communications operations or where installation and maintenance must take place after normal business hours. At these locations, mechanics work a variety of shifts, including weekend and holiday hours. Repairers may be on call around the clock, in case of emergencies, and may have to work overtime.

Training, Other Qualifications, and Advancement

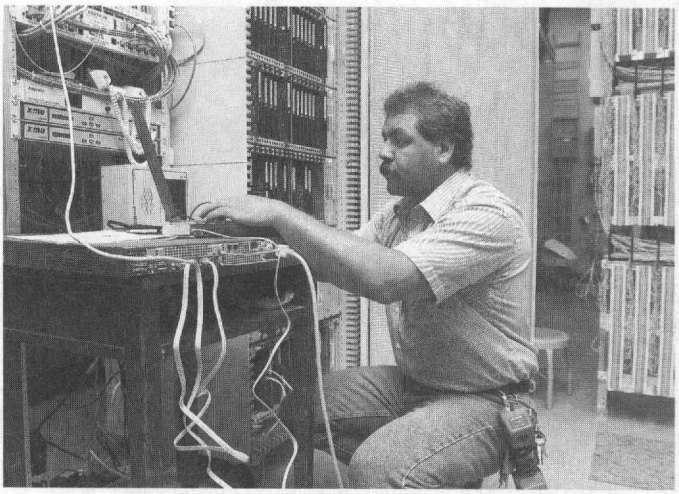
Postsecondary education in electronics and computer technology is increasingly required for radio and telecommunications equipment installers and repairer jobs, and a few employers even prefer people with a bachelor's degree for some of the most complex types of work.

Education and training. As telecommunications technology becomes more complex, the education required for radio and telecommunications equipment installers and repairer jobs has increased. Most employers prefer applicants with postsecondary training in electronics and familiarity with computers. The education needed for these jobs may vary from certification to a 2- or 4-year degree in electronics or a related subject. Sources of training include 2- and 4-year college programs in electronics or communications technology, military experience in radios and electronics, trade schools, and programs offered by equipment and software manufacturers. Educational requirements are higher for central office installers and repairers and for those working in nonresidential settings.

Many in the telecommunications industry work their way up into this occupation by gaining experience at less difficult jobs. Experience as a telecommunications line installer or station installer is helpful before moving up to the job of central office installer and other more complex jobs, for example. Military experience with communications equipment is also valued by many employers in both telecommunications and radio repair.

Newly hired repairers usually receive some training from their employers. This may include formal classroom training in electronics, communications systems, or software and informal hands-on training assisting an experienced repairer. Large companies may send repairers to outside training sessions to learn about new equipment and service procedures. As networks have become more sophisticated—often including equipment from a variety of companies—the knowledge needed for installation and maintenance also has increased.

Licensure. Aviation and marine radio mechanics are required to have a license from the Federal Communications



Radio and telecommunications equipment installers often use computers to diagnose problems with telecommunications switching equipment.

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Commission before they can work on these types of radios. This requires passing several exams on radio law, electronics fundamentals, and maintenance practices.

Other qualifications. Familiarity with computers, being mechanically inclined, and being able to solve problems are traits that are highly regarded by employers. Repairers must also be able to distinguish colors, because wires are typically color-coded. For positions that require climbing poles and towers, workers must be in good physical shape and not afraid of heights. Repairers who handle assignments alone at a customer's site must be able to work without close supervision. For workers who frequently contact customers, a pleasant personality, neat appearance, and good communications skills also are important.

Certification and advancement. This is an occupation where the technology is changing rapidly. Workers must keep abreast of the latest equipment available and know how to repair it. Telecommunications equipment installers and repairers often need to be certified to perform certain tasks or to work on specific equipment. Certification usually requires taking classes. Some certifications are needed to enter the occupation; others are meant to improve one's current abilities or to advance in the occupation.

The Society of Cable and Telecommunications Engineers and the Telecommunications Industry Association offer certifications to workers in this field. Telecommunications equipment manufacturers also provide training on specific equipment.

Experienced repairers with advanced training may become specialists or troubleshooters who help other repairers diagnose difficult problems, or may work with engineers in designing equipment and developing maintenance procedures. Home installers may advance to wiring computer networks or working as a central office installer and repairer. Because of their familiarity with equipment, repairers are particularly well qualified to become manufacturers' sales workers. Workers with leadership ability also may become maintenance supervisors or service managers. Some experienced workers open their own repair service shops, or become wholesalers or retailers of electronic equipment.

Employment

Radio and telecommunications equipment installers and repairers held about 208,800 jobs in 2008. About 203,100 were telecommunications equipment installers and repairers, except line installers. The remaining 5,700 were radio mechanics.

Telecommunications equipment installers and repairers work mostly in the telecommunications industry. Increasingly, however, they can be found in the construction industry working as contractors to the telecommunications industry.

Radio mechanics work in the electronic and precision equipment repair and maintenance industry, the telecommunications industry, electronics and appliance stores, government, and other industries.

Job Outlook

Little or no change in employment of radio and telecommunications equipment installers and repairers is projected. Job opportunities vary by specialty; good opportunities are expected for central office installers and repairers, but station installers and repairers can expect keen competition. Job prospects are best for those with computer skills and postsecondary training in electronics.

Employment change. Little or no change in employment of radio and telecommunications equipment installers and repairers is expected during the 2008-18 period. Over the next decade, telecommunications companies will provide faster Internet connections, provide video-on-demand, add hundreds of television stations, and many services that haven't even been invented yet. Although building the new networks required to provide these services will create jobs, these gains will be offset by a decline in maintenance work. The new equipment requires much less maintenance work because it is newer, more reliable, easier to repair, and more resistant to damage from the elements.

The increased reliability of radio equipment and the use of self-monitoring systems also will continue to lessen the need for radio mechanics. However, technological changes are also creating new wireless applications that create jobs for radio mechanics.

Job prospects. Applicants with computer skills and postsecondary training in electronics should have the best opportunities for radio and telecommunications equipment installer and repairer jobs, but opportunities will vary by specialty. Good opportunities should be available for central office and PBX installers and repairers experienced in current technology, as the growing popularity of VoIP, expanded multimedia offerings such as video on demand, and other telecommunications services continue to place additional demand on telecommunications networks. These new services require high data transfer rates, which can be achieved only by installing new optical switching and routing equipment. Extending high-speed communications from central offices to customers also will require telecommunications equipment installers to put in place more advanced switching and routing equipment,

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Radio and telecommunications equipment installers and repairers	49-2020	208,800	208,100	-700	0
Radio mechanics	49-2021	5,700	5,500	-200	-4
Telecommunications equipment installers and repairers, except line installers	49-2022	203,100	202,600	-500	0

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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but opportunities for repairers will be limited by the increased reliability and automation of the new switching equipment.

Station installers and repairers can expect keen competition. Prewired buildings and the increasing reliability of telephone equipment will reduce the need for installation and maintenance of customers' telephones, as will the declining number of pay telephones in operation as use of cellular telephones grows. However, some of these losses should be offset by the need to upgrade internal lines in businesses and the wiring of new homes and businesses with fiber optic lines.

Radio mechanics should find good opportunities if they have a strong background in electronics and an ability to work independently. Increasing competition from cellular services is limiting the growth of radio services, but employers report difficulty finding adequate numbers of qualified radio mechanics to perform repair work.

Earnings

In May 2008, median annual wages of telecommunications equipment installers and repairers, except line installers, were $55,600. The middle 50 percent earned between $42,930 and $63,030. The bottom 10 percent earned less than $31,330, whereas the top 10 percent earned more than $69,470. Median annual wages of these workers in the wired telecommunications carriers industry were $57,160 in May 2008.

Median annual wages of radio mechanics in May 2008 were $40,260. The middle 50 percent earned between $30,680 and $51,560. The bottom 10 percent earned less than $24,610, whereas the top 10 percent earned more than $63,600.

About 32 percent of radio and telecommunication equipment installers and repairers are members of unions, such as the Communications Workers of America (CWA) and the International Brotherhood of Electrical Workers (IBEW.)

Telecommunications equipment installers and repairers employed by large telecommunications companies who also belong to unions often have very good benefits, including health, dental, vision, and life insurance. They also usually have good retirement and leave policies. Those working for small independent companies and contractors may get fewer benefits.

Radio mechanics tend to work for small electronics firms or government. Benefits vary widely depending upon the type of work and size of firm. Government jobs usually have good benefits.

Related Occupations

Other occupations that involve work with electronic and telecommunications equipment includes:

	Page
Broadcast and sound engineering technicians and radio operators	337
Computer, automated teller, and office machine repairers	672
Electrical and electronics installers and repairers	675
Engineering technicians	173
Line installers and repairers	713

Sources of Additional Information

For information on career and training opportunities, contact:

➤ International Brotherhood of Electrical Workers, Telecommunications Department, 900 7th St. NW. Washington, DC 20001.

➤ Communications Workers of America, 501 3rd St. NW. Washington, DC 20001. Internet: **http://www.cwa-union.org/jobs**

➤ National Coalition for Telecommunications Education and Learning, CAEL, 6021 South Syracuse Way, Suite 213 Greenwood Village, CO 80111. Internet: **http://www.nactel.org**

For information on training and professional certifications in broadband telecommunications, contact:

➤ Society of Cable Telecommunications Engineers, Certification Department, 140 Philips Rd., Exton, PA 19341-1318. **Internet: http://www.scte.org**

For information on training and licensing for aviation and marine radio mechanics, contact:

➤ The Federal Communications Commission (FCC), 445 12th St. SW. Washington, DC 20554. Internet: **http://wireless.fcc.gov/commoperators**

For more information on employers, education, and training in marine electronics and radios, contact:

➤ National Marine Electronics Association, 7 Riggs Ave., Severna Park, MD 21164. Internet: **http://www.nmea.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos188.htm**

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Vehicle and Mobile Equipment Mechanics, Installers, and Repairers

Aircraft and Avionics Equipment Mechanics and Service Technicians

Significant Points

- Most workers learn their jobs in 1 of about 170 schools certified by the Federal Aviation Administration (FAA).
- Job opportunities should be favorable for persons who have completed an aircraft mechanic training program, but keen competition is likely for jobs at major airlines, which offer the best pay and benefits.
- Job opportunities are likely to continue to be best at small commuter and regional airlines, at FAA repair stations, and in general aviation.

Nature of the Work

Today's airplanes are highly complex machines with parts that must function within extreme tolerances for them to operate safely. To keep aircraft in peak operating condition, *aircraft and avionics equipment mechanics and service technicians* perform scheduled maintenance, make repairs, and complete inspections required by the FAA.

Many aircraft mechanics specialize in preventive maintenance. They inspect aircraft engines, landing gear, instruments, pressurized sections, accessories—brakes, valves, pumps, and air-conditioning systems, for example—and other parts of the aircraft, and do the necessary maintenance and replacement of parts. They also keep records related to the maintenance performed on the aircraft. Mechanics and technicians conduct inspections following a schedule based on the number of hours the aircraft has flown, calendar days since the last inspection, cycles of operation, or a combination of these factors. In large, sophisticated planes equipped with aircraft monitoring systems, mechanics can gather valuable diagnostic information from electronic boxes and consoles that monitor the aircraft's basic operations. In planes of all sorts, aircraft mechanics examine engines by working through specially designed openings while standing on ladders or scaffolds or by using hoists or lifts to remove the entire engine from the craft. After taking an engine apart, mechanics use precision instruments to measure parts for wear and use x-ray and magnetic inspection equipment to check for invisible cracks. They repair or replace worn or defective parts. Mechanics also may repair sheet metal or composite surfaces; measure the tension of control cables; and check for corrosion, distortion, and cracks in the fuselage, wings, and tail. After completing all repairs, they must test the equipment to ensure that it works properly.

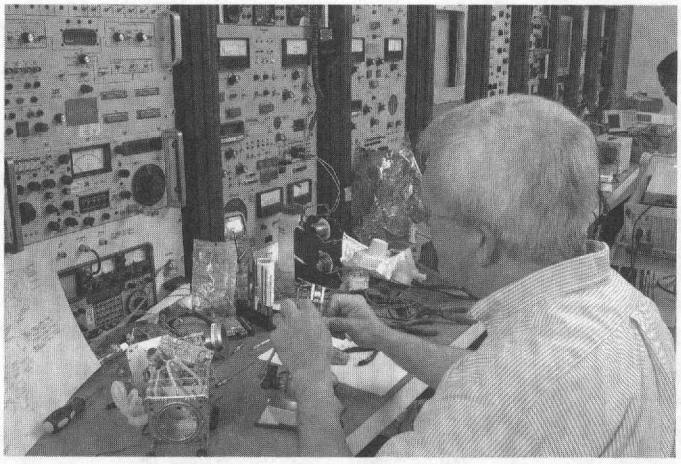
Other mechanics specialize in repair work rather than inspection. They find and fix problems that pilots describe. For example, during a preflight check, a pilot may discover that the aircraft's fuel gauge does not work. To solve the problem, mechanics may troubleshoot the electrical system, using electrical test equipment to make sure that no wires are broken or shorted out, and replace any defective electrical or electronic components. Mechanics work as fast as safety permits so that the aircraft can be put back into service quickly.

Some mechanics work on one or many different types of aircraft, such as jets, propeller-driven airplanes, and helicopters. Others specialize in one section of a particular type of aircraft, such as the engine, hydraulics, or electrical system. In small, independent repair shops, mechanics usually inspect and repair many different types of aircraft.

Airframe mechanics are authorized to work on any part of the aircraft except the instruments, power plants, and propellers. *Powerplant mechanics* are authorized to work on engines and do limited work on propellers. Combination airframe-and-powerplant mechanics—called *A&P mechanics*—work on all parts of the plane except the instruments. Most mechanics working on civilian aircraft today are A&P mechanics.

Avionics systems—components used for aircraft navigation and radio communications, weather radar systems, and other instruments and computers that control flight, engine, and other primary functions—are now an integral part of aircraft design and have vastly increased aircraft capability. *Avionics technicians* repair and maintain these systems. Because of the increasing use of technology, more time is spent repairing electronic systems, such as computerized controls. Technicians also may be required to analyze and develop solutions to complex electronic problems.

Work environment. Mechanics work in hangars, repair stations, or out on the airfield on the "flight lines" where aircraft park. Mechanics often work under time pressure to maintain flight schedules or, in general aviation, to keep from inconveniencing customers. At the same time, mechanics have a tre-



Avionics technicians are responsible for repairing an aircraft's electronics systems.

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mendous responsibility to maintain safety standards, and this can cause the job to be stressful.

Frequently, mechanics must lift or pull objects weighing more than 70 pounds. They often stand, lie, or kneel in awkward positions and occasionally must work in precarious positions, such as on scaffolds or ladders. Noise and vibration are common when engines are being tested, so ear protection is necessary. According to BLS data, full-time aircraft mechanics and service technicians experienced a higher than average work-related injury and illness rate. Aircraft mechanics usually work 40 hours a week on 8-hour shifts around the clock. Overtime and weekend work is frequent.

Training, Other Qualifications, and Advancement

Most mechanics who work on civilian aircraft are certified by the FAA, which requires mechanics to be at least 18 years of age, fluent in English, and have a high school diploma or its equivalent in addition to having the needed technical skills. Most mechanics learn their skills in an FAA-certified Aviation Maintenance Technician School

Education and training. Although a few people become mechanics through on-the-job training, most learn the skills needed to do their jobs in 1 of about 170 Aviation Maintenance Technician schools certified by the FAA. By law, FAA standards require that certified mechanic schools offer students a minimum of 1,900 class-hours. Coursework in schools normally lasts from 12 to 24 months and provides training with the tools and equipment used on the job. About one-third of these schools award 2-year and 4-year degrees in avionics, aviation technology, or aviation maintenance management.

Aircraft trade schools are placing more emphasis on technologies such as turbine engines, composite materials, and aviation electronics, which are increasingly being used in the construction of new aircraft. Technological advances have also affected aircraft maintenance, meaning mechanics must have an especially strong background in computers and electronics to get or keep jobs in this field.

Courses in mathematics, physics, chemistry, electronics, computer science, and mechanical drawing are helpful because they demonstrate many of the principles involved in the operation of aircraft, and knowledge of these principles is often necessary to make repairs. Courses that develop writing skills also are important because mechanics are often required to submit reports. Mechanics must be able to read, write, and understand English.

A few mechanics are trained on the job by experienced mechanics. Their work must be supervised and documented by certified mechanics until they have FAA certificates.

Licensure. The FAA requires that all maintenance work on aircraft be performed by certified mechanics or under the supervision of a certified mechanic. As a result, most airlines hire mechanics that have FAA certification. The FAA offers certification for airframe mechanics and powerplant mechanics, although most airlines prefer to hire mechanics with a combined A&P certificate.

Mechanics need at least 18 months of work experience before applying for an airframe or powerplant certificate, and 30 months of experience working with both engines and airframes for a combined A&P certificate, although completion of a program at an FAA-certified school can be substituted for theses work experience requirements.

In addition to having experience or formal training, applicants for all certificates must pass written, oral, and practical tests that demonstrate that they can do the work authorized by the certificate. Written tests are administered at one of the many designated computer testing facilities worldwide, while the oral and practical tests are administered by a Designated Mechanic Examiner of the FAA. All tests must be passed within a 24- month period to receive certification.

FAA regulations require current work experience to keep certificates valid. Applicants must have at least 1,000 hours of work experience in the previous 24 months or take a refresher course. Mechanics also must take at least 16 hours of training every 24 months to keep their certificates current. Many mechanics take training courses offered by manufacturers or employers, usually through outside contractors.

The FAA allows certified airframe mechanics who are trained and qualified and who have the proper tools to work on avionics equipment. However, avionics technicians are not required to have FAA certification if they have avionics repair experience from the military or from working for avionics manufacturers. Avionics technicians who work on communications equipment must obtain a restricted radio-telephone operator license from the Federal Communications Commission.

Other qualifications. Aircraft mechanics must do careful and thorough work that requires a high degree of mechanical aptitude. Employers seek applicants who are self-motivated, hard-working, enthusiastic, and able to diagnose and solve complex mechanical problems. Additionally, employers prefer mechanics who can perform a variety of tasks. Agility is important for the reaching and climbing necessary to do the job. Because they may work on the tops of wings and fuselages on large jet planes, aircraft mechanics must not be afraid of heights.

Advances in computer technology, aircraft systems, and the materials used to manufacture airplanes have made mechanics' jobs more highly technical. Aircraft mechanics must possess the skills necessary to troubleshoot and diagnose complex aircraft systems. They also must continually update their skills with and knowledge of new technology and advances in aircraft technology.

Some aircraft mechanics in the Armed Forces acquire enough general experience to satisfy the work experience requirements for the FAA certificate. With additional study, they may pass the certifying exam. In general, however, jobs in the military services are too specialized to provide the broad experience required by the FAA. Most Armed Forces mechanics have to complete the entire FAA training program, although a few receive some credit for the material they learned in the service. In any case, military experience is a great advantage when seeking employment; employers consider applicants with formal training to be the most desirable applicants.

Advancement. As aircraft mechanics gain experience, they may advance to lead mechanic (or crew chief), inspector, lead inspector, or shop supervisor positions. Opportunities are best for those who have an aircraft inspector's authorization. To obtain an

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Aircraft and avionics equipment mechanics and service technicians	–	140,300	150,100	9,800	7
Avionics technicians	49-2091	18,800	20,800	2,000	11
Aircraft mechanics and service technicians	49-3011	121,500	129,300	7,800	6

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

inspector's authorization, a mechanic must have held an A&P certificate for at least 3 years, with 24 months of hands-on experience.

In the airlines, where promotion often is determined by examination, supervisors sometimes advance to executive positions. Those with broad experience in maintenance and overhaul might become inspectors with the FAA. With additional business and management training, some open their own aircraft maintenance facilities. Mechanics with the necessary pilot licenses and flying experience may take the FAA examination for the position of flight engineer, with opportunities to become pilots.

Mechanics and technicians learn many different skills in their training that can be applied to other jobs, and some transfer to other skilled repairer occupations or electronics technician jobs. For example, some avionics technicians continue their education and become aviation engineers, electrical engineers (specializing in circuit design and testing), or communication engineers. Others become repair consultants, in-house electronics designers, or join research groups that test and develop products.

Employment

Aircraft and avionics equipment mechanics and service technicians held about 140,300 jobs in 2008; about 87 percent of these workers were aircraft mechanics and service technicians; the rest were avionics technicians.

Employment of aircraft and avionics equipment mechanics and service technicians primarily is concentrated in a small number of industries. Almost half of aircraft and avionics equipment mechanics and service technicians worked in air transportation and support activities for air transportation. About 21 percent worked in aerospace product and parts manufacturing and about 15 percent worked for the Federal Government. Most of the rest worked for companies that operate their own planes to transport executives and cargo.

Most airline mechanics and service technicians work at major airports near large cities. Civilian mechanics employed by the U.S. Armed Forces work at military installations.

Job Outlook

Job growth for aircraft and avionics equipment mechanics and service technicians is expected to be about as fast as the average for all occupations. Job opportunities should be favorable for people who have completed an aircraft mechanic training program, but keen competition is likely for jobs at major airlines.

Employment change. Employment is expected to increase by 7 percent during the 2008-18 period, which is about as fast as the average for all occupations. Passenger air traffic is expected to increase as the result of an expanding economy and a growing population, and the need for aircraft mechanics and service technicians will grow accordingly. Although there is an increasing trend for some large airlines to outsource aircraft and avionics equipment mechanic jobs overseas, most airline companies still prefer that aircraft maintenance be performed in the U.S. because overseas contractors may not comply with more stringent U.S. safety regulations.

Job prospects. Most job openings for aircraft mechanics through the year 2018 will stem from the need to replace the many mechanics expected to retire over the next decade. In addition, some mechanics will leave to work in related fields, such as automobile repair, as their skills are largely transferable to other maintenance and repair occupations.

Also contributing to favorable future job opportunities for mechanics is the long-term trend toward fewer students entering technical schools to learn skilled maintenance and repair trades. Many of the students who have the ability and aptitude to work on planes are choosing to go to college, work in computer-related fields, or go into other repair and maintenance occupations with better working conditions. If this trend continues, the supply of trained aviation mechanics may not keep up with the needs of the air transportation industry.

Job opportunities will continue to be the best at small commuter and regional airlines, at FAA repair stations, and in general aviation. Commuter and regional airlines is the fastest growing segment of the air transportation industry, but wages in these airlines tend to be lower than those in the major airlines, so they attract fewer job applicants. Also, some jobs will become available as experienced mechanics leave for higher paying jobs with the major airlines or transfer to other occupations. Mechanics will face more competition for jobs with large airlines because the high wages and travel benefits that these jobs offer generally attract more qualified applicants than there are openings.

Nonetheless, job opportunities with the airlines are expected to be better than they have been in the past. In general, prospects will be best for applicants with experience and an A&P certification. Mechanics who keep abreast of technological advances in electronics, composite materials, and other areas will be in greatest demand. Also, mechanics who are willing to relocate to smaller rural areas will have better job opportunities.

Avionics technicians who are trained to work with complex aircraft systems, performing some duties normally performed by certified A&P mechanics, should have the best job prospects. Additionally, technicians with licensing that enables them to work on the airplane, either removing or reinstalling equipment, are expected to be in especially high demand.

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Earnings

Median hourly wages of aircraft mechanics and service technicians were about $24.71 in May 2008. The middle 50 percent earned between $20.25 and $29.25. The lowest 10 percent earned less than $15.85, and the highest 10 percent earned more than $33.19. Median hourly wages in the industries employing the largest numbers of aircraft mechanics and service technicians in May 2008 were:

Scheduled air transportation	$27.96
Federal Executive Branch	24.98
Aerospace product and parts manufacturing	24.47
Nonscheduled air transportation	24.27
Support activities for air transportation	20.95

Median hourly wages of avionics technicians were about $23.71 in May 2008. The middle 50 percent earned between $20.10 and $28.02. The lowest 10 percent earned less than $16.45, and the highest 10 percent earned more than $30.87.

Mechanics who work on jets for the major airlines generally earn more than those working on other aircraft. Those who graduate from an aviation maintenance technician school often earn higher starting salaries than individuals who receive training in the Armed Forces or on the job. Airline mechanics and their immediate families receive reduced-fare transportation on their own and most other airlines.

Almost 3 in 10 aircraft and avionics equipment mechanics and service technicians are members of unions or covered by union agreements. The principal unions are the International Association of Machinists and Aerospace Workers and the Transport Workers Union of America. Some mechanics are represented by the International Brotherhood of Teamsters.

Related Occupations

Workers in some other occupations that involve similar mechanical and electrical work include:

	Page
Automotive service technicians and mechanics	690
Electrical and electronics installers and repairers	675
Electricians	641
Elevator installers and repairers	644

Sources of Additional Information

Information about jobs with a particular airline can be obtained by writing to the personnel manager of the company.

For general information about aircraft and avionics equipment mechanics and service technicians, contact:

➤ Professional Aviation Maintenance Association, 400 North Washington St., Suite 300. Alexandria, VA 22314. Internet: **http://www.pama.org**

For information on jobs in a particular area, contact employers at local airports or local offices of the State employment service.

Information on obtaining positions as aircraft and avionics equipment mechanics and service technicians with the Federal Government is available from the Office of Personnel Management through USAJOBS, the Federal Government's official employment information system. This resource for locating and applying for job opportunities can be accessed through the Internet at **http://www.usajobs.opm.gov** or through an interactive voice response telephone system at (703) 724-1850 or TDD (978) 461-8404. These numbers are not toll free, and charges may result.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos179.htm**

Automotive Body and Related Repairers

Significant Points

- Little or no change in the overall number of jobs is expected.
- Repairers need good reading ability and basic mathematics and computer skills to use print and digital technical manuals.
- Many repairers, particularly in urban areas, need a national certification to advance past entry-level work.

Nature of the Work

Most of the damage resulting from everyday vehicle collisions can be repaired, and vehicles can be refinished to look and drive like new. This damage may be relatively minor, such as scraped paint or a dented panel, or major, requiring the complex replacement of parts. Such repair services are performed by trained workers.

Automotive body and related repairers, often called *collision repair technicians*, straighten bent bodies, remove dents, and replace crumpled parts that cannot be fixed. They repair all types of vehicles, and although some work on large trucks, buses, or tractor-trailers, most work on cars and small trucks. They can work alone, with only general direction from supervisors, or as specialists on a repair team. In some shops, helpers or apprentices assist experienced repairers.

Each damaged vehicle presents different challenges for repairers. Using their broad knowledge of automotive construction and repair techniques, automotive body repairers must decide how to handle each job based on what the vehicle is made of and what needs to be fixed. They must first determine the extent of the damage and decide which parts can be repaired or need to be replaced.

If the car is heavily damaged, an automotive body repairer might start by measuring the frame to determine if there has been structural damage. Repairers would then attach or clamp frames and sections to structural machines that use hydraulic pressure to align damaged components. "Unibody" vehicles—designs built without frames—must be restored to precise factory specifications for the vehicle to operate correctly. For these vehicles, repairers use bench systems to accurately measure how much each section is out of alignment, and hydraulic machinery to return the vehicle to its original shape.

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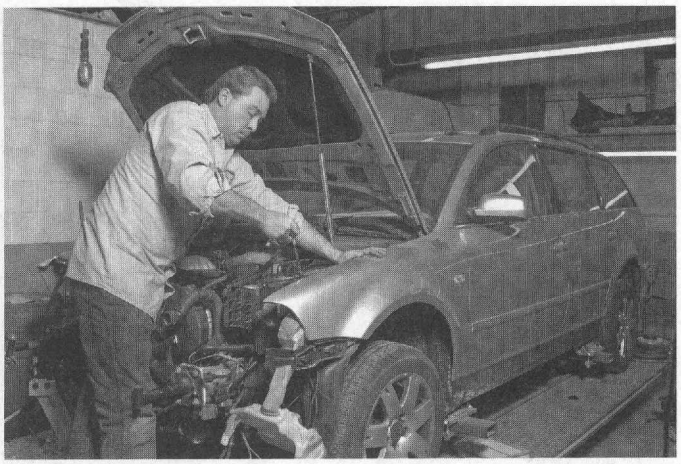

Automotive body repairers must carefully restore cars to given specifications following an accident.

Only once the frame is aligned properly can repairers begin to fix or replace other damaged body parts. If the vehicle or part is made of metal, body repairers will use a pneumatic metal-cutting gun or a plasma cutter to remove badly damaged sections of body panels and then weld or otherwise attach replacement sections. Less serious dents are pulled out with a hydraulic jack or hand prying bar or knocked out with hand tools or pneumatic hammers. Small dents and creases in the metal are smoothed by holding a small anvil against one side of the damaged area while hammering the opposite side. Repairers may also remove very small pits and dimples with pick hammers and punches in a process called metal finishing. Body repairers then use plastic or solder to fill small dents that cannot be worked out of plastic or metal panels. On metal panels, they sculpt the hardened filler to the original shape by filing, grinding and sanding the repair back to the shape that is desired.

Body repairers may also repair or replace the plastic body parts that are increasingly used on new vehicles. They remove damaged panels and identify the type and properties of the plastic used. Some types of plastic allow repairers to apply heat from a hot-air welding gun or immerse the panel in hot water and press the softened section back into shape by hand. In most cases, it is more cost effective for the plastic parts to be replaced rather than to be repaired. A few body repairers specialize in fixing fiberglass car bodies.

Some body repairers specialize in installing and repairing glass in automobiles and other vehicles. *Automotive glass installers and repairers* remove broken, cracked, or pitted windshields and window glass. Glass installers apply a moisture-proofing compound along the edges of the glass, place the glass in the vehicle, and install rubber strips around the sides of the windshield or window to make it secure and weatherproof.

Many large shops make repairs using an assembly-line approach where vehicles are fixed by a team of repairers who each specialize in several types of repair. One worker might straighten frames while another repairs doors and fenders, for example. In most shops, automotive painters do the priming and refinishing, but in small shops, workers often do both body repairing and painting. (Automotive painters are discussed in the section on painting and coating workers, except construction and maintenance elsewhere in the *Handbook*.)

Work environment. Repairers work indoors in body shops where noise from the clatter of hammers against metal and the whine of power tools is prevalent. Most shops are well ventilated to disperse dust and paint fumes. Body repairers may also be required to work in awkward or cramped positions, and much of their work can be physically challenging. Hazards include cuts from sharp metal edges, burns from torches and heated metal, and injuries from power tools. However, serious accidents usually are avoided when the shop is kept clean and orderly and safety practices are observed.

Most automotive body repairers work a standard 40-hour week. More than 40 hours a week may be required when there is a backlog of repair work to be completed. This may include working on weekends.

Training, Other Qualifications, and Advancement

As automotive technology rapidly becomes more sophisticated, most employers prefer applicants who have completed a formal training program in automotive body repair or refinishing. Most new repairers complete at least part of this training on the job, while continuing to receive training from industry vendors or suppliers throughout their careers. Many repairers, particularly in urban areas, need a national certification to advance past entry-level work.

Education and training. A high school diploma or GED is often all that is required to enter this occupation, but more specific education and training is needed to learn how to repair newer automobiles. Collision repair programs may be offered in high school or in postsecondary vocational schools and community colleges. Courses in electronics, physics, chemistry, English, computers, and mathematics provide a good background for a career as an automotive body repairer. Training programs combine classroom instruction and hands-on practice.

Trade and technical school programs typically award certificates to graduates after 6 months to a year of collision repair study. Some community colleges offer 2-year programs in collision repair. Many of these schools also offer certificates for individual courses, so that students are able to take classes incrementally or as needed.

New repairers begin by assisting experienced body repairers in tasks such as removing damaged parts and sanding body panels. Novices learn to remove small dents and make other minor repairs. They then progress to more difficult tasks, such as straightening body parts and installing either repaired or replaced bolt-on parts. Generally, it takes 3 to 4 years of hands-on training to become skilled in all aspects of body repair, some of which may be completed as part of a formal education program. Basic automotive glass installation and repair can be learned in as little as 6 months, but becoming fully qualified can take several years.

Continuing education and training are needed throughout a career in automotive body repair. Automotive parts composition, body materials, electronics, and airbags and other new safety components continue to change and to become more complex. To keep up with these technological advances, repairers must continue to gain new skills by reading technical manuals and furthering their education with classes and seminars. Many companies within the automotive body repair industry

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Automotive body and related repairers	–	185,900	187,000	1,100	1
Automotive body and related repairers	49-3021	166,400	167,200	800	0
Automotive glass installers and repairers	49-3022	19,500	19,900	400	2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

send employees to advanced training programs to brush up on old skills or to learn new techniques.

Other qualifications. Fully skilled automotive body repairers must have good reading ability and basic mathematics, including geometry, physics, and computer skills. Restoring unibody automobiles to their original specification requires repairers to follow instructions and diagrams in print and digital technical manuals and to make precise three-dimensional measurements of the position of one body section relative to another. In addition, repairers should enjoy working with their hands and be able to pay attention to detail while they work.

Certification and advancement. Certification by the National Institute for Automotive Service Excellence (ASE), although voluntary, is the pervasive industry credential for experienced automotive body repairers. Many repairers, particularly in urban areas, need a national certification to advance past entry-level work. Repairers may take up to four ASE Master Collision Repair and Refinish Exams. Repairers who pass at least one exam and have 2 years of hands-on work experience earn ASE certification. The completion of a postsecondary program in automotive body repair may be substituted for 1 year of work experience. Those who pass all four exams become ASE Master Collision Repair and Refinish Technicians. Automotive body repairers must retake the examination at least every 5 years to retain their certification. Ongoing training through the Inter-Industry Conference on Auto Collision Repair (I-CAR) can lead to additional recognition as a Platinum technician. Finally, many vehicle manufacturers and paint manufacturers also have product certification programs that can advance a repairer's career.

As beginners increase their skills, learn new techniques, earn certifications, and complete work more rapidly, their pay increases. An experienced automotive body repairer with managerial ability may advance to shop supervisor, and some workers open their own body repair shops. Other repairers become automobile damage appraisers for insurance companies.

Employment

Automotive body and related repairers held about 185,900 jobs in 2008; about 10 percent specialized in automotive glass installation and repair. Around 62 percent of repairers worked for automotive repair and maintenance shops, while 17 percent worked for automobile dealers. A small number worked for wholesalers of motor vehicles, parts, and supplies. About 12 percent of automotive body repairers were self-employed.

Job Outlook

Employment is projected to see little or no change. Job opportunities will be excellent for people with formal training in automotive body repair and refinishing as older workers retire and need to be replaced; those without any training or experience will face competition.

Employment change. Employment of automotive body repairers is expected to grow by 1 percent over the 2008-18 decade. The number of vehicles on the road is expected to continue increasing over the next decade. This will lead to overall growth in the demand for collision repair services. The increasing role of technology in vehicles also will mean new opportunities for workers with expertise or training in repairing particular makes and models of cars or working with specific materials.

However, several factors will limit the number of new jobs for automotive body repairers. The increasingly advanced technology used in vehicles has led to significant increases in the prices of new and replacement parts. Collision repair shop owners, in an effort to stay profitable, have adopted productivity enhancing techniques. The result of this has also been consolidation within the industry, or a decreasing number of collision repair shops and limited total employment growth. In some cases, the use of new technology like airbags has led to more cars that are involved in accidents to be declared a total loss – where repairing a car costs more than the value of the vehicle. High insurance deductibles have meant that an increasing number of cars suffering minor collision damage are going unrepaired.

Job prospects. Although few jobs are expected to arise due to growth, the need to replace experienced repairers who transfer to other occupations or who retire or stop working for other reasons will provide many job openings over the next 10 years. Opportunities will be excellent for people with formal training in automotive body repair and refinishing. Those without any training or experience in automotive body refinishing or collision repair will face competition for these jobs.

Earnings

Median hourly wages of automotive body and related repairers, including incentive pay, were $17.81 in May 2008. The middle 50 percent earned between $13.74 and $23.57 an hour. The lowest 10 percent earned less than $10.75, and the highest 10 percent earned more than $30.17 an hour. Median hourly wages of automotive body and related repairers were $18.95 in automobile dealers and $17.40 in automotive repair and maintenance.

Median hourly wages of automotive glass installers and repairers, including incentive pay, were $15.44 in May 2008. The middle 50 percent earned between $12.40 and $18.88 an hour. The lowest 10 percent earned less than $9.71 and the highest 10 percent earned more than $23.39 an hour. Median hourly wages in automotive repair and maintenance shops, the industry employing most automotive glass installers and repairers, were $15.34.

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The majority of body repairers employed by independent repair shops and automotive dealers are paid on an incentive basis. Under this system, body repairers are paid a set amount for various tasks, and earnings depend on both the amount of work assigned and how fast it is completed. Employers frequently guarantee workers a minimum weekly salary. Body repairers who work for trucking companies, buslines, and other organizations that maintain their own vehicles usually receive an hourly wage.

Helpers and trainees typically earn between 30 percent and 60 percent of the earnings of skilled workers. They are paid by the hour until they are skilled enough to be paid on an incentive basis.

Employee benefits vary widely from business to business. However, industry sources report that benefits such as paid leave, health insurance, and retirement assistance are increasingly common in the collision repair industry. Automotive dealerships are the most likely to offer such incentives.

Related Occupations

Other occupations associated with vehicle maintenance and repair includes:

	Page
Automotive service technicians and mechanics	690
Diesel service technicians and mechanics	694
Glaziers	647
Heavy vehicle and mobile equipment service technicians and mechanics	697
Painting and coating workers, except construction and maintenance	778

Sources of Additional Information

Additional details about work opportunities may be obtained from automotive body repair shops, automobile dealers, or local offices of your State employment service. State employment service offices also are a source of information about training programs.

For general information about automotive body repairer careers, contact any of the following sources:

➤ Automotive Careers Today, 8400 Westpark Dr., MS #2, McLean, VA 22102. Internet: **http://www.autocareerstoday.org**

➤ Automotive Service Association, P.O. Box 929, Bedford, TX 76095. Internet: **http://www.asashop.org**

➤ Inter-Industry Conference on Auto Collision Repair Education Foundation (I-CAR), 5125 Trillium Blvd., Hoffman Estates, IL 60192. Internet: **http://www.collisioncareers.org**

➤ Society of Collision Repair Specialists, P.O. Box 909 Prosser, WA 99350. Internet: **http://www.scrs.com**

For general information about careers in automotive glass installation and repair, contact:

➤ National Glass Association, 8200 Greensboro Dr., Suite 302, McLean, VA 22102. Internet: **http://www.myglassclass.com**

For information on how to become a certified automotive body repairer, write to:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.asecert.org**

For a directory of certified automotive body repairer programs, contact:

➤ National Automotive Technician Education Foundation, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.natef.org**

For a directory of accredited private trade and technical schools that offer training programs in automotive body repair, contact:

➤ Accrediting Commission of Career Schools and Colleges, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: **http://www.accsc.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos180.htm**

Automotive Service Technicians and Mechanics

Significant Points

- Automotive service technicians and mechanics must continually adapt to changing technology and repair techniques.
- Formal automotive technician training is the best preparation.
- Opportunities should be very good for those who complete postsecondary automotive training programs; those without formal automotive training are likely to face competition for entry-level jobs.

Nature of the Work

Automotive service technicians inspect, maintain, and repair automobiles and light trucks that run on gasoline, electricity, or alternative fuels, such as ethanol. They perform basic care maintenance, such as oil changes and tire rotations, diagnose more complex problems, and plan and execute vehicle repairs. (Service technicians who work on diesel-powered trucks, buses, and equipment are discussed in the *Handbook* section on diesel service technicians and mechanics. Motorcycle technicians—who repair and service motorcycles, motor scooters, mopeds, and small all-terrain vehicles—are discussed in the *Handbook* section on small engine mechanics.)

Automotive service technicians' and mechanics' responsibilities have evolved from simple mechanical repairs to high-level technology-related work. Today, integrated electronic systems and complex computers regulate vehicles and their performance while on the road. This increasing sophistication of automobiles requires workers who can use computerized shop equipment and work with electronic components while maintaining their skills with traditional hand tools. Technicians must have an increasingly broad knowledge of how vehicles' complex components work and interact. They also must be able to work with electronic diagnostic equipment and digital manuals and reference materials.

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When mechanical or electrical troubles occur, technicians first get a description of the problem from the owner or, in a large shop, from the repair service estimator or service advisor who wrote the repair order. To locate the problem, technicians use a diagnostic approach. First, they test to see whether components and systems are secure and working properly. Then, they isolate the components or systems that might be the cause of the problem. For example, if an air-conditioner malfunctions, the technician might check for a simple problem, such as a low coolant level, or a more complex issue, such as a bad drive-train connection that has shorted out the air conditioner. As part of their investigation, technicians may test drive the vehicle or use a variety of testing equipment, including onboard and hand-held diagnostic computers or compression gauges. These tests may indicate whether a component is salvageable or whether a new one is required. Accuracy and efficiency are critical in diagnosing and repairing vehicles, as parts are increasingly expensive, and timely repairs allow shops to take on more business.

During routine service inspections, technicians test and lubricate engines and other major components. Sometimes, technicians repair or replace worn parts before they cause breakdowns or damage the vehicle. Technicians usually follow a checklist to ensure that they examine every critical part. Belts, hoses, plugs, brakes, fuel systems, and other potentially troublesome items are watched closely.



Automotive service technicians and mechanics perform routine vehicle maintenance as well as major repairs.

Service technicians use a variety of tools in their work. They use power tools, such as pneumatic wrenches, to remove bolts quickly; machine tools like lathes and grinding machines to rebuild brakes; welding and flame-cutting equipment to remove and repair exhaust systems; and jacks and hoists to lift cars and engines. They also use common hand tools, such as screwdrivers, pliers, and wrenches, to work on small parts and in hard-to-reach places. Technicians usually provide their own hand tools, and many experienced workers have thousands of dollars invested in them. Employers furnish expensive power tools, engine analyzers, and other diagnostic equipment.

Computers are also commonplace in modern repair shops. Service technicians compare the readouts from computerized diagnostic testing devices with benchmarked standards given by the manufacturer. Deviations outside of acceptable levels tell the technician to investigate that part of the vehicle more closely. Through the Internet or from software packages, most shops receive automatic updates to technical manuals and access to manufacturers' service information, technical service bulletins, and other databases that allow technicians to keep up with common problems and to learn new procedures.

High technology tools are needed to fix the computer equipment that operates everything from the engine to the radio in many cars. In fact, today, most automotive systems, such as braking, transmission, and steering systems, are controlled primarily by computers and electronic components. Additionally, luxury vehicles often have integrated global positioning systems, accident-avoidance systems, and other new features with which technicians will need to become familiar. Also, as more alternate-fuel vehicles are purchased, more automotive service technicians will need to learn the science behind these automobiles and how to repair them.

Automotive service technicians in large shops often specialize in certain types of repairs. For example, *transmission technicians and rebuilders* work on gear trains, couplings, hydraulic pumps, and other parts of transmissions. Extensive knowledge of computer controls, the ability to diagnose electrical and hydraulic problems, and other specialized skills are needed to work on these complex components, which employ some of the most sophisticated technology used in vehicles. *Tune-up technicians* adjust ignition timing and valves and adjust or replace spark plugs and other parts to ensure efficient engine performance. They often use electronic testing equipment to isolate and adjust malfunctions in fuel, ignition, and emissions control systems.

Automotive air-conditioning repairers install and repair air-conditioners and service their components, such as compressors, condensers, and controls. These workers require special training in Federal and State regulations governing the handling and disposal of refrigerants. *Front-end mechanics* align and balance wheels and repair steering mechanisms and suspension systems. They frequently use special alignment equipment and wheel-balancing machines. *Brake repairers* adjust brakes, replace brake linings and pads, and make other repairs on brake systems. Some technicians specialize in both brake and front-end work.

Work environment. While in 2008, most automotive service technicians worked a standard 40 hour week, 24 percent

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worked longer hours. Some may work evenings and weekends to satisfy customer service needs. Generally, service technicians work indoors in well-ventilated and well-lighted repair shops. However, some shops are drafty and noisy. Although many problems can be fixed with simple computerized adjustments, technicians frequently work with dirty and greasy parts and in awkward positions. They often lift heavy parts and tools. As a result, minor workplace injuries are not uncommon, but technicians usually can avoid serious accidents if safe practices are observed.

Training, Other Qualifications, and Advancement

Automotive technology is rapidly growing in sophistication, and employers are increasingly looking for workers who have completed a formal training program in high school or in a postsecondary vocational school or community college. Acquiring National Institute for Automotive Service Excellence (ASE) certification is important for those seeking work in large, urban areas.

Education and training. Most employers regard the successful completion of a vocational training program in automotive service technology as the best preparation for trainee positions. High school programs, while an asset, vary greatly in scope. Graduates of these programs may need further training to become qualified. Some of the more extensive high school programs participate in Automotive Youth Education Service (AYES), a partnership between high school automotive repair programs, automotive manufacturers, and franchised automotive dealers. All AYES high school programs are certified by the National Institute for Automotive Service Excellence. Students who complete these programs are well prepared to enter entry-level technician positions or to advance their technical education. Courses in automotive repair, electronics, physics, chemistry, English, computers, and mathematics provide a good educational background for a career as a service technician.

Postsecondary automotive technician training programs usually provide intensive career preparation through a combination of classroom instruction and hands-on practice. Schools update their curriculums frequently to reflect changing technology and equipment. Some trade and technical school programs provide concentrated training for 6 months to a year, depending on how many hours the student attends each week, and upon completion, award a certificate. Community college programs usually award a certificate or an associate degree. Some students earn repair certificates in a particular skill and leave to begin their careers. Associate degree programs, however, usually take 2 years to complete and include classes in English, basic mathematics, computers, and other subjects, as well as automotive repair. Recently, some programs have added classes on customer service, stress management, and other employability skills. Some formal training programs have alliances with tool manufacturers that help entry-level technicians accumulate tools during their training period.

Various automobile manufacturers and participating franchised dealers also sponsor 2-year associate degree programs at postsecondary schools across the Nation. Students in these programs typically spend alternate 6-week to 12-week periods attending classes full time and working full time in the service departments of sponsoring dealers. At these dealerships, students work with an experienced worker who provides hands-on instruction and timesaving tips.

Those new to automotive service usually start as trainee technicians, technicians' helpers, or lubrication workers, and gradually acquire and practice their skills by working with experienced mechanics and technicians. In many cases, on-the-job training may be a part of a formal education program. With a few months' experience, beginners perform many routine service tasks and make simple repairs. While some graduates of postsecondary automotive training programs often are able to earn promotion to the journey level after only a few months on the job, it typically takes 2 to 5 years of experience to become a fully qualified service technician, who is expected to quickly perform the more difficult types of routine service and repairs. An additional 1 to 2 years of experience familiarizes technicians with all types of repairs. Complex specialties, such as transmission repair, require another year or two of training and experience. In contrast, brake specialists may learn their jobs in considerably less time because they do not need complete knowledge of automotive repair.

Employers increasingly send experienced automotive service technicians to manufacturer training centers to learn to repair new models or to receive special training in the repair of components, such as electronic fuel injection or air-conditioners. Motor vehicle dealers and other automotive service providers may send promising beginners or experienced technicians to manufacturer-sponsored technician training programs to upgrade or maintain employees' skills. Factory representatives also visit many shops to conduct short training sessions.

Other qualifications. The ability to diagnose the source of a problem quickly and accurately requires good reasoning ability and a thorough knowledge of automobiles. Many technicians consider diagnosing hard-to-find troubles one of their most challenging and satisfying duties. For trainee automotive service technician jobs, employers look for people with strong communication and analytical skills. Technicians need good reading, mathematics, and computer skills to study technical manuals. They must also read to keep up with new technology and learn new service and repair procedures and specifications.

Training in electronics is vital because electrical components, or a series of related components, account for nearly all malfunctions in modern vehicles. Trainees must possess mechanical aptitude and knowledge of how automobiles work. Experience working on motor vehicles in the Armed Forces or as a hobby can be very valuable.

Certification and advancement. ASE certification has become a standard credential for automotive service technicians. While not mandatory for work in automotive service, certification is common for all experienced technicians in large, urban areas. Certification is available in eight different areas of automotive service, such as electrical systems, engine repair, brake systems, suspension and steering, and heating and air-conditioning. For certification in each area, technicians must have at least 2 years of experience and pass the examination. Completion of an automotive training program in high school, vocational or trade school, or community or junior college may be substituted for 1 year of experience. For ASE certification as a Master Automobile Technician, technicians must pass all eight examinations.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Automotive service technicians and mechanics	49-3023	763,700	799,600	35,900	5

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

By becoming skilled in multiple auto repair services, technicians can increase their value to their employer and their pay. Experienced technicians who have administrative ability sometimes advance to shop supervisor or service manager. Those with sufficient funds many times open independent automotive repair shops. Technicians who work well with customers may become automotive repair service estimators. They may also find work as educators.

Employment

Automotive service technicians and mechanics held about 763,700 jobs in 2008. Automotive repair and maintenance shops and automobile dealers employed the majority of these workers, with 31 percent working in shops and 28 percent employed by dealers. In addition, automotive parts, accessories, and tire stores employed 7 percent of automotive service technicians. Others worked in gasoline stations; automotive equipment rental and leasing companies; Federal, State, and local governments; and other organizations. About 16 percent of service technicians were self-employed, compared with 7 percent of all installation, maintenance, and repair occupations.

Job Outlook

The number of jobs for automotive service technicians and mechanics is projected to grow slower than the average for all occupations, although many job openings will arise as experienced technicians retire. Opportunities should be good for those who complete postsecondary automotive training programs, as some employers report difficulty finding workers with the right skills; those without formal automotive training are likely to face competition for entry-level jobs.

Employment change. Employment of automotive service technicians and mechanics is expected to increase by 5 percent between 2008 and 2018, slower than the average for all occupations. Continued growth in the number of vehicles in use in the United States will lead to new jobs for workers performing basic car maintenance and repair. More entry-level workers will be needed to perform these services, such as oil changes and replacing worn brakes. Additionally, the average lifespan of vehicles is increasing, which will further increase the demand for repair services, especially post-warranty work. The increasing use of advanced technology in automobiles will also lead to new opportunities for repair technicians, especially those with specialized skills or certifications. Workers with expertise in certain makes or models of vehicles, or with an advanced understanding of certain systems, such as hybrid-fuel technology, will be in demand. At the same time, consolidation in the automobile dealer industry, a significant employer of technicians, will limit the need for new workers.

Job prospects. In addition to openings from growth, many job openings will be created by the need to replace retiring technicians. Job opportunities are expected to be very good for those who complete postsecondary automotive training programs and who earn ASE certification. Some employers report difficulty in finding workers with the right skills. People with good diagnostic and problem-solving abilities, training in electronics, and computer skills are expected to have the best opportunities. Those without formal automotive training are likely to face competition for entry-level jobs.

Most new job openings will be in automobile dealerships and independent repair shops where most automobile service technicians currently work. However, the large-scale restructuring and closing of many automobile dealerships will lead to fewer openings in dealer service centers for the initial part of the next decade.

Earnings

Median hourly wages of automotive service technicians and mechanics, including commission, were $16.88 in May 2008. The middle 50 percent earned between $12.44 and $22.64 per hour. The lowest 10 percent earned less than $9.56, and the highest 10 percent earned more than $28.71 per hour. Median annual wages in the industries employing the largest numbers of service technicians were as follows:

Local government	$20.07
Automobile dealers	19.61
Automotive repair and maintenance	15.26
Gasoline stations	15.22
Automotive parts, accessories, and tire stores	14.90

Many experienced technicians employed by automobile dealers and independent repair shops receive a commission related to the labor cost charged to the customer. Under this system, weekly earnings depend on the amount of work completed. Employers frequently guarantee commissioned technicians a minimum weekly salary. Some employees offer health and retirement benefits, but such compensation packages are not universal and can vary widely.

Related Occupations

Other workers who repair and service motor vehicles include:

	Page
Automotive body and related repairers	687
Diesel service technicians and mechanics	694
Heavy vehicle and mobile equipment service technicians and mechanics	697
Small engine mechanics	700

Sources of Additional Information

For more details about work opportunities, contact local automobile dealers and repair shops or local offices of the State em-

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ployment service. The State employment service also may have information about training programs.

For general information about a career as an automotive service technician, contact:

➤ Automotive Careers Today, 8400 Westpark Dr., MS #2, McLean, VA 22102. Internet: **http://www.autocareerstoday.org**

➤ Career Voyages, U.S. Department of Labor, 200 Constitution Ave., NW., Washington, DC 20210. Internet: **http://www.careervoyages.gov/automotive-main.cfm**

A list of certified automotive service technician training programs can be obtained from:

➤ National Automotive Technicians Education Foundation, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.natef.org**

For a directory of accredited private trade and technical schools that offer programs in automotive service technician training, contact:

➤ Accrediting Commission of Career Schools and Colleges, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: **http://www.accsc.org**

Information on automobile manufacturer-sponsored programs in automotive service technology can be obtained from:

➤ Automotive Youth Educational Systems (AYES), 101 Blue Seal Dr. SE, Suite 101, Leesburg, VA, 20175. Internet: **http://www.ayes.org**

Information on how to become a certified automotive service technician is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.asecert.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos181.htm**

Diesel Service Technicians and Mechanics

Significant Points

- In addition to high school course offerings in automotive repair and electronics, programs in diesel engine repair are offered by many community colleges and trade and technical schools.
- Opportunities are expected to be very good for people who complete formal training programs; applicants without formal training will face competition for jobs.
- National certification, the recognized standard of achievement, enhances a diesel service technician's advancement opportunities.

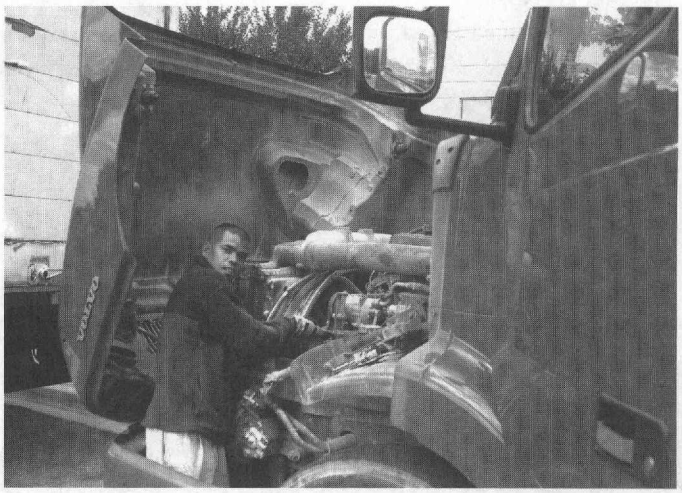
Nature of the Work

Diesel-powered engines are more efficient and durable than their gasoline-burning counterparts. These powerful engines are standard in our Nation's trucks, locomotives, and buses and are becoming more prevalent in light vehicles, including passenger vehicles, pickups, and other work trucks.

Diesel service technicians and mechanics, including *bus and truck mechanics* and *diesel engine specialists*, repair and maintain the diesel engines that power transportation equipment. Other diesel technicians and mechanics work on other heavy vehicles and mobile equipment, including bulldozers, cranes, road graders, farm tractors, and combines. Others repair diesel-powered passenger automobiles, light trucks, or boats. (For information on technicians and mechanics working primarily on gasoline-powered automobiles, heavy vehicles and mobile equipment, or boat engines, see the *Handbook* sections on automotive service technicians, heavy vehicle and mobile equipment service technicians and mechanics, and small engine mechanics.)

Increasingly, diesel technicians must be versatile enough to adapt to customers' needs and to new technologies. It is common for technicians to handle all kinds of repairs, working on a vehicle's electrical system one day and doing major engine repairs the next. Diesel maintenance is becoming increasingly complex, as more electronic components are used to control the operation of an engine. For example, microprocessors now regulate and manage fuel injection and engine timing, increasing the engine's efficiency. Also, new emissions standards may require mechanics to retrofit engines with emissions control systems, such as emission filters and catalysts, to comply with pollution regulations. In modern shops, diesel service technicians use hand-held or laptop computers to diagnose problems and adjust engine functions.

Technicians who work for organizations that maintain their own vehicles spend most of their time doing preventive maintenance. During a routine maintenance check, technicians follow a checklist that includes inspecting brake systems, steering mechanisms, wheel bearings, and other important parts. Following inspection, technicians repair or adjust parts that do not work properly or remove and replace parts that cannot be fixed.



Diesel service technicians and mechanics repair large trucks to keep them running smoothly.

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Diesel service technicians use a variety of tools in their work, including power tools, such as pneumatic wrenches that remove bolts quickly; machine tools, such as lathes and grinding machines to rebuild brakes; welding and flame-cutting equipment to remove and repair exhaust systems; and jacks and hoists to lift and move large parts. Common hand tools—screwdrivers, pliers, and wrenches—are used to work on small parts and get at hard-to-reach places. Diesel service technicians and mechanics also use a variety of computerized testing equipment to pinpoint and analyze malfunctions in electrical systems and engines. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment, but workers usually accumulate their own hand tools over time.

Work environment. Technicians normally work in well-lighted and ventilated areas. However, some shops are drafty and noisy. Many employers provide lockers and shower facilities. Diesel technicians usually work indoors, although they occasionally repair vehicles on the road or at the jobsite. Diesel technicians may lift heavy parts and tools, handle greasy and dirty parts, and stand or lie in awkward positions while making repairs. Minor cuts, burns, and bruises are common, although serious accidents can usually be avoided when safety procedures are followed. Technicians may work as a team or be assisted by an apprentice or helper when doing heavy work, such as removing engines and transmissions.

Most service technicians work a standard 40-hour week, although some work longer hours, particularly if they are self-employed. A growing number of shops have expanded their hours to speed repairs and offer more convenience to customers. Some truck and bus firms provide maintenance and repair service around the clock and on weekends.

Training, Other Qualifications, and Advancement

Employers prefer to hire graduates of formal training programs because those workers are able to advance quickly to the journey level of diesel service. Other workers who learn diesel engine repair through on-the-job training need 3 to 4 years of experience before becoming journey-level technicians.

Education and training. High school courses in automotive repair, electronics, English, mathematics, and physics provide a strong educational background for a career as a diesel service technician or mechanic. Many mechanics have additional training after high school.

A large number of community colleges and trade and vocational schools offer programs in diesel engine repair. These programs usually last from 6 months to 2 years and may lead to a certificate of completion or an associate degree. Some offer about 30 hours per week of hands-on training with equipment; others offer more lab or classroom instruction. Formal training provides a foundation in the latest diesel technology and instruction in the service and repair of the equipment that technicians will encounter on the job. Training programs also teach technicians to interpret technical manuals and to communicate well with co-workers and customers. Increasingly, employers work closely with representatives of educational programs, providing instructors with the latest equipment, techniques, and tools and offering jobs to graduates.

Although formal training programs lead to the best prospects, some technicians and mechanics learn through on-the-job training. Unskilled beginners generally are assigned tasks such as cleaning parts, fueling and lubricating vehicles, and driving vehicles into and out of the shop. Beginners are usually promoted to trainee positions as they gain experience and as vacancies become available.

After a few months' experience, most trainees can perform routine service tasks and make minor repairs. These workers advance to increasingly difficult jobs as they improve their ability and competence. After technicians master the repair and service of diesel engines, they learn to work on related components, such as brakes, transmissions, and electrical systems. Generally, technicians with at least 3 to 4 years of on-the-job experience will qualify as journey-level diesel technicians.

Employers often send experienced technicians and mechanics to special training classes conducted by manufacturers and vendors, in which workers learn about the latest technology and repair techniques.

Other qualifications. Employers usually look for applicants who have mechanical aptitude and strong problem-solving skills and who are at least 18 years old and in good physical condition. Technicians need a State commercial driver's license to test-drive trucks or buses on public roads. Many companies also require applicants to pass a drug test. Practical experience in automobile repair at an automotive service station, in the Armed Forces, or as a hobby is valuable as well.

Certification and advancement. Experienced diesel service technicians and mechanics with leadership ability may advance to shop supervisor or service manager, and some open their own repair shops. Technicians and mechanics with sales ability sometimes become sales representatives.

Although national certification is not required for employment, many diesel engine technicians and mechanics find that it increases their ability to advance. Certification by the National Institute for Automotive Service Excellence (ASE) is the recognized industry credential for diesel and other automotive service technicians and mechanics. Diesel service technicians may be certified in specific areas of truck repair, such as drivetrains, brakes, suspension and steering, electrical and electronic systems, or preventive maintenance and inspection. For certification in each area, a technician must pass one or more of the ASE-administered exams and present proof of 2 years of relevant work experience. To become what's known as a master

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Bus and truck mechanics and diesel engine specialists	49-3031	263,100	278,000	14,900	6

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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technician, all the tests in a given series must be passed. To remain certified, technicians must be retested every 5 years.

Employment

Diesel service technicians and mechanics held about 263,100 jobs in 2008. These workers were employed in almost every industry, particularly those that use trucks, buses, and equipment to haul, deliver, and transport materials, goods, and people. The largest employer, the truck transportation industry, employed about 17 percent of diesel service technicians and mechanics. About 8 percent were employed by automotive repair and maintenance facilities. The rest were employed throughout the economy, including construction, manufacturing, retail and wholesale trade, and automotive leasing. About 6 percent were self-employed. Nearly every area of the country employs diesel service technicians and mechanics, although most work is found in towns and cities where trucking companies, bus lines, and other fleet owners have large operations.

Job Outlook

The number of jobs for diesel service technicians and mechanics is projected to grow slower than the average for all occupations. Opportunities should be very good for people who complete formal training in diesel mechanics; applicants without formal training will face competition for jobs.

Employment change. Employment of diesel service technicians and mechanics is expected to grow by 6 percent from 2008 to 2018, slower than the average for all occupations. The diesel engine, because of its durability and fuel efficiency, is the preferred engine for heavy-duty trucks, buses, and other large vehicles. As more freight is shipped across the country, additional trucks, and corresponding truck repairers, will be needed. Despite this trend, the increasing durability of new vehicles will limit the need for additional workers. Most new jobs will continue to be in the freight trucking and automotive repair and maintenance industries. Beyond the growth in the number of vehicles that need to be serviced, there will be additional demand for diesel engines mechanics to retrofit and modernize existing vehicles to comply with environmental regulations.

Due to higher fuel efficiency requirements for automakers, diesel engines are expected to be used in a small but increasing number of cars and light trucks. This will create additional jobs for diesel service technicians, specifically in the automotive repair and maintenance and automobile dealer industries.

Job prospects. People who enter diesel engine repair will find favorable opportunities, especially as the need to replace workers who retire increases over the next decade. Opportunities should be very good for people with strong technical skills and who complete formal training in diesel mechanics at community colleges or vocational schools. Applicants without formal training will face competition for jobs.

Earnings

Median hourly wages of bus and truck mechanics and diesel engine specialists, including incentive pay, were $18.94 in May 2008. The middle 50 percent earned between $15.25 and $23.58 an hour. The lowest 10 percent earned less than $12.50, and the highest 10 percent earned more than $28.41 an hour. Median hourly wages in the industries employing the largest numbers of bus and truck mechanics and diesel engine specialists in May 2008 were as follows:

Automotive equipment rental and leasing	$19.27
Motor vehicle and motor vehicle parts and supplies merchant wholesalers	19.04
General freight trucking	18.00
Automotive repair and maintenance	17.83
Specialized freight trucking	16.99

Because many experienced technicians employed by truck fleet dealers and independent repair shops receive a commission related to the labor cost charged to the customer, weekly earnings depend on the amount of work completed. Beginners usually earn from 50 to 75 percent of the rate of skilled workers and receive increases as they become more skilled.

About 23 percent of diesel service technicians and mechanics are members of labor unions, including the International Association of Machinists and Aerospace Workers; the Amalgamated Transit Union; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the Transport Workers Union of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters. Labor unions may provide additional benefits for their members.

Related Occupations

Diesel service technicians and mechanics repair trucks, buses, and other diesel-powered equipment. Related technician and mechanic occupations include:

	Page
Aircraft and avionics equipment mechanics and service technicians	684
Automotive body and related repairers	687
Automotive service technicians and mechanics	690
Heavy vehicle and mobile equipment service technicians and mechanics	697
Small engine mechanics	700

Sources of Additional Information

More details about work opportunities for diesel service technicians and mechanics may be obtained from local employers such as trucking companies, truck dealers, or bus lines; locals of the unions previously mentioned; and local offices of your State employment service. Local State employment service offices also may have information about training programs. State boards of postsecondary career schools have information on licensed schools with training programs for diesel service technicians and mechanics.

General information about a career as a diesel service technician or mechanic is available from:

➤ Association of Diesel Specialists, 400 Admiral Blvd., Kansas City, MO 64106. Internet: **http://www.diesel.org**

Information on how to become a certified diesel technician of medium to heavy-duty vehicles or a certified bus technician is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.asecert.org**

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For a directory of accredited private trade and technical schools with training programs for diesel service technicians and mechanics, contact:

➤ Accrediting Commission of Career Schools and Colleges, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: **http://www.accsc.org**

➤ National Automotive Technicians Education Foundation, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.natef.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos182.htm**

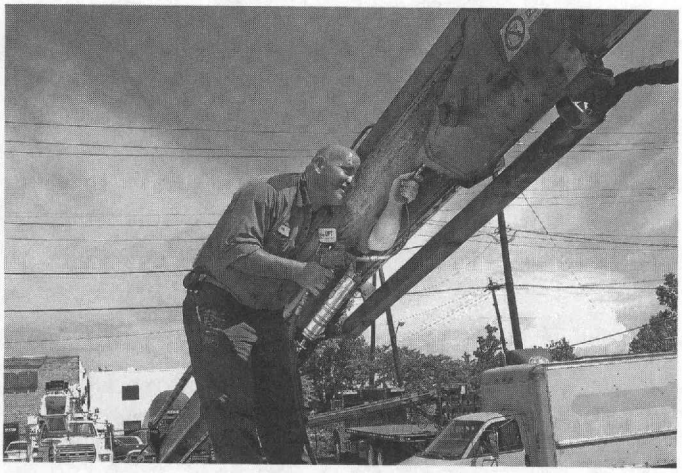
Heavy Vehicle and Mobile Equipment Service Technicians and Mechanics

Significant Points

- Opportunities should be excellent for people with formal postsecondary training in heavy equipment repair; those without formal training will face competition.
- Generally, a service technician with at least 3 to 4 years of on-the-job experience is accepted as fully qualified.
- Wages for mobile heavy equipment mechanics are higher than the average for all installation, maintenance, and repair workers.

Nature of the Work

Heavy vehicles and mobile equipment are indispensable to many industrial activities, from construction to railroad transportation. Various types of equipment move materials, till land, lift beams, and dig earth to pave the way for development and production.



Heavy vehicle and mobile equipment service technicians and mechanics often work on hydraulic equipment, performing needed repairs.

Heavy vehicle and mobile equipment service technicians and mechanics repair and maintain engines and hydraulic, transmission, and electrical systems for this equipment. Farm machinery, cranes, bulldozers, and railcars are all examples of heavy vehicles that require such service. (For information on service technicians specializing in diesel engines, see the section on diesel service technicians and mechanics elsewhere in the *Handbook*.)

Service technicians perform routine maintenance checks on agricultural, industrial, construction, and rail equipment. They service fuel, brake, and transmission systems to ensure peak performance, safety, and longevity of the equipment. Maintenance checks and comments from equipment operators usually alert technicians to problems. After locating the problem, these technicians rely on their training and experience to use the best possible technique to solve it.

With many types of modern equipment, technicians can use diagnostic computers to diagnose components needing adjustment or repair. If necessary, they may partially dismantle affected components to examine parts for damage or excessive wear. Then, using hand-held tools, they repair, replace, clean, and lubricate parts as necessary. In some cases, technicians re-calibrate systems by typing codes into the onboard computer. After reassembling the component and testing it for safety, they put it back into the equipment and return the equipment to the field.

Many types of heavy and mobile equipment use hydraulic systems to raise and lower movable parts. When hydraulic components malfunction, technicians examine them for fluid leaks, ruptured hoses, or worn gaskets on fluid reservoirs. Occasionally, the equipment requires extensive repairs, as when a defective hydraulic pump needs replacing.

Service technicians diagnose electrical problems and adjust or replace defective components. They also disassemble and repair undercarriages and track assemblies. Occasionally, technicians weld broken equipment frames and structural parts, using electric or gas welders.

Technicians use a variety of tools in their work: power tools, such as pneumatic wrenches to remove bolts quickly, machine tools, like lathes and grinding machines, to rebuild brakes, welding and flame-cutting equipment to remove and repair exhaust systems, and jacks and hoists to lift and move large parts. Service technicians also use common hand tools—screwdrivers, pliers, and wrenches—to work on small parts and to get at hard-to-reach places. They may use a variety of computerized testing equipment to pinpoint and analyze malfunctions in electrical systems and other essential systems. Tachometers and dynamometers, for example, can be used to locate engine malfunctions. Service technicians also use ohmmeters, ammeters, and voltmeters when working on electrical systems. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment, but hand tools are normally accumulated with experience, and many experienced technicians have thousands of dollars invested in them.

It is common for technicians in large shops to specialize in one or two types of repair. For example, a shop may have individual specialists in major engine repair, transmission work, electrical systems, and suspension or brake systems. Technicians in smaller shops, on the other hand, generally perform multiple functions.

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Technicians also specialize in types of equipment. *Mobile heavy equipment mechanics and service technicians,* for example, keep construction and surface mining equipment, such as bulldozers, cranes, graders, and excavators in working order. Typically, these workers are employed by equipment wholesale distribution and leasing firms, large construction and mining companies, local and Federal governments, and other organizations operating and maintaining heavy machinery and equipment fleets. Service technicians employed by the Federal Government may work on tanks and other armored military equipment.

Farm equipment mechanics service, maintain, and repair farm equipment, as well as smaller lawn and garden tractors sold to homeowners. What once was a general repairer's job around the farm has evolved into a specialized technical career. Farmers have increasingly turned to farm equipment dealers to service and repair their equipment because the machinery has grown in complexity. Modern equipment uses more computers, electronics, and hydraulics, making it difficult to perform repairs without specialized training and tools.

Railcar repairers specialize in servicing railroad locomotives and other rolling stock, streetcars and subway cars, or mine cars. Most railcar repairers work for railroads, public and private transit companies, and railcar manufacturers.

Work environment. Heavy vehicle and mobile equipment service technicians usually work indoors. To repair vehicles and equipment, technicians often lift heavy parts and tools, handle greasy and dirty parts, and stand or lie in awkward positions. Minor cuts, burns, and bruises are common. However, serious accidents normally can be avoided as long as safety practices are observed. Although some shops are drafty and noisy, technicians usually work in well-lighted and ventilated areas. Many employers provide uniforms, locker rooms, and shower facilities. Mobile heavy equipment mechanics and railcar repairers generally work a standard 40-hour week.

When heavy or mobile equipment breaks down at a construction site, it may be too difficult or expensive to bring into a repair shop, so the shop will send a field service technician to the site to make repairs. Field service technicians work outdoors and spend much of their time away from the shop. Generally, more experienced service technicians specialize in field service. They drive trucks specially equipped with replacement parts and tools. On occasion, they must travel many miles to reach disabled machinery.

The hours of work for farm equipment mechanics vary according to the season of the year. During the busy planting and harvesting seasons, farm equipment mechanics often work 6 or 7 days a week, 10 to 12 hours daily. In slow winter months, however, they may work fewer than 40 hours a week.

Training, Other Qualifications, and Advancement

Although industry experts recommend that applicants complete a formal diesel or heavy equipment mechanic training program after graduating from high school, many people qualify for service technician jobs by training on the job. Employers seek people with mechanical aptitude who are knowledgeable about diesel engines, transmissions, electrical systems, computers, and hydraulics.

Education and training. High school courses in automobile repair, physics, chemistry, and mathematics provide a strong foundation for a career as a service technician or mechanic. After high school, those interested in heavy vehicle repair can choose to attend community colleges or vocational schools that offer programs in diesel technology. Some of these schools tailor programs to heavy equipment mechanics. These programs teach the basics of analytical and diagnostic techniques, electronics, and hydraulics. The increased use of electronics and computers makes training in electronics essential for new heavy and mobile equipment mechanics. Some 1-year to 2-year programs lead to a certificate of completion, while others lead to an associate degree in diesel or heavy equipment mechanics. Formal training programs enable trainee technicians to advance to the journey, or experienced worker, level sooner than with informal ones.

Entry-level workers with no formal background in heavy vehicle repair begin to perform routine service tasks and make minor repairs after a few months of on-the-job training. As they prove their ability and competence, workers advance to harder jobs. Generally, a service technician with at least 3 to 4 years of on-the-job experience is accepted as fully qualified.

Many employers send trainee technicians to training sessions conducted by heavy equipment manufacturers. The sessions, which typically last up to 1 week, provide intensive instruction in the repair of the manufacturer's equipment. Some sessions focus on particular components found in the equipment, such as diesel engines, transmissions, axles, or electrical systems. Other sessions focus on particular types of equipment, such as crawler-loaders and crawler-dozers. When appropriate, experienced technicians attend training sessions to gain familiarity with new technology or equipment.

Other qualifications. Technicians must read and interpret service manuals, so reading ability and communication skills are both important. The technology used in heavy equipment is becoming more sophisticated, and technicians should feel comfortable with computers and electronics because handheld diagnostic computers are often used to make engine adjustments and diagnose problems. Experience in the Armed Forces working on diesel engines and heavy equipment provides valuable background for these positions.

Certification and advancement. There is no one certification that is recognized throughout the various industries that employ heavy vehicle mobile equipment service technicians. Rather, graduation or completion of an accredited postsecondary program in heavy vehicle repair is seen as the best credential for employees to have. Manufacturers also offer certificates in specific repairs or working with particular equipment. Such credentials allow employees to take on more responsibilities and advance faster.

Experienced technicians may advance to field service jobs, where they have a greater opportunity to tackle problems independently and earn additional pay. Field positions may require a commercial driver's license and a clean driving record. Technicians with administrative ability may become shop supervisors or service managers. Some technicians open their own repair shops or invest in a franchise.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Heavy vehicle and mobile equipment service technicians and mechanics	49-3040	190,700	206,100	15,500	8
Farm equipment mechanics	49-3041	31,200	33,400	2,100	7
Mobile heavy equipment mechanics, except engines	49-3042	136,300	148,100	11,800	9
Rail car repairers	49-3043	23,100	24,600	1,500	7

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Employment

Heavy vehicle and mobile equipment service technicians and mechanics held about 190,700 jobs in 2008. Approximately 136,300 were mobile heavy equipment mechanics, 31,200 were farm equipment mechanics, and 23,100 were railcar repairers.

About 29 percent were employed by machinery, equipment, and supplies merchant wholesalers. About 13 percent worked in construction, primarily for specialty trade contractors and highway, street, and bridge construction companies; another 11 percent were employed by Federal, State, and local governments. Other service technicians worked in mining; rail transportation; and commercial and industrial machinery and equipment rental, leasing, and repair. A small number repaired equipment for machinery and railroad rolling stock manufacturers. About 6 percent of service technicians were self-employed.

Nearly every area of the country employs heavy and mobile equipment service technicians and mechanics, although most work in towns and cities where equipment dealers, equipment rental and leasing companies, and construction companies have repair facilities.

Job Outlook

The number of heavy vehicle and mobile equipment service technicians and mechanics is expected to grow about as fast as the average for all occupations. Those who have completed postsecondary training programs should find excellent opportunities, as employers report difficulty finding candidates with this training to fill available positions. Those without a formal background in diesel engine or heavy vehicle repair will face competition.

Employment change. Employment of heavy vehicle and mobile equipment service technicians and mechanics is expected to grow by 8 percent through the year 2018, about as fast as the average for all occupations. Demand will be driven primarily by growth in the use of heavy equipment in the construction industry, although growth will be slower in this industry than in recent years. In addition, the increasing sophistication of the technology used in heavy vehicles and mechanics should lead to greater demand for technicians and mechanics with specialized skills.

Growth in other industries that use heavy equipment, such as energy exploration and mining, will also contribute to the need for new workers. The need to feed a growing population, and the increased use of agriculture products to make biofuels, will lead to additional farm mechanic jobs, while the continued expansion of railways for freight shipping and transportation will lead to new openings for railcar repairers. Many new mobile heavy equipment and farm equipment mechanic positions are expected be in firms that sell, rent, or lease such machines, as their repair services make up an important part of their business. Employment of mobile heavy equipment mechanics is expected to grow by 9 percent from 2008-18, while jobs for farm equipment mechanics and rail car repairers are expected to increase by 7 percent.

Job prospects. Opportunities for heavy vehicle and mobile equipment service technicians and mechanics should be excellent for those who have completed formal training programs in diesel or heavy equipment mechanics. Employers report difficulty finding candidates with formal postsecondary training to fill available service technician positions. People without formal training are expected to encounter growing difficulty entering these jobs. Most job openings for mobile, rail, and farm equipment technicians will arise from the need to replace experienced repairers who retire or change occupations.

Construction and mining operations, which use large numbers of heavy vehicles and mobile equipment, are particularly sensitive to changes in the level of economic activity. While the increased use of such equipment increases the need for periodic service and repair, heavy and mobile equipment may be idle during downturns. As a result, opportunities for service technicians who work on construction and mining equipment may fluctuate with the cyclical nature of these industries. In addition, opportunities for farm equipment mechanics are seasonal and are best in warmer months.

Earnings

Median hourly wages of mobile heavy equipment mechanics were $20.59 in May 2008, higher than the $18.60 per hour median for all installation, maintenance, and repair occupations. The middle 50 percent earned between $16.71 and $24.85. The lowest 10 percent earned less than $13.61, and the highest 10 percent earned more than $30.57. Median hourly wages in the industries employing the largest numbers of mobile heavy equipment mechanics were as follows:

Local government	$21.93
Machinery, equipment, and supplies merchant wholesalers	20.49
Other specialty trade contractors	19.83
Commercial and industrial machinery and equipment rental and leasing	19.39
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	18.93

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Median hourly wages of farm equipment mechanics were $15.32 in May 2008. The middle 50 percent earned between $12.54 and $18.61. The lowest 10 percent earned less than $10.28, and the highest 10 percent earned more than $22.37. In machinery, equipment, and supplies merchant wholesalers, the industry employing the largest number of farm equipment mechanics, median wages were $15.64.

Median hourly wages of railcar repairers were $21.48 in May 2008. The middle 50 percent earned between $16.83 and $25.84. The lowest 10 percent earned less than $13.49, and the highest 10 percent earned more than $30.23. Median hourly wages were $23.82 in rail transportation, the industry employing the largest number of railcar repairers.

About 23 percent of heavy vehicle and mobile equipment service technicians and mechanics are members of unions, including the International Association of Machinists and Aerospace Workers, the International Union of Operating Engineers, and the International Brotherhood of Teamsters. Members may enjoy job benefits in addition to what employers provide.

Related Occupations

Workers in related repair occupations include:

	Page
Aircraft and avionics equipment mechanics and service technicians	684
Automotive service technicians and mechanics	690
Diesel service technicians and mechanics	694
Industrial machinery mechanics and millwrights	709
Small engine mechanics	700

Sources of Additional Information

More details about job openings for heavy vehicle and mobile equipment service technicians and mechanics may be obtained from local heavy and mobile equipment dealers and distributors, construction contractors, and government agencies. Local offices of the State employment service also may have information on job openings and training programs.

For general information about a career as a heavy vehicle and mobile equipment service technician or mechanic, contact:

➤ Associated Equipment Distributors, 615 W. 22nd St., Oak Brook, IL 60523. Internet: **http://www.aedcareers.com**

A list of certified diesel service technician training programs can be obtained from:

➤ National Automotive Technician Education Foundation (NATEF), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.natef.org**

Information on certification as a heavy-duty diesel service technician is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: **http://www.asecert.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos197.htm**

Small Engine Mechanics

Significant Points

- Job prospects should be excellent for people who complete formal training programs.
- Average job growth is expected.
- Use of motorcycles, motorboats, and outdoor power equipment is seasonal in many areas, so mechanics may service other types of equipment or work reduced hours in the winter.

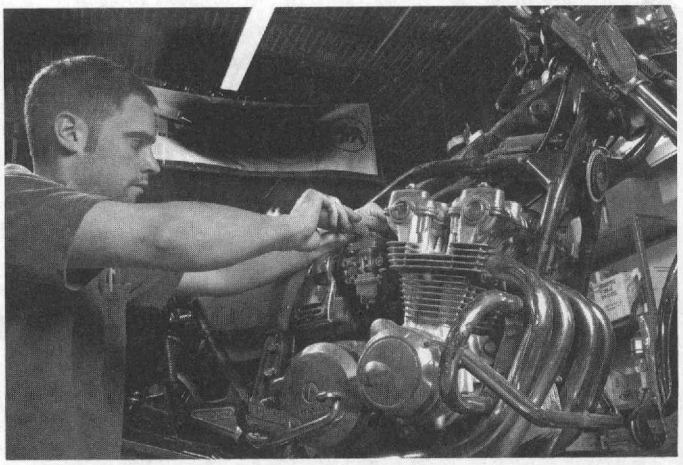
Nature of the Work

Small engine mechanics repair and service power equipment ranging from jet skis to chainsaws. Mechanics usually specialize in the service and repair of one type of equipment, such as motorcycles, motorboats, and outdoor power equipment, although they may work on closely related products.

When a piece of equipment breaks down, mechanics use various techniques to diagnose the source and extent of the problem. The mark of a skilled mechanic is the ability to diagnose mechanical, fuel, and electrical problems and to make repairs quickly. Quick and accurate diagnosis requires problem-solving ability and a thorough knowledge of the equipment's operation.

Some jobs require minor adjustments or the replacement of a single item, but a complete engine overhaul could require hours to disassemble the engine and replace worn valves, pistons, bearings, and other internal parts. Some highly skilled mechanics use specialized components and the latest computerized equipment to customize and tune motorcycles and motorboats for racing.

Hand tools are the most important work-related possessions of mechanics. Small engine mechanics use wrenches, pliers, and screwdrivers on a regular basis. Mechanics usually provide their own tools, although employers will furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment. Computerized engine analyzers, compression gauges, ammeters and voltmeters, and other testing devices help mechanics locate faulty parts and tune engines. This equipment provides a systematic performance report of



Motorcycle mechanics use hand tools to make needed adjustments and repairs.

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various components to compare against normal ratings. After pinpointing the problem, the mechanic makes the needed adjustments, repairs, or replacements.

Small engines also require periodic service to minimize the chance of breakdowns and to keep them operating at peak performance. During routine maintenance, mechanics follow a checklist that includes the inspection and cleaning of brakes, electrical systems, fuel injection systems, plugs, carburetors, and other parts. Following inspection, mechanics usually repair or adjust parts that do not work properly or replace unfixable parts.

Motorcycle mechanics specialize in the repair and overhaul of motorcycles, motor scooters, mopeds, dirt bikes, and all-terrain vehicles. Besides repairing engines, they may work on transmissions, brakes, and ignition systems and make minor body repairs. Mechanics often service just a few makes and models of motorcycles because most work for dealers that service only the products they sell.

Motorboat mechanics and *marine equipment mechanics* repair and adjust the electrical and mechanical equipment of inboard and outboard boat engines. Most small boats have portable outboard engines that are removed and brought into the repair shop. Larger craft, such as cabin cruisers and commercial fishing boats, are powered by diesel or gasoline inboard or inboard-outboard engines, which are removed only for major overhauls. Most of these repairs, therefore, are performed at docks or marinas. Motorboat mechanics also may work on propellers, steering mechanisms, marine plumbing, and other boat equipment.

Outdoor power equipment and other small engine mechanics service and repair outdoor power equipment such as lawnmowers, garden tractors, edge trimmers, and chain saws. They also may occasionally work on portable generators and go-carts. In addition, small engine mechanics in certain parts of the country may work on snowblowers and snowmobiles, but demand for this type of repair is both seasonal and regional.

Work environment. Small engine mechanics usually work in repair shops that are well lighted and ventilated but are sometimes noisy when engines are tested. Motorboat mechanics may work outdoors in poor weather conditions when making repairs aboard boats. They may also work in cramped or awkward positions to reach a boat's engine. Outdoor power equipment mechanics face similar conditions when they need to make on-site repairs.

During the winter months in the northern United States, mechanics may work fewer than 40 hours a week because the amount of repair and service work declines when lawnmowers, motorboats, and motorcycles are not in use. Many mechanics work full time only during the busy spring and summer seasons. However, they often schedule time-consuming engine overhauls or work on snowmobiles and snowblowers during winter downtime. Mechanics may work considerably more than 40 hours a week when demand is strong.

Training, Other Qualifications, and Advancement

Due to the increasing complexity of motorcycles and motorboats, employers prefer to hire mechanics who have graduated from formal training programs. However, because the number of these specialized postsecondary programs is limited, most mechanics still learn their skills on the job or while working in related occupations.

Education and training. Employers prefer to hire high school graduates for trainee mechanic positions, but many will accept applicants with less education if they possess adequate reading, writing, and math skills. Helpful high school courses include small engine repair, automobile mechanics, science, and business math. Many equipment dealers employ high school students part time and during the summer to help assemble new equipment and perform minor repairs.

Once employed, trainees learn routine service tasks under the guidance of experienced mechanics by replacing ignition points and spark plugs or by taking apart, assembling, and testing new equipment. As they gain experience and proficiency, trainees progress to more difficult tasks, such as advanced computerized diagnosis and engine overhauls. Anywhere from several months to 3 years of on-the-job training may be necessary before a novice worker becomes competent in all aspects of the repair of motorcycle and motorboat engines. Repair of outdoor equipment, because of fewer moving parts, requires less on-the-job training.

A growing number of motorcycle and marine equipment mechanics graduate from formal motorcycle and motorboat postsecondary programs. Employers prefer to hire these workers for their advanced knowledge of small engine repair. These workers also need far less on-the-job training and tend to advance quickly to more demanding small engine repair jobs.

Employers often send mechanics and trainees to courses conducted by motorcycle, motorboat, and outdoor power equipment manufacturers or distributors. These courses, which can last up to 2 weeks, upgrade workers' skills and provide information on repairing new models. Manufacturer classes are usually a prerequisite for any mechanic who performs warranty work for manufacturers or insurance companies.

Other qualifications. For trainee jobs, employers hire people with mechanical aptitude who are knowledgeable about the fundamentals of small engines. Many trainees get their start by working on automobiles, motorcycles, motorboats, or outdoor power equipment as a hobby. Knowledge of basic electronics is essential because many parts of small vehicles and engines are electric.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Small engine mechanics	49-3050	70,400	75,100	4,800	7
Motorboat mechanics	49-3051	22,100	23,400	1,200	6
Motorcycle mechanics	49-3052	18,800	20,500	1,600	9
Outdoor power equipment and other small engine mechanics	49-3053	29,400	31,300	1,900	6

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Advancement. The skills needed for small engine repair can transfer to other occupations, such as automobile, diesel, or heavy vehicle and mobile equipment mechanics. Experienced mechanics with leadership ability may advance to shop supervisor or service manager jobs. Mechanics with sales ability sometimes become sales representatives or open their own repair shops or dealerships.

Employment

Small engine mechanics held about 70,400 jobs in 2008. Motorcycle mechanics held around 18,800 jobs, motorboat mechanics held approximately 22,100 jobs, and outdoor power equipment and other small engine mechanics held about 29,400 jobs. Thirty-seven percent of small engine mechanics worked for motor vehicle and parts dealers, while 13 percent were employed in retail lawn and garden equipment and supplies stores. Nine percent were employed by repair and maintenance shops. Most of the remainder worked in wholesale distributors, equipment rental and leasing companies, and landscaping services. About 13 percent were self-employed, compared to about 7 percent of workers in all installation, maintenance, and repair occupations.

Job Outlook

Average employment growth is projected for small engine mechanics. Job prospects should be excellent for people who complete formal training programs. Use of motorcycles, motorboats, and outdoor power equipment is seasonal in many areas, so mechanics may service other types of equipment or work reduced hours in the winter.

Employment change. Employment of small engine mechanics is expected to grow by 7 percent between 2008 and 2018, about as fast as the average for all occupations. Growth will vary by the type of equipment these mechanics repair.

The number of registered motorcycles has increased steadily in recent years, leading to corresponding greater demand for motorcycle repair services. This trend is expected to continue, leading to new opportunities for motorcycle mechanics. Most new jobs will continue to be in the motorcycle dealer industry, as service operations are an important aspect of business for many firms in this industry. The increasing sophistication of motorcycles will create new opportunities for specialists in independent repair shops as well, however. Overall, motorcycle mechanics will grow by 9 percent.

By contrast, the number of additional motorboats in use has been limited in recent years. The retail boat industry, the primary employer of repair technicians, has consolidated, creating fewer new opportunities for mechanics. As such, motorboat mechanics are expected to grow by 6 percent.

Outdoor equipment mechanics will also grow by 6 percent. Demand for repair services is expected to rise over time as outdoor machines become more complex. Growth is also projected in the landscaping services industry, which frequently uses small engine equipment that needs regular servicing. Most new jobs in this in this occupation will continue to be in outdoor small engine equipment retail shops.

Job prospects. Job prospects should be excellent for people who complete formal training programs. Employers prefer mechanics that have knowledge of multiple types of engines and emissions-reducing technology as the government increases regulation of the emissions produced by small engines. Many of the job openings for small engine mechanics will result from the need to replace the many experienced small engine mechanics who are expected to transfer to other occupations, retire, or stop working for other reasons.

Earnings

Median wages of motorcycle mechanics were $15.08 an hour in May 2008, as compared to $18.60 for all installation, maintenance, and repair occupations. The middle 50 percent earned between $12.10 and $19.20. The lowest 10 percent earned less than $9.76, and the highest 10 percent earned more than $24.27. Median hourly wages in the industry employing the largest number of motorcycle mechanics, other motor vehicle dealers, or retail shops selling vehicles other than cars and trucks, were $15.13.

Median wages of motorboat mechanics were $16.60 an hour in May 2008. The middle 50 percent earned between $13.31 and $20.68. The lowest 10 percent earned less than $10.74, and the highest 10 percent earned more than $25.41. Median hourly wages in other motor vehicle dealers, the industry employing the largest number of motorboat mechanics, were $16.48.

Median wages of outdoor power equipment and other small engine mechanics were $13.91 an hour in May 2008. The middle 50 percent earned between $11.24 and $17.03. The lowest 10 percent earned less than $9.12, and the highest 10 percent earned more than $20.40. Median hourly wages in lawn and garden equipment and supplies stores, the industry employing the largest number of outdoor power equipment and other small engine mechanics, were $13.66.

Small engine mechanics in small shops usually receive few benefits, but those employed in larger shops often receive typical benefits such as paid vacations, sick leave, and health insurance. Some employers also pay for work-related training, provide uniforms, and help mechanics purchase new tools.

Related Occupations

Mechanics and repairers who work on durable equipment other than small engines include:

	Page
Automotive service technicians and mechanics	690
Diesel service technicians and mechanics	694
Heavy vehicle and mobile equipment service technicians and mechanics	697
Home appliance repairers	707

Sources of Additional Information

To learn about work opportunities, contact local motorcycle, motorboat, and lawn and garden equipment dealers, boatyards, and marinas. Local offices of the State employment service also may have information about employment and training opportunities.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos198.htm**

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Miscellaneous Installation, Maintenance, and Repair Occupations

Heating, Air-conditioning, and Refrigeration Mechanics and Installers

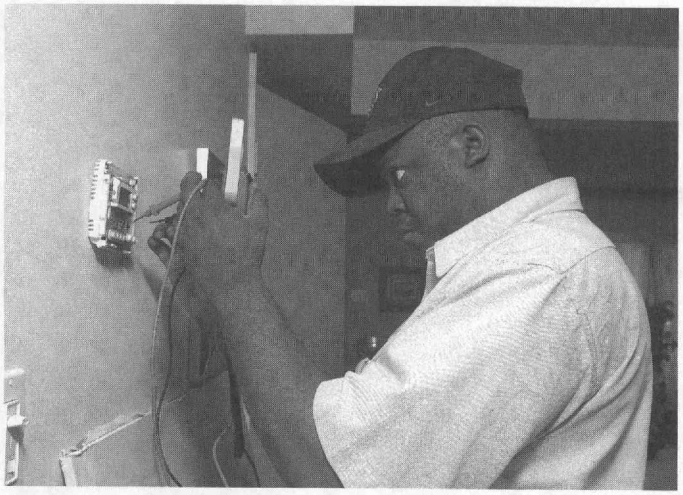
Significant Points

- Job prospects are expected to be excellent.
- Employment is projected to grow much faster than the average.
- Employers prefer to hire those who have completed technical school training or a formal apprenticeship.

Nature of the Work

Heating and air-conditioning systems control the temperature, humidity, and the total air quality in residential, commercial, industrial, and other buildings. By providing a climate controlled environment, refrigeration systems make it possible to store and transport food, medicine, and other perishable items. *Heating, air-conditioning, and refrigeration mechanics and installers*—also called *technicians*—install, maintain, and repair such systems. Because heating, ventilation, air-conditioning, and refrigeration systems often are referred to as HVACR systems, these workers also may be called HVACR technicians.

Heating, air-conditioning, and refrigeration systems consist of many mechanical, electrical, and electronic components, such as motors, compressors, pumps, fans, ducts, pipes, thermostats, and switches. In central forced air heating systems, for example, a furnace heats air, which is then distributed through a system of metal or fiberglass ducts. Technicians maintain, diagnose, and correct problems throughout the entire system. To do this, they adjust system controls to recommended settings and test the performance of the system using special tools and test equipment.



A heating, air-conditioning, and refrigeration mechanic works on a thermostat for a heating and air-conditioning system.

Technicians often specialize in either installation or maintenance and repair, although they are trained to do both. They also may specialize in doing heating work or air-conditioning or refrigeration work. Some specialize in one type of equipment—for example, hydronics (water-based heating systems), solar panels, or commercial refrigeration.

Technicians are often required to sell service contracts to their clients. Service contracts provide for regular maintenance of the heating and cooling systems, and they help to reduce the seasonal fluctuations of this type of work.

Technicians follow blueprints or other specifications to install oil, gas, electric, solid-fuel, and multiple-fuel heating systems and air-conditioning systems. After putting the equipment in place, they install fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring and controls and check the unit for proper operation. To ensure the proper functioning of the system, furnace installers often use combustion test equipment, such as carbon dioxide testers, carbon monoxide testers, combustion analyzers, and oxygen testers. These tests ensure that the system will operate safely and at peak efficiency.

After a furnace or air-conditioning unit has been installed, technicians often perform routine maintenance and repair work to keep the systems operating efficiently. They may adjust burners and blowers and check for leaks. If the system is not operating properly, technicians check the thermostat, burner nozzles, controls, or other parts to diagnose and correct the problem.

Technicians also install and maintain heat pumps, which are similar to air conditioners but can be reversed so that they both heat and cool a home. Because of the added complexity, and the fact that they run both in summer and winter, these systems often require more maintenance and need to be replaced more frequently than traditional furnaces and air conditioners.

During the summer, when heating systems are not being used, heating equipment technicians do maintenance work, such as replacing filters, ducts, and other parts of the system that may accumulate dust and impurities during the operating season. During the winter, air-conditioning mechanics inspect the systems and do required maintenance, such as overhauling compressors.

Refrigeration mechanics install, service, and repair industrial and commercial refrigerating systems and a variety of refrigeration equipment. They follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, piping, and other components. They connect this equipment to the ductwork, refrigerant lines, and electrical power source. After making the connections, refrigerator mechanics charge the system with refrigerant, check it for proper operation and leaks, and program control systems.

When air-conditioning and refrigeration technicians service equipment, they must use care to conserve, recover, and recycle the refrigerants used in air-conditioning and refrigeration systems. The release of these refrigerants can be harmful to the

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environment. Technicians conserve the refrigerant by making sure that there are no leaks in the system; they recover it by venting the refrigerant into proper cylinders; they recycle it for reuse with special filter-dryers; or they ensure that the refrigerant is properly disposed of.

Heating, air-conditioning, and refrigeration mechanics and installers are adept at using a variety of tools to work with refrigerant lines and air ducts, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, measurement gauges, and acetylene torches. They use voltmeters, thermometers, pressure gauges, manometers, and other testing devices to check airflow, refrigerant pressure, electrical circuits, burners, and other components.

Other craft workers sometimes install or repair cooling and heating systems. For example, on a large air-conditioning installation job, especially where workers are covered by union contracts, ductwork might be done by sheet metal workers and duct installers; electrical work by electricians; and installation of piping, condensers, and other components by pipelayers, plumbers, pipefitters, and steamfitters. Home appliance repairers usually service room air-conditioners and household refrigerators. (Additional information about each of these occupations appears elsewhere in the *Handbook*.)

Work environment. Heating, air-conditioning, and refrigeration mechanics and installers work in homes, retail establishments, hospitals, office buildings, and factories—anywhere there is climate-control equipment that needs to be installed, repaired, or serviced. They may be assigned to specific job sites at the beginning of each day or may be dispatched to a variety of locations if they are making service calls.

Technicians may work outside in cold or hot weather, or in buildings that are uncomfortable because the air-conditioning or heating equipment is broken. In addition, technicians might work in awkward or cramped positions, and sometimes they are required to work in high places. Hazards include electrical shock, burns, muscle strains, and other injuries from handling heavy equipment. Appropriate safety equipment is necessary when handling refrigerants because contact can cause skin damage, frostbite, or blindness. When working in tight spaces, inhalation of refrigerant is a possible hazard.

The majority of mechanics and installers work at least 40 hours per week. During peak seasons, they often work overtime or irregular hours. Maintenance workers, including those who provide maintenance services under contract, often work evening or weekend shifts and are on call. Most employers try to provide a full workweek year-round by scheduling both installation and maintenance work, and many manufacturers and contractors now provide or even require year-round service contracts. In most shops that service both heating and air-conditioning equipment, employment is stable throughout the year.

Training, Other Qualifications, and Advancement

Because of the increasing sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those who have completed technical school training or a formal apprenticeship. Some mechanics and installers, however, still learn the trade informally on the job.

Education and training. Many heating, air-conditioning, and refrigeration mechanics and installers receive their primary training in secondary and postsecondary technical and trade schools and junior and community colleges that offer programs in heating, air-conditioning, and refrigeration. These programs can take between 6 months and 2 years to complete. Others get their training in the Armed Forces.

High school students interested in some initial training for this industry should take courses in shop math, mechanical drawing, applied physics and chemistry, electronics, blueprint reading, and computer applications. Some knowledge of plumbing or electrical work and a basic understanding of electronics are beneficial for an HVACR technician. Secondary and postsecondary students studying HVACR learn about theory of temperature control, equipment design and construction, and electronics. They also learn the basics of installation, maintenance, and repair.

Three accrediting agencies have set academic standards for HVACR programs: HVAC Excellence; the National Center for Construction Education and Research; and the Partnership for Air-Conditioning, Heating, and Refrigeration Accreditation. After completing these programs, new technicians generally need between 6 months to 2 years of field experience before they are considered proficient.

Many other technicians train through apprenticeships. Apprenticeship programs frequently are run by joint committees representing local chapters of the Air-Conditioning Contractors of America, the Mechanical Contractors Association of America, Plumbing-Heating-Cooling Contractors—National Association, and locals of the Sheet Metal Workers' International Association or the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada. Local chapters of the Associated Builders and Contractors and the National Association of Home Builders sponsor other apprenticeship programs. Formal apprenticeship programs normally last 3 to 5 years and combine paid on-the-job training with classroom instruction. Classes include subjects such as safety practices, the use and care of tools, blueprint reading, and the theory and design of heating, ventilation, air-conditioning, and refrigeration systems. In addition to understanding how systems work, technicians must learn about refrigerant products and the legislation and regulations that govern their use.

Applicants for apprenticeships must have a high school diploma or equivalent. Math and reading skills are essential. After completing an apprenticeship program, technicians are considered skilled trades workers and capable of working alone. These programs are also a pathway to certification and, in some cases, college credits.

Those who acquire their skills on the job usually begin by assisting experienced technicians. They may begin by performing simple tasks such as carrying materials, insulating refrigerant lines, or cleaning furnaces. In time, they move on to more difficult tasks, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuits.

Licensure. Heating, air-conditioning, and refrigeration mechanics and installers are required to be licensed by some States and localities. Requirements for licensure vary greatly, but all States or localities that require a license have a test that must

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be passed. The contents of these tests vary by State or locality, with some requiring extensive knowledge of electrical codes and others focusing more on HVACR-specific knowledge. Completion of an apprenticeship program or 2 to 5 years of experience are also common requirements.

In addition, all technicians who purchase or work with refrigerants must be certified in their proper handling. To become certified to purchase and handle refrigerants, technicians must pass a written examination specific to the type of work in which they specialize. The three possible areas of certification are: Type I—servicing small appliances; Type II—high-pressure refrigerants; and Type III—low-pressure refrigerants. Exams are administered by organizations approved by the U.S. Environmental Protection Agency, such as trade schools, unions, contractor associations, or building groups.

Other qualifications. Because technicians frequently deal directly with the public, they should be courteous and tactful, especially when dealing with an aggravated customer. They should be in good physical condition because they sometimes have to lift and move heavy equipment.

Certification and advancement. Throughout the learning process, technicians may have to take a number of tests that measure their skills. For those with relevant coursework and less than 2 years of experience, the industry has developed a series of exams to test basic competency in residential heating and cooling, light commercial heating and cooling, and commercial refrigeration. These are referred to as "Entry-level" certification exams and are commonly conducted at both secondary and postsecondary technical and trade schools.

Additionally, HVACR technicians who have at least 1 year of experience performing installations and 2 years of experience performing maintenance and repair can take a number of different tests to certify their competency in working with specific types of equipment, such as oil-burning furnaces. The Air Conditioning, Heating, and Refrigeration Institute offers an Industry Competency Exam; HVAC Excellence offers both a Secondary Employment Ready Exam and a Secondary Heat and Heat Plus exams; and National Occupational Competency Testing Institute offers a secondary exam; and the Refrigeration Service Engineers Society offers two levels of certification, as well. Employers increasingly recommend taking and passing these tests and obtaining certification; doing so may increase advancement opportunities.

Another way to increase advancement opportunities is to take advantage of any courses that will improve competency with computers; these courses are useful because of the increasing complexity of automated computer controls in larger buildings.

Advancement usually takes the form of higher wages. Some technicians, however, may advance to positions as supervisor or service manager. Others may move into sales and marketing. Still others may become building superintendents, cost estimators, system test and balance specialists, or, with the necessary certification, teachers. Those with sufficient money and managerial skill can open their own contracting business.

Employment

Heating, air-conditioning, and refrigeration mechanics and installers held about 308,200 jobs in 2008; about 54 percent worked for plumbing, heating, and air-conditioning contractors. The rest were employed in a variety of industries throughout the country, reflecting a widespread dependence on climate-control systems. Some worked for refrigeration and air-conditioning service and repair shops, schools, and stores that sell heating and air-conditioning systems. Local governments, the Federal Government, hospitals, office buildings, and other organizations that operate large air-conditioning, refrigeration, or heating systems also employed these workers. About 16 percent of these workers were self-employed.

Job Outlook

With much faster than average job growth and numerous expected retirements, heating, air-conditioning, and refrigeration mechanics and installers should have excellent employment opportunities.

Employment change. Employment of heating, air-conditioning, and refrigeration mechanics and installers is projected to increase 28 percent during the 2008-18 decade, much faster than the average for all occupations. As the population and stock of buildings grows, so does the demand for residential, commercial, and industrial climate-control systems. Residential HVACR systems generally need replacement after 10 to 15 years; the large number of homes built in recent years will enter this replacement timeframe by 2018. The increased complexity of HVACR systems, which increases the possibility that equipment may malfunction, also will create opportunities for service technicians. A growing focus on improving indoor air quality and the increasing use of refrigerated equipment by a rising number of stores and gasoline stations that sell food should also create more jobs for heating, air-conditioning, and refrigeration technicians.

Concern for the environment and the need to reduce energy consumption overall has prompted the development of new energy-saving heating and air-conditioning systems. This emphasis on better energy management is expected to lead to the replacement of older systems and the installation of newer, more efficient systems in existing homes and buildings. Also, demand for maintenance and service work should rise as businesses and homeowners strive to keep increasingly complex systems operating at peak efficiency. Regulations prohibiting the discharge and production of older types of refrigerants that pollute the atmosphere should continue to result in

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Heating, air conditioning, and refrigeration mechanics and installers	49-9021	308,200	394,800	86,600	28

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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the need to replace many existing air conditioning systems or to modify them to use new environmentally safe refrigerants. The pace of replacement in the commercial and industrial sectors will quicken if Congress or individual States change tax rules designed to encourage companies to buy new HVACR equipment.

Job prospects. Job prospects for heating, air-conditioning, and refrigeration mechanics and installers are expected to be excellent, particularly for those who have completed training from an accredited technical school or a formal apprenticeship. A growing number of retirements of highly skilled technicians are expected to generate many more job openings. Many contractors have reported problems finding enough workers to meet the demand for service and installation of HVACR systems.

Technicians who specialize in installation work may experience periods of unemployment when the level of new construction activity declines, but maintenance and repair work usually remains relatively stable. People and businesses depend on their climate-control or refrigeration systems and must keep them in good working order, regardless of economic conditions.

In light of the complexity of new computer-controlled HVACR systems in modern high-rise buildings, prospects should be best for those who can acquire and demonstrate computer competency. Training in new techniques that improve energy efficiency will also make it much easier to enter the occupation.

Earnings

Median hourly wages of heating, air-conditioning, and refrigeration mechanics and installers were $19.08 in May 2008. The middle 50 percent earned between $14.94 and $24.84 an hour. The lowest 10 percent earned less than $12.19, and the top 10 percent earned more than $30.59. Median hourly wages in the industries employing the largest numbers of heating, air-conditioning, and refrigeration mechanics and installers were:

Local government	$22.79
Hardware, and plumbing and heating equipment and supplies merchant wholesalers	22.18
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	20.83
Direct selling establishments	20.03
Building equipment contractors	18.26

Apprentices usually earn about 50 percent of the wage rate paid to experienced workers. As they gain experience and improve their skills, they receive periodic increases until they reach the wage rate of experienced workers.

Heating, air-conditioning, and refrigeration mechanics and installers generally receive a variety of employer-sponsored benefits. In addition to typical benefits such as health insurance and pension plans, some employers pay for work-related training and provide uniforms, company vans, and tools.

About 15 percent of heating, air-conditioning, and refrigeration mechanics and installers are members of a union. The unions to which the greatest numbers of mechanics and installers belong are the Sheet Metal Workers International Association and the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada.

Related Occupations

Heating, air-conditioning, and refrigeration mechanics and installers work with sheet metal and piping, and repair machinery, such as electrical motors, compressors, and burners. Other workers who have similar duties include:

	Page
Boilermakers	613
Electricians	641
Home appliance repairers	707
Plumbers, pipelayers, pipefitters, and steamfitters	659
Sheet metal workers	665

Sources of Additional Information

For more information about opportunities for training, certification, and employment in this trade, contact local vocational and technical schools; local heating, air-conditioning, and refrigeration contractors; a local of the unions or organizations previously mentioned; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

For information on career opportunities, training, and technician certification, contact:

➤ Air-Conditioning Contractors of America, 2800 Shirlington Rd., Suite 300, Arlington, VA 22206-3607. Internet: **http://www.acca.org**

➤ Air-Conditioning, Heating, and Refrigeration Institute, 2111 Wilson Blvd., Suite 500, Arlington, VA 22201-3001. Internet: **http://www.ahrinet.org**

➤ Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203-1607. Internet: **http://www.trytools.org**

➤ Carbon Monoxide Safety Association, P.O. Box 669, Eastlake, CO 80614-0669. Internet: **http://www.cosafety.org**

➤ Green Mechanical Council 1701 Pennsylvania, Ave. NW, Suite 300 Washington, DC 20006-5813. Internet: **http://www.greenmech.org**

➤ Home Builders Institute, National Association of Home Builders, 1201 15th St. NW., 6th Floor, Washington, DC 20005-2842. Internet: **http://www.hbi.org**

➤ HVAC Excellence, P.O. Box 491, Mt. Prospect, IL 60056-0521. Internet: **http://www.hvacexcellence.org**

➤ Mechanical Contractors Association of America, Mechanical Service Contractors of America, 1385 Piccard Dr., Rockville, MD 20850-4329. Internet: **http://www.mcaa.org**

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➤ National Center for Construction Education and Research, 3600 NW 43rd Street, Bldg. G, Gainesville, FL 32606-8134. Internet: **http://www.nccer.org**

➤ National Occupational Competency Testing Institute, 500 North Bronson Ave., Big Rapids, MI 49307-2737. Internet: **http://www.nocti.org**

➤ North American Technician Excellence, 2111 Wilson Blvd., Suite 510, Arlington, VA 22201-3051. Internet: **http://www.natex.org**

➤ Plumbing-Heating-Cooling Contractors, 180 S. Washington St., P.O. Box 6808, Falls Church, VA 22046-6808. Internet: **http://www.phccweb.org**

➤ Radiant Panel Association, P.O. Box 717, Loveland, CO 80539-0717. Internet: **http://www.radiantpanelassociation.org**

➤ Refrigeration Service Engineers Society, 1666 Rand Rd., Des Plaines, IL 60016-3552. Internet: **http://www.rses.org**

➤ Sheet Metal and Air-Conditioning Contractors National Association, 4201 Lafayette Center Dr., Chantilly, VA 20151-1209. Internet: **http://www.smacna.org**

➤ United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry, United Association Bldg., 3 Park Place, Annapolis, MD 21401-3687. Internet: **http://www.ua.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos192.htm**

Home Appliance Repairers

Significant Points

- Little or no change in employment is projected; however, excellent job opportunities are expected, particularly for those with formal training in appliance repair and electronics.
- Good customer service skills and a driver's license are essential.

Nature of the Work

Home appliance repairers, more commonly referred to as home appliance repair technicians, install and repair home appliances such as refrigerators, dishwashers, washers and dryers, ranges, microwave ovens, and window air-conditioning units. This work is typically done on site. (Workers whose primary responsibility is the installation and repair of heating and central air-conditioning units are covered in a separate *Handbook* statement on heating, air-conditioning, and refrigeration mechanics and installers.) A small number of home appliance repair technicians service small appliances such as vacuum cleaners, small kitchen appliances, and microwaves that are portable and usually repaired in a central repair shop rather than in the home.

When installing major appliances such as refrigerators, washing machines, and cooking products, technicians may have to connect the appliances to a gas or water line. In these cases, once the connections are in place, they turn on the gas or water and check for leaks. When complete, they may show the customer how to work the appliance and answer customers' questions about the care and use of the appliance.

When problems with major home appliances occur, home appliance repair technicians will usually make a site visit to visually inspect the appliance and make the repair. To determine the cause of the failure, they will check for unusual noises, excessive vibration, leakage of fluid, or loose parts. Technicians disassemble the appliance to examine its internal parts for signs of wear or corrosion. They follow service manual diagnostic procedures and use testing devices such as ammeters, voltmeters, and wattmeters to check electrical systems for shorts and faulty connections.

After identifying problems, home appliance repair technicians replace or repair defective belts, motors, heating elements, switches, gears, or other items. They tighten, align, clean, and lubricate parts as necessary. Technicians use common handtools, including screwdrivers, wrenches, files, and pliers, as well as soldering guns and tools designed for specific appliances. Appliances with electronic parts often require new circuit boards or other electronic components.

When repairing refrigerators and window air-conditioners, repairers must take care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in the cooling systems, as is required by law. Federal regulations also require that home appliance repair technicians document the capture and disposal of refrigerants.

In addition to making repairs, technicians keep records of parts used and hours worked, prepare bills, and collect payments. If an appliance is under warranty, a technician may need to confer with the manufacturer of the appliance to recoup monetary claims for work performed.

Work environment. When they are fully qualified to work alone, home appliance repair technicians usually work with little or no direct supervision and spend much of the day on the road driving to and from appointments and emergency calls. Those who work on portable appliances generally work in service center repair shops. Although many home appliance repair technicians work a standard 40-hour week, some work weekends and early morning or evening shifts to cover hours as needed and some remain on call for emergencies. In summer, demand for repairs to refrigerators and window air conditioners go up and may cause additional work and overtime.

Technicians sometimes work in cramped and uncomfortable positions when they are replacing parts in hard-to-reach areas of appliances, but the jobs are generally not hazardous as long as workers exercise care and follow safety precautions to avoid electrical shocks and gas leaks, and use safety measures when lifting and moving large appliances.

Training, Other Qualifications, and Advancement

Most entry-level workers in this profession enter without any specific training or experience and learn on the job, although employers prefer to hire those who have completed programs in electronics

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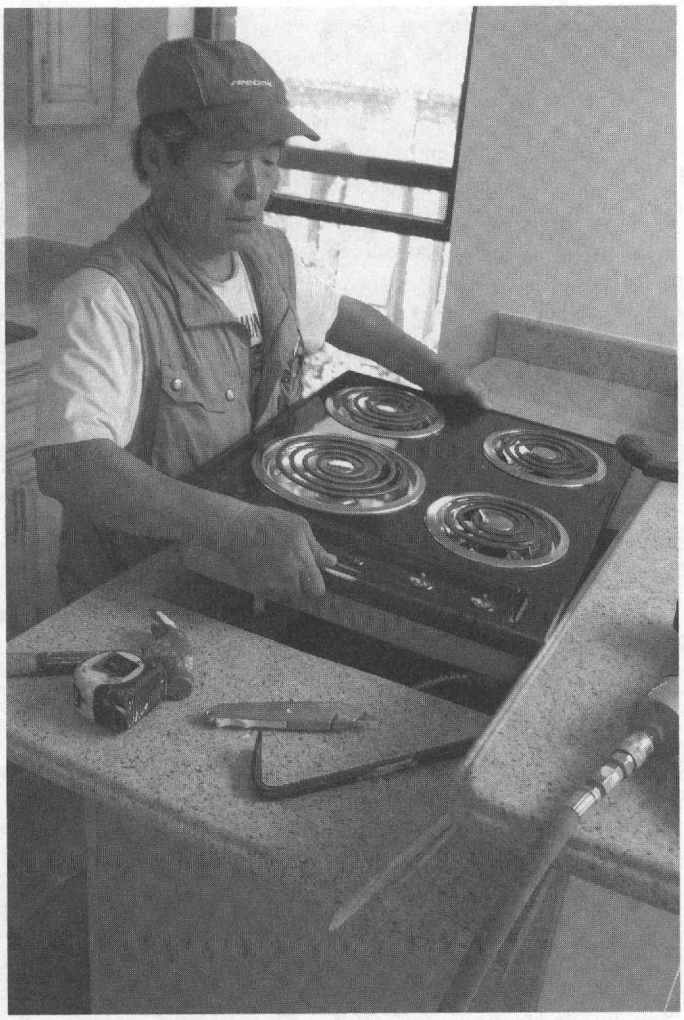

Most home appliance repairers enter the occupation with a high school diploma and little or no training repairing appliances.

or appliance repair. A driver's license and good customer service skills are essential to work on appliances in customer's homes.

Education and training. Most home appliance repair technicians enter the occupation with a high school diploma or its equivalent and little training in repairing appliances. Most learn their jobs while working with more experienced workers and by attending in-house classes sponsored by the employer. Some appliance manufacturers and employers have formal training programs that include home study and shop classes, in which trainees work with demonstration appliances and other training equipment. Many technicians also receive supplemental instruction through 2- or 3-week seminars conducted by appliance manufacturers. Technicians authorized for warranty work by manufacturers are required to attend periodic training sessions. Training can last from several months to a few years.

In businesses that fix portable appliances in a repair shop, trainees work on a single type of appliance, such as a vacuum cleaner, until they master its repair. Then they move on to others, until they can work on all appliances repaired by the shop.

While on-the-job training is the most common method of training, employers prefer to hire workers that have attended high school or postsecondary vocational or technical programs in electronics or appliance repair. These programs can last 1 to 2 years and include courses in basic electricity and electronics as most home appliances contain electronic components. These programs can help reduce the amount of on-the-job training required for entry-level workers.

Most home appliance repair technicians will need to take periodic classes throughout their careers to keep their skills up to date and to be able to repair the latest home appliance models.

Licensure. The U.S. Environmental Protection Agency (EPA) has mandated that all repair technicians who buy or work with refrigerants pass a written examination to become certified in proper refrigerant handling. Exams are administered by EPA-approved organizations, such as trade schools, unions, and employer associations. There also are EPA-approved take-home certification exams. Although no formal training is required for certification, many of these organizations offer training programs designed to prepare workers for the certification examination.

Certification and other qualifications. A helpful manner with customers and good communication skills are essential for those who work in clients' homes. Technicians must be courteous and tactful. They must also be dependable. A driver's license with a clean driving record is also usually required to drive to customers' homes, and some employers may require a background check and drug test. Mechanical and electrical aptitudes are desirable. Those who are self-employed need good business and financial skills to maintain a business. Membership in a trade association can help business owners learn from others in the field.

Home appliance repair technicians may demonstrate their competence by passing one of several certification examinations offered by various organizations. Although voluntary, such certifications can be helpful when seeking employment. The National Appliance Service Technician Certification (NASTeC), which is administered by the International Society of Certified Electronics Technicians (ISCET), requires technicians to pass a comprehensive examination that tests their competence in the diagnosis, repair, and maintenance of major home appliances. The Professional Service Association (PSA) administers a similar certification program based on skill competencies developed by the industry and updated annually. Those who pass the PSA examination can earn the Master Certified Appliance Professional (MCAP) designation.

Advancement. Technicians in large shops or service centers may be promoted to supervisor, assistant service manager, or service manager. Some technicians advance to managerial positions such as regional service manager or parts manager for

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Home appliance repairers	49-9031	49,600	50,600	1,100	2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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appliance or tool manufacturers. Experienced technicians who have sufficient funds and knowledge of small-business management frequently open their own repair shops.

Employment

Home appliance repair technicians are employed throughout the country, but a higher concentration of jobs can be found in more populated areas. Home appliance repair technicians held 49,600 jobs in 2008. About 32 percent of salaried technicians worked for retail trade establishments, mainly electronics and appliance stores. Another 21 percent worked in the personal and household goods repair and maintenance industry. About 27 percent of repairers were self-employed.

Job Outlook

Little to no change in employment of home appliance repairers is projected. However, excellent job opportunities are projected, particularly for individuals with formal training in appliance repair and electronics.

Employment change. Employment of home appliance repairers will increase by 2 percent between 2008 and 2018, reflecting the difficulty of employers in finding qualified applicants. Although the number of home appliances in use is expected to increase with growth in the numbers of households, companies report difficulty in hiring repair technicians. In addition, the decision to repair an appliance often depends on the price to replace the appliance versus the cost to make the repairs. So while higher priced major appliances designed to have a long life are more likely to be repaired, small and cheaper appliances are increasingly being discarded rather than be repaired. With sales of high-end appliances growing, demand for major appliance repair technicians should be strong into the future, but weaker for those specializing in small, portable appliances.

Job prospects. Job opportunities for home appliance repair technicians are expected to be excellent over the 2008-18 period, with job openings continuing to outnumber jobseekers. Companies report numerous unfilled vacancies and the expected retirement of many older technicians. Opportunities will be best in metropolitan areas. Individuals with formal training in appliance repair and electronics should have the best opportunities.

Jobs are expected to be increasingly concentrated in larger household goods repair services companies as stores increasingly outsource repair work to companies that specialize in maintenance and repair. Employment is relatively steady and workers are rarely laid off because demand for major appliance repair services is fairly constant.

Earnings

Median hourly wages, including commissions, of home appliance repairers were $16.30 in May 2008. The middle 50 percent earned between $12.87 and $20.92 an hour. The lowest 10 percent earned less than $9.98, and the highest 10 percent earned more than $25.92 an hour. In May 2008, median hourly wages of home appliance repairer technicians in the largest employing industries were $15.05 in electronics and appliance stores and $17.58 in personal and household goods repair and maintenance.

Earnings of home appliance repairer technicians vary with skill level, geographic location, and type of equipment repaired. Many repairers receive a commission along with their salary, therefore earnings increase with the number of jobs a repairer can complete in a day.

Many larger dealers, manufacturers, and service stores offer typical benefits such as health insurance coverage, sick leave, and retirement and pension programs. Some provide company vehicles.

Related Occupations

Other workers who repair electrical and electronic equipment include:

	Page
Coin, vending, and amusement machine servicers and repairers	720
Electrical and electronics installers and repairers	675
Electronic home entertainment equipment installers and repairers	678
Heating, air-conditioning, and refrigeration mechanics and installers	703
Small engine mechanics	700

Sources of Additional Information

For general information on home appliance repair technicians and the Certified Appliance Professional program, contact:

➤ Professional Service Association, 71 Columbia St., Cohoes, NY 12047. Internet: **http://www.psaworld.com**

For information on the National Appliance Service Technician Certification program, contact:

➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107. Internet: **http://www.nastec.org**

For general information on home appliance repair technicians, contact:

➤ United Servicers Association, 1 Presidential Way, Suite 106, Woburn, MA 01801. Internet: **http://www.unitedservicers.com**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos193.htm**

Industrial Machinery Mechanics and Millwrights

Significant Points

- Most workers are employed in manufacturing.
- Machinery maintenance workers learn on the job, industrial machinery mechanics usually need some education after high school, and millwrights typically learn through formal apprenticeship programs.
- Applicants with broad skills in machine repair and maintenance should have favorable job prospects.

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Nature of the Work

Imagine an automobile assembly line: a large conveyor system moves unfinished automobiles down the line, giant robotic welding arms bond the different body panels together, hydraulic lifts move the motor into the body of the car, and giant presses stamp body parts from flat sheets of steel. All these complex machines need workers to install them and service them to make sure they function properly. Assembling and setting up these machines on the factory floor is the job of millwrights, while industrial machinery mechanics and machinery maintenance workers maintain and repair these machines.

Millwrights are the highly skilled workers who install, assemble, and, when necessary, dismantle machinery in factories, power plants, and construction sites. These workers consult with engineers and managers to determine the best location to place a machine. Millwrights then transport the machine parts to the desired location, using fork lifts, hoists, winches, cranes and other equipment. Machines do not arrive in one piece, and millwrights need to assemble them from their component parts. Millwrights must understand how a machine functions to assemble and disassemble it properly; this may involve knowledge of electronics, pneumatics, and computer systems. They use complex instruction books that detail the assembly of the machinery and use tools such as levels, welding machines, and hydraulic torque wrenches. Millwrights use micrometers, precision measuring devices, to achieve the extreme tolerances required by modern machines. On large projects, the use of cranes and trucks is common.

Assembly of a machine can take a few days or several weeks. Aside from assembly, millwrights are also involved in major repairs and disassembly of machines. If a manufacturing plant needs to clear floor space for new machinery, it can sell or trade-in old equipment. The breaking down of a machine is normally just as complicated as assembling it; all parts must be carefully taken apart, categorized and packaged for shipping.

While major repairs may require the assistance of a millwright, keeping machines in good working order is the primary responsibility of *industrial machinery mechanics,* also called industrial machinery repairers or maintenance machinists. To do this effectively, these workers must be able to detect minor problems and correct them before they become larger problems. Machinery mechanics use technical manuals, their understanding of the equipment, and careful observation to discover the cause of the problem. For example, after hearing a vibration from a machine, the mechanic must decide whether it is due to worn belts, weak motor bearings, or some other problem. Mechanics often need years of training and experience to fully diagnose all problems, but computerized diagnostic systems and vibration analysis techniques provide aid in determining the nature of the problem.

After diagnosing the problem, the industrial machinery mechanic may disassemble the equipment to repair or replace the necessary parts. Increasingly, mechanics are expected to have the electrical, electronics, and computer programming skills to repair sophisticated equipment on their own. Once a repair is made, mechanics perform tests to ensure that the machine is running smoothly. Primary responsibilities of industrial machinery mechanics also include preventive maintenance; for example, they adjust and calibrate automated manufacturing equipment, such as industrial robots.

The most basic maintenance and repair tasks are performed by *machinery maintenance workers.* These employees are responsible for cleaning and lubricating machinery, performing basic diagnostic tests, checking performance, and testing damaged machine parts to determine whether major repairs are necessary. In carrying out these tasks, maintenance workers must follow machine specifications and adhere to maintenance schedules. Maintenance workers may perform minor repairs, but major repairs generally are left to machinery mechanics.

Industrial machinery mechanics and machinery maintenance workers use a variety of tools to perform repairs and preventive maintenance. They may use handtools to adjust a motor or a chain hoist to lift a heavy printing press off the ground. When replacements for broken or defective parts are not readily available, or when a machine must be returned quickly to production, mechanics may create a new part using lathes, grinders, or drill presses. Mechanics use catalogs to order replacement parts and often follow blueprints, technical manuals, and engineering specifications to maintain and fix equipment. By keeping complete and up-to-date records, mechanics try to anticipate trouble and service equipment before factory production is interrupted. If an industrial machinery mechanic is unable to repair a machine and a major overhaul is needed, a millwright with expertise on the machine may be hired to make the repair.

Work environment. In production facilities, these workers are subject to common shop injuries such as cuts, bruises, and strains. In the construction setting, workers must be careful of heavy equipment. They also may work in awkward positions, including on top of ladders or in cramped conditions under large machinery, which exposes them to additional hazards. To avoid injuries, workers must follow safety precautions and use protective equipment, such as hardhats, safety glasses, steel-tipped shoes, hearing protectors, and belts.

Because factories and other facilities cannot afford to have industrial machinery out of service for long periods, mechanics may be on call or assigned to work nights or on weekends. Overtime is common among these occupations, as about 30 percent of employees worked over 40 hours per week, on average, in 2008.

Millwrights are typically employed on a contract basis and may only spend a few days or weeks at a single site. As a result, schedules of work can be unpredictable, and workers may experience down time in between jobs.

Training, Other Qualifications, and Advancement

Millwrights typically go through formal apprenticeship programs that last a few years and involve both classroom and on-the-job training. Industrial machinery mechanics usually need some education after high school plus experience working on specific machines before they can be considered a mechanic. Machinery maintenance workers can usually get a job with little more than a high school diploma or its equivalent; most workers learn on the job.

Education and training. All machinery maintenance and millwright worker positions generally require a high school diploma, GED, or its equivalent. However, employers increasingly prefer to hire machinery maintenance workers with some training in industrial technology. Employers also prefer to hire

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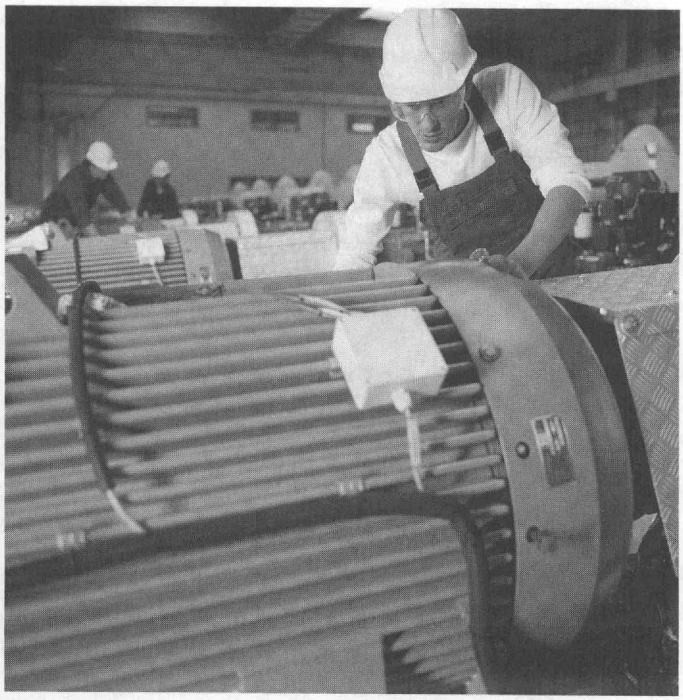

Millwrights install and inspect power generating turbines.

those who have taken high school or postsecondary courses in mechanical drawing, mathematics, blueprint reading, computer programming, or electronics.

Most millwrights, and some industrial machinery mechanics, enter the occupation through an apprenticeship program that typically lasts about 4 years. Apprenticeships can be sponsored by local union chapters, employers, or the State labor department. Training in these apprenticeships involves a combination of on-the-job training and classroom learning. Jobseekers can apply for union apprenticeships, and qualified applicants may begin training in local training facilities and factories.

Industrial machinery mechanics usually need a year or more of formal education and training after high school to learn the growing range of mechanical and technical skills that they need. While mechanics used to specialize in one area, such as hydraulics or electronics, many factories now require every mechanic to have knowledge of electricity, electronics, hydraulics, and computer programming.

Workers can get this training in a number of different ways. A 2-year associate degree program in industrial maintenance provides good preparation. Other mechanics may start as helpers or in other factory jobs and learn the skills of the trade informally and by taking courses offered through their employer. It is common for experienced production workers to move into maintenance positions if they show good mechanical abilities. Employers may offer on-site classroom training or send workers to local technical schools while they receive on-the-job training. Classroom instruction focuses on subjects such as shop mathematics, blueprint reading, welding, electronics, and computer training. In addition to classroom training, it is important that mechanics train on the specific machines they will repair. They can get this training on the job, through dealer or manufacturer's representatives, or in a classroom.

Machinery maintenance workers typically receive on-the-job training lasting a few months to a year to perform routine tasks, such as setting up, cleaning, lubricating, and starting machinery. This training may be offered by experienced workers, professional trainers, or representatives of equipment manufacturers.

Other qualifications. Machinery mechanics must have good problem-solving abilities, as it is important for them to be able to discover the cause of a problem to repair it. Mechanical aptitude and manual dexterity are also important. Good reading comprehension is necessary to understand the technical manuals of a wide range of machines; and good communications skills are also essential in order for millwrights, mechanics and maintenance workers to understand the needs of other workers and managers. In addition, good physical conditioning and agility are necessary because repairers sometimes have to lift heavy objects or climb to reach equipment.

Advancement. Opportunities for advancement vary by specialty. Machinery maintenance workers, if they take classes and gain additional skills, may advance to industrial machinery mechanic or supervisor. Industrial machinery mechanics also advance by working with more complicated equipment and gaining additional repair skills. The most highly skilled repairers can be promoted to supervisor, master mechanic, or millwright. Experienced millwrights can advance into team leading roles.

Employment

Industrial machinery mechanics, machinery maintenance workers and millwrights held about 408,300 jobs in 2008. 45,200 of these jobs were held by millwrights, with the largest concentration of workers in manufacturing and construction industries. In manufacturing, many of these workers are employed in the transportation equipment, wood product, and paper manufacturing industries. In construction, most workers were employed in the nonresidential building, and building equipment contractors, industries. Also, some millwrights work in the utilities industry.

Industrial machinery mechanics held about 287,700 jobs, while machinery maintenance workers accounted for 75,400 jobs. Many of both types of workers were employed in the manufacturing sector in industries such as food processing and chemical, fabricated metal product, machinery, and motor

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Industrial machinery mechanics and millwrights	–	408,300	433,300	25,000	6
Industrial machinery mechanics	49-9041	287,700	308,600	20,900	7
Maintenance workers, machinery	49-9043	75,400	78,800	3,400	5
Millwrights	49-9044	45,200	45,900	600	1

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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vehicle and parts manufacturing. Additionally, about 10 percent work in wholesale trade, mostly for dealers of industrial equipment. Manufacturers often rely on these dealers to make complex repairs to specific machines. About 9 percent of mechanics work for the commercial and industrial machinery and equipment repair and maintenance industry, often making site visits to companies to repair equipment.

Job Outlook

Employment is projected to grow more slowly than average, and applicants with broad skills in machine repair and maintenance should have favorable job prospects.

Employment change. Employment of industrial machinery mechanics and millwrights is expected to grow 6 percent from 2008 to 2018, more slowly than the average for all occupations. The increased use of machinery in manufacturing will require more millwrights to install this equipment and more mechanics and maintenance workers to keep it in good working order.

Employment of millwrights is expected to grow 1 percent from 2008 to 2018. The demand for millwrights is driven by the purchasing of machinery in the construction and manufacturing industries. Cost-cutting pressures will drive manufacturers to further automate production and increase machinery presence on the factory floor. The growth of the power industry will also generate work for millwrights, as they install and repair turbines on wind mills, coal plants, and hydroelectric dams.

Employment of industrial machinery mechanics and maintenance workers is expected to grow 7 percent from 2008 to 2018. As factories become increasingly automated, these workers will be needed to maintain and repair the automated equipment. However, many new computer-controlled machines are capable of diagnosing problems quickly, resulting in faster and easier repair, which somewhat slows the growth of these occupations.

Job prospects. Applicants with broad skills in machine repair and maintenance should have favorable job prospects. In addition to job openings from growth, there will be a need to replace the many older workers who are expected to retire, and those who leave the occupation for other reasons. Some employers have reported difficulty in recruiting young workers with the necessary skills.

Mechanics and millwrights are not as affected by changes in production levels as other manufacturing workers, as mechanics and millwrights often are retained during production downtime to complete major equipment overhaul and to keep expensive machinery in working order.

Earnings

Median hourly wages of millwrights were $22.87 in May 2008. The middle 50 percent earned between $17.85 and $30.53. The lowest 10 percent earned less than $14.37, and the highest 10 percent earned more than $37.02.

Median hourly wages of industrial machinery mechanics were $20.99 in May 2008. The middle 50 percent earned between $16.87 and $25.82. The lowest 10 percent earned less than $13.63, and the highest 10 percent earned more than $31.40.

Machinery maintenance workers earned somewhat less than the higher skilled industrial machinery mechanics. Median hourly wages of machinery maintenance workers were $17.69 in May 2008. The middle 50 percent earned between $13.75 and $22.82. The lowest 10 percent earned less than $10.83, and the highest 10 percent earned more than $28.10.

Earnings vary by industry and geographic region. Median hourly wages in the industries employing the largest numbers of industrial machinery mechanics are:

Motor vehicle parts manufacturing	$24.04
Machinery, equipment, and supplies merchant wholesalers	20.17
Plastics product manufacturing	20.05
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	18.65
Animal slaughtering and processing	16.65

In 2008, almost half of all millwrights belonged to unions, while about 19 percent of industrial machinery mechanics were union members.

Related Occupations

Other workers do installation, maintenance, and repair, including:

	Page
Electrical and electronics installers and repairers	675
Electricians	641
Machinists	737
Maintenance and repair workers, general	716
Plumbers, pipelayers, pipefitters, and steamfitters	659
Welding, soldering, and brazing workers	743

Sources of Additional Information

For information about millwright training and apprenticeships, contact:

➤ United Brotherhood of Carpenters/Millwrights, 6801 Placid St., Las Vegas, NV 89119. Internet: **www.ubcmillwrights.org**

For further information on apprenticeship programs, write to the Apprenticeship Council of your State's labor department or local firms that employ machinery mechanics and repairers. You can also find information on registered apprenticeships, together with links to State apprenticeship programs, on the U.S. Department of Labor Web site: **www.doleta.gov/OA/eta_default.cfm**. Apprenticeship information is also available from the U.S. Department of Labor toll-free helpline: (877) 872-5627.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos353.htm**

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Line Installers and Repairers

Significant Points

- Earnings are higher in this occupation than in many other occupations that do not require postsecondary education.
- A growing number of retirements should create very good job opportunities, especially for electrical power-line installers and repairers.
- Line installers and repairers often work outdoors, and conditions can be hazardous.
- Most positions require several years of long-term on-the-job training.

Nature of the Work

Every time you turn on your lights, call someone on the phone, watch cable television, or access the Internet, you are connecting to complex networks of lines and cables that provide you with electricity and connect you with the outside world. *Line installers and repairers*, also known as *line workers* or *linemen,* are the people who install and maintain these networks.

Because these systems are so complicated, most line workers specialize in certain skill areas; the areas in which they specialize depend on their employers and on what part of the network the workers service. Line workers can be divided into two categories: *electrical power-line installers and repairers,* and *telecommunications line installers and repairers.* Workers can further specialize in either installation or repair. Electrical line workers can also be divided into workers who install and maintain the multistate power grids, and those who work for local utilities. Similarly, telecommunications line workers specialize in telephone, cable, fiber-optic, and other networks. Each of these specializations requires specific skills, and it may be difficult to transfer skills learned in one area to another. In many cases, two or more skills sets will be combined, especially for experienced workers and supervisors.

Electrical power-line installers and repairers install and maintain the power grid—the network of power lines that moves electricity from generating plants to customers. They routinely work with high voltage electricity, which requires extreme caution. This can range from hundreds of thousands of volts for long-distance transmission lines that make up the power grid to less than 10,000 volts for distribution lines that supply electricity to homes and businesses. Line workers who maintain the interstate power grid work in crews that travel to work locations throughout a large region to maintain transmission lines and towers. Workers employed by local utilities work mainly with lower voltage distribution lines, maintaining equipment such as transformers, voltage regulators, and switches. They may also work on traffic lights and streetlights.

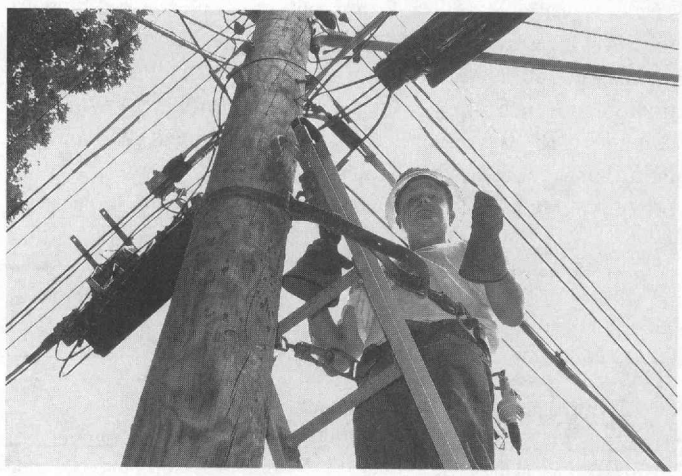
In contrast, telecommunications line installers and repairers install and maintain the lines and cables used by local and long-distance telephone services, cable television, the Internet, and other communications networks. These services use a variety of different types of cables, including fiber-optic cables. Unlike metallic cables that carry electricity, fiber optic cables are made of glass or plastic and transmit signals using light. Working with fiber optics requires special skills, such as splicing and terminating optical cables. Additionally, workers must be able to test and troubleshoot cables and networking equipment.

Line installers are workers who install new cable. They may work for construction contractors, utilities, or telecommunications companies. They generally start a new job by digging underground trenches or erecting utility poles and towers to carry the wires and cables. They use a variety of construction equipment, including digger derricks, which are trucks equipped with augers and cranes used to dig holes in the ground and set poles in place. Line installers also use trenchers, cable plows, and borers, which are used to cut openings in the earth for the laying of underground cables. Once the infrastructure is in place, line installers string cable along poles and towers or through tunnels and trenches.

Line repairers are employed by utilities and telecommunications companies that maintain existing power and telecommunications lines. Maintenance needs may be identified in a variety of ways, including remote monitoring equipment, inspections by airplane or helicopter, and customer reports of service outages. Workers may also replace aging or outdated equipment. Many of these workers have installation duties in addition to their repair duties.

When a problem is reported, line repairers must identify its cause and fix it. This usually involves testing equipment and replacing it as necessary. In order to work on poles, line installers usually use bucket trucks to elevate themselves to the top of the structure, although all line workers must be adept at climbing poles when necessary. Workers use special safety equipment to keep them from falling when climbing utility poles. Storms and other natural disasters can cause extensive damage to networks of lines. When a connection goes out, line repairers must work quickly to restore service to customers.

Work environment. The work of line installers and repairers can be very physically demanding. Line installers must be comfortable working both at heights and in confined spaces. While bucket trucks have reduced the amount of climbing workers must do, all line workers must be able to climb utility poles and balance while working on them. They must also be able to lift equipment and work in a variety of positions, such as stoop-



Most line installers need several years of on-the-job training.

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ing or kneeling. Their work often requires that they drive utility vehicles, travel long distances, and work outdoors under poor weather conditions.

Line workers encounter serious hazards on their jobs and must follow safety procedures to minimize potential danger. They wear safety equipment when entering utility holes and test for the presence of gas before going underground. Electric power-line workers have somewhat hazardous jobs. High-voltage power lines can instantly electrocute a worker who comes in contact with a live cable. When possible, workers arrange for lines to be de-energized and test to make sure that any remaining voltage has been neutralized. When workers must work with live wires, they use electrically insulated protective devices and tools to ensure their safety. Power lines are typically higher than telephone and cable television lines, increasing the risk of severe injury due to falls. To prevent injuries, line installers must use fall-protection equipment when working on poles or towers.

While safety procedures and training have significantly reduced the danger that line workers face, the job is still among the most dangerous jobs in the American economy. Both telecommunications and electrical line workers have relatively high rates of nonfatal occupational injuries. In the early days of electricity, one in four line workers suffered fatal injuries on the job. Today, however, fatalities are extremely rare.

Workers on the interstate power grid or on long-distance communications systems are often required to travel extensively as part of their jobs. Since line installers and repairers fix damage from storms, they may be asked to work long and irregular hours during unpleasant weather. They can expect to frequently be on-call and work overtime. When performing normal maintenance and constructing new lines, line installers work more traditional hours.

Training, Other Qualifications, and Advancement

Most line installers and repairers require several years of long-term on-the-job training and some classroom work to become proficient. Formal apprenticeships are common.

Education and training. Most companies require that line installers and repairers have a high school diploma or the equivalent. Employers look for people with basic knowledge of algebra and trigonometry and good reading and writing skills. Technical knowledge of electricity or electronics obtained through military service, vocational programs or community colleges can be helpful, but it is rarely required for new employees.

Many community colleges offer programs in telecommunications, electronics, or electricity. Some programs work with local companies to offer 1-year certificates that emphasize hands-on field work. More advanced 2-year associate degree programs provide students with a broader knowledge of the technology used in telecommunications and electrical utilities. They offer courses in electricity, electronics, fiber optics, and microwave transmission.

Line installers and repairers receive most of their training on the job. Electrical line installers and repairers often must complete formal apprenticeships or other employer training programs. These programs, which can last up to 5 years, combine on-the-job training with formal classroom courses and are sometimes administered jointly by the employer and the union representing the workers. Safety regulations strictly define the training and educational requirements for apprentice electrical line installers, but licensure is not required.

Line installers and repairers working for telephone and cable television companies receive several years of on-the-job training. They also may attend training or take online courses provided by equipment manufacturers, schools, unions, or industry training organizations.

Other qualifications. Physical fitness is important because line workers must be able to climb, lift heavy objects (many employers require applicants to be able to lift at least 50 pounds), and do other physical activity that requires stamina, strength, and coordination. They often must work at a considerable height above the ground, so they cannot be afraid of heights. They must also work underground and in bucket trucks, so they must also be comfortable working in confined spaces. Normal ability to distinguish colors is necessary because wires and cables are often color coded. In addition, line workers usually need commercial driver's licenses to operate company-owned vehicles, and a good driving record is important.

Line installers and repairers must also be able to read instructions, write reports, and solve problems. They should also be mechanically inclined and like working with computers and new technology. Workers often rely on their fellow crew members for their safety, so teamwork is critical. Being able to get along with other people is very important in this job.

Advancement. Entry-level line workers generally begin with classroom training and begin an apprenticeship. Their on-the-job training begins with basic tasks, such as ground work and tree trimming. As they continue to learn additional skills from more experienced workers, they may advance to stringing cable and performing service installations. In time, they advance to more sophisticated maintenance and repair positions in which they are responsible for increasingly larger portions of the network.

After about 3 to 5 years of working, qualified line workers reach the journeyman level. A journeyman line worker is no longer considered apprenticed, and can do most tasks without supervision. Journeyman line workers may also qualify for positions at other companies. Workers with many years of ex-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Line installers and repairers	49-9050	284,900	291,600	6,600	2
Electrical power-line installers and repairers	49-9051	113,900	119,000	5,100	4
Telecommunications line installers and repairers	49-9052	171,000	172,600	1,600	1

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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perience may become first-line supervisors or may advance to trainer positions.

Employment

Line installers and repairers held about 284,900 jobs in 2008. Approximately 171,000 were telecommunications line installers and repairers while the remaining 113,900 were electrical power-line installers and repairers. Nearly all line installers worked for telecommunications companies, including both cable television distribution and telecommunications companies; construction contractors; and electric power generation, transmission, and distribution companies.

Job Outlook

Little or no change in employment is expected. Retirements are expected to create very good job opportunities for new workers, particularly for electrical power-line installers and repairers.

Employment change. Overall employment of line installers and repairers will grow by 2 percent between 2008 and 2018. Despite employment declines in some of the major industries that employ these workers, some growth will occur as population growth and expansion of cities create increased need for power and communications lines. Further, the emphasis of both the electrical power and telecommunications industries on reliability will lead to reinforcement of these networks, which will require more workers.

Employment of telecommunications line installers and repairers will grow by about 1 percent over the 2008–2018 decade. As the population grows, installers will continue to be needed to provide new telephone, cable, and Internet services for new developments. Additionally, the exponential growth of the Internet will require more long-distance fiber-optic lines, including interstate and undersea cables.

Employment of electrical power-line installers and repairers is expected to grow by about 4 percent between 2008 and 2018. As with telecommunications line installers and repairers, growth will be largely attributable to the growing population and expansion of cities. With each new development, new lines are installed which will require maintenance. In addition, the interstate power grid will continue to grow in complexity to ensure reliability.

Job prospects. Very good job opportunities are expected, especially for electrical power-line installers and repairers. Because of layoffs in the 1990s, more of the electrical power industry is near retirement age than in most industries. This is of special concern for electrical line workers, who must be in good physical shape and cannot necessarily put off retirement in response to incentives. Telecommunications line workers face a similar demographic challenge. Additionally, technically skilled workers who do not have a college degree have an increasing number of employment opportunities, creating competition among employers. As a result, opportunities for new entrants should be very good.

Earnings

Earnings for line installers and repairers are above the average for occupations that do not require postsecondary education. In May 2008, median annual wages for electrical power-line installers and repairers were $55,100. The middle 50 percent earned between $41,340 and $66,030. The lowest 10 percent earned less than $31,420, and the highest 10 percent earned more than $78,780. Median annual wages in the industries employing the largest numbers of electrical power-line installers and repairers in May 2008 are shown below:

Natural gas distribution	$84,350
Electric power generation, transmission and distribution	58,530
Local government	52,900
Building equipment contractors	52,870
Utility system construction	45,420

Median annual wages for telecommunications line installers and repairers were $48,090 in May 2008. The middle 50 percent earned between $33,680 and $60,670. The lowest 10 percent earned less than $25,790, and the highest 10 percent earned more than $67,990. Median annual wages in the industries employing the largest numbers of telecommunications line installers and repairers in May 2008 are shown below:

Other telecommunications	$58,100
Wired telecommunications carriers	54,860
Cable and other subscription programming	39,970
Building equipment contractors	37,760
Utility system construction	34,580

Many line installers and repairers belong to unions, principally the Communications Workers of America, the International Brotherhood of Electrical Workers, and the Utility Workers Union of America. For these workers, union contracts set wage rates and wage increases and determine the time needed to advance from one wage level to the next.

Good health, education, and vacation benefits are common in the occupation.

Related Occupations

Other workers who install and repair electrical and electronic equipment include:

	Page
Electrical and electronics installers and repairers	675
Electricians	641
Power plant operators, distributors, and dispatchers	760
Radio and telecommunications equipment installers and repairers	680

Sources of Additional Information

For more details about employment opportunities, contact the telephone, cable television, or electrical power companies in your community. For general information and educational resources on line installer and repairer jobs, contact:

➤ American Public Power Association, 1875 Connecticut Ave. NW, Suite 1200, Washington, DC 20009-5715. Internet: **http://www.appanet.org**

➤ Center for Energy Workforce Development, 701 Pennsylvania Ave. NW., Washington, DC 20004-2696. Internet: **http://www.cewd.org**

➤ The Fiber Optic Association, 1119 S Mission Rd #355, Fallbrook, CA 92028. Internet: **http://www.thefoa.org**

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➤ International Brotherhood of Electrical Workers, 900 Seventh St. NW, Washington, DC 20001. Internet: **http://www.ibew.org**

➤ National Joint Apprenticeship and Training Committee (NJATC), 301 Prince Georges Blvd., Suite D, Upper Marlboro, MD 20774. Internet: **http://www.njatc.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos195.htm**

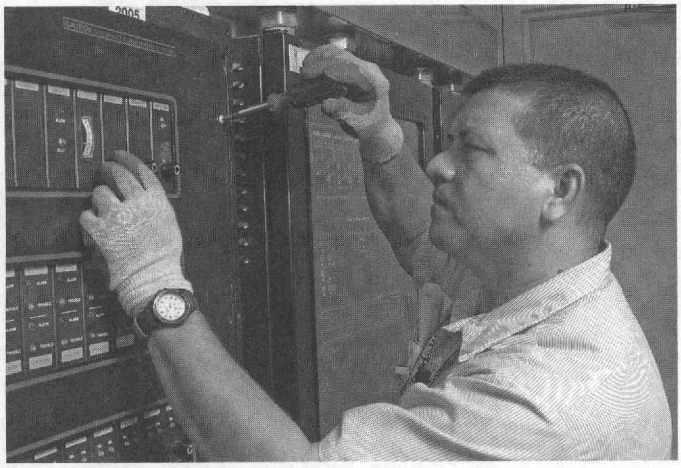
Maintenance and Repair Workers, General

Significant Points

- General maintenance and repair workers are employed in almost every industry.
- Many workers learn their skills informally on the job; obtaining certification may result in better advancement opportunities in higher paying industries.
- Job growth and turnover in this large occupation should result in excellent job opportunities, especially for people with experience in maintenance and related fields.

Nature of the Work

Most craft workers specialize in one kind of work, such as plumbing or carpentry. *General maintenance and repair workers*, however, have skills in many different crafts. They repair and maintain machines, mechanical equipment, and buildings and work on plumbing, electrical, and air-conditioning and heating systems. They build partitions, make plaster or drywall repairs, and fix or paint roofs, windows, doors, floors, woodwork, and other parts of building structures. They also maintain and repair specialized equipment and machinery found in cafeterias, laundries, hospitals, stores, offices, and factories.



Maintenance and repair workers need to know about computer controls of various building systems.

Typical duties include troubleshooting and fixing faulty electrical switches, repairing air-conditioning motors, and unclogging drains. New buildings sometimes have computer-controlled systems that allow maintenance workers to make adjustments in building settings and monitor for problems from a central location. For example, they can remotely control light sensors that turn off lights automatically after a set amount of time or identify a broken ventilation fan that needs to be replaced.

General maintenance and repair workers inspect and diagnose problems and determine the best way to correct them, frequently checking blueprints, repair manuals, and parts catalogs. They obtain supplies and repair parts from distributors or storerooms. Using common hand and power tools such as screwdrivers, saws, drills, wrenches, and hammers, as well as specialized equipment and electronic testing devices, these workers replace or fix worn or broken parts, where necessary, or make adjustments to correct malfunctioning equipment and machines.

General maintenance and repair workers also perform routine preventive maintenance and ensure that machines continue to run smoothly, building systems operate efficiently, and the physical condition of buildings does not deteriorate. Following a checklist, they may inspect drives, motors, and belts, check fluid levels, replace filters, and perform other maintenance actions. Maintenance and repair workers keep records of their work.

Employees in small establishments, where they are often the only maintenance worker, make all repairs, except for very large or difficult jobs. In larger establishments, duties may be limited to the maintenance of everything in a single workshop or a particular area.

Work environment. General maintenance and repair workers often carry out many different tasks in a single day, at any number of locations, including indoor and outdoor. They may work inside a single building, such as a hotel or hospital, or be responsible for the maintenance of many buildings, such as those in an apartment complex or college campus. They may have to stand for long periods, lift heavy objects, and work in uncomfortably hot or cold environments, in awkward and cramped positions, or on ladders. Those employed in small establishments often work with only limited supervision. Those in larger establishments frequently work under the direct supervision of an experienced worker. Some tasks put workers at risk of electrical shock, burns, falls, cuts, and bruises. Data from the U.S. Bureau of Labor Statistics show that full-time general maintenance workers experienced a work-related injury and illness rate that was much higher than the national average. Most general maintenance workers work a 40-hour week. Some work evening, night, or weekend shifts or are on call for emergency repairs.

Training, Other Qualifications, and Advancement

Many general maintenance and repair workers learn their skills informally on the job as helpers to other repairers or to carpenters, electricians, and other construction workers. Certification is available for entry-level workers, as well as experienced workers seeking advancement.

Education and training. General maintenance and repair workers often learn their skills informally on the job. They start as helpers, watching and learning from skilled maintenance

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Maintenance and repair workers, general	49-9042	1,361,300	1,509,200	147,900	11

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

workers. Helpers begin by performing simple jobs, such as fixing leaky faucets and replacing light bulbs, and progress to more difficult tasks, such as overhauling machinery or building walls. Some learn their skills by working as helpers to other types of repair or construction workers, including machinery repairers, carpenters, or electricians.

Several months of on-the-job training are required to become fully qualified, depending on the skill level required. Some jobs require a year or more to become fully qualified. Because a growing number of new buildings rely on computers to control their systems, general maintenance and repair workers may need basic computer skills, such as how to log onto a central computer system and navigate through a series of menus. Companies that install computer-controlled equipment usually provide on-site training for general maintenance and repair workers.

Many employers prefer to hire high school graduates. High school courses in mechanical drawing, electricity, woodworking, blueprint reading, science, mathematics, and computers are useful. Because of the wide variety of tasks performed by maintenance and repair workers, technical education is an important part of their training. Maintenance and repair workers often need to do work that involves electrical, plumbing, and heating and air- conditioning systems, or painting and roofing tasks. Although these basic tasks may not require a license to do the work, a good working knowledge of many repair and maintenance tasks is required. Many maintenance and repair workers learn some of these skills in high school shop classes and postsecondary trade or vocational schools or community colleges.

Licensure. Licensing requirements vary by State and locality. In some cases, workers may need to be licensed in a particular specialty such as electrical or plumbing work.

Other qualifications. Technical and mechanical aptitude, the ability to use shop mathematics, and manual dexterity are important attributes. Good health is necessary because the job involves much walking, climbing, standing, reaching, and heavy lifting. Difficult jobs require problem-solving ability, and many positions require the ability to work without direct supervision.

Certification and advancement. The International Management Institute (IMI) offers certification for three levels of competence, focusing on a broad range of topics, including blueprints, mathematics, basic electricity, piping systems, landscape maintenance, and troubleshooting skills. The lowest level of certification is Certified Maintenance Technician, the second level is Certified Maintenance Professional, and the highest level of certification is Certified Maintenance Manager. To become certified, applicants must meet several prerequisites and pass a comprehensive written examination.

Many general maintenance and repair workers in large organizations advance to maintenance supervisor or become craftworkers such as electricians, heating and air-conditioning mechanics, or plumbers. Within small organizations, promotion opportunities may be limited. Obtaining IMI certification may lead to better advancement opportunities in higher paying industries.

Employment

General maintenance and repair workers held about 1.4 million jobs in 2008. They were employed in almost every industry. Around 18 percent worked in manufacturing industries, while about 11 percent worked for Government. Others worked for wholesale and retail firms and for real estate firms that operate office and apartment buildings.

Job Outlook

Average employment growth is expected. Job growth and the need to replace those who leave this large occupation should result in excellent job opportunities, especially for those with experience in maintenance and related fields.

Employment change. Employment of general maintenance and repair workers is expected to grow 11 percent during the 2008-18 decade, about as fast as the average for all occupations. Employment is related to the number of buildings—for example, office and apartment buildings, stores, schools, hospitals, hotels, and factories—and the amount of equipment needing maintenance and repair. One factor limiting job growth is that computers allow buildings to be monitored more efficiently, partially reducing the need for workers.

Job prospects. Job opportunities should be excellent, especially for those with experience in maintenance or related fields. Those who obtain certification will also face excellent opportunities. General maintenance and repair is a large occupation, generating many job openings due to growth and the need to replace those who leave the occupation. Many job openings are expected to result from the retirement of experienced maintenance workers over the next decade.

Earnings

Median hourly wages of general maintenance and repair workers were $16.21 in May 2008. The middle 50 percent earned between $12.44 and $21.09. The lowest 10 percent earned less than $9.78, and the highest 10 percent earned more than $25.94. Median hourly wages in the industries employing the largest numbers of general maintenance and repair workers in May 2008 are shown in the following tabulation:

Local government	$17.11
Elementary and secondary schools	16.86
Activities related to real estate	14.41
Lessors of real estate	13.91
Traveler accommodation	12.65

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About 15 percent of general maintenance and repair workers are members of unions, including the American Federation of State, County, and Municipal Employees and the United Auto Workers.

Related Occupations

Some duties of general maintenance and repair workers are similar to those of:

	Page
Boilermakers	613
Carpenters	618
Electricians	641
Heating, air-conditioning, and refrigeration mechanics and installers	703
Plumbers, pipelayers, pipefitters, and steamfitters	659

Other, more specific, duties are similar to those of:

Coin, vending, and amusement machine servicers and repairers	720
Electrical and electronics installers and repairers	675
Electronic home entertainment equipment installers and repairers	678
Radio and telecommunications equipment installers and repairers	680

Sources of Additional Information

Information about job opportunities may be obtained from local employers and local offices of the State.

For information related to training and certification, contact:

➤ International Maintenance Institute, P.O. Box 751896, Houston, TX 77275-1896. Internet: **http://www.imionline.org**

➤ Society for Maintenance and Reliability Professionals, 8400 Westpark Drive, 2nd Floor, McLean, VA 22102-3570. Internet: **http://www.smrp.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos194.htm**

Medical Equipment Repairers

Significant Points

- Employment is projected to grow 27 percent, which is much faster than the average for all occupations.
- Excellent job opportunities are expected.
- Employers generally prefer applicants with an associate's degree in biomedical equipment technology or engineering; a bachelor's degree often is needed for advancement.
- Repairers may be on-call around the clock in case of emergencies.

Nature of the Work

Medical equipment repairers, also known as *biomedical equipment technicians* (BMET), maintain, adjust, calibrate, and repair a wide variety of electronic, electromechanical, and hydraulic equipment used in hospitals and other medical environments, including health practitioners' offices. They may work on patient monitors, defibrillators, medical imaging equipment (x rays, CAT scanners, and ultrasound equipment), voice-controlled operating tables, electric wheelchairs, as well as other sophisticated dental, optometric, and ophthalmic equipment.

Medical equipment repairers use a wide variety of tools to conduct their work, including multimeters, specialized software, and computers designed to communicate with specific pieces of hardware. They may also use hand tools, soldering irons, and other electronic tools to fix or adjust malfunctioning equipment, such as a broken wheelchair. If a machine is not functioning to its potential, the repairer may have to adjust the mechanical or hydraulic components, or adjust the software to bring the equipment back into calibration. Most medical equipment is powered by electricity, but because many also have mechanical and hydraulic components, being familiar with all of these systems is critical.

In some cases, medical equipment repairers perform routine scheduled maintenance to ensure that all equipment is in good working order. Since many doctors, particularly specialty practitioners, regularly use complex medical devices to run tests and diagnose patients, they must be guaranteed that the readings are accurate. For less complicated equipment, such as electric hospital beds, many repairs may take place on an as-needed-basis.

In a hospital setting, specialists must be comfortable working around patients because repairs occasionally must take place while equipment is being used. When this is the case, the repairer must take great care to ensure that repairs do not disturb patients.

Many medical equipment repairers are employed in hospitals. Some, however, work for electronic equipment repair and maintenance companies that service medical equipment used by other health practitioners, including gynecologists, orthodontists, veterinarians, and other diagnostic medical professionals. Whereas some medical equipment repairers are trained to fix a wide variety of equipment, others specialize and become proficient at repairing one or a small number of machines.

Work environment. Medical equipment repairers usually work daytime hours, but are often expected to be on call. Still, like other hospital employees, some repairers work irregular hours and may be required to work overtime if an important piece of medical equipment malfunctions. Medical equipment repairers often must work in a patient environment, which has the potential to expose them to diseases and other health risks. Because medical equipment is often used in life-saving therapies, diagnosing and repairing equipment can be urgent. Although this may be gratifying, it can also be very stressful. Those who work as contractors often have to travel—sometimes long distances—to perform needed repairs.

Training, Other Qualifications, and Advancement

Employers generally prefer candidates with an associate's degree in biomedical technology or engineering; a bachelor's degree often is needed for advancement.

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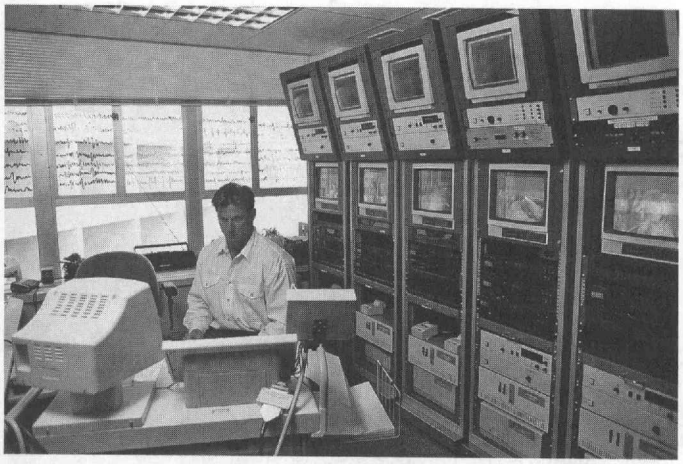

In some cases, medical equipment repairs must be performed while equipment is in use.

Education and training. Although education requirements vary depending on a worker's experience and area of specialization, the most common education path for repairers is an associate degree in biomedical equipment technology or engineering. Those who repair less complicated equipment, such as hospital beds or electric wheelchairs, may learn entirely through on-the-job training. Others, particularly those who work on more sophisticated equipment such as CAT scanners and defibrillators, may need a bachelor's degree. New workers generally start by observing and assisting experienced repairers over a period of 3 to 6 months, learning a single piece of equipment at a time. Gradually, they begin working more independently, while still under close supervision. Each piece of equipment is different, and medical equipment repairers must learn each one separately. In some cases, this requires careful study of a machine's technical specifications and manual. Medical device manufacturers also may provide training courses in a classroom or online.

Because medical equipment technology is rapidly evolving and new devices are frequently introduced, repairers must constantly update their skills and knowledge of equipment. As a result, they must constantly learn new technologies and equipment through seminars, self-study, and certification exams.

Certification and other qualifications. Medical equipment repairers are problem solvers—diagnosing and repairing equipment, often under time constraints—therefore, being able to work under pressure is critical. As in most repair occupations, having mechanical and technical aptitude, as well as manual dexterity, is important.

Some associations offer certifications for medical equipment repairers. For example, the Association for the Advancement of Medical Instrumentation (AAMI) offers certification in three specialty areas—Certified Biomedical Equipment Technician (CBET), Certified Radiology Equipment Specialists (CRES), and Certified Laboratory Equipment Specialist (CLEB). Those who wish to become certified must satisfy a combination of education and experience requirements prior to taking the AAMI examination. Candidates who meet the necessary criteria can begin pursuing the desired certification on the basis of their qualifications. Certification demonstrates a level of competency and can make an applicant more attractive to employers, as well as increase one's opportunities for advancement. Most employers, particularly hospitals, often pay for their in-house medical repairers to become certified.

Advancement. Most medical equipment repairers advance by demonstrating competency at lower levels, which allows them to repair more complex equipment. Some may become supervisors or managers, but these positions usually require a bachelor's degree. Experienced repairers also may serve as mentors for new employees or teach training courses on specific products.

Employment

Medical equipment repairers held 41,400 jobs in May 2008. Industries employing the largest number of medical equipment repairers in 2008 were:

Professional and commercial equipment and supplies merchant wholesalers	9,400
Hospitals, public and private	7,100
Electronic and precision equipment repair and maintenance	5,700
Health and personal care stores	2,300
Consumer goods rental	2,300

Job Outlook

Medical equipment repairers are projected to grow much faster than average between 2008 and 2018. Opportunities should be excellent for qualified job seekers.

Employment change. Employment of medical equipment repairers is expected to grow 27 percent over the 2008-18 decade, which is much faster than the average for all occupations. As the proportion of people in older age groups will grow faster than the total population between 2008 and 2018, demand for overall healthcare will increase. Increased demand for healthcare services and increasing complexity of the medical equipment used in hospitals and by private practitioners will result in a greater need for repairers. For example, a growing number of hospital diagnostic, electromedical, and patient monitoring equipment including CAT scans, electrocardiogram, magnetic resonance imaging, ultrasound, and x-ray machines, as well as hospital furniture, such as full electric beds and wheelchairs, will all need to be maintained and repaired. Additionally, machines used by private practitioners and technicians to diagnose and treat vision, teeth, and other parts of the human body also are becoming increasingly sophisticated, and will further spur growth of medical equipment repairers.

Job prospects. A combination of employment growth and the need to replace workers leaving the occupation will result

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Medical equipment repairers	49-9062	41,400	52,600	11,300	27

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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in excellent job prospects over the next decade. The number of job openings is expected to outnumber the number of qualified applicants; therefore, applicants should have little difficulty finding jobs. Candidates with an associate's degree in biomedical equipment technology or engineering should have the best prospects. Opportunities should be even more abundant for those who are willing to relocate because relatively few qualified applicants can be found in rural areas.

Earnings

Median annual wages for medical equipment repairers in May 2008 were $41,520. The middle 50 percent earned between $31,590 and $53,720. The lowest 10 percent earned less than $25,860, and the highest 10 percent earned more than $65,930.

Median annual wages for medical equipment repairers in the largest industries were:

General medical and surgical hospitals	$45,990
Electronic and precision equipment repair and maintenance	44,740
Professional and commercial equipment and supplies merchant wholesalers	42,950
Health and personal care stores	32,770
Consumer goods rental	29,020

Related Occupations

Other workers who repair precision mechanical and electronic equipment include:

	Page
Coin, vending, and amusement machine servicers and repairers	720
Computer, automated teller, and office machine repairers	672
Medical, dental, and ophthalmic laboratory technicians	774

Sources of Additional Information

For information about medical equipment technicians and a list of schools with related programs of study, contact:

➤ Association for the Advancement of Medical Instrumentation (AAMI), 1110 North Glebe Rd., Suite 220, Arlington, VA 22201-4795. Internet: **http://www.aami.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos355.htm**

Other Installation, Maintenance, and Repair Occupations

Camera and Photographic Equipment Repairers

Nature of the Work

Camera and photographic equipment repairers fix broken film and digital cameras and other optical devices.

Education and Training

Most camera repairers undergo internships or apprenticeships; these usually last about 2 years.

Job Outlook

Current and projected employment:

2008 Employment	4,600
2018 Employment	3,900
Employment change	-700
Growth rate	-15%

Employment change. Employment is expected to decline rapidly. Technological improvements mean that most consumers prefer to replace broken cameras with newer models, even at the high end, saving on the high cost of repair.

Job prospects. Competition for jobs is expected. Decline of the occupation is expected to make job opportunities scarce, although there continue to be some positions working for warranty repair centers.

Earnings

Median annual wages for camera and photographic equipment repairers were $34,300 in May 2008.

Related Occupations

	Page
Electrical and electronics installers and repairers	675
Electronic home entertainment equipment installers and repairers	678
Watch repairers	721

Sources of Additional Information

➤ PMA, The Worldwide Community of Imaging Associations, 3000 Picture Place, Jackson, MI 49201. Internet: **http://www.pmai.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos354.htm**

Coin, Vending, and Amusement Machine Servicers and Repairers

Nature of the Work

Coin, vending, and amusement machine servicers and repairers install, service, adjust, or repair machines, including arcade games, food and beverage machines, slot machines, jukeboxes,

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and other similar machines that dispense games or merchandise for money or credit. Servicers usually stock the machines and record the items sold and money collected. Repairers ensure the machines are operating correctly and make repairs as needed.

Education and Training

Most workers learn their skills on the job, but employers increasingly prefer to hire applicants with some high school or vocational school courses in electronics, refrigeration, and machine repair. A driver's license is required for those who need to drive to stock or repair machines.

Job Outlook

Current and projected employment:

2008 Employment	43,800
2018 Employment	46,900
Employment change	3,100
Growth rate	7%

Employment change. Average growth is expected. While the number of vending and slot machines are expected to rise, they are also becoming easier to service and require fewer repairs. There will be fewer video arcade machines as people play more of these games at home.

Job prospects. Job opportunities should be excellent for repairers who have training in electronics, and who are willing to travel and work at times outside regular business hours. Opportunities will be fair for servicers, or route drivers.

Earnings

Median annual wages of coin, vending, and amusement machine servicers and repairers were $29,930 in May 2008.

Related Occupations

	Page
Electrical and electronics installers and repairers	675
Electronic home entertainment equipment installers and repairers	678
Heating, air-conditioning, and refrigeration mechanics and installers	703
Home appliance repairers	707

Sources of Additional Information

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos200.htm**

Musical Instrument Repairers and Tuners

Nature of the Work

Musical instrument repairers and *tuners* are craft workers who use a variety of techniques and tools to bring damaged or out-of-tune instruments into proper working order. They often specialize by type of instrument and in either tuning or repair.

Education and Training

Most musical instrument repairers and tuners learn their craft through trade schools or apprenticeships. A basic ability to play the instruments being repaired is normally required.

Job Outlook

Current and projected employment:

2008 Employment	6,100
2018 Employment	6,100
Employment change	0
Growth rate	0%

Employment change. Musical instrument repairers and tuners are expected to experience little or no change in employment from 2008-18. Band and orchestra programs in high schools provide most of the business for repairers, and they are not as prevalent as they once were, but this has been offset somewhat by population growth.

Job prospects. Job prospects should be excellent. As the baby boomer generation retires and many skilled workers leave the workforce, new workers will be needed to replace them.

Earnings

Median annual wages for musical instrument repairers and tuners were $33,080 in May 2008.

Related Occupations

	Page
Musicians, singers, and related workers	328
Watch repairers	721

Sources of Additional Information

➤ National Association of Professional Band Instrument Repair Technicians (NAPBIRT), P.O. Box 51, Normal, IL 61761. Internet: **http://www.napbirt.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos356.htm**

Watch Repairers

Nature of the Work

Watch repairers, also known as *watchmakers* or *horologists*, use precision tools to fix expensive and antique timepieces. They diagnose problems and repair, clean, adjust, and replace parts as necessary to return watches to proper working condition.

Education and Training

Developing proficiency in watch repair requires several years of education and experience. Some workers take advanced train-

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ing courses and earn certifications, such as the Certified Watchmaker (CW) title.

Job Outlook

Current and projected employment:

2008 Employment	3,200
2018 Employment	2,800
Employment change	-400
Growth rate	-14%

Employment change. Employment of watch repairers is expected to decline rapidly. The high cost of repairs will compel many consumers to replace their watches rather than have them fixed.

Job prospects. Good job prospects are expected. There will be many openings for new entrants as baby boomers retire.

Earnings

Median annual wages for watch repairers were $34,660 in May 2008.

Related Occupations

	Page
Camera and photographic equipment repairers	720
Jewelers and precious stone and metal workers	770
Musical instrument repairers and tuners	721

Sources of Additional Information

➤ American Watchmakers-Clockmakers Institute (AWCI), 701 Enterprise Dr., Harrison, OH 45030-1696. Internet: **http://www.awi-net.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos357.htm**

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Production Occupations

Assemblers and Fabricators

Significant Points

- Most assemblers work on teams, making good communication skills and the ability to get along with others important.
- A high school diploma is sufficient for most jobs, but experience and extra training is needed for more advanced assembly work.
- Employment is projected to experience little or no change between 2008 and 2018.
- Job opportunities are expected to be good in the manufacturing sector, particularly in growing, high-technology industries.

Nature of the Work

Assemblers and fabricators play an important role in the manufacturing process. They assemble both finished products and the pieces that go into them. The products they assemble using tools, machines, and their hands range from entire airplanes to children's toys. They fabricate and assemble household appliances, automobiles, computers, electronic devices, and more.

Changes in technology have transformed the manufacturing and assembly process. Modern manufacturing systems use robots, computers, programmable motion control devices, and various sensing technologies. These systems change the way in which goods are made and affect the jobs of those who make them. The more advanced assemblers must be able to work with these new technologies and use them to produce goods.

The job of an assembler or fabricator ranges from very easy to very complicated, requiring a range of knowledge and skills. Skilled assemblers putting together complex machines, for example, begin by reading detailed schematics or blueprints that show how to assemble the machine. After determining how parts should connect, they use hand or power tools to trim, shim, cut, and make other adjustments to fit components together and align properly. Once the parts are properly aligned, they connect them with bolts and screws or by welding or soldering pieces together.

Careful quality control is important throughout the assembly process, so assemblers look for faulty components and mistakes in the assembly process. They help to fix problems before more defective products are produced.

Manufacturing techniques are evolving away from traditional assembly line systems toward "lean" manufacturing systems, which are causing the nature of assemblers' work to change. Lean manufacturing uses teams of workers to produce entire products or components. *Team assemblers* may still work on an assembly line, but they rotate through different tasks, rather than specializing in a single task. The team also may decide how the work is assigned and how different tasks are performed. This worker flexibility helps companies cover for absent workers, improves productivity, and increases companies' ability to respond to changes in demand by shifting labor from one product line to another. For example, if demand for a product drops, companies may reduce the total number of workers producing it, asking the remaining workers to perform more stages of the assembly process. Some aspects of lean production, such as rotating tasks and seeking worker input on improving the assembly process, are common to all assembly and fabrication occupations.

Although most assemblers and fabricators are classified as team assemblers, others specialize in producing one type of product or perform the same or similar tasks throughout the assembly process. These workers are classified according to the products they assemble or produce. *Electrical and electronic equipment assemblers*, for example, build products such as electric motors, computers, electronic control devices, and sensing equipment. Automated systems have been put in place as many small electronic parts are too small or fragile for human assembly. Much of the remaining work of electrical and electronic assemblers is manual assembly during the small-scale production of electronic devices used in avionic systems, military systems, and medical equipment. Manual production requires these workers to use devices such as soldering irons. *Electromechanical equipment assemblers* assemble and modify electromechanical devices such as household appliances, CT scanners, or vending machines. The workers use a variety of tools, such as rulers, rivet guns and soldering irons. *Coil winders, tapers, and finishers* wind wire coil used in a variety of electric and electronic products, including resistors, transformers, generators, and electric motors.

Engine and other machine assemblers construct, assemble, or rebuild engines and turbines, and machines used in automobiles, construction and mining equipment, and power generators. *Aircraft structure, surfaces, rigging, and systems assemblers* assemble, fit, fasten, and install parts of airplanes, space vehicles, or missiles, including tails and wings, landing gear, and heating and ventilation systems. *Structural metal fabricators and fitters* cut, align, and fit together structural metal parts and may assist in welding or riveting the parts together. *Fiberglass laminators and fabricators* develop products made of fiberglass, mainly boat decks and hulls. *Timing device assemblers, adjusters, and calibrators* perform precision assembling or adjusting of timing devices within very narrow tolerances.

It has become more common to involve assemblers and fabricators in product development. Designers and engineers consult manufacturing workers during the design stage to improve product reliability and manufacturing efficiency. For example, an assembler may tell a designer that the dashboard of a new car design will be too difficult to install quickly and consistently. The designer could then redesign it to make it easier to install.

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Some experienced assemblers work with designers and engineers to build prototypes or test products. These assemblers must be able to read and interpret complex engineering specifications from text, drawings, and computer-aided drafting systems. They also may need to use a variety of tools and precision measuring instruments.

Work environment. Most assemblers and manufacturers work in manufacturing plants. The working environment is improving, but varies by plant and by industry. Many physically difficult tasks have been automated or made easier through the use of power tools, such as tightening massive bolts or moving heavy parts into position. Assembly work, however, may still involve long periods of standing or sitting.

Most factories today are generally clean, well-lit, and well-ventilated; and depending on what type of work is being performed, they may also need to be dirt and dust-free. Electronic and electromechanical assemblers particularly must work in environments free of dust that could affect the operation of the products they build. Some assemblers may come into contact with potentially harmful chemicals or fumes, but ventilation systems and other safety precautions normally minimize any harmful effects. Other assemblers may come in contact with oil and grease, and their working areas may be quite noisy. Fiberglass laminators and fabricators are exposed to fiberglass, which may irritate the skin; these workers wear gloves and long sleeves and must use respirators for safety.

Most full-time assemblers work a 40-hour week, although overtime and shift work are common in some industries. Work schedules of assemblers may vary at plants with more than one shift.

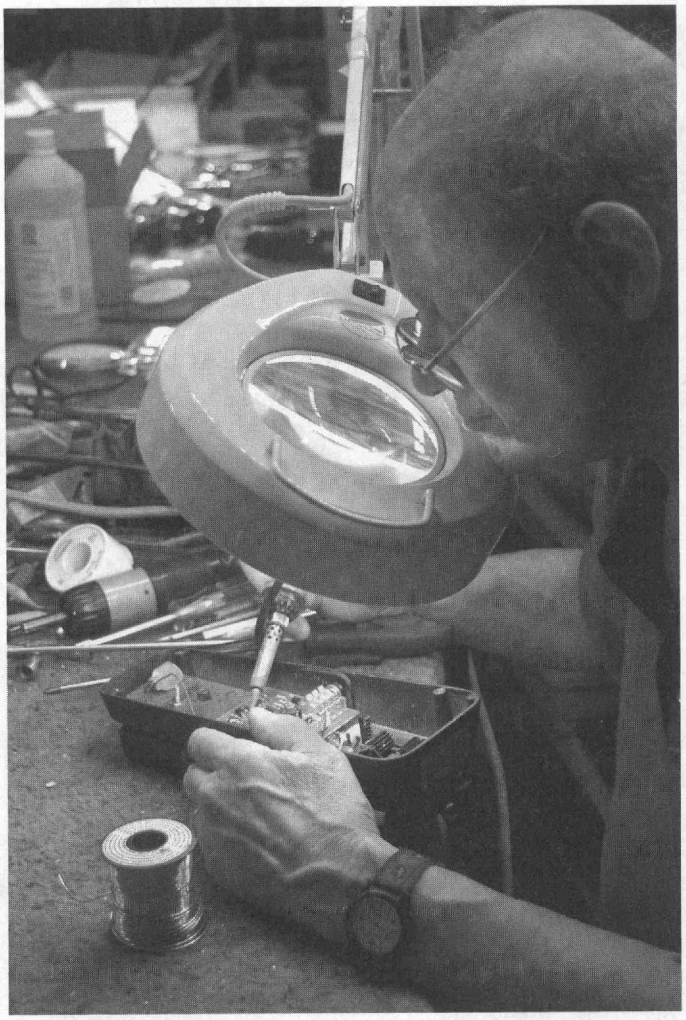
Training, Other Qualifications, and Advancement

The education level and qualifications needed to enter these jobs vary depending on the industry and employer. While a high school diploma or GED is sufficient for most jobs, experience and extra training is needed for more advanced assembly work.

Education and training. Most applicants for assembler positions need only a high school diploma or GED, with workers learning the skills they need through on-the-job training, sometimes including employer-sponsored classroom instruction. Some employers may require specialized training or an associate degree for the most skilled assembly jobs. For example, jobs with electrical, electronic, and aircraft and motor vehicle products manufacturers typically require more formal education through technical schools.

Certification and other qualifications. Assembly workers must be able to follow instructions carefully, which may require some basic reading skills and the ability to follow diagrams and pictures. Manual dexterity and the ability to carry out complex, repetitive tasks quickly and methodically also are important. For some positions, the ability to lift heavy objects may be needed. Team assemblers also need good interpersonal and communication skills to be able to work well with their teammates. Good eyesight and manual dexterity is necessary for assemblers and fabricators who work with small parts. Plants that make electrical and electronic products may test applicants for color vision, because their products often contain many differently colored wires.

Certifications are not common for most types of assemblers and fabricators. However, many employers that hire electrical and electronic assembly workers, especially those in the aerospace and defense industries, require certifications in soldering, such as those offered by the IPC.



Assemblers test circuits in electronic devices.

Advancement. As assemblers and fabricators become more experienced, they may progress to jobs that require greater skill and may be given more responsibility. Experienced assemblers may become product repairers, if they have learned the many assembly operations and understand the construction of a product. These workers fix assembled pieces that operators or inspectors have identified as defective. Assemblers also can advance to quality control jobs or be promoted to supervisor. Experienced assemblers and fabricators also may become members of research and development teams, working with engineers and other project designers to design, develop, and build prototypes, and test new product models.

Employment

Assemblers and fabricators held about 2.0 million jobs in 2008. They worked in many industries, but over 75 percent worked in manufacturing. Within the manufacturing sector, assembly of transportation equipment, such as aircraft, autos, trucks, and buses, accounted for 20 percent of all jobs. Assembly of computers and electronic products accounted for another 11 percent of all jobs. Other industries that employ many assemblers and fabricators are machinery manufacturing and electrical equipment, appliance, and component manufacturing.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Assemblers and fabricators	51-2000	1,950,900	1,913,100	-37,800	-2
Aircraft structure, surfaces, rigging, and systems assemblers	51-2011	44,100	48,200	4,100	9
Electrical, electronics, and electromechanical assemblers	51-2020	297,500	254,200	-43,200	-15
Coil winders, tapers, and finishers	51-2021	22,100	16,500	-5,600	-25
Electrical and electronic equipment assemblers	51-2022	213,300	182,000	-31,300	-15
Electromechanical equipment assemblers	51-2023	62,100	55,700	-6,400	-10
Engine and other machine assemblers	51-2031	39,900	36,700	-3,200	-8
Structural metal fabricators and fitters	51-2041	114,100	113,700	-400	0
Miscellaneous assemblers and fabricators	51-2090	1,455,400	1,460,200	4,900	0
Fiberglass laminators and fabricators	51-2091	30,300	28,900	-1,400	-5
Team assemblers	51-2092	1,112,300	1,112,700	400	0
Timing device assemblers, adjusters, and calibrators	51-2093	2,700	2,600	-100	-4
All other assemblers and fabricators	51-2099	309,900	316,000	6,000	2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

The following tabulation shows the employment of assemblers and fabricators in the manufacturing industries that employed the most workers in 2008:

Motor vehicle parts manufacturing	134,900
Semiconductor and other electronic component manufacturing	94,800
Motor vehicle manufacturing	85,000
Navigational, measuring, electromedical, and control instruments manufacturing	72,400
Architectural and structural metals manufacturing	71,700

Assemblers and fabricators also work in many other nonmanufacturing industries. Twelve percent were employed by employment services firms, mostly as temporary workers; these temporary workers were mostly assigned to manufacturing plants. Wholesale and retail trade firms employed the next highest number of assemblers and fabricators. Many of these assemblers perform the final assembly of goods before the item is delivered to the customer. For example, most imported furniture is shipped in pieces and assemblers for furniture wholesalers and retailers put together the furniture prior to delivery.

Team assemblers, the largest specialty, accounted for 57 percent of assembler and fabricator jobs. The distribution of employment among the various types of assemblers was as follows in 2008:

Team assemblers	1,112,300
Electrical and electronic equipment assemblers	213,300
Structural metal fabricators and fitters	114,100
Electromechanical equipment assemblers	62,100
Aircraft structure, surfaces, rigging, and systems assemblers	44,100
Engine and other machine assemblers	39,900
Fiberglass laminators and fabricators	30,300
Coil winders, tapers, and finishers	22,100
Timing device assemblers, adjusters, and calibrators	2,700
Assemblers and fabricators, all other	309,900

Job Outlook

Employment is projected to experience little or no change, primarily reflecting productivity growth and strong foreign competition in manufacturing. Job opportunities are expected to be good for qualified applicants in the manufacturing sector, particularly in growing, high-technology industries.

Employment change. Employment of assemblers and fabricators is expected to experience little or no change between 2008 and 2018, declining by 2 percent. Within the manufacturing sector, employment of assemblers and fabricators will be determined largely by the growth or decline in the production of certain manufactured goods. In general, despite projected growth in the output of manufactured goods, overall employment is not expected to grow as the whole sector becomes more efficient and is able to produce more with fewer workers. However, some individual industries are projected to have more jobs than others. The aircraft products and parts industry is projected to gain jobs over the decade as demand for new commercial planes grows significantly. Thus, the need for aircraft structure, surfaces, rigging, and systems assemblers is expected to grow. Also, industries such as electromedical product manufacturing, which includes magnetic resonance imaging (MRI) machines, pacemakers, and other devices, should grow with an aging population requiring additional medical technology.

In most other manufacturing industries, employment of assemblers and fabricators will be negatively affected by increasing productivity, which will come from improved processes, tools, and, in some cases, automation. Automation is limited in assembly by intricate products and complicated techniques. Automation will replace workers in operations with a large volume of simple, repetitive work. Automation will have less effect on the assembly of products that are low in volume or very complicated.

The use of team production techniques has been one factor in the continuing success of the manufacturing sector, boosting productivity and improving the quality of goods. Thus, while the number of assemblers overall is expected to decline in manufacturing, the number of team assemblers should grow as more manufacturing plants convert to using team production techniques.

Some manufacturers have sent their assembly functions to countries where labor costs are lower. Decisions by U.S. corporations to move manufacturing to other nations may limit employment growth for assemblers in some industries.

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The largest increase in the number of assemblers and fabricators is projected to be in the employment services industry, which supplies temporary workers to various industries. Temporary workers are gaining in importance in the manufacturing sector and elsewhere, as companies facing cost pressures strive for a more flexible workforce to meet fluctuations in the market.

Job prospects. Job opportunities for assemblers are expected to be good for qualified applicants in the manufacturing sector, particularly in growing, high-technology industries, such as aerospace and electromedical devices. Some employers report difficulty finding qualified applicants looking for manufacturing employment. Many job openings will result from the need to replace workers leaving or retiring from this large occupational group.

Earnings

Wages vary by industry, geographic region, skill, educational level, and complexity of the machinery operated. Median hourly wages of team assemblers were $12.32 in May 2008. The middle 50 percent earned between $9.75 and $15.60. The lowest 10 percent earned less than $8.20, and the highest 10 percent earned more than $19.69. Median hourly wages in the manufacturing industries employing the largest numbers of team assemblers were as follows:

Motor vehicle manufacturing	$24.91
Motor vehicle body and trailer manufacturing	14.13
Motor vehicle parts manufacturing	13.76
Plastics product manufacturing	11.31
Employment services	9.61

Median hourly wages of electrical and electronic equipment assemblers were $13.22 in May 2008. The middle 50 percent earned between $10.52 and $16.85. The lowest 10 percent earned less than $8.77, and the highest 10 percent earned more than $21.15. Median hourly wages in the manufacturing industries employing the largest numbers of electrical and electronic equipment assemblers were as follows:

Navigational, measuring, electromedical, and control instruments manufacturing	$14.76
Electrical equipment manufacturing	13.25
Other electrical equipment and component manufacturing	12.62
Semiconductor and other electronic component manufacturing	12.59
Employment services	10.68

In May 2008, other assemblers and fabricators had the following median hourly wages:

Aircraft structure, surfaces, rigging, and systems assemblers	$21.22
Engine and other machine assemblers	15.70
Structural metal fabricators and fitters	15.58
Electromechanical equipment assemblers	14.11
Timing device assemblers, adjusters, and calibrators	13.73
Fiberglass laminators and fabricators	13.48
Coil winders, tapers, and finishers	13.33
Assemblers and fabricators, all other	13.37

Some assemblers and fabricators are members of labor unions. These unions include the International Association of Machinists and Aerospace Workers; the United Automobile, Aerospace and Agricultural Implement Workers of America; the International Brotherhood of Electrical Workers; and the United Steelworkers of America.

Related Occupations

Other occupations that involve operating machines and tools and assembling and checking products include:

	Page
Industrial machinery mechanics and millwrights	709
Inspectors, testers, sorters, samplers, and weighers	768
Machine setters, operators, and tenders—metal and plastic	734
Welding, soldering, and brazing workers	743

Sources of Additional Information

For information on certifications in electronics soldering, contact:

➤ IPC, 3000 Lakeside Dr., 309 S, Bannockburn, IL 60015
Internet: **http://www.ipc.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos217.htm**

Food Processing Occupations

Significant Points

- Most workers in manual food processing jobs require little or no training prior to being hired.
- As more jobs involving cutting and processing meat shift from retail stores to food processing plants, job growth will be concentrated among lesser skilled workers, who are employed primarily in manufacturing.
- Highly skilled bakers should be in demand.

Nature of the Work

Food processing occupations include many different types of workers who process raw food products into the finished goods sold by grocers, wholesalers, restaurants, or institutional food services. These workers perform a variety of tasks and are responsible for producing many of the food products found in every household. Some of these workers are bakers, others slaughter or process meat, and still others operate food processing equipment.

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Bakers mix and bake ingredients according to recipes to produce varying types and quantities of breads, pastries, and other baked goods. Bakers commonly are employed in commercial bakeries that distribute breads and pastries through established wholesale and retail outlets, mail order, or manufacturers' outlets. In these manufacturing facilities, bakers produce mostly standardized baked goods in large quantities, using high-volume mixing machines, ovens, and other equipment. Grocery stores and specialty shops produce smaller quantities of breads, pastries, and other baked goods for consumption on their premises or for sale as specialty baked goods. Although the quantities prepared and sold in these stores are often small, they often come in a wide variety of flavors and sizes.

Other food processing workers convert animal carcasses into manageable pieces of meat, known as boxed meat or case-ready meat, suitable for sale to wholesalers and retailers. The nature of their jobs varies significantly depending on the stage of the process in which they are involved. In animal slaughtering and processing plants, slaughterers and meat packers slaughter cattle, hogs, and sheep, and cut carcasses into large wholesale cuts, such as rounds, loins, ribs, tenders, and chucks, to facilitate the handling, distribution, marketing, and sale of meat. In most plants, some *slaughterers and meat packers* further process the large parts into case-ready cuts that are ready for retail stores. Retailers and grocers increasingly prefer such prepackaged meat products because a butcher isn't needed to further portion the cuts for sale. Slaughterers and meat packers also produce hamburger meat and meat trimmings, and prepare sausages, luncheon meats, and other fabricated meat products. They usually work on assembly lines, with each individual responsible for only a few of the many cuts needed to process a carcass. Depending on the type of cut, these workers use knives; cleavers; meat saws; bandsaws; or other potentially dangerous equipment.

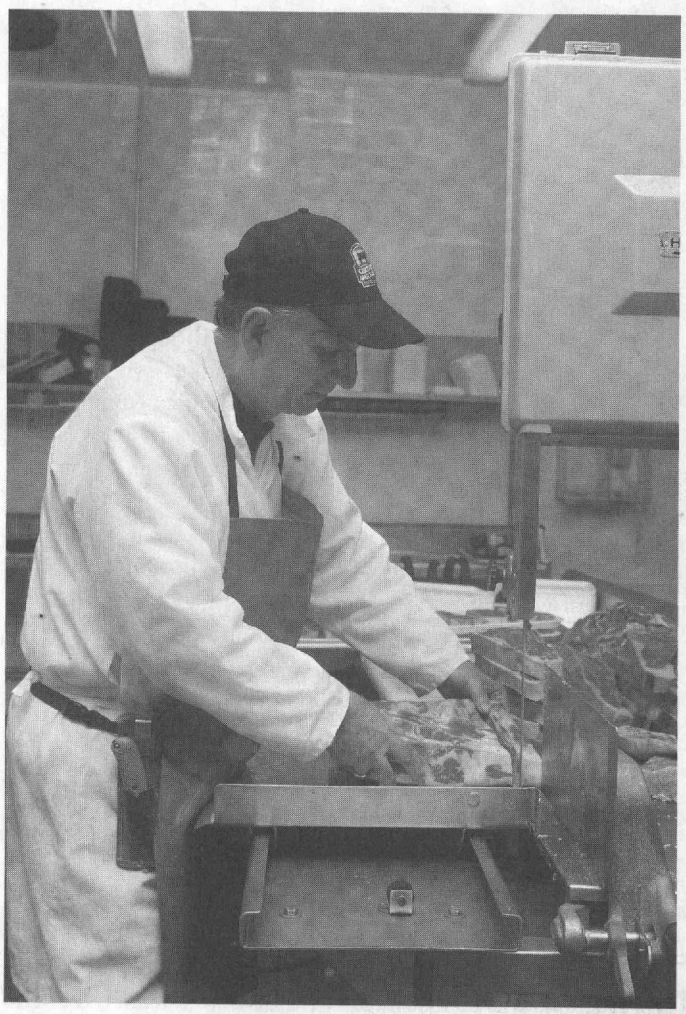
Poultry cutters and trimmers slaughter and cut up chickens, turkeys, and other types of poultry. Although the packaging end of the poultry processing industry is becoming increasingly automated, many jobs, such as slaughtering, trimming, and deboning, are still done manually. Most poultry cutters and trimmers perform routine cuts on poultry as it moves along production lines.

Meat, poultry, and fish cutters and trimmers also prepare ready-to-cook foods, often at processing plants, but increasingly at grocery and specialty food stores. This preparation often entails filleting meat, poultry, or fish; cutting it into bite-sized pieces or tenders; preparing and adding vegetables; and applying sauces and flavorings, marinades, or breading. These case-ready products are gaining in popularity as they offer quick and easy preparation for consumers while, in many cases, also offering healthier options.

Manufacturing and retail establishments are both likely to employ fish cutters and trimmers, also called fish cleaners. These workers primarily scale, cut, and dress fish by removing the head, scales, and other inedible portions and then cut the fish into steaks or fillets. In retail markets, these workers also may wait on customers and clean fish to order. Some fish processing is done aboard ships where fish can be caught, processed, and often flash frozen to preserve freshness.

Butchers and meat cutters generally process meat at later stages of production, although some are employed at meat processing plants. Most work for grocery stores, wholesale establishments that supply meat to restaurants, or institutional food service facilities that separate wholesale cuts of meat into retail cuts or smaller pieces, known as primals. These butchers cut meat into steaks and chops, shape and tie roasts, and grind beef for sale as chopped meat. Boneless cuts are prepared using knives, slicers, or power cutters, while bandsaws and cleavers are required to cut bone-in pieces of meat. Butchers and meat cutters in retail food stores also may weigh, wrap, and label the cuts of meat; arrange them in refrigerated cases for display; and prepare special cuts to fill orders by customers.

Others who work in food processing include *food batchmakers,* who set up and operate equipment that mixes, blends, or cooks ingredients used in the manufacture of food products according to formulas or recipes; *food cooking machine operators and tenders*, who operate or tend cooking equipment, such as steam-cooking vats, deep-fry cookers, pressure cookers, kettles, and boilers to prepare a wide range of cooked food products, and *food and tobacco roasting, baking, and drying machine operators and tenders*, who use equipment to reduce the moisture content of food or tobacco products or to prepare food for canning. The machines they use include hearth ovens, kiln driers, roasters, char kilns, steam ovens, and vacuum drying equipment. These workers monitor equipment for temperature, humidity, or



Food processing workers cut meat into smaller sizes and wrap them for sale.

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other factors and make the appropriate adjustments to ensure proper cooking and processing.

All workers who work with food must regularly clean and sanitize utensils, work surfaces, and equipment used to process food to comply with health and sanitation guidelines to prevent the spread of disease.

Work environment. Working conditions vary by occupation and by type and size of establishment, but all employees are required to maintain good personal hygiene and keep equipment clean. Facilities that process food, regardless of industry or location, are regularly inspected to ensure that equipment and employees comply with health and sanitation regulations.

Most bakers work in bakeries, grocery stores, and restaurants. Bakeries are often hot and noisy. Bakers typically work under strict order deadlines and critical time-sensitive baking requirements, both of which can induce stress. Bakers usually work odd hours and may work early mornings, evenings, weekends, and holidays.

Butchers and meat cutters in animal slaughtering and processing plants and in large grocery stores, work in large meat cutting rooms equipped with power machines, extremely sharp knives, and conveyors. In smaller retail shops, butchers or fish cleaners may work in a cramped space behind the meat or fish counter where they also can keep track of customers.

Butchers and meat cutters, poultry and fish cutters and trimmers, and slaughterers and meatpackers often work in cold, damp rooms where meat is kept to prevent spoiling. In addition, long periods of standing and repetitious physical tasks make the work tiring. Working with sharp knives on slippery floors makes butchers and meat cutters more susceptible to injury than almost all other workers in the economy; however, injury rates for the animal slaughtering and processing industry have been declining. Injuries include cuts and occasional amputations, which occur when knives, cleavers, or power tools are used improperly. Also, repetitive slicing and lifting often lead to cumulative trauma injuries, such as carpal tunnel syndrome and back strains. To reduce the incidence of cumulative trauma injuries, some employers have reduced employee workloads, added prescribed rest periods, redesigned jobs and tools, and promoted increased awareness of early warning signs as steps to prevent further injury. Nevertheless, workers in the occupation still face the potential threat that some injuries may be disabling.

Workers who operate food processing machinery typically work in production areas that are specially designed for food preservation or processing. Food batchmakers, in particular, work in kitchen-type, assembly-line production facilities. The ovens, as well as the motors of blenders, mixers, and other equipment, often make work areas very warm and noisy. Hazards created by the equipment that these workers use can cause injuries such as cuts and scrapes from cleaning and handling sharp tools and utensils and burns from being in contact with hot surfaces and liquids.

Food batchmakers; food and tobacco roasting, baking, and drying machine operators; and food cooking machine operators and tenders spend a great deal of time on their feet and generally work a regular 40-hour week that may include night and early morning shifts.

Training, Other Qualifications, and Advancement

No formal education is required for most food processing jobs. Employers generally provide most of the training for these occupations upon being hired.

Education and training. Bakers need to become skilled in baking, icing, and decorating. They often start their careers as apprentices or trainees. Apprentice bakers usually start in craft bakeries, while trainees usually begin in store bakeries, such as those in supermarkets. Many apprentice bakers participate in correspondence study and may work towards a certificate in baking.

The skills needed to be a baker are often underestimated. Bakers need to learn how to combine ingredients and to learn how ingredients are affected by heat. They need to learn how to operate and maintain a range of equipment used in the production process. Courses in nutrition are helpful for those selling baked goods or developing new recipes. If running a small business, they need to know how to operate a business. All bakers must follow government health and sanitation regulations.

Most butchers and meat, poultry, and fish cutters and trimmers acquire their skills through on-the-job training programs. The length of training varies significantly. Simple cutting operations require a few days to learn, while more complicated tasks, such as eviscerating slaughtered animals, generally require several months of training. The training period for highly skilled butchers at the retail level may be 1 or 2 years.

Generally, trainees begin by doing less difficult jobs, such as making simple cuts or removing bones. Under the guidance of experienced workers, trainees learn the proper use and care of tools and equipment, while also learning how to prepare various cuts of meat. After demonstrating skill with various meat cutting tools, trainees learn to divide carcasses into wholesale cuts and wholesale cuts into retail and individual portions. Trainees also may learn to roll and tie roasts, prepare sausage, and cure meat. Those employed in retail food establishments often are taught to perform basic business operations, such as inventory control, meat buying, and recordkeeping. In addition, growing concern about food-borne pathogens in meats has led employers to offer numerous safety seminars and extensive training in food safety to employees.

On-the-job training is common among food machine operators and tenders. They learn to run the different types of equipment by watching and helping other workers. Training can last anywhere from a month to a year, depending on the complexity of the tasks and the number of products involved. A degree in an appropriate area—dairy processing for those working in dairy product operations, for example—is helpful for advancement to a lead worker or a supervisory role. Most food batchmakers participate in on-the-job training, usually from about a month to a year. Some food batchmakers learn their trade through an approved apprenticeship program.

Other qualifications. Bakers need to be able to follow instructions, have an eye for detail, and communicate well with others. Meat, poultry, and fish cutters and trimmers need manual dexterity, good depth perception, color discrimination, and good hand-eye coordination. They also need physical strength to lift and move heavy pieces of meat. Butchers and fish cleaners who wait on customers should have a pleasant personality, a neat

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Food processing occupations	51-3000	706,700	734,000	27,400	4
Bakers	51-3011	151,600	151,900	300	0
Butchers and other meat, poultry, and fish processing workers	51-3020	397,100	413,900	16,800	4
Butchers and meat cutters	51-3021	129,100	131,000	1,900	1
Meat, poultry, and fish cutters and trimmers	51-3022	169,600	180,400	10,800	6
Slaughterers and meat packers	51-3023	98,400	102,500	4,100	4
Miscellaneous food processing workers	51-3090	157,900	168,200	10,300	7
Food and tobacco roasting, baking, and drying machine operators and tenders	51-3091	18,100	18,200	100	0
Food batchmakers	51-3092	100,500	109,200	8,800	9
Food cooking machine operators and tenders	51-3093	39,300	40,800	1,500	4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

appearance, and the ability to communicate clearly. In some States, a health certificate is required for employment.

Certification and advancement. Bakers have the option of obtaining certification through the Retail Bakers of America. While not mandatory, obtaining certification assures the public and prospective employers that the baker has sufficient skills and knowledge to work at a retail baking establishment.

The Retail Bakers of America offers certification for four levels of competence with a focus on several broad areas, including baking sanitation, management, retail sales, and staff training. Those who wish to become certified must satisfy a combination of education and experience requirements prior to taking an examination. The education and experience requirements vary by the level of certification desired. For example, a certified journey baker requires no formal education but a minimum of 1 year of work experience. By contrast, a certified master baker must have earned the certified baker designation, and must have completed 30 hours of sanitation coursework approved by a culinary school or government agency, 30 hours of professional development courses or workshops, and a minimum of 8 years of commercial or retail baking experience.

Food processing workers in retail or wholesale establishments may progress to supervisory jobs, such as department managers or team leaders in supermarkets. A few of these workers may become buyers for wholesalers or supermarket chains. Some food processing workers go on to open their own markets or bakeries. In processing plants, workers may advance to supervisory positions or become team leaders.

Employment

Food processing workers held 706,700 jobs in 2008. Employment among the various types of food processing occupations was distributed as follows:

Meat, poultry, and fish cutters and trimmers	169,600
Bakers	151,600
Butchers and meat cutters	129,100
Food batchmakers	100,500
Slaughterers and meat packers	98,400
Food cooking machine operators and tenders	39,300
Food and tobacco roasting, baking, and drying machine operators and tenders	18,100

Fifty-eight percent of all food processing workers were employed in food manufacturing, including animal slaughtering and processing plants, the largest industry component. Food and beverage stores, which include grocery and specialty food stores, employed another 27 percent. Butchers, meat cutters, and bakers are employed in stores in almost every city and town in the Nation, while most other food processing jobs are concentrated in communities with food processing plants.

Job Outlook

Increased demand for processed food and meat by a growing population will increase the need for food processing workers; however, processing plant and distribution efficiencies will offset growing output and cause employment of these workers to grow more slowly than the average between 2008 and 2018. In addition, job opportunities should be good as the need to replace experienced workers who transfer to other occupations or leave the labor force should generate additional job openings.

Employment change. Overall employment in the food processing occupations is projected to increase 4 percent during the 2008–18 decade, more slowly than the average for all occupations. As the Nation's population grows, the demand for meat, poultry, and seafood, baked goods, and other processed foods will increase requiring additional people to work in these occupations. Additionally, consumers are increasingly seeking out more convenient methods of preparing meals, which is driving up demand for convenient ready-to-eat or heat foods. These foods are increasingly being prepared at the factory, as well as the local grocery store for carry-out, thus increasing the need for workers in both locations. However, increasing productivity at meat and food processing plants should offset some of the need for more workers at these plants.

Slaughterers and meat packers, meat, poultry, and fish cutters and trimmers, and butchers and meat cutters are all expected to experience some growth in employment. For these occupations in particular, faster growth will take place at the processing plant and away from retail stores, as meats are increasingly processed at processing plants or centralized facilities for delivery to stores. This shift from retail stores to food processing plants will cause demand for lesser skilled workers, who are employed primarily in meat packing manufacturing plants, to be greater than for butchers and meat cutters.

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Many of these same reasons apply to employment in food processing jobs; however, these jobs are more automated than the meat processing occupations, thus productivity improvements will likely impact these workers more. Food batchmakers will experience average employment growth largely due to improved packaging and distribution operations; employment of food cooking machine operators and tenders will grow more slowly than the average; and food and tobacco roasting, baking, and drying machine operators and tenders will show little or no growth.

A growing number of stores that sell cookies, bread, and other specialty baked goods, will spur demand for bakers, particularly in grocery and other specialty stores, but increased use of off-site contract bakers with larger baking capacities will offset increased demand and cause employment to show little or no change.

Job prospects. Jobs should be available in all food processing specialties because of the need to replace experienced workers who transfer to other occupations or leave the labor force. Highly skilled bakers should be especially in demand because of growing demand for specialty products and the time it takes to learn to make these products.

Earnings

Earnings vary by industry, skill, geographic region, and educational level. Median annual wages of bakers were $23,290 in May 2008. The middle 50 percent earned between $18,760 and $29,720. The lowest 10 percent earned less than $16,420, and the highest 10 percent earned more than $37,250. Median annual wages in the industries employing the largest numbers of bakers in May 2008 were:

Bakeries and tortilla manufacturing	$23,860
Grocery stores	23,700
Other general merchandise stores	23,610
Full-service restaurants	22,300
Limited-service eating places	20,500

Median annual wages of butchers and meat cutters were $28,290 in May 2008. The middle 50 percent earned between $21,700 and $36,670. The lowest 10 percent earned less than $17,600, and the highest 10 percent earned more than $45,060. Butchers and meat cutters employed at the retail level typically earned more than those in manufacturing. Median annual wages in the industries employing the largest numbers of butchers and meat cutters in May 2008 were:

Other general merchandise stores	$33,830
Grocery stores	29,090
Grocery and related products merchant wholesalers	28,710
Specialty food stores	25,830
Animal slaughtering and processing	24,060

Meat, poultry, and fish cutters and trimmers typically earn less than butchers and meat cutters. In May 2008, median annual wages for these lower skilled workers were $21,810. The middle 50 percent earned between $18,520 and $25,130. The lowest 10 percent earned less than $16,640, while the highest 10 percent earned more than $30,070. Median annual wages in the industries employing the largest numbers of meat, poultry, and fish cutters and trimmers in May 2008 were:

Grocery and related product merchant holesalers	$23,030
Animal slaughtering and processing	22,100
Grocery stores	21,360
Specialty food stores	19,490
Seafood product preparation and packaging	18,600

In May 2008, median annual wages for slaughterers and meat packers were $23,030. The middle 50 percent earned between $19,700 and $26,450. The lowest 10 percent earned less than $17,130, and the highest 10 percent earned more than $30,740. Median annual wages in animal slaughtering and processing, the industry employing the largest number of slaughterers and meat packers, were $23,040 in May 2008.

In May 2008, median annual wages for food and tobacco roasting, baking, and drying machine operators and tenders were $26,640. The middle 50 percent earned between $21,100 and $35,470. The lowest 10 percent earned less than $17,610, and the highest 10 percent earned more than $42,370. Median annual wages in bakeries and tortilla manufacturing, the industry employing the largest number of food and tobacco roasting, baking, and drying machine operators and tenders, were $29,700 in May 2008.

Median annual earnings of food batchmakers were $24,170 in May 2008. The middle 50 percent earned between $18,820 and $31,980. The lowest 10 percent earned less than $16,260, and the highest 10 percent earned more than $40,210. Median annual wages in the industries employing the largest numbers of food batchmakers in May 2008 were:

Dairy product manufacturing	$31,840
Other food manufacturing	25,780
Fruit and vegetable preserving and specialty food manufacturing	24,190
Sugar and confectionery product manufacturing	23,310
Bakeries and tortilla manufacturing	22,800

Median annual wages for food cooking machine operators and tenders were $22,880 in May 2008. The middle 50 percent earned between $18,650 and $28,680. The lowest 10 percent earned less than $16,370, and the highest 10 percent earned more than $34,330. Median annual wages in the industries employing the largest numbers of food cooking machine operators and tenders in May 2008 were:

Other food manufacturing	$26,820
Fruit and vegetable preserving and specialty food manufacturing	25,520
Bakeries and tortilla manufacturing	22,900
Animal slaughtering and processing	22,090
Grocery stores	19,710

Food processing workers generally received typical benefits, including pension plans for union members or those employed by grocery stores. However, poultry workers rarely earned substantial benefits. In 2008, 16 percent of all food processing workers were union members or were covered by a union contract. Many food processing workers are members of the United Food and Commercial Workers International Union.

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Related Occupations

Food processing workers must be skilled at both hand and machine work and must have some knowledge of processes and techniques that are involved in handling and preparing food. Other occupations that require similar skills and knowledge include

	Page
Chefs, head cooks, and food preparation and serving supervisors	484
Cooks and food preparation workers	487

Sources of Additional Information

See your State employment service offices for information about job openings for food processing occupations.

For information on various levels of certification as a baker, contact:

➤ Retail Bakers of America, 8400 Westpark Drive, 2nd Floor, McLean, VA, 22102

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos219.htm**

Metal Workers and Plastic Workers

Computer Control Programmers and Operators

Significant Points

- Manufacturing industries employ almost all of these workers.
- Workers learn in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools; many entrants have previously worked as machinists or machine setters, operators, and tenders.
- Applicants are expected to face competition for jobs.

Nature of the Work

Computer control programmers and operators use computer numerically controlled (CNC) machines to produce a wide variety of products, from automobile engines to computer keyboards. CNC machines operate by reading the code included in a computer-controlled module, which drives the machine tool and performs the functions of forming and shaping a part formerly done by machine operators. CNC machines include tools such as lathes, laser cutting machines, roll forms, press brakes and printing presses. CNC machines use the same techniques as many other mechanical manufacturing machines but are controlled by a central computer instead of a human operator or electric switchboard. Many old-fashioned machines can be retrofitted with a computer control, which can greatly improve the productivity of a machine. Computer control programmers and operators normally produce large quantities of one part, although they may produce small batches or one-of-a-kind items. These machines are most commonly used in metalworking industries where precision is imperative, because computers can be more accurate than humans in this work.

CNC programmers—also referred to as *numerical tool and process control programmers*—develop the programs that run the machine tools. They often review three-dimensional computer-aided/automated design (CAD) blueprints of a part and determine the sequence of events that will be needed to make the part. This may involve calculating where to cut or bore into the workpiece, how fast to feed the metal into the machine, and how much metal to remove.

Next, CNC programmers turn the planned machining operations into a set of instructions. These instructions are translated into a computer aided/automated manufacturing (CAM) program containing a set of commands for the machine to follow. On a CNC machine, commands normally are a series of numbers (hence, numerical control) that may describe where cuts should occur, where a roll should bend a piece, or the speed of the feed into the machine. After the program is developed, CNC programmers and operators check the programs to ensure that the machinery will function properly and that the output will meet specifications. Because a problem with the program could damage costly machinery and cutting tools or simply waste valuable time and materials, computer simulations may be used to check the program before a trial run. If errors are found, the program must be changed and retested until the problem is resolved. In addition, growing connectivity between CAD/CAM software and CNC machine tools is raising productivity by automatically translating designs into instructions for the computer controller on the machine tool. Many new machines take advantage of easy-to-use graphical user interface programs that use pictures and buttons, instead of long strings of a computer programming language. This improvement in usability has pushed many manufacturing companies to combine the jobs of CNC programmers and machine operators.

After the programming work is completed, *CNC setup operators*—also referred to as *computer-controlled machine tool operators, metal and plastic*—set up the machine for the job. They download the program into the machine, load the proper tools into the machine, position the workpiece on the CNC machine tool—spindle, lathe, milling machine, or other machine—and then start the machine. During the test run of a new program, the setup operator, who may also have some programming skills, or the CNC programmer closely monitors the machine for signs of problems, such as a vibrating work piece, the breakage of cutting tools, or an out-of-specification final product. If a problem is detected, a setup operator or CNC programmer will modify the program using the control module to eliminate the problems or to improve the speed and accuracy of the program.

Once a program is completed, the operation of the CNC machine may move from the more experienced setup operator to a less-skilled machine operator. Operators load workpieces and

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Applicants for computer control programmer and operator jobs are expected to face competition.

tools into a machine, press the start button, monitor the machine for problems, and measure the parts produced to check that they match specifications. If they encounter a problem that requires modification to the cutting program, they shut down the machine and wait for a more experienced CNC setup operator to fix the problem. Many CNC operators start at this basic level and gradually perform more setup tasks as they gain experience.

Regardless of skill level, all CNC operators detect some problems by listening for specific sounds—for example, a dull cutting tool that needs changing or excessive vibration. Machine tools rotate at high speeds, which can create problems with harmonic vibrations in the workpiece. Vibrations cause the machine tools to make minor cutting errors, hurting the quality of the product. Operators listen for vibrations and then adjust the cutting speed to compensate. For common errors in the machine, programmers write code that displays an error code to help operators, who are expected to make minor repairs, and machine mechanics fix a problem quickly. CNC operators also ensure that the workpiece is being properly lubricated and cooled, since the machining of metal products generates a significant amount of heat.

Since CNC machines can operate with limited input from the operator, a single operator may monitor several machines simultaneously. Typically, an operator might monitor two machines cutting relatively simple parts from softer materials, while devoting most of his or her attention to a third machine cutting a much more difficult part from hard metal, such as stainless steel. Operators are often expected to carefully schedule their work so that all of the machines are always operating.

Work environment. Most machine shops are clean, well lit, and ventilated. Most modern CNC machines are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. People working in this occupation report fewer injuries than most other manufacturing jobs; nevertheless, working around machine tools can be noisy and presents certain dangers, and workers must follow safety precautions to minimize injuries. Computer-controlled machine tool operators, metal and plastic, wear protective equipment, such as safety glasses to shield against bits of flying metal and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants. The job requires stamina, because operators stand most of the day and, at times, may need to lift moderately heavy workpieces.

Numerical tool and process control programmers work on desktop computers that may be in offices or on the shop floor. The office areas usually are clean, well lit, and free of machine noise. On the shop floor, CNC programmers encounter the same hazards and exercise the same safety precautions as do CNC operators.

Many computer control programmers and operators work a 40-hour week. CNC operators increasingly work evening and weekend shifts as companies justify investments in more expensive machinery by extending hours of operation. Overtime is common during peak production periods.

Training, Other Qualifications, and Advancement

Computer control programmers and operators train in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. In general, the more skills needed for the job, the more education and training are needed to qualify. Many entrants have previously worked as machinists or machine setters, operators, and tenders.

Education and training. The amount and type of education and training needed depends on the type of job. Entry-level CNC machine operators may need at least a few months of on-the-job training to reach proficiency. Setup operators and programmers, however, may need years of experience or formal training to write or modify programs. Programmers and operators can receive their training in various ways—in apprenticeship programs, informally on the job, and in secondary, vocational, or postsecondary schools. A growing number of computer control programmers and more skilled operators receive their formal training from community or technical colleges. For some specialized types of programming, such as that needed to produce complex parts for the aerospace or shipbuilding industries, employers may prefer individuals with a degree in engineering.

For those interested in becoming computer control programmers or operators, high school or vocational school courses in mathematics (trigonometry and algebra), blueprint reading, computer programming, metalworking, and drafting are recommended. Apprenticeship programs consist of shop training and related classroom instruction. In shop training, apprentices learn filing, handtapping, and dowel fitting, as well as the operation of various machine tools. Classroom instruction includes math, physics, programming, blueprint reading, CAD software, safety, and shop practices. Skilled computer control programmers and operators need an understanding of the machining process, including the complex physics that occur at the cutting point. Thus, most training programs teach CNC operators and programmers to perform operations on manual machines prior to operating CNC machines.

As new technology is introduced, computer control programmers and operators normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Many employers offer tuition reimbursement for job-related courses.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Computer control programmers and operators	51-4010	157,800	164,500	6,700	4
Computer-controlled machine tool operators, metal and plastic	51-4011	141,000	150,300	9,300	7
Numerical tool and process control programmers	51-4012	16,800	14,200	-2,600	-15

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Certification and other qualifications. Employers prefer to hire workers who have a basic knowledge of computers and electronics and experience with machine tools. In fact, many entrants to these occupations have experience working as machine setters, operators, and tenders or machinists. Persons interested in becoming computer control programmers or operators should be mechanically inclined and able to work independently and do highly accurate work.

To boost the skill level of all metalworkers and to create a more uniform standard of competency, a number of training facilities and colleges have formed certification programs. Employers may pay for training and certification tests after hiring an entry-level worker.

Advancement. Computer control programmers and operators can advance in several ways. Experienced CNC operators may become CNC programmers or machinery mechanics, and some are promoted to supervisory or administrative positions in their firms. Some highly skilled workers move into tool and die making, and a few open their own shops.

Employment

Computer control programmers and operators held about 157,800 jobs in 2008. About 90 percent were computer-controlled machine tool operators, metal and plastic, and about 10 percent were numerical tool and process control programmers. The manufacturing industry employs almost all these workers. Employment was concentrated in fabricated metal products manufacturing, machinery manufacturing, plastics products manufacturing, and transportation equipment manufacturing making mostly aerospace and automobile parts. Although computer control programmers and operators work in all parts of the country, jobs are most plentiful in the areas where manufacturing is concentrated.

Job Outlook

Despite the projected increase in employment, applicants are expected to face competition for jobs, as there are more trained workers than available jobs.

Employment change. Overall employment of computer control programmers and operators is expected to increase by 4 percent over the 2008–18 period, which is slower than average for all occupations. Employment of computer controlled machine tool operators, metal and plastic is expected to increase by 7 percent, which is about as fast as the average for all occupations. The increasing use of CNC machine tools in all sectors of the manufacturing industry, replacing older mechanical metal and plastic working machines, will increase demand for computer-controlled machine tool operators. However, the demand for computer control programmers will be negatively affected by the increasing use of software (CAD/CAM) that automatically translates part and product designs into CNC machine tool instructions, and by simpler interfaces that allow machine operators to program the machines themselves. As a result, employment of numerical tool and process control programmers will decline by 15 percent over the projection period.

Job prospects. Computer control programmers and operators should face competition for jobs, as many workers currently operating mechanical machines will be retrained to operate computer controlled machines and programming activities are increasingly done by these operators; however, workers with the ability to operate multiple CNC machine types should have better opportunities, as companies are increasingly demanding more versatile workers.

Earnings

Median hourly wages of computer-controlled machine tool operators, metal and plastic, were $16.03 in May 2008. The middle 50 percent earned between $12.83 and $19.45. The lowest 10 percent earned less than $10.49, whereas the top 10 percent earned more than $23.84. Median hourly wages in the manufacturing industries employing the largest numbers of computer-controlled machine tool operators, metal and plastic, in May 2008 were:

Aerospace product and parts manufacturing	$18.89
Metalworking machinery manufacturing	18.08
Machine shops; turned product; and screw, nut, and bolt manufacturing	15.57
Motor vehicle parts manufacturing	15.18
Plastics product manufacturing	14.19

Median hourly wages of numerical tool and process control programmers were $21.30 in May 2008. The middle 50 percent earned between $16.94 and $26.55. The lowest 10 percent earned less than $13.65, while the top 10 percent earned more than $32.59.

Many employers, especially those with formal apprenticeship programs, offer tuition assistance for training classes.

Related Occupations

Occupations most closely related to computer control programmers and operators are other metal and plastic working occupations, which include:

	Page
Computer software engineers and computer programmers	134
Industrial machinery mechanics and millwrights	709
Machinists	737
Machine setters, operators, and tenders—metal and plastic	734
Tool and die makers	740
Welding, soldering, and brazing workers	743

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Sources of Additional Information

For more information on training and new technology for computer control programmers and operators, contact:

➤ Fabricators and Manufacturers Association, 833 Featherstone Rd., Rockford, IL 61107 Internet: **http://www.fmanet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos286.htm**

Machine Setters, Operators, and Tenders—Metal and Plastic

Significant Points

- Manufacturing industries employ over 90 percent of workers.
- A few weeks of on-the-job training is sufficient for most workers to learn basic machine tending operations, but a year or more is required to become a highly skilled operator or setter.
- Employment is projected to decline rapidly.
- Those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

Nature of the Work

Consider the parts of a toaster, such as the metal or plastic housing or the lever that lowers the toast. These parts, and many other metal and plastic products, are produced by machines that are controlled by machine setters, operators, and tenders—metal and plastic. In fact, machine operators in the metalworking and plastics industries play a major role in producing most of the consumer products on which we rely daily.

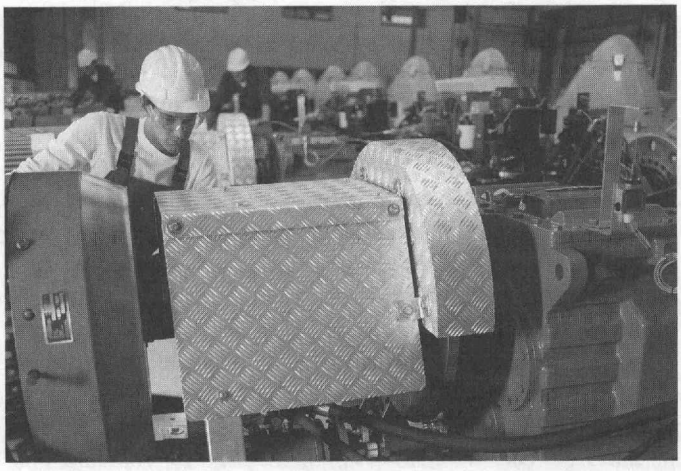
In general, these workers can be separated into two groups—those who set up machines for operation and those who operate the machines during production. *Machine setters*, or setup workers, prepare the machines prior to production, perform initial test runs producing a part, and may adjust and make minor repairs to the machinery during its operation. *Machine operators and tenders* primarily monitor the machinery during its operation; sometimes they load or unload the machine or make minor adjustments to the controls. Many workers both set up and operate equipment.

Setup workers prepare machines for production runs. Most machines can make a variety of products, and these different items are made by using different inputs or tooling. For instance, a single machine may use different sized tools to produce both large and small wheels for cars. The tools inside the machine must be changed and maintained by setup workers. On some machines, tools may become dull after extended use and must be sharpened. It is common for a setter to remove the tool, use a grinder or file to sharpen the tool, and place the tool back in the machine. New tools are produced by tool and die makers. (See statement on tool and die makers elsewhere in the *Handbook*.) After installing the tools into a machine, setup workers often produce the initial batch of goods, inspect the products, and turn the machine over to an operator.

Machine operators and tenders are responsible for running machines in manufacturing plants. After a setter prepares a machine for production, an operator observes the machine and the objects it produces. Operators may have to load the machine with materials for production or adjust machine speeds during production. Operators must periodically inspect the parts a machine produces by comparing the parts to blueprint using rulers, micrometers, and other specialized measuring devices. If the products do not meet design parameters, the machine is shut down; if it is a common, minor error the operator may fix the machine, but if it is more serious an industrial machinery mechanic is called to make a repair. (See the statement on industrial machinery mechanics and millwrights elsewhere in the *Handbook*.) Some machines don't require constant input or attention, so the operator may oversee multiple machines at a given time. In many cases, operators must document production numbers in a notebook or computer database at the end of every hour or shift.

Setters, operators, and tenders usually are identified by the type of machine with which they work. Some examples of specific titles are drilling-machine and boring-machine setup workers, milling-machine and planing-machine tenders, and lathe-machine and turning-machine tool operators. Job duties usually vary with the size of the firm and the type of machine being operated. Although some workers specialize in one or two types of machinery, many are trained to set up or operate a variety of machines. Increasing automation allows machine setters to operate multiple machines simultaneously. In addition, newer production techniques, such as team-oriented "lean" manufacturing, require machine operators to rotate between different machines. Rotating assignments results in more varied work, but also requires workers to have a wider range of skills.

Work environment. Most machine setters, operators, and tenders—metal and plastic work in areas that are clean, well lit, and well ventilated. Nevertheless, stamina is required, because machine operators and setters are on their feet much of the



Machine operators stop production when faulty parts are produced.

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day and may do moderately heavy lifting. Also, these workers operate powerful, high-speed machines that can be dangerous if strict safety rules are not observed. Most operators wear protective equipment, such as safety glasses, earplugs, and steel-toed boots, to protect against flying particles of metal or plastic, noise from the machines, and heavy objects that could be dropped. Many modern machines are enclosed, minimizing the exposure of workers to noise, dust, and lubricants used during machining. Other required safety equipment varies by work setting and machine. For example, those in the plastics industry who work near materials that emit dangerous fumes or dust must wear respirators.

Overtime is common during periods of increased production for most machine setters, operators, and tenders—metal and plastic, but they usually work a 40-hour week. Because many metalworking and plastics working shops operate more than one shift daily, some operators work nights and weekends.

Training, Other Qualifications, and Advancement

A few weeks of on-the-job training is sufficient for most workers to learn basic machine operations, but a year or more is required to become a highly skilled operator or setter.

Education and training. Employers generally prefer workers who have a high school diploma or equivalent for jobs as machine setters, operators, and tenders. Those interested in this occupation can improve their employment opportunities by completing high school courses in shop and blueprint reading and by gaining a working knowledge of the properties of metals and plastics. A solid math background, including courses in algebra, geometry, trigonometry, and basic statistics, also is useful, along with experience working with computers.

Machine operator trainees begin by observing and assisting experienced workers, sometimes in formal training programs or apprenticeships. Under supervision, they may start by supplying materials, starting and stopping the machine, or removing finished products from it. Then they advance to the more difficult tasks performed by operators, such as adjusting feed speeds, changing cutting tools, or inspecting a finished product for defects. Eventually, some develop the skills and experience to set up machines and assist newer operators.

The complexity of the equipment largely determines the time required to become an operator. Most operators learn the basic machine operations and functions in a few weeks, but a year or more may be needed to become skilled operators or to advance to the more highly skilled job of setter. Although many operators learn on the job, some community colleges and other educational institutions offer courses and certifications in operating metal and plastics machines. In addition to providing on-the-job training, some employers send promising machine operators to classes. Other employers prefer to hire workers who have completed, or currently are enrolled in, a training program.

Setters or technicians often plan the sequence of work, make the first production run, and determine which adjustments need to be made. As a result, these workers need a thorough knowledge of the machinery and of the products being manufactured. Strong analytical abilities are particularly important for this job. Some companies have formal training programs for operators and setters, which often combine classroom instruction with on-the-job training.

Other qualifications. As the machinery in manufacturing plants becomes more complex and with changes to shop-floor organization that require more teamwork among employees, employers increasingly look for persons with good communication and interpersonal skills. Mechanical aptitude, manual dexterity, and experience working with machinery also are helpful.

Certification and advancement. Job opportunities and advancement can be enhanced by becoming certified in a particular machine skill. There are many trade groups that offer certification for machine operators and setup workers, and certifications vary greatly depending upon the skill level involved. Certifications may allow operators and setters to switch jobs more easily because they can prove their skills to a potential employer.

Advancement usually takes the form of higher pay and a wider range of responsibilities. With experience and expertise, workers can become trainees for more highly skilled positions; for instance, it is common for machine operators to move into setup or machinery maintenance positions. Setup workers may also move into maintenance, machinist, or tool and die maker roles. (See the statements on industrial machinery mechanics and millwrights, machinists, and tool and die makers elsewhere in the *Handbook*.) Skilled workers with good communication and analytical skills can move into supervisory positions.

Employment

Machine setters, operators, and tenders, metal and plastic held about 1.0 million jobs in 2008. About 9 out of 10 jobs were found in manufacturing—primarily in fabricated metal products, plastics and rubber products, primary metal, machinery, and motor vehicle parts manufacturing.

Job Outlook

Employment is expected to decline rapidly. Those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

Employment change. Employment in the various machine setter, operator, and tender occupations is expected to decline rapidly by 13 percent from 2008 to 2018. Employment will be affected by technological advances, changing demand for the goods they produce, foreign competition, and the reorganization of production processes.

One of the most important factors influencing employment change in this occupation is the implementation of labor-saving machinery. Many firms are adopting new technologies, such as computer-controlled machine tools and robots in order to improve quality, lower production costs, and remain competitive. The switch to computer-controlled machinery requires the employment of computer control programmers and operators (see this statement elsewhere in the *Handbook*) instead of machine setters, operators and tenders. The lower-skilled manual machine tool operators and tenders jobs are more likely to be eliminated by these new technologies, because the functions they perform may be more effectively completed with computer-controlled machinery.

The demand for machine setters, operators, and tenders—metal and plastic is also affected by the demand for the parts they

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Machine setters, operators, and tenders—metal and plastic	–	1,028,400	899,000	-129,400	-13
Forming machine setters, operators, and tenders, metal and lastic	51-4020	153,200	137,700	-15,500	-10
Extruding and drawing machine setters, operators, and tenders, metal and plastic	51-4021	90,700	86,000	-4,700	-5
Forging machine setters, operators, and tenders, metal and plastic	51-4022	28,100	22,600	-5,500	-19
Rolling machine setters, operators, and tenders, metal and plastic	51-4023	34,400	29,000	-5,300	-16
Machine tool cutting setters, operators, and tenders, metal and plastic	51-4030	444,300	368,400	-75,900	-17
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	51-4031	236,800	203,500	-33,300	-14
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	51-4032	33,000	24,200	-8,900	-27
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	51-4033	92,700	77,900	-14,800	-16
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	51-4034	55,700	40,800	-14,900	-27
Milling and planing machine setters, operators, and tenders, metal and plastic	51-4035	26,200	22,000	-4,100	-16
Metal furnace and kiln operators and tenders	51-4050	34,100	31,000	-3,100	-9
Metal-refining furnace operators and tenders	51-4051	19,100	17,400	-1,600	-9
Pourers and casters, metal	51-4052	15,100	13,600	-1,500	-10
Model makers and patternmakers, metal and plastic	51-4060	17,100	16,100	-1,000	-6
Model makers, metal and plastic	51-4061	10,100	9,500	-600	-6
Patternmakers, metal and plastic	51-4062	7,000	6,600	-400	-6
Molders and molding machine setters, operators, and tenders, metal and plastic	51-4070	158,800	150,700	-8,200	-5
Foundry mold and coremakers	51-4071	15,000	13,200	-1,800	-12
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	51-4072	143,800	137,400	-6,400	-4
Multiple machine tool setters, operators, and tenders, metal and plastic	51-4081	86,000	73,400	-12,600	-15
Miscellaneous metalworkers and plastic workers	51-4190	134,900	121,800	-13,100	-10
Heat treating equipment setters, operators, and tenders, metal and plastic	51-4191	23,200	20,700	-2,500	-11
Lay-out workers, metal and plastic	51-4192	8,300	7,300	-1,000	-12
Plating and coating machine setters, operators, and tenders, metal and plastic	51-4193	39,500	34,600	-4,900	-12
Tool grinders, filers, and sharpeners	51-4194	18,800	17,400	-1,400	-7
All other metal workers and plastic workers	51-4199	45,000	41,700	-3,300	-7

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

produce. Both the plastic and metal manufacturing industries face stiff foreign competition that is limiting the demand for domestically produced parts. Some domestic firms have outsourced their production to foreign countries, which has limited employment of machine setters and operators. Another way domestic manufacturers compete with low-wage foreign competition is by increasing their use of automated systems, which can make manufacturing establishments more competitive by improving their productivity. This increased automation also limits employment growth.

Job prospects. Despite the overall projected employment decline, a number of machine setter, operator, and tender jobs will become available because of an expected surge in retirements, primarily baby boomers, in the coming years. Workers with a thorough background in machine operations, certifications from industry associations, exposure to a variety of machines, and a good working knowledge of the properties of metals and plastics will be better able to adjust to the changing environment. In addition, new shop-floor arrangements will reward workers with good basic mathematics and reading skills, good communication skills, and the ability and willingness to learn new tasks. As workers adapt to team-oriented production methods, those who can operate multiple machines will have the best opportunities for advancement and for gaining jobs with more long-term potential.

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Earnings

Wages for machine operators can vary by size of the company, union status, industry, and skill level and experience of the operator. Also, temporary employees, who are being hired in greater numbers, usually get paid less than permanently employed workers. The median hourly wages in May 2008 for a variety of machine setters, operators, and tenders—metal and plastic were:

Model makers, metal and plastic	$19.55
Patternmakers, metal and plastic	17.75
Metal-refining furnace operators and tenders	17.47
Lay-out workers, metal and plastic	16.79
Rolling machine setters, operators, and tenders, metal and plastic	16.40
Milling and planing machine setters, operators, and tenders, metal and plastic	16.00
Lathe and turning machine tool setters, operators, and tenders, metal and plastic	15.84
Pourers and casters, metal	15.66
Heat treating equipment setters, operators, and tenders, metal and plastic	15.40
Tool grinders, filers, and sharpeners	15.37
Forging machine setters, operators, and tenders, metal and plastic	14.90
Multiple machine tool setters, operators, and tenders, metal and plastic	14.87
Drilling and boring machine tool setters, operators, and tenders, metal and plastic	14.83
Extruding and drawing machine setters, operators, and tenders, metal and plastic	14.31
Grinding, lapping, polishing, and buffing machine tool setters, operators, and tenders, metal and plastic	14.16
Foundry mold and coremakers	14.13
Plating and coating machine setters, operators, and tenders, metal and plastic	13.65
Cutting, punching, and press machine setters, operators, and tenders, metal and plastic	13.54
Molding, coremaking, and casting machine setters, operators, and tenders, metal and plastic	13.17
Metal workers and plastic workers, all other	15.61

Related Occupations

Workers whose duties are closely related to machine setters, operators, and tenders—metal and plastic include:

	Page
Assemblers and fabricators	723
Computer control programmers and operators	731
Machinists	737
Painting and coating workers, except construction and maintenance	778
Tool and die makers	740
Welding, soldering, and brazing workers	743

Sources of Additional Information

For general information about careers and companies employing metal machine setters, operators, and tenders, contact:

➤ Fabricators and Manufacturers Association, 833 Featherstone Rd., Rockford, IL 61107 Internet: **http://www.fmanet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos224.htm**

Machinists

Significant Points

- Machinists learn their job skills in apprenticeship programs, informally on the job, in vocational high schools, and in community or technical colleges.
- Many entrants previously have worked as machine setters, operators, or tenders.
- Employment is projected to decline slowly, but job opportunities are expected to be good.

Nature of the Work

Machinists use machine tools, such as lathes, milling machines, and grinders, to produce precision metal parts. Although they may produce large quantities of one part, precision machinists often produce small batches or one-of-a-kind items. They use their knowledge of the working properties of metals and their skill with machine tools to plan and carry out the operations needed to make machined products that meet precise specifications. The parts that machinists make range from bolts to automobile pistons.

Machinists first review electronic or written blueprints or specifications for a job before they machine a part. Next, they calculate where to cut or bore into the workpiece—the piece of steel, aluminum, titanium, plastic, silicon, or any other material that is being shaped. They determine how fast to feed the workpiece into the machine and how much material to remove. They then select tools and materials for the job, plan the sequence of cutting and finishing operations, and mark the workpiece to show where cuts should be made.

After this layout work is completed, machinists perform the necessary machining operations. They position the workpiece on the machine tool—drill press, lathe, milling machine, or other type of machine—set the controls, and make the cuts. During the machining process, they must constantly monitor the feed rate and speed of the machine. Machinists also ensure that the workpiece is properly lubricated and cooled, because the machining of metal products generates a significant amount of heat. The temperature of the workpiece is a key concern, because most metals expand when heated; machinists must adjust the size of their cuts relative to the temperature.

During the cutting process, machinists detect problems by listening for specific sounds—for example, that of a dull cutting tool or excessive vibration. Dull cutting tools are removed and replaced. Cutting speeds are adjusted to compensate for harmonic vibrations, which can decrease the accuracy of cuts, particularly on newer high-speed spindles and lathes. After the work is completed, machinists use both simple and highly sophisticated

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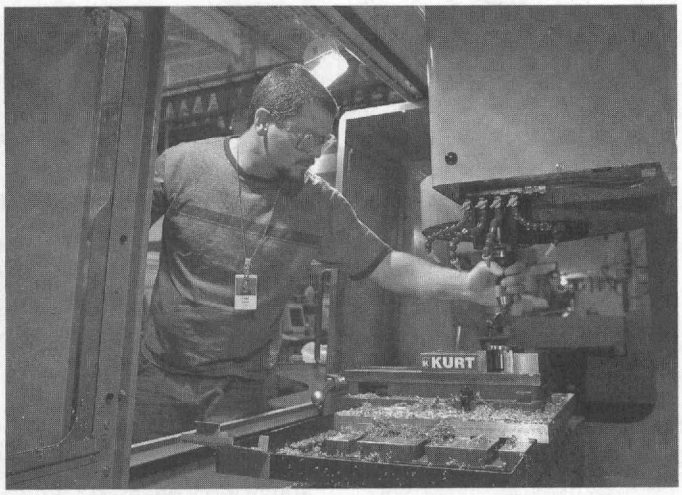

Machinists remove and replace worn-out machine tools.

measuring tools to check the accuracy of their work against the blueprints.

Some machinists, often called *production machinists*, may produce large quantities of one part, especially parts requiring the use of complex operations and great precision. Many modern machine tools are computer numerically controlled (CNC). CNC machines, following a computer program, control the cutting tool speed, change dull tools, and perform all necessary cuts to create a part. Frequently, machinists work with computer control programmers to determine how the automated equipment will cut a part. (See the section on computer control programmers and operators elsewhere in the *Handbook.*) The machinist determines the cutting path, speed of the cut and the feed rate, and the programmer converts path, speed, and feed information into a set of instructions for the CNC machine tool. Many machinists must be able to use both manual and computer-controlled machinery in their job.

Because most machinists train in CNC programming, they may write basic programs themselves and often modify programs in response to problems encountered during test runs. Modifications, called offsets, not only fix problems, but they also improve efficiency by reducing manufacturing time and tool wear. After the production process is designed, computer control operators implement it by performing relatively simple and repetitive operations.

Some manufacturing techniques employ automated parts loaders, automatic tool changers, and computer controls, allowing machines to operate without anyone present. One production machinist, working 8 hours a day, might monitor equipment, replace worn cutting tools, check the accuracy of parts being produced, adjust offsets, and perform other tasks on several CNC machines that operate 24 hours a day. In the off-hours, during what is known as "lights out manufacturing," which is the practice of running machines while the operators are not present, a factory may need only a few workers to monitor the entire factory.

Maintenance machinists repair or make new parts for existing machinery. After an industrial machinery mechanic or maintenance worker discovers the broken part of a machine, they give the broken part to the machinist. (See the section on industrial machinery mechanics and millwrights elsewhere in the *Handbook.*) To replace broken parts, maintenance machinists refer to blueprints and perform the same machining operations that were needed to create the original part. While production machinists are concentrated in a few industries, maintenance machinists work in many manufacturing industries.

Because the technology of machining is changing rapidly, machinists must learn to operate a wide range of machines. Some newer machines use lasers, water jets, or electrified wires to cut the workpiece. While some of the computer controls are similar to other machine tools, machinists must understand the unique cutting properties of these different machines. As engineers create new types of machine tools and new materials to machine, machinists must constantly learn new machining properties and techniques.

Work environment. Today, many machine shops are relatively clean, well lit, and ventilated. Computer-controlled machines often are partially or totally enclosed, minimizing the exposure of workers to noise, debris, and the lubricants used to cool workpieces during machining. Nevertheless, working around machine tools presents certain dangers, and workers must follow safety precautions. Machinists wear protective equipment, such as safety glasses to shield against bits of flying metal, and earplugs to dampen machinery noise. They also must exercise caution when handling hazardous coolants and lubricants, although many common water-based lubricants present little hazard. The job requires stamina, because machinists stand most of the day and, at times, may need to lift moderately heavy workpieces. Modern factories use autoloaders and overhead cranes to reduce heavy lifting.

Many machinists work a 40-hour week. Evening and weekend shifts are becoming more common, as companies extend hours of operation to make better use of expensive machines. However, this trend is somewhat offset by lights-out manufacturing that uses fewer machinists and the use of machine operators for less desirable shifts. Overtime work is common during peak production periods.

Training, Other Qualifications, and Advancement

Machinists train in apprenticeship programs, vocational schools, or community or technical colleges, or informally on the job. Many entrants previously have worked as machine setters, operators, or tenders.

Education and training. There are many different ways to become a skilled machinist. Many entrants previously have worked as machine setters, operators, or tenders. In high school, students should take math courses, especially trigonometry and geometry and, if available, courses in blueprint reading, metalworking, and drafting. Some advanced positions, such as those in the aircraft manufacturing industry, require the use of advanced applied calculus and physics. Due to the increasing use of computer controlled machinery, basic computer skills are needed before entering a training program. After high school, some machinists learn entirely on the job, but most acquire their skills in a mix of classroom and on-the-job training. Formal apprenticeship programs, typically sponsored by a union or manufacturer, are an excellent way to learn the job of machinist, but are often hard

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Machinists	51-4041	421,500	402,200	-19,300	-5

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

to get into. Apprentices usually must have a high school diploma, GED, or the equivalent; and most have taken algebra and trigonometry classes.

Apprenticeship programs consist of paid shop training and related classroom instruction lasting up to 4 years. In shop training, apprentices work almost full time and are supervised by an experienced machinist, while learning to operate various machine tools. Classroom instruction includes math, physics, materials science, blueprint reading, mechanical drawing, and quality and safety practices. In addition, as machine shops have increased their use of computer-controlled equipment, training in the operation and programming of CNC machine tools has become essential. Apprenticeship classes are often taught in cooperation with local community colleges or vocational-technical schools. A growing number of machinists are learning the trade through 2-year associate degree programs at community or technical colleges. Graduates of these programs still need significant on-the-job experience as machinists' assistants before they are fully qualified.

Certification and other qualifications. People interested in becoming machinists should be mechanically inclined, have good problem-solving abilities, be able to work independently, and be able to do highly accurate work (tolerances may reach 50/1,000,000ths of an inch) that requires concentration and physical effort. Experience working with machine tools is helpful. In fact, many entrants have worked as machine setters, operators, or tenders.

To boost the skill level of machinists and to create a more uniform standard of competency, a number of training facilities, State apprenticeship boards, and colleges offer certification programs. Completing a recognized certification program provides a machinist with better career opportunities and helps employers better judge the abilities of new hires. Journeyworker certification can be obtained from State apprenticeship boards after completing an apprenticeship; this certification is recognized by many employers and often leads to better career opportunities.

As new automation is introduced, machinists normally receive additional training to update their skills. This training usually is provided by a representative of the equipment manufacturer or a local technical school. Some employers offer tuition reimbursement for job-related courses.

Advancement. Machinists can advance in several ways. Experienced machinists may become CNC programmers, tool and die makers, or mold makers, or be promoted to supervisory or administrative positions in their firms. A few open their own machine shops.

Employment

Machinists held about 421,500 jobs in 2008. About 78 percent of machinists work in manufacturing industries, such as machine shops and machinery, motor vehicle and parts, aerospace products and parts, and other transportation equipment manufacturing. Maintenance machinists work in most industries that use production machinery.

Job Outlook

Although employment of machinists is projected to decline slowly, job prospects are expected to be good.

Employment change. Employment of machinists is projected to decline by 5 percent over the 2008–18 decade, due to rising productivity among these workers and strong foreign competition in the manufacture of goods. Machinists are becoming more efficient as a result of the expanded use of and improvements in technologies such as CNC machine tools, autoloaders, high-speed machining, and lights out manufacturing. This allows fewer machinists to accomplish the same amount of work. Technology is not expected to affect the employment of machinists as significantly as that of some other production workers, however, because machinists monitor and maintain many automated systems. Due to modern production techniques, employers prefer workers, such as machinists, who have a wide range of skills and are capable of performing almost any task in a machine shop.

Job prospects. Despite the projected decline in employment, job opportunities for machinists should continue to be good, as employers value the wide-ranging skills of these workers. Also, many young people with the necessary educational and personal qualifications needed to become machinists prefer to attend college or may not wish to enter production occupations. Therefore, the number of workers learning to be machinists is expected to be less than the number of job openings arising each year from the need to replace experienced machinists who retire or transfer to other occupations. Employment levels in this occupation are influenced by economic cycles—as the demand for machined goods falls, machinists involved in production may be laid off or forced to work fewer hours.

Earnings

Median hourly wages of machinists were $17.41 in May 2008. The middle 50 percent earned between $13.66 and $21.85. The lowest 10 percent earned less than $10.79, while the top 10 percent earned more than $26.60. Median hourly wages in the manufacturing industries employing the largest number of machinists were:

Aerospace product and parts manufacturing	$19.49
Metalworking machinery manufacturing	17.90
Motor vehicle parts manufacturing	17.06
Machine shops; turned product; and screw, nut, and bolt manufacturing	16.93
Employment services	12.94

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Apprentices earn much less than experienced machinists, but earnings increase quickly as they improve their skills. Also, most employers pay for apprentices' training classes.

Related Occupations

Machinists share similar duties with these other manufacturing occupations:

	Page
Computer control programmers and operators	731
Industrial machinery mechanics and millwrights	709
Machine setters, operators, and tenders—metal and plastic	734
Tool and die makers	740

Sources of Additional Information

For information on training and new technology for machinists, contact:

➤ Fabricators and Manufacturers Association, 833 Featherstone Rd., Rockford, IL 61107 Internet: **http://www.fmanet.org**

Information on the registered apprenticeship system with links to State apprenticeship programs may also be found on the U.S. Department of Labor Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor toll-free helpline: (877) 872-5627.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos223.htm**

Tool and Die Makers

Significant Points

- Tool and die makers are one of the highest paid and most highly skilled production occupations.
- Most tool and die makers need 4 or 5 years of classroom instruction and on-the-job training to become fully qualified.
- Employment is projected to decline moderately, but job opportunities should be excellent, as many employers report difficulty finding qualified applicants.

Nature of the Work

Tool and die makers are among the most highly skilled workers in manufacturing. These workers produce and repair tools, dies, and special guiding and holding devices that enable machines to produce a variety of products we use daily—from clothing and furniture to heavy equipment and parts for aircraft. They may work in manufacturing plants that produce tools in house, or in machine shops that only produce specialized machine tools for other manufacturers.

Toolmakers craft precision tools and machines that are used to cut, shape, and form metal and other materials. They also produce jigs and fixtures—devices that hold metal while it is bored, stamped, or drilled—and gauges and other measuring devices. *Die makers* construct metal forms, called dies, that are used to shape metal in stamping and forging operations. They also make metal molds for diecasting and for molding plastics, ceramics, and composite materials. Some tool and die makers craft prototypes of parts, and then, working with engineers and designers, determine how best to manufacture the part. In addition to developing, designing, and producing new tools and dies, these workers also may repair worn or damaged tools, dies, gauges, jigs, and fixtures.

To perform these functions, tool and die makers employ many types of machine tools and precision measuring instruments. They also must be familiar with the machining properties, such as hardness and heat tolerance of a wide variety of common metals, alloys, plastics, ceramics, and other composite materials. Tool and die makers are knowledgeable in machining operations, mathematics, and blueprint reading. In fact, tool and die makers often are considered highly specialized machinists. Machinists typically produce less elaborate parts for machinery, while tool and die makers craft very durable, complex machine tools. As a result, tool and die makers must have a general understanding of the mechanics of machinery. (See the section on machinists elsewhere in the *Handbook*.)

While many tools and dies are designed by engineers or tool designers, tool and die makers are also trained to design tools and often do. They may travel to a customer's plant to observe the operation and suggest ways in which a new tool could improve the manufacturing process.

Once a tool or die is designed, tool and die makers, working from blueprints, plan the sequence of operations necessary to manufacture the tool or die. They measure and mark the pieces of metal that will be cut to form parts of the final product. At this point, tool and die makers cut, drill, or bore the part as required, checking to ensure that the final product meets specifications. Finally, these workers assemble the parts and perform finishing jobs, such as filing, grinding, and polishing surfaces. While manual machining has declined, it is still used for unique parts and sharpening of used tools.

Many tool and die makers use computer-aided design (CAD) to develop products and parts. Specifications entered into computer programs can be used to electronically develop blueprints for the required tools and dies. Numerical tool and process control programmers use CAD or computer-aided manufacturing (CAM) programs to convert electronic drawings into CAM-based computer programs that contain instructions for a sequence of cutting tool operations. (See the section on computer control programmers and operators elsewhere in the *Handbook*.) Once these programs are developed, computer numerically controlled (CNC) machines follow the set of instructions contained in the program to produce the part. Computer-controlled machine tool operators or machinists normally operate CNC machines, but tool and die makers are often trained in both operating CNC machines and writing CNC programs; and they may perform either task. CNC programs are stored electronically for future use, saving time and increasing worker productivity.

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After machining the parts, tool and die makers carefully check the accuracy of the parts using many tools, including coordinate measuring machines, which use sensor arms and software to compare the dimensions of the part to electronic blueprints. Next, they assemble the different parts into a functioning machine. They file, grind, shim, and adjust the different parts to properly fit them together. Finally, tool and die makers set up a test run, using the tools or dies they have made to make sure that the manufactured parts meet specifications. If problems occur, they compensate by adjusting the tools or dies.

Work environment. Tool and die makers may either work in toolrooms or manufacturing production floors. Toolrooms are generally kept clean and cool to minimize heat-related expansion of metal workpiece, while specialty machine shops have a factory floor covered with machinery. To minimize the exposure of workers to moving parts, machines have guards and shields. Most computer-controlled machines are totally enclosed, minimizing workers' exposure to noise, dust, and the lubricants used to cool workpieces during machining. Working around this machinery can still be dangerous, so tool and die makers must follow safety rules and wear protective equipment, such as safety glasses to shield against bits of flying metal, earplugs to protect against noise, and gloves and masks to reduce exposure to hazardous lubricants and cleaners. These workers also need stamina, because they often spend much of the day on their feet and may do moderately heavy lifting. Companies employing tool and die makers have traditionally operated only one shift per day. Overtime and weekend work are common, especially during peak production periods.

Training, Other Qualifications, and Advancement

It usually takes 4 or 5 years of classroom and paid on-the-job training to become a fully trained tool and die maker. Good math, problem-solving, and computer skills are important requirements for these workers.

Education and training. Most tool and die makers learn their trade through 4 or 5 years of education and training in formal apprenticeships or in other postsecondary programs offered at local community colleges or technical schools. These programs often include a mix of classroom instruction and paid hands-on experience. According to most employers, apprenticeship programs are the best way to learn all aspects of tool and die making. Most apprentices must have a high school diploma, GED, or equivalent. In high school, students should take courses in physics and mathematics, including trigonometry and geometry.

Traditional apprenticeships usually require that the apprentice complete a specific number of work and classroom hours to complete the program, which typically takes 4 or 5 years. Some companies and State apprenticeship programs, however, are now shifting from time-based programs to competency-based programs. Under competency-based programs, apprentices can move ahead more quickly by passing a series of exams and demonstrating competency in a particular job skill.

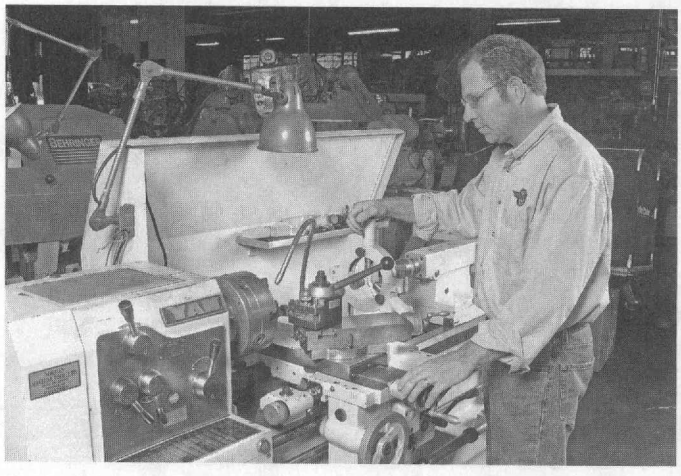
While formal apprenticeship programs may be the best way to learn the job, many tool and die makers receive most of their formal classroom training from community and technical colleges, while working for a company that often supports the employee's training goals and provides the needed on-the-job training less formally. Apprentices usually work 40 hours per week and attend technical college courses at night. These trainees often begin as machine operators and gradually take on more difficult assignments. Many machinists become tool and die makers.

During their training, tool and die maker trainees learn to operate milling machines, lathes, grinders, laser and water cutting machines, wire electrical discharge machines, and other machine tools. They also learn to use handtools for fitting and assembling gauges and other mechanical and metal-forming equipment. In addition, they study metalworking processes, such as heat treating and plating. Classroom training usually consists of tool designing, tool programming, blueprint reading, and mathematics courses, including algebra, geometry, calculus, trigonometry, and statistics. Tool and die makers must have good computer skills to work with CAD/CAM technology, CNC machine tools, and computerized measuring machines.

Even after completing a formal training program, tool and die makers still need years of experience to become highly skilled. Most specialize in making certain types of tools, molds, or dies.

Certification and other qualifications. State apprenticeship boards certify tool and die makers as journey workers after they have completed a licensed program. While a State certification is not necessary to work as a tool and die maker, it gives workers more flexibility in employment, as many employers require this certification. Apprentices usually must be at least 18 years old, in addition to having a high school education and high school mathematics classes.

Because tools and dies must meet strict specifications—precision to one ten-thousandth of an inch is common—the work of tool and die makers requires skill with precision measuring devices and a high degree of patience and attention to detail. Good eyesight is essential. People entering this occupation also should be mechanically inclined, able to work and solve problems independently, have strong mathematical skills, and be capable of doing work that requires concentration and physical effort. Tool and die makers who visit customers' plants need good communication, interpersonal, and sales skills.



Tool and die makers wear safety glasses for eye protection.

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Employers generally look for someone with a strong educational background, as they desire intelligent, dependable workers. Problem-solving skills are also a must in this occupation, as technologies and skills are constantly changing in this profession. As automation continues to change the way tools and dies are made, workers regularly need to update their skills to learn how to operate new equipment. Also, as materials such as alloys, ceramics, polymers, and plastics are increasingly used, tool and die makers need to learn new machining techniques to deal with these new materials.

Advancement. There are several ways for skilled workers to advance. Some move into supervisory and administrative positions in their firms or they start their own shop. Others may take computer courses and become computer-controlled machine tool programmers. With a college degree, a tool and die maker can go into engineering or tool design.

Employment

Tool and die makers held about 84,300 jobs in 2008. Most worked in industries that manufacture metalworking machinery, transportation equipment, such as motor vehicle parts, fabricated metal products, and plastics products. Although they are found throughout the country, jobs are most plentiful in the Midwest and the Northeast, where many metalworking companies are located.

Job Outlook

Employment is projected to decline moderately. However, excellent job opportunities are expected, as many employers report difficulty finding qualified applicants.

Employment change. Employment of tool and die makers is projected to decline by 8 percent over the 2008–18 decade, due to foreign competition in manufacturing and advances in automation, including CNC machine tools and computer-aided design, that should improve worker productivity. On the other hand, tool and die makers play a key role in building and maintaining advanced automated manufacturing equipment, which makes them less susceptible to lay-offs from automation than other less skilled production workers. As firms invest in new equipment, modify production techniques, and implement product design changes more rapidly, they will continue to rely heavily on skilled tool and die makers for retooling.

Job prospects. Despite declining employment, excellent job opportunities are expected as many openings will result from workers retiring or leaving the occupation for other reasons. Employers in certain parts of the country report difficulty attracting skilled workers and apprenticeship candidates with the necessary abilities to fill openings. The number of workers receiving training in this occupation is expected to continue to be fewer than the number of openings created each year by tool and die makers who retire or transfer to other occupations. A major factor limiting the number of people entering the occupation is that many young people who have the educational and personal qualifications necessary to learn tool and die making usually prefer to attend college or do not wish to enter production occupations.

Earnings

Median hourly wages of tool and die makers were $22.32 in May 2008. The middle 50 percent earned between $18.00 and $27.99. The lowest 10 percent had earnings of less than $14.69, while the top 10 percent earned more than $34.76. Median hourly wages in the manufacturing industries employing the largest numbers of tool and die makers were as follows:

Motor vehicle parts manufacturing	$27.99
Forging and stamping	21.80
Plastics product manufacturing	21.55
Machine shops; turned product; and screw, nut, and bolt manufacturing	20.73
Metalworking machinery manufacturing	20.46

The pay of apprentices is tied to their skill level. As they gain more skills and reach specific levels of performance and experience, their pay increases. About 22 percent of tool and die makers belong to unions.

Related Occupations

Some manufacturing occupations similar to tool and die makers are:

	Page
Computer control programmers and operators	731
Industrial machinery mechanics and millwrights	709
Machine setters, operators, and tenders—metal and plastic	734
Machinists	737
Welding, soldering, and brazing workers	743

Sources of Additional Information

For more information on education and technology for tool and die makers, contact:

➤ Fabricators and Manufacturers Association, 833 Featherstone Rd., Rockford, IL 61107 Internet: **http://www.fmanet.org**

Information on the registered apprenticeship system with links to State apprenticeship programs can be found on the U.S. Department of Labor Web site: **http://www.doleta.gov/OA/eta_default.cfm.** Apprenticeship information is also available from the U.S. Department of Labor toll free helpline: (877) 872-5627.

The Occupational Information Network (O*NET) provides information on a wide range of occupational charac-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Tool and die makers	51-4111	84,300	77,600	-6,700	-8

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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teristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos225.htm**

Welding, Soldering, and Brazing Workers

Significant Points

- About 2 out of 3 jobs in this occupation are in manufacturing industries.
- Training ranges from a few weeks to several years of school and on-the-job training.
- Employment is projected to experience little or no change.
- Job prospects should be good for skilled welders because employers are reporting difficulty finding enough qualified people.

Nature of the Work

Welding is the most common way of permanently joining metal parts. In this process, heat is applied to metal pieces, melting and fusing them to form a permanent bond. Because of its strength, welding is used in shipbuilding, automobile manufacturing and repair, aerospace applications, and thousands of other manufacturing activities. Welding also is used to join beams in the construction of buildings, bridges, and other structures and to join pipes in pipelines, powerplants, and refineries.

Welders may work in a wide variety of industries, from car racing to manufacturing. The work done in the different industries and the equipment used may vary greatly. The most common and simplest type of welding today is arc welding, which uses electrical currents to create heat and bond metals together, but there are over 100 different processes that a welder can employ. The type of weld used is normally determined by the types of metals being joined and the conditions under which the welding is to take place. Steel, for instance, can be welded more easily than titanium. Some of these processes involve manually using a rod and heat to join metals, while others are semiautomatic, with a welding machine feeding wire to bond materials. Automated welding, done completely by robots, is increasingly being used in the manufacturing industry.

Like welders, *soldering and brazing workers* use molten metal to join two pieces of metal. However, the metal added during the soldering and brazing process has a melting point lower than that of the piece, so only the added metal is melted, not the piece. Soldering uses metals with a melting point below 840 degrees Fahrenheit; brazing uses metals with a higher melting point. Because soldering and brazing do not melt the pieces being joined, these processes normally do not create the distortions or weaknesses in the pieces that can occur with welding. Soldering commonly is used to make electrical and electronic circuit boards, such as computer chips. Soldering workers tend to work with small pieces that must be precisely positioned. Brazing often is used to connect copper plumbing pipes and thinner metals that the higher temperatures of welding would warp. Brazing also can be used to apply coatings to parts to reduce wear and protect against corrosion.

Skilled welding, soldering, and brazing workers generally plan work from drawings, called blueprints, or specifications and use their knowledge of welding processes and base metals to determine how best to join the parts. The difficulty of the weld is determined by its position—horizontal, vertical, overhead, or 6G (circular, as in large pipes)—and by the type of metals to be fused. Highly skilled welders often are trained to work with a wide variety of materials, such as titanium, aluminum, or plastics, in addition to steel. Welders then select and set up welding equipment, execute the planned welds, and examine the welds to ensure that they meet standards or specifications.

Automated welding is being used in an increasing number of production processes. In these instances, a machine or robot performs the welding tasks while being monitored by a welding machine operator. *Welding, soldering, and brazing machine setters, operators, and tenders* follow specified layouts, work orders, or blueprints. Operators must load parts correctly and monitor the machine constantly to ensure that it produces the desired bond. About 12 percent of all welding, soldering, and brazing workers operate automated machinery.



Welders inspect the placement of parts before bonding metals.

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The work of *arc, plasma, and oxy-gas cutters* is closely related to that of welders. However, instead of joining metals, cutters use the heat from an electric arc, a stream of ionized gas called plasma, or burning gases to cut and trim metal objects to specific dimensions. Cutters also dismantle large objects, such as ships, railroad cars, automobiles, buildings, or aircraft. Some operate and monitor cutting machines similar to those used by welding machine operators.

Work environment. Welding, soldering, and brazing workers often are exposed to a number of hazards, including very hot materials and the intense light created by the arc. They wear safety shoes, goggles, masks with protective lenses, and other devices designed to prevent burns and eye injuries and to protect them from falling objects. The Occupational Safety and Health Administration (OSHA) requires that welders work in safely ventilated areas to avoid the danger from inhalation of gases and particulates that can result from welding processes. Because of these hazards, welding, soldering, and brazing workers suffer more work-related injuries than do workers in most occupations, but injuries can be minimized if proper safety procedures are followed. Automated welding, soldering, and brazing machine operators are not exposed to as many dangers, and a face shield or goggles usually provide adequate protection for these workers.

Welders and cutters may work outdoors, often in inclement weather, or indoors, sometimes in a confined area designed to contain sparks and glare. Outdoors, they may work on a scaffold or platform high off the ground. In addition, they may be required to lift heavy objects and work in a variety of awkward positions while bending, stooping, or standing to perform work overhead.

Although about 50 percent of welders, solderers, and brazers work a 40-hour week, overtime is common, and about 1 out of 5 welder works 50 hours per week or more. Many manufacturing firms offer two or three shifts, ranging from 8 to 12 hours, which allows them to continue production around the clock if needed.

Training, Other Qualifications, and Advancement

Training for welding, soldering, and brazing workers can range from a few weeks of school or on-the-job training for low-skilled positions to several years of combined school and on-the-job training for highly skilled jobs.

Education and training. Formal training is available in high schools and postsecondary institutions, such as vocational-technical institutes, community colleges, and private welding, soldering, and brazing schools. The U.S. Armed Forces operate welding and soldering schools as well. Some employers are willing to hire inexperienced entry-level workers and train them on the job, but many prefer to hire workers who have been through formal training programs. Courses in blueprint reading, shop mathematics, mechanical drawing, physics, chemistry, and metallurgy are helpful. An understanding of electricity also is very helpful, and knowledge of computers is gaining importance, especially for welding, soldering, and brazing machine operators, who are becoming more responsible for programming robots and other computer-controlled machines. Because understanding the welding process and inspecting welds is important for both welders and welding machine operators, companies hiring machine operators prefer workers with a background in welding.

Certification and other qualifications. Some welding positions require general certifications in welding or certifications in specific skills such as inspection or robotic welding. The American Welding Society certification courses are offered at many welding schools. Some employers have developed their own internal certification tests. Some employers are willing to pay training and testing costs for employees, while others require workers to pay for classes and certification themselves.

The Institute for Printed Circuits offers certifications and training in soldering. In industries such as aerospace and defense, where highly accurate and skilled work is required, many employers require these certifications. In addition, the increasing use of lead-free soldering techniques, which require more skill than traditional lead-based soldering techniques, has increased the importance of certification to employers.

Welding, soldering, and brazing workers need good eyesight, hand-eye coordination, and manual dexterity, along with good math, problem-solving, and communication skills. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions. In addition, welders increasingly must be willing to receive training and perform tasks required in other production jobs.

Advancement. Welders can advance to more skilled welding jobs with additional training and experience. For example, they may become welding technicians, supervisors, inspectors, or instructors. Some experienced welders open their own repair shops. Other welders, especially those who obtain a bachelor's degree or have many years of experience, may become welding engineers.

Employment

In 2008, welders, cutters, solderers, and brazers held about 412,300 jobs and welding, soldering, and brazing machine setters, operators, and tenders held about 54,100 jobs. About 65 percent of welding jobs were found in manufacturing. Jobs were concentrated in fabricated metal product manufacturing, transportation equipment manufacturing, machinery manufacturing, architectural and structural metals manufacturing, and construction.

Job Outlook

Employment is projected to experience little or no change over the next decade. Good job opportunities are expected for skilled welders because some employers are reporting difficulty finding qualified workers.

Employment change. Employment of welders, cutters, solderers, and brazers is expected to experience little or no change, declining by about 2 percent over the 2008–18 decade, while employment of welding, soldering, and brazing machine setters, operators, and tenders is expected to decline about 7 percent over the same decade. Continued enhancements in productivity and increased automation will reduce the need for welders, although the outlook for welders in man-

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Welding, soldering, and brazing workers	51-4120	466,400	455,900	-10,500	-2
Welders, cutters, solderers, and brazers	51-4121	412,300	405,600	-6,700	-2
Welding, soldering, and brazing machine setters, operators, and tenders	51-4122	54,100	50,300	-3,800	-7

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

ufacturing is stronger than that for other occupations in this industry because of the importance and versatility of welding as a manufacturing process. The basic skills of welding are the same across industries, so welders can easily shift from one industry to another, depending on where they are needed most. For example, welders laid off in the automotive manufacturing industry may be able to find work in the oil and gas industry, although the shift may require relocating.

Automation will affect welders and welding machine operators differently than other manufacturing occupations. Semiautomated and automated welding machines can be used for many types of welds, but welders still are needed to operate the machines and to inspect the weld and make adjustments. In addition, much of the work in custom applications is difficult or impossible to automate. This type of work includes manufacturing small batches of items, construction work, and making repairs in factories.

Job prospects. Job prospects for welders will vary with the welder's skill level. Prospects should be good for welders trained in the latest technologies. Welding schools report that graduates have little difficulty finding work, and many welding employers report difficulty finding properly skilled welders. However, welders without up-to-date training may face competition for job openings. For all welders, prospects will be better for workers who are willing to relocate to different parts of the country.

Earnings

Median wages of welders, cutters, solderers, and brazers were $16.13 an hour in May 2008. The middle 50 percent earned between $13.20 and $19.61. The lowest 10 percent earned less than $10.85, and the top 10 percent earned more than $24.38. The range of wages of welders reflects the wide range of skill levels in the occupation. Median hourly wages of welders, cutters, solderers, and brazers in the industries employing the largest numbers of them were as follows:

Other general purpose machinery manufacturing	$16.34
Agriculture, construction, and mining machinery manufacturing	16.28
Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance	15.93
Architectural and structural metals manufacturing	15.05
Motor vehicle body and trailer manufacturing	14.73

Median wages of welding, soldering, and brazing machine setters, operators, and tenders were $15.20 an hour in May 2008. The middle 50 percent earned between $12.62 and $18.63. The lowest 10 percent earned less than $10.47, and the top 10 percent earned more than $23.92. Median wages in motor vehicle parts manufacturing, the industry employing these workers in the largest numbers, were $15.34 an hour in May 2008.

About 20 percent of welders belong to labor unions; the particular unions that welders belong to depend on the industry and company in which the welder is employed.

Related Occupations

Other skilled metal workers include the following:

	Page
Assemblers and fabricators	723
Boilermakers	613
Computer control programmers and operators	731
Jewelers and precious stone and metal workers	770
Machine setters, operators, and tenders—metal and plastic	734
Machinists	737
Plumbers, pipelayers, pipefitters, and steamfitters	659
Sheet metal workers	665
Tool and die makers	740

Sources of Additional Information

For information on training opportunities and jobs for welding, soldering, and brazing workers, contact local employers, the local office of the State employment service, or schools providing welding, soldering, or brazing training.

Information on careers, certifications, and educational opportunities in welding is available from:

➤ American Welding Society, 550 N.W. LeJeune Rd., Miami, FL 33126. Internet: **http://www.aws.org**

➤ Fabricators and Manufacturers Association, 833 Featherstone Rd., Rockford, IL 61107 Internet: **http://www.fmanet.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos226.htm**

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Printing Occupations

Bookbinders and Bindery Workers

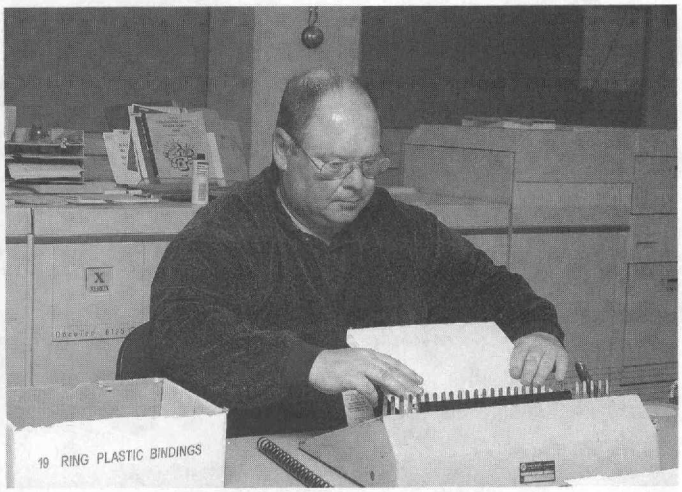
Significant Points

- Employment is expected to decline rapidly, reflecting the use of more productive machinery and the growth of electronic media.
- Opportunities for hand bookbinders are limited because of the declining demand for this highly specialized work and the resulting decline in the number of establishments that do this work.
- Most bookbinders and bindery workers train on the job.

Nature of the Work

The process of combining printed sheets into finished products such as books, magazines, catalogs, folders, and directories is known as "binding." When publications or advertising supplements have been printed, they must then be folded, glued, stitched, stapled, trimmed, or otherwise turned into the finished product that will be seen by the public. *Bindery workers* set up, operate, and maintain the machines that perform these various tasks, while *bookbinders* perform highly skilled hand finishing operations.

Job duties depend on the material being bound. Some types of binding and finishing jobs consist of only one step. Preparing leaflets or newspaper inserts, for example, requires only folding and trimming. Binding books and magazines, on the other hand, requires a number of steps. Bindery workers first assemble the books and magazines from large, flat, printed sheets of paper. They then operate machines that first fold printed sheets into "signatures," which are groups of pages arranged sequentially. They then assemble the signatures in sequence and join them by means of a saddle-stitch process or perfect binding (where no stitches are used).



Bookbinders and bindery workers use automated binding machines to finish printed reports.

In firms that do "edition binding," workers bind books produced in large numbers, or "runs."

Bookbinders also do repair work on rare books, such as sewing, stitching, or gluing the assembled printed sheets. They also shape book bodies with presses and trimming machines and reinforce them with glued fabric strips. Covers are created separately and glued, pasted, or stitched onto the book bodies. The books then undergo a variety of finishing operations, often including wrapping in paper jackets. In establishments that print new books, this work is done mechanically.

A small number of bookbinders work in hand binderies. These highly skilled workers design original or special bindings for limited editions, or restore and rebind rare books. Some binders repair books and provide other specialized binding services to libraries.

Bookbinders and bindery workers in small shops may perform many binding tasks, while those in large shops tend to specialize. Tasks may include performing perfect binding or operating laminating machinery. Others specialize as folder operators or cutter operators, and may perform adjustments and minor repairs to equipment as needed.

Work environment. Binderies often are noisy and jobs can be strenuous, requiring considerable lifting, standing, and carrying. Binding often resembles an assembly line on which workers perform repetitive tasks. The jobs also may require stooping, kneeling, and crouching. Equipment and protective clothing that help minimize injuries is available; however, minor injuries occur frequently in the occupation.

Bookbinders and bindery workers normally work 40 hours per week, although weekend and holiday hours may be necessary to meet production schedules. Some bindery workers may work on shifts for larger printers that operate around the clock. Part-time and on-call schedules are common to meet fluctuating demand or impending deadlines.

Training, Other Qualifications, and Advancement

On-the-job training remains the most common form of training for entry level bindery workers, but new technology will require workers to obtain more formal training. Attention to detail and mechanical aptitude are important for these jobs.

Education and training. High school students interested in bindery careers should take shop courses or attend a vocational-technical high school. Occupational skill centers also provide an introduction to bindery work and bookbinding. For entry-level positions, most employers look for high school graduates or those with associate degrees.

Training in graphic communications also can be an asset. Vocational-technical institutes offer postsecondary programs in the graphic arts, as do some skill-updating or retraining programs and community colleges. Other programs are made available by unions to their members. Four-year colleges also offer programs related to printing and publishing, but their emphasis is on preparing people for careers as graphic artists, educators, or managers in the graphic arts field.

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While postsecondary education is available, most bookbinders and bindery workers learn the craft through on-the-job training. Inexperienced workers may start out as helpers and perform simpler tasks, such as moving paper from cutting machines to folding machines or catching stock as it comes off machines. They learn basic binding skills, including the characteristics of paper and how to cut large sheets of paper into different sizes with the least amount of waste. Usually, it takes one to three months to learn to operate simpler machines but it can take up to one year to become completely familiar with more complex equipment, such as computerized binding machines. As workers gain experience, they learn to operate more types of equipment. To keep pace with changing technology, retraining is increasingly important for bindery workers.

Formal apprenticeships are not as common as they used to be, but still are offered by some employers. Apprenticeships allow beginners to acquire skills by working alongside skilled workers while also taking classes. The more structured apprenticeship programs enable workers to acquire the high levels of specialization and skill needed for some bindery and bookbinding jobs.

Other qualifications. Bindery work requires careful attention to detail. Accuracy, patience, neatness, and good eyesight are all important. Mechanical aptitude is necessary to operate automated equipment, and workers with computer skills will increasingly be in demand. Manual dexterity is needed in order to count, insert, and fold. In addition, creativity and artistic ability are necessary for hand bookbinding.

Certification and advancement. With experience, binders can expect increased salaries and more responsibility. Completion of a formal certification program can further advancement opportunities. Without additional training, advancement opportunities outside of bindery work are limited. In large binderies, experienced bookbinders or bindery workers may advance to supervisory positions.

Employment

In 2008, bookbinders and bindery workers held about 66,500 jobs, including 6,100 as bookbinders and 60,400 as bindery workers. More than 8 out of 10 bookbinding and bindery jobs were in printing and related support activities. Traditionally, the largest employers of bindery workers were bindery trade shops, which are companies that specialize in providing binding services for printers without binderies or whose printing production exceeds their binding capabilities. However, this type of binding is now being done increasingly in-house, and is now called "in-line finishing." The publishing industry employed 5 percent of bookbinders and bindery workers.

Job Outlook

Employment of bookbinders and bindery workers is projected to decline rapidly between 2008 and 2018, but opportunities for skilled, specialized bindery workers should be good because of their experience and expertise. Many job openings also will be created by bindery workers who transfer to other occupations.

Employment change. Overall employment of bookbinders and bindery workers is expected to decline rapidly by 19 percent between 2008 and 2018. Over this period, demand for bindery workers will slow as distribution of advertising supplements shifts from print to electronic media even as print productivity increases. Employment declines, however, may be ameliorated somewhat, because the demand for quick turnaround of print work, typical for most commercial printing work, makes work less amenable to being outsourced to foreign countries. To a great extent, sophisticated equipment has automated much of the mechanical bindery work, allowing more companies to perform bindery services in-house rather than send work to specialized binding shops. Also, more efficient and flexible binding machinery will slow the growth in demand for workers to do specialized binding.

Job prospects. Experienced workers will continue to have the best opportunities for skilled jobs. Prospects for all bindery jobs will be best for workers who have completed training or certification programs, internships, or who have experience in a related production occupation.

Earnings

Median hourly wages of bookbinders were $14.92 in May 2008, compared to $13.99 per hour for all production occupations. The middle 50 percent earned between $10.34 and $19.46 an hour. The lowest 10 percent earned less than $8.35, and the highest 10 percent earned more than $27.68.

Median hourly wages of bindery workers were $13.17 in May 2008. The middle 50 percent earned between $10.23 and $17.02 an hour. The lowest 10 percent earned less than $8.42, and the highest 10 percent earned more than $21.31.

Related Occupations

Other workers who set up and operate production machinery include:

	Page
Machine setters, operators, and tenders—metal and plastic	734
Prepress technicians and workers	748
Printing machine operators	750

Sources of Additional Information

Information about apprenticeships and other training opportunities may be obtained from local printing industry associations,

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Bookbinders and bindery workers	51-5010	66,500	53,600	-12,900	-19
Bindery workers	51-5011	60,400	48,200	-12,100	-20
Bookbinders	51-5012	6,100	5,400	-700	-12

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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local binderies, local offices of the Graphic Communications Conference or local offices of the State employment service. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: 1 (877) 282-5627.

For information on careers and training programs in printing and the graphic arts, contact:

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.gaerf.org/**

➤ Printing Industries of America 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.printing.org/**

➤ NPES The Association for Suppliers of Printing Publishing, and Converting Technologies, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/education/index.html**

➤ National Association of Printing Leadership , 75 West Century Road, Suite 100, Paramus, NJ 07652. Internet: **http://www.napl.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos232.htm**

Prepress Technicians and Workers

Significant Points

- Most prepress technician jobs now require formal postsecondary graphic communications training in the various types of computer software used in digital imaging.
- Employment is projected to decline rapidly as the increased use of computers in typesetting and page layout requires fewer prepress technicians.

Nature of the Work

The printing process has three stages: prepress, press, and binding or finishing. While workers in small print shops are usually responsible for all three stages, in most printing firms, formatting print jobs and correcting layout errors before the job goes to print is the responsibility of a specialized group of workers. *Prepress technicians and workers* are responsible for this prepress work. They perform a variety of tasks to help transform text and pictures into finished pages and prepare the pages for print.

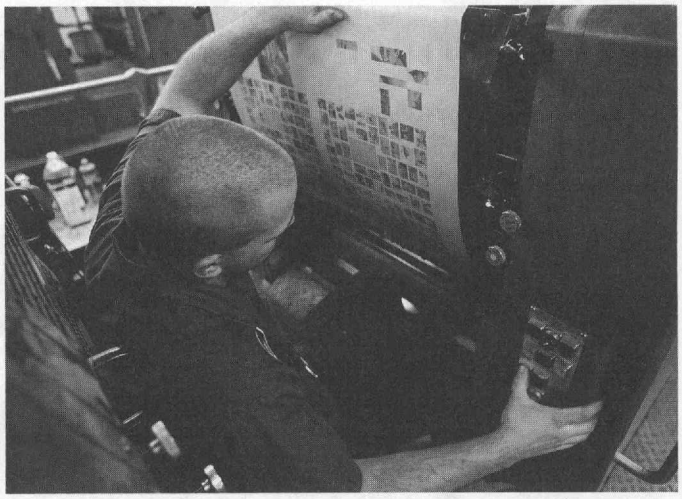
Some prepress technicians, known as "preflight technicians," take images from graphic designers, customer service staff, team leaders, or directly from customers and check them for completeness. They review job specifications and design either from submitted sketches or clients' electronic files to ensure that everything is correct and all files and photos are included. Once clients and preflight technicians agree that everything is in order, preflight technicians forward the files to prepress technicians to set up printers.

Offset printing plates are thin sheets of metal that carry the final image to be printed. Printing presses use this plate to copy the image to the final printed products. Once a printing plate has been created, prepress technicians collaborate with printing press operators to check for any potential printing problems. Several plates may be needed if a job requires color, but advanced printing technology generally does not require plates.

Prepress workers generally use a photographic process to make offset printing plates. This is a complex process involving ultraviolet light and chemical exposure through which the text and images of a print job harden on a metal plate and become water repellent. These hard, water repellent portions of the metal plate are in the form of the text and images that will be printed. More recently, however, the printing industry has moved to technology known as "direct-to-plate," by which the prepress technicians send the data directly to a plating system, bypassing the need for the photographic technique. The direct-to-plate technique is just one example of digital imaging technology that has largely replaced cold-type print technology.

Using direct-to-plate technology, the technicians produce an electronic image of the printed pages. The electronic image is used to create a "proof" which is printed and delivered or mailed to the customer. Alternatively, the electronic file can be e-mailed to the client for a final check. Once the customer approves the proofs, technicians use laser "imagesetters" to expose digital images of the pages directly onto the thin metal printing plates or directly to a digital press and skip the plate-making process altogether.

Advances in computer software and printing technology continue to change prepress work. Prepress workers often receive files from customers on a computer disk, via e-mail, or through an Internet site that contains typeset material already laid out in pages. This work is usually done by desktop publishers or graphic designers who have knowledge of publishing software. (Sections on desktop publishers and graphic designers appear elsewhere in the Handbook.) Despite the shortcuts that technological advancements allow, workers still need to understand the basic processes behind prepress, press, and finishing operations. Some workers, known as job printers, perform prepress and print operations.



Prepress technicians and workers ensure that printing presses are set correctly and that images and colors are correct before the full job order is printed.

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Job printers often are found in small establishments where work combines several job skills.

Work environment. Prepress technicians and workers usually work in clean, air-conditioned areas with little noise. Some workers may develop eyestrain from working in front of a video display terminal or other problems, such as muscle aches or back pain. Workers are often subject to stress and the pressures of deadlines and tight work schedules.

Prepress employees usually work an 8-hour day. Some workers—particularly those employed by newspapers—work night shifts. Weekend and holiday work may be required, particularly when a print job is behind schedule. Part-time job printers and prepress technicians made up about 14 percent of this occupation in 2008.

Training, Other Qualifications, and Advancement

Employers prefer workers with formal training in printing or publishing. Familiarity with the printing process, including the technology used, and attention to detail are the qualities that employers will seek most in job applicants.

Education and training. Many employers consider the best candidates for prepress jobs to be individuals with a combination of work experience in the printing industry and formal training in new digital technology. The experience of these applicants provides them with an understanding of how printing plants operate and demonstrates their interest in advancing within the industry.

Traditionally, prepress technicians and workers started as helpers and were trained on the job. Some of these jobs required years of experience performing detailed manual work to become skillful enough to perform the most difficult tasks. Today, however, employers expect workers to have some formal postsecondary graphic communications training in the various types of computer software used in digital imaging and will train workers on the job as needed.

For beginners, 2-year associate degree programs offered by community colleges, junior colleges, and technical schools teach the latest prepress skills and allow students to practice applying them. There are also 4-year bachelor's degree programs in graphic design aimed primarily at students who plan to move into management positions in printing or design. For workers who do not wish to enroll in a degree program, prepress-related courses are offered at many community colleges, junior colleges, 4-year colleges and universities, vocational-technical institutes, and private trade and technical schools. Workers with experience in other printing techniques can take a few college-level graphic communications courses to upgrade their skills and qualify for prepress jobs.

Other qualifications. Employers prefer workers with good communication skills, both oral and written. When prepress problems arise, prepress technicians should be able to deal courteously with customers to resolve them. In small shops, they may take customer orders and provide pricing information. Persons interested in working for firms using advanced printing technology need to be comfortable with electronics and computers. At times, prepress personnel may have to perform computations in order to estimate job costs or operate many of the machines used to run modern printing equipment.

Prepress technicians and workers need manual dexterity and accurate eyesight. Good color vision helps workers find mistakes and locate potential problems. It is essential for prepress workers to be able to pay attention to detail and work independently. Artistic ability is often a plus. Employers also seek persons who are comfortable with the pressures of meeting deadlines, using new software, and operating new equipment.

Advancement. Employers may send experienced technicians to industry-sponsored programs to update or develop new skills. Retraining due to technology and equipment changes is a constant as printing firms continually seek ways to improve efficiency and lower production costs. This kind of prepress training is sometimes offered in-house or through equipment makers and unions in the printing industry.

Employment

Prepress technicians and workers overall held about 106,900 jobs in 2008. Most prepress jobs are found in the printing and related support activities industry, while newspaper publishers employ the second largest number of prepress technicians and workers.

The printing and publishing industries are among the most geographically dispersed in the United States. While prepress jobs thus are found throughout the country, large numbers are concentrated in large printing centers such as the Chicago, Los Angeles–Long Beach, New York City, Minneapolis–St. Paul, Philadelphia, Boston, and Washington, DC metropolitan areas.

Job Outlook

Employment of prepress technicians and workers is projected to decline rapidly through 2018, because of improvements in printing technology that require fewer of these workers. Despite this, job prospects are good for prepress technicians with good computer and customer service skills.

Employment change. Overall employment of prepress technicians and workers is expected to decline by 13 percent over

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Prepress technicians and workers	–	106,900	92,600	-14,300	-13
Job printers	51-5021	45,700	42,200	-3,500	-8
Prepress technicians and workers	51-5022	61,200	50,400	-10,800	-18

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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the 2008–2018 period. Demand for printed material, especially product packaging, should grow, reflecting an increase in consumer demand for manufactured goods and an expanding population. But the growing use of computers and publishing software by even the smallest of printing shops will result in rising productivity of prepress technicians, offsetting the growth of new jobs.

Computer software now allows office workers to specify text typeface and style and to format pages. This development shifts traditional prepress functions away from printing plants into advertising and public relations agencies, graphic design firms, and large corporations. As page layout and graphic design capabilities of computer software become less expensive and more user-friendly, many companies are turning to in-house desktop publishing. Some organizations also find it less costly to prepare their own newsletters and other reports. At some publishing companies, writers and editors do more composition of their stories using publishing software to gauge layout needs, but generally rely on prepress technicians to perform the actual layout. The rapid growth in the use of digital printing and desktop publishing has eliminated many prepress technician jobs associated with older printing technologies. In addition, new technologies are increasing the amount of automation in printing companies, requiring fewer prepress workers to do the same work.

Job prospects. Despite a decline in the number of new prepress positions, opportunities will be favorable for workers with strong computer and customer service skills, such as preflight technicians who electronically check materials prepared by clients and adapt them for printing. Electronic prepress technicians, digital proofers, platemakers, and graphic designers are using new equipment and ever-improving software to design and lay out publications and complete their printing more quickly.

To remain competitive and profitable, commercial printing companies are offering other services in addition to printing to increase the value of their core service and provide customers with a one-stop option. For example, printers are looking for database administrators, Web site developers, and information technology specialists to assist with providing e-mail distribution and graphic design services. Individuals who are technologically savvy can pick up sales or customer service functions; those who have completed postsecondary programs in printing technology or graphic communications will have the best opportunities.

Earnings

Wage rates for prepress technicians and workers depend on basic factors such as employer, education, and location. Median hourly wages of prepress technicians and workers were $16.84 in May 2008, compared to $13.99 per hour for all production occupations. The middle 50 percent earned between $12.74 and $21.80 an hour. The lowest 10 percent earned less than $10.01, and the highest 10 percent earned more than $26.30 an hour. Median hourly wages in printing and related support activities were $17.39 in May 2008, while workers at newspaper, periodical, book, and directory publishers earned $15.82 an hour.

For job printers, median hourly wages were $16.21 in May 2008. The middle 50 percent earned between $12.59 and $20.57 an hour. The lowest 10 percent earned less than $9.91, and the highest 10 percent earned more than $25.38 an hour. Median hourly wages in the industries employing the largest numbers of job printers in May 2008 were $16.77 in printing and related support activities, and $15.18 in the newspaper, periodical, book, and directory publishers industry.

Related Occupations

Other printing workers and those who use artistic skills in their work include:

	Page
Artists and related workers	301
Bookbinders and bindery workers	746
Desktop publishers	579
Graphic designers	312
Printing machine operators	750

Sources of Additional Information

Details about training programs may be obtained from local employers, such as newspapers and printing shops, or from local offices of the State employment service.

Information on careers and training in printing and the graphic arts is available from:

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.gaerf.org**

➤ Printing Industries of America, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.printing.org/**

➤ NPES The Association for Suppliers of Printing Publishing, and Converting Technologies, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/education/index.html**

➤ NAPL National Association of Printing Leadership, 75 West Century Road, Suite 100, Paramus, NJ 07652. Internet: **http://www.napl.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos230.htm**

Printing Machine Operators

Significant Points

- Most printing machine operators are trained on the job.
- Retirements among older press operators are expected to create openings for skilled workers.
- Rising demand for customized print jobs will mean those skilled in digital printing operations will have the best job opportunities.

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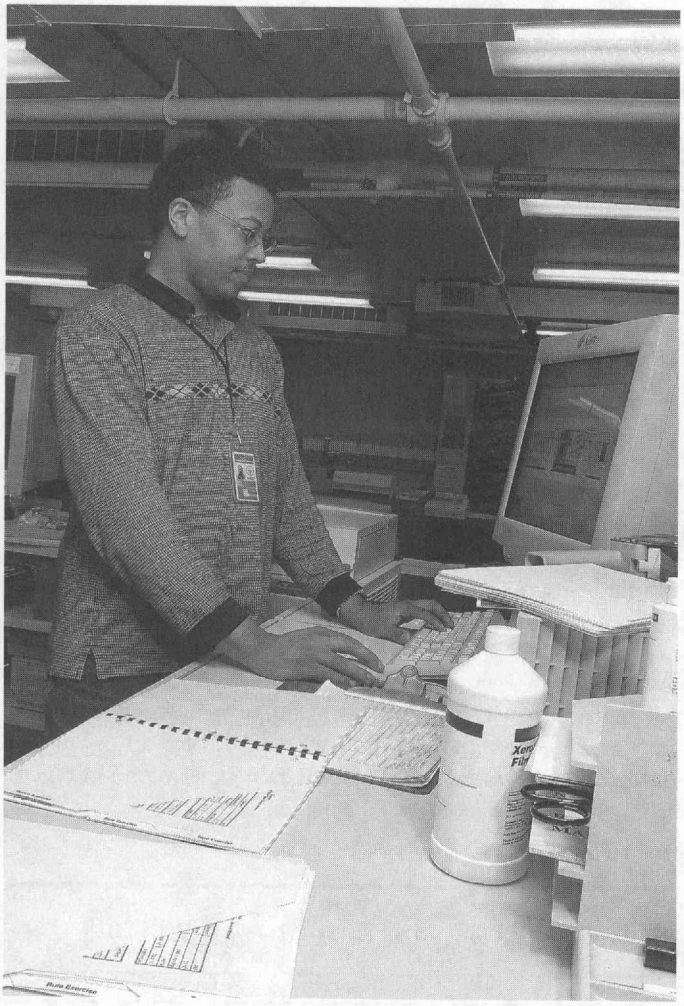
Nature of the Work

Printing machine operators, also known as *press operators*, prepare, operate, and maintain printing presses. Duties vary according to the type of press they operate. Traditional printing methods, such as offset lithography, gravure, flexography, and letterpress, use a plate or roller that carries the final image that is to be printed and copies the image to paper. In addition to the traditional printing processes, plateless or nonimpact processes are coming into general use. Plateless processes—including digital, electrostatic, and ink-jet printing—are used for copying, duplicating, and document and specialty printing, usually by quick printing shops and smaller in-house printing shops. Digital presses with longer run capabilities are increasingly being used by commercial printers for short-run or customized printing jobs. Digital presses also allow printers to transfer files, blend colors, and proof images electronically, thus avoiding the costly and time-consuming steps of making printing plates that are common to lithographic or off-set printing.

Printing machine operators' jobs differ from one shop to another because of differences in the types and sizes of presses. Small commercial shops with relatively small presses, those that print only one or two colors at a time, can be operated by one person, often an owner or manager who performs all business activities. To attract a wider range of clients, larger commercial print shops may run several presses with different size and color capacities. Press operators typically specialize in operating one type of press but may operate more than one press at a time. However, press operators who are trained on more than one type of printing press are valuable because they can work on multiple types of printing jobs. Large newspaper, magazine, and book printers use giant "in-line web" presses that require a crew of several press operators and press assistants.



Printing machine operators monitor each print job to ensure proper printer maintenance and to minimize malfunctions.

After working with prepress technicians (who are covered elsewhere in the Handbook) to identify and resolve any potential problems with a job, press operators prepare machines for printing. To prepare presses, operators install the printing plate with the images to be printed and adjust the pressure at which the machine prints. They then ink the presses, load paper, and adjust the press to the paper size. Operators ensure that paper and ink meet specifications, and adjust the flow of ink to the inking rollers accordingly. They then feed paper through the press cylinders and adjust feed and tension controls. New digital technology, in contrast, is able to automate much of this work.

While printing presses are running, press operators monitor their operation and keep the paper feeders well stocked. They make adjustments to manage ink distribution, speed, and temperature in the drying chamber, if the press has one. If paper tears or jams and the press stops, which can happen with some offset presses, operators quickly correct the problem to minimize downtime. Similarly, operators working with other high-speed presses constantly look for problems, and when necessary make quick corrections to avoid expensive losses of paper and ink. Throughout the run, operators must regularly pull sheets to check for any printing imperfections. Most printers have, or will soon have, presses with computers and sophisticated instruments to control press operations, making it possible to complete printing jobs in less time. With this equipment, press operators set up, monitor, and adjust the printing process on a control panel or computer monitor, which allows them to control the press electronically.

In most shops, press operators also perform preventive maintenance. They oil and clean the presses and make minor repairs.

Work environment. Operating a press can be physically and mentally demanding, and sometimes tedious. Press operators are on their feet most of the time. Operators often work under pressure to meet deadlines. Most printing presses are capable of high printing speeds, and adjustments must be made quickly to avoid waste. Pressrooms are noisy, and workers in certain areas wear ear protection. Working with press machinery can be hazardous, but the threat of serious accidents has decreased. Newer computerized presses are equipped with safety features and allow operators to make most adjustments from a control panel.

Many press operators, particularly those who work for newspapers, work weekends, nights, and holidays as many presses operate continuously. They also may work overtime to meet deadlines. Most operators worked 40 hours per week in 2008.

Training, Other Qualifications, and Advancement

Although employers prefer that beginners complete a formal apprenticeship or a postsecondary program in printing equipment operation, many press operators are trained on the job. Attention to detail and familiarity with electronics and computers are essential for operators.

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Education and training. Beginning press operators load, unload, and clean presses. With time and training, they may become fully qualified to operate that type of press. Operators can gain experience on more than one kind of printing press during the course of their career.

Experienced operators will periodically receive retraining and skill updating. For example, printing plants that change from sheet-fed offset presses to digital presses have to retrain the entire press crew because skill requirements for the two types of presses are different.

Apprenticeships for press operators, once the dominant method for preparing for this occupation, are becoming less prevalent. When they are offered by the employer, they include on-the-job instruction and related classroom training or correspondence school courses.

Formal postsecondary programs in printing equipment operation offered by technical and trade schools, community colleges, and universities are growing in importance. Postsecondary courses in printing provide the theoretical and technical knowledge needed to operate advanced equipment. Some postsecondary school programs require two years of study and award an associate degree.

Because of technical developments in the printing industry, courses in chemistry, electronics, color theory, and physics are helpful.

Other qualifications. Persons who wish to become press operators need mechanical aptitude to make press adjustments and repairs. Workers need good vision and attention to detail to locate and fix problems with print jobs. Oral and written communication skills also are required. Operators should possess the mathematical skills necessary to compute percentages, weights, and measures, and to calculate the amount of ink and paper needed to do a job. Operators now also need basic computer skills to work with newer printing presses.

Certification and advancement. As press operators gain experience, they may advance in pay and responsibility by working on more complex printing presses. For example, operators who have demonstrated their ability to work with one-color sheet-fed presses may be trained to operate four-color sheet-fed presses. Voluntarily earning formal certification may also help press operators advance. Operators also may advance to pressroom supervisors and become responsible for an entire press crew. In addition, press operators can draw on their knowledge of press operations to become cost estimators, providing estimates of printing jobs to potential customers, sales representatives, and instructors of printing-related courses, or move into other administrative or executive occupations.

Employment

Printing machine operators held about 195,600 jobs in 2008. Over half of all press operator jobs were in printing and related support activities. Paper manufacturing and newspaper publishers also were large employers. Additional jobs were in advertising, public relations, and related services and plastics product manufacturing.

The printing and newspaper publishing industries are two of the most geographically dispersed in the United States. While printing machine operators thus can find jobs throughout the country, large numbers of jobs are concentrated in large printing centers such as the Chicago, Los Angeles-Long Beach, New York, Minneapolis-St. Paul, Philadelphia, Boston, and Washington, DC metropolitan areas.

Job Outlook

Employment of printing machine operators is projected to decline moderately through 2018, as newer printing presses require fewer operators. Despite this, job opportunities are expected to be favorable because a large number of these workers are expected to retire or leave the occupation over the next decade. The best opportunities will be available to skilled press operators.

Employment change. Employment of press operators is expected to decline by 5 percent over the 2008-18 period. Employment will fall because increasing printer speed and automation require fewer press operators to maintain production levels. This will be especially true among the large printing press operations such as those used by the newspaper industry. Expansion of digital printing technologies and related increases in production cost efficiencies, however, will allow printers to print smaller quantities more profitably and meet the growing interest in the print-on-demand and electronic publishing markets. This should widen the market for printed materials, offsetting some of the employment loss from increased productivity. Short-run print capabilities will permit printers to distribute a wider variety of catalogs, direct mail enclosures, newspaper inserts, and other kinds of print as advertisers are better able to identify the specific interests of a targeted market or audience.

Job prospects. Opportunities for employment in printing press operations should be favorable. Retirements of older printing machine operators and the need for workers trained on computerized printing equipment will create many job openings. For example, small printing jobs will increasingly be run on sophisticated high-speed digital printing equipment that requires a complex set of skills, such as knowledge of database management software. Those who complete postsecondary training programs in printing and who are comfortable with computers will have the best employment opportunities.

Earnings

Median hourly wages of printing machine operators were $15.46 in May 2008, compared to $13.99 per hour for all production occupations. The middle 50 percent earned between $11.65 and $20.08 an hour. The lowest 10 percent earned less than $9.13,

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Printing machine operators	51-5023	195,600	185,000	-10,700	-5

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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and the highest 10 percent earned more than $24.98 an hour. Median hourly wages in May 2008 were $17.70 in newspaper, periodical, book and directory publishers and $15.85 in printing and related support activities, industries employing among the largest numbers of printing machine operators.

The basic wage rate for a printing machine operator depends on the geographic area in which the work is located and on the size and complexity of the printing press being operated.

Related Occupations

Other workers who set up and operate production machinery include:

	Page
Bookbinders and bindery workers	746
Machine setters, operators, and tenders—metal and plastic	734
Prepress technicians and workers	748

Sources of Additional Information

Details about apprenticeships and other training opportunities may be obtained from local employers, such as newspapers and printing shops, local offices of the Graphic Communications Conference of the International Brotherhood of Teamsters, local affiliates of Printing Industries of America, or local offices of the State employment service. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: 1 (877) 282-5627.

For information on careers and training in printing and the graphic arts contact:

➤ NPES The Association for Suppliers of Printing Publishing, and Converting Technologies, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.npes.org/education/index.html**

➤ Printing Industries of America, 200 Deer Run Rd., Sewickley, PA 15143. Internet: **http://www.printing.org/**

➤ Graphic Arts Education and Research Foundation, 1899 Preston White Dr., Reston, VA 20191. Internet: **http://www.gaerf.org**

➤ NAPL National Association of Printing Leadership, 75 West Century Road, Suite 100, Paramus, NJ 07652. Internet: **http://www.napl.org/**

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Textile, Apparel, and Furnishings Occupations

Significant Points

- Most workers learn their skills informally on the job, working alongside more experienced workers.
- International competition and greater worker productivity will result in rapidly declining employment for most occupations; upholsterers and laundry and dry-cleaning workers, however, are expected to experience some employment growth.
- The need to replace workers who retire or leave the occupation for other reasons will lead to numerous job openings.
- Earnings of most workers are relatively low.

Nature of the Work

Textile, apparel, and furnishings workers produce fibers, cloth, and upholstery, and fashion them into a wide range of products that we use in our daily lives. Textiles are the basis of towels, bed linens, hosiery and socks, and nearly all clothing, but they also are a key ingredient in products ranging from roofing to tires. This statement covers a wide variety of occupations related to the production and care of textiles, apparel, and furnishings, ranging from heavy industrial machine operators to craft workers who make custom clothing and upholster furniture.

Laundry and dry-cleaning workers, the largest specialty, clean garments, linens, draperies, blankets, and other articles. They also may clean leather, suede, furs, and rugs. Laundry and dry-cleaning workers ensure proper cleaning by adjusting machine settings for a given fabric or article, as determined by the cleaning instructions on each item of clothing. When necessary, workers treat spots and stains on articles before laundering or dry-cleaning. They tend machines during cleaning and ensure that items are not lost or misplaced with those of another customer.

Closely related to dry-cleaning workers are *pressers, textile, garment, and related materials*. These workers often work in dry-cleaning establishments and are responsible for starching, steaming and ironing clothing and other items to remove wrinkles. When finished, they assemble each customer's items, bag or box the articles, and prepare an itemized bill for the customer.

Tailors, dressmakers, and custom sewers alter and repair garments in local neighborhood shops, department stores, or dry-cleaning establishments. Alterations may include hemming pants or dresses, and repairs commonly consist of patching or sewing a torn article of clothing. Some workers may be required to make elaborate custom clothing for special occasions or other unique events.

Most workers in apparel occupations, however, are found in manufacturing, performing specialized tasks in the production of large numbers of garments that are shipped to retail establishments for sale. *Fabric and apparel patternmakers* convert a clothing designer's original model of a garment into separate parts that can be laid out on a length of fabric. They use computers to outline the parts and draw in details to indicate the position of pleats, buttonholes, and other features. They then alter the size of the pieces in the pattern to produce garments of various sizes and, in doing so, determine the best layout of pieces to minimize waste of material. Once a pattern has been created, mass production of the garment begins.

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The first step in manufacturing textiles is preparing the fibers. *Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers*, set up and operate machines that extrude or force liquid synthetic material, such as rayon, fiberglass, or liquid polymers through small holes and draw out filaments. Other operators put natural fibers such as cotton or wool through carding and combing machines that clean and align them into short lengths. *Textile winding, twisting, and drawing-out machine setters, operators, and tenders* make yarn from this material, taking care to repair any breaks. *Textile bleaching and dyeing machine operators and tenders* control machines that wash, bleach, and dye yarn or finished fabrics.

When the yarn or fiber has been prepared, the next step is to produce fabric. *Textile knitting and weaving machine setters, operators, and tenders* put the yarn on machines that weave, knit, loop, or tuft it into a product. Different types of machines are used for these processes, but operators may perform similar tasks, repairing breaks in the yarn and monitoring the yarn supply. Some products, such as hosiery and carpeting, emerge nearly finished. In other cases, the fabric goes on to the next step in the manufacturing process.

Textile cutting machine setters, operators, and tenders use patterns—those from patternmakers—to prepare the pieces from which finished apparel will be made. *Sewing machine operators* then join these pieces together, reinforce seams, and attach buttons, hooks, zippers, and accessories. In some cases, *hand sewers* may be employed to make adjustments and perform specialty work. After the product is sewn, other workers remove lint and loose threads, inspect, and package the garments.

Shoe machine operators and tenders tend machines used in making footwear. They perform a variety of duties including cutting, joining, decorating, reinforcing, and finishing shoes and shoe parts. *Shoe and leather workers and repairers* may finish work that cannot be done by machine. Most repairers are employed in cobbler shops, where they fix shoes and other leather products, such as luggage and saddles.

Upholsterers make, fix, and restore furniture that is covered with fabric. Those who produce new furniture typically start with bare wooden frames. First, they install webbing, tacking it to one side of the frame, stretching it tight, and tacking it to the other side. They then tie each spring to the webbing and its neighboring springs, covering it with filler, such as foam or polyester batting. Next, they measure and cut pieces of fabric for the arms, backs, seats, sides, and other surfaces, leaving as little waste as possible. Finally, they sew the fabric pieces together and attach them to frames with tacks, staples, or glue, while also affixing any ornaments, such as fringes, buttons, or rivets. Some upholsterers work with used furniture, often repairing or replacing fabric that is in poor condition.

Work environment. Most people in textile, apparel, and furnishings occupations work a standard 5-day, 35- to 40-hour week. Working on evenings and weekends is common for shoe and leather workers, laundry and dry-cleaning workers, and tailors, dressmakers, and sewers, who often are employed in retail stores. Many textile and fiber mills often use rotating schedules of shifts so that employees do not continuously work nights or days.



Upholsterers make, fix, and restore furniture that is covered with fabric.

Working conditions vary by establishment and by occupation. For example, machinery in textile mills is often noisy, as are areas in which sewing and pressing are performed in apparel factories; patternmaking and spreading areas tend to be much quieter. Older factories are cluttered, hot, and poorly lit and ventilated, but more modern facilities usually have more workspace and are well lit and ventilated. Textile machinery operators use protective glasses and masks that cover their noses and mouths to protect against airborne particles. Many machines operate at high speeds, and textile machinery workers must be careful not to wear clothing or jewelry that could get caught in moving parts. In addition, extruding and forming machine operators wear protective shoes and clothing when working with certain chemical compounds.

Work in apparel production can be physically demanding. Some workers sit for long periods, and others spend many hours on their feet, leaning over tables and operating machinery. Operators must be attentive while running sewing machines, pressers, automated cutters, and the like. A few workers may need to wear protective clothing, such as gloves. Data from the U.S. Bureau of Labor Statistics show that full-time shoe machine operators and tenders experienced a work-related injury and illness rate that was higher than the national average.

Laundries and dry-cleaning establishments are often hot and noisy. Employees also may be exposed to harsh solvents, but newer environmentally-friendly and less-toxic cleaning solvents are improving the work environment in these establishments. Areas in which shoe and leather workers make or repair shoes and other leather items can be noisy, and odors from leather dyes and stains frequently are present. Workers must take care to avoid punctures, lacerations, and abrasions.

Upholstery work can be dangerous, and upholsterers usually wear protective gloves and clothing when using sharp tools and lifting and handling furniture or springs. During most of the workday, upholsterers stand and may do a lot of bending and heavy lifting. They also may work in awkward positions for short periods. Full-time upholsterers also experienced a work-related injury and illness rate that was much higher than the national average.

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Training, Other Qualifications, and Advancement

Most textile, apparel, and furnishings workers learn their skills informally on the job, working alongside more experienced workers.

Education and training. Most workers in these jobs have a high school diploma or less education. However, applicants with postsecondary vocational training or previous work experience may have a better chance of getting a more skilled job and advancing to a supervisory position.

Machine operators usually are trained on the job by more experienced employees or by machinery manufacturers' representatives. Operators begin with simple tasks and are assigned more difficult operations as they gain experience.

Precision shoe and leather workers and repairers also learn their skills on the job. Manual dexterity and mechanical aptitude are important in shoe repair and leatherworking. Beginners start as helpers for experienced workers, but in manufacturing, they may attend more formal in-house training programs. Beginners gradually take on more tasks until they are fully qualified, a process that takes about 2 years in an apprenticeship program or as a helper in a shop. Other workers spend 6 months to a year in a vocational training program.

Custom tailors, dressmakers, and sewers often have previous experience in apparel production, design, or alteration. Knowledge of fabrics, design, and construction is very important. Custom tailors sometimes learn these skills through courses in high school or a community college. Tailors who perform alterations usually learn informally by observing other, more experienced workers.

Laundry and dry-cleaning workers, including pressers, usually learn on the job. Although laundries and dry-cleaners prefer entrants with previous work experience, they routinely hire inexperienced workers.

Most upholsterers learn their skills on the job, but a few do so through apprenticeships. Inexperienced persons also may take training in basic upholstery in vocational schools and some community colleges. The length of training may vary from 6 weeks to 3 years. Upholsterers who work on custom-made pieces may train for 8 to 10 years.

Other qualifications. In manufacturing, textile and apparel workers need good hand-eye coordination, manual dexterity, physical stamina, and the ability to perform repetitive tasks for long periods. As machinery in the industry continues to become more complex, knowledge of the basics of computers and electronics will increasingly be an asset. In addition, the trends toward cross-training of operators and working in teams will increase the time needed to become fully trained on all machines and require interpersonal skills to work effectively with others.

Upholsterers should have manual dexterity, good coordination, and the strength to tightly stretch fabric and lift heavy furniture. An eye for detail, a flair for color, and the ability to use fabrics creatively also are helpful.

Advancement. Some production workers may become first-line supervisors. A small number or workers in shoemaking and leatherworking occupations begin as workers or repairers and advance to salaried supervisory and managerial positions. Some open their own shops. These workers are more likely to succeed if they understand business practices and management and offer good customer service, in addition to their technical skills.

Upholsterers, too, can open their own shops. However, the upholstery business is highly competitive, and successfully operating a shop is difficult. Some experienced or highly skilled upholsterers may become supervisors or sample makers in large shops and factories.

Employment

Textile, apparel, and furnishings workers held 787,500 jobs in 2008. Employment in the detailed occupations that make up this group was distributed as follows:

Laundry and dry-cleaning workers	235,400
Sewing machine operators	212,400
Pressers, textile, garment, and related materials	66,600
Tailors, dressmakers, and custom sewers	54,600
Upholsters	52,700
Textile winding, twisting, and drawing out machine setters, operators, and tenders	34,900
Textile knitting and weaving machine setters, operators, and tenders	29,200
Textile cutting machine setters, operators, and tenders	19,400
Textile bleaching and dyeing machine operators and tenders	16,000
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	14,100
Sewers, hand	12,200
Shoe and leather workers and repairers	9,200
Fabric and apparel patternmakers	8,200
Shoe machine operators and tenders	4,800
All other textile, apparel, and furnishings workers	17,900

Many manufacturing jobs can be found in California, New York, North Carolina, Texas, and Pennsylvania. Jobs in reupholstery, shoe repair and custom leatherwork, and laundry and dry-cleaning establishments are found in cities and towns throughout the Nation. Overall, about 11 percent of all workers in textile, apparel, and furnishings occupations were self-employed; however, about 43 percent of all tailors, dressmakers, and sewers and about 29 percent of all upholsterers were self-employed.

Job Outlook

Overall employment of textile, apparel, and furnishings workers is expected to decline rapidly through 2018, but outlook varies by detailed occupation. In addition to some employment growth in a few specialties, the vast majority of openings will stem from the need to replace workers who leave the occupation each year.

Employment change. Employment in textile, apparel, and furnishing occupations is expected to decline by 15 percent between 2008 and 2018. Apparel workers have been among the most rapidly declining occupational groups in the economy. Increasing imports, the growing use of offshore assembly, and greater productivity through automation will contribute to additional job losses. Also, many new textiles require less production and processing.

Domestic production of apparel and textiles will continue to move abroad, and imports to the U.S. market are expected to increase. Fierce competition in the market for apparel will

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Textile, apparel, and furnishings occupations	51-6000	787,500	667,600	-119,900	-15
Laundry and dry-cleaning workers	51-6011	235,400	242,000	6,600	3
Pressers, textile, garment, and related materials	51-6021	66,600	61,100	-5,500	-8
Sewing machine operators	51-6031	212,400	140,900	-71,500	-34
Shoe and leather workers	51-6040	14,000	11,000	-3,000	-21
Shoe and leather workers and repairers	51-6041	9,200	7,900	-1,300	-14
Shoe machine operators and tenders	51-6042	4,800	3,100	-1,700	-35
Tailors, dressmakers, and sewers	51-6050	66,800	64,700	-2,100	-3
Sewers, hand	51-6051	12,200	11,200	-1,000	-8
Tailors, dressmakers, and custom sewers	51-6052	54,600	53,600	-1,100	-2
Textile machine setters, operators, and tenders	51-6060	99,500	60,600	-38,800	-39
Textile bleaching and dyeing machine operators and tenders	51-6061	16,000	8,800	-7,200	-45
Textile cutting machine setters, operators, and tenders	51-6062	19,400	13,400	-6,000	-31
Textile knitting and weaving machine setters, operators, and tenders	51-6063	29,200	17,700	-11,500	-39
Textile winding, twisting, and drawing out machine setters, operators, and tenders	51-6064	34,900	20,700	-14,200	-41
Miscellaneous textile, apparel, and furnishings workers	51-6090	92,900	87,200	-5,700	-6
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	51-6091	14,100	9,300	-4,800	-34
Fabric and apparel patternmakers	51-6092	8,200	6,000	-2,200	-27
Upholsterers	51-6093	52,700	56,300	3,600	7
All other textile, apparel, and furnishings workers	51-6099	17,900	15,600	-2,300	-13

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

keep domestic apparel and textile firms under intense pressure to cut costs and produce more with fewer workers. Although the textile industry already is highly automated, it will continue to seek to increase worker productivity through the introduction of labor-saving machinery and the invention of new fibers and fabrics that reduce production costs. Technological developments, such as computer-aided marking and grading, computer-controlled cutters, semiautomatic sewing and pressing machines, and automated material-handling systems have increased output while reducing the need for some workers in larger firms.

Despite advances in technology, the apparel industry has had difficulty utilizing automated equipment for assembly tasks because of the delicate properties of many textiles. Also, the industry produces a wide variety of apparel items that change frequently with changes in style and season. Even so, increasing numbers of sewing machine operator jobs are expected to be lost to workers abroad. Employment of sewing machine operators is expected to decline rapidly by 34 percent.

Tailors, dressmakers, and custom sewers—the most skilled apparel workers—are expected to experience little or no change in employment. Most of these workers are self-employed or work in clothing stores. The demand for custom home furnishings and tailored clothes is diminishing in general, but remains steady in upscale stores and by certain clients. Designer apparel and other handmade goods also appeal to people looking for one-of-a-kind items.

Employment of shoe and leather workers and repairers is expected to decline by 14 percent through 2018 as a result of growing imports of less expensive shoes and leather goods and of increasing productivity of U.S. manufacturers. Also, buying new shoes often is cheaper than repairing worn or damaged ones.

Employment of laundry and dry-cleaning workers is expected to grow 3 percent, slower than the average for all occupations. Many of these jobs continue to be locally-based, thus an expanding population will result in some employment growth.

Employment of upholsterers is expected to grow 7 percent, which is about as fast as the average for all occupations. Employment growth will be driven by custom upholstery services, which is expected to increase as consumers seek to restore antique furniture and items with sentimental or intrinsic value.

The following table shows the projected growth rates from 2008 to 2018 for detailed textile and apparel manufacturing occupations:

Upholsters	7
Laundry and dry-cleaning workers	3
Tailors, dressmakers, and custom sewers	-2
Pressers, textile, garment, and related materials	-8
Sewers, hand	-8
Shoe and leather workers and repairers	-14
Fabric and apparel patternmakers	-27
Textile cutting machine setters, operators, and tenders	-31
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	-34
Sewing machine operators	-34
Shoe machine operators and tenders	-35
Textile knitting and weaving machine setters, operators, and tenders	-39
Textile winding, twisting, and drawing out machine setters, operators, and tenders	-41
Textile bleaching and dyeing machine operators and tenders	-45
All other textile, apparel, and furnishings workers	-13

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Job prospects. Despite a rapid decline in overall employment, the need to replace workers who transfer to other occupations, retire, or leave the occupation for other reasons will lead to numerous job openings. Relatively low earnings and poor working conditions will continue to result in a high job turnover.

Earnings

Earnings of textile, apparel, and furnishings workers vary by occupation. Because many production workers in apparel manufacturing are paid according to the number of acceptable pieces they produce, their total earnings depend on skill, speed, and accuracy. Workers covered by union contracts tend to have higher earnings. Median hourly wages by occupation in May 2008 were as follows:

Fabric and apparel patternmakers	$18.15
Extruding and forming machine setters, operators, and tenders, synthetic and glass fibers	14.98
Upholsters	13.94
Textile knitting and weaving machine setters, operators, and tenders	12.21
Shoe machine operators and tenders	12.06
Tailors, dressmakers, and custom sewers	12.01
Textile winding, twisting, and drawing out machine setters, operators, and tenders	11.53
Textile bleaching and dyeing machine operators and tenders	11.38
Shoe and leather workers and repairers	11.00
Textile cutting machine setters, operators, and tenders	10.88
Sewers, hand	10.58
Sewing machine operators	9.55
Pressers, textile, garment, and related materials	9.15
Laundry and dry-cleaning workers	9.14
All other textile, apparel, and furnishings workers	11.85

Benefits vary by size of company and work that is done. Apparel workers in retail trade also may receive a discount on their purchases from the company for which they work. In addition, some of the larger manufacturers operate company stores from which employees can purchase apparel products at significant discounts. Some small firms and dry-cleaning establishments, however, offer only limited benefits. Self-employed workers generally have to purchase their own insurance.

In the manufacturing industry, many workers are union members. Workers who are covered by union contracts often have higher pay and better benefits.

Related Occupations

Textile, apparel, and furnishings workers are primarily light manufacturing workers. Similar occupations include:

	Page
Assemblers and fabricators	723
Food processing occupations	726
Jewelers and precious stone and metal workers	770
Woodworkers	757

Sources of Additional Information

Information about job opportunities in textile, apparel, and furnishings occupations is available from local employers and local offices of State employment services.

For information on dry-cleaning occupations, contact:

➤ Drycleaning & Laundry Institute, 14700 Sweitzer Ln., Laurel, MD 20707. Internet: **http://www.ifi.org**

For information on textile and apparel manufacturing occupations, contact:

➤ American Apparel & Footwear Association, 1601 No. Kent Street, 12th floor, Arlington, VA 22209. Internet: **http://www.apparelandfootwear.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos233.htm**

Woodworkers

Significant Points

- Most woodworkers are trained on the job; becoming a skilled woodworker often requires several years of experience.
- Job prospects should be excellent for highly skilled woodworkers who are proficient users of computerized numerical control machines.
- Employment is highly sensitive to economic cycles; during economic downturns, workers are subject to layoffs or reductions in hours.

Nature of the Work

Despite the abundance of plastics, metals, and other materials, wood products continue to be an important part of our daily lives. Many of these products are mass produced, including most furniture, kitchen cabinets, and musical instruments. Other products are custom-crafted in shops using specialized tools. The people who design, produce, and test these products are called *woodworkers*.

Although the term woodworker may evoke the image of a craftsman who builds ornate furniture using hand tools, the modern woodworking trade is highly technical and relies on advanced equipment and highly-skilled operators. Workers use automated machinery, such as computerized numerical control (CNC) machines to do much of the work. Even specialized artisans generally use a variety of power tools in their work. Much of the work is often done in a high production assembly line facility, but there is also some work that is customized and does not lend itself to assembly line fabrication. Woodworkers are employed in every part of the secondary

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wood products industry—from sawmill to finished product—and their activities vary greatly.

Woodworkers set up, operate and tend all types of machines, such as drill presses, lathes, shapers, routers, sanders, planers, and wood-nailing machines. Operators set up the equipment, cut and shape wooden parts, and verify dimensions using a template, caliper, or rule. After wood parts are made, woodworkers add fasteners and adhesives and connect the pieces to form a complete unit. Products are then sanded, stained, and, if necessary, coated with a sealer, such as a lacquer or varnish.

In some cases, these tasks are managed by different workers with specialized training. For instance, *woodworking machine setters, operators, and tenders* may specialize in operating specific pieces of woodworking machinery. *Furniture finishers* stain and seal wood products; they often work with antiques and must make judgments about how to best preserve and repair them.

On the other hand, some woodworkers are less specialized, and must know how to complete many stages of the process. *Cabinetmakers* and *bench carpenters* often design and create sets of cabinets that are customized for particular spaces. In some cases, their duties could begin with designing a set of cabinets to particular specifications and end with installing them. *Architectural woodworkers* design and create customized wooden furniture and accents that are part of a building. This might include a desk that is built into a hotel lobby, a bar in a pub, or booths in a restaurant. Other woodworkers, such as *model makers*, create scale models of products or buildings that are used in construction; *patternmakers* construct dies that are used for castings.



Woodworkers set up equipment, verify dimensions, and cut and shape wooden parts.

Work environment. Working conditions vary greatly, depending on specific job duties. Workers may have to handle heavy, bulky materials and often encounter excessive noise and dust. Workers must often wear earplugs, gloves, and goggles to protect themselves. These occupations tend to have relatively high non-fatal injury rates, since woodworkers spend much of their time using power tools, which can be dangerous. Data from the U.S. Bureau of Labor Statistics show that sawing machine operators experienced a work-related injury and illness rate that was much higher than the national average.

Training, Other Qualifications, and Advancement

Becoming a fully-trained woodworker requires many skills, and generally takes several years of on-the-job training. Skill with computers and computer-controlled machinery is increasingly important.

Education and training. Many employers seek applicants with a high school diploma or the equivalent because of the growing sophistication of machinery and the constant need for retraining. People seeking woodworking jobs can enhance their employment and advancement prospects by completing high school and receiving training in mathematics and computer applications.

Some woodworkers acquire skills through technical schools or community college courses. Others may attend universities that offer training in wood technology, furniture manufacturing, wood engineering, and production management. These programs prepare students for positions in production, supervision, engineering, and management and are increasingly important as woodworking technology advances.

While education is helpful, woodworkers are primarily trained on the job, where they learn skills from experienced workers. Beginning workers are assigned basic tasks, such as putting a piece of wood through a machine or catching the wood at the end of the process. As they gain experience, they perform more complex jobs with less supervision. They can learn basic machine operations and job tasks in about a year. Skilled workers learn to read blueprints, set up machines, and plan work sequences. Becoming a skilled woodworker often requires 3 or more years.

Other qualifications. In addition to training, woodworkers need mechanical ability, manual dexterity, and the ability to pay attention to detail and safety. They should be comfortable working with geometric concepts; for example, they must be able to visualize how shapes will fit together in three dimensions. Skill with computers and computer-controlled machinery is increasingly important in this high-tech occupation.

Advancement. Advancement opportunities depend on education and training, seniority, and a worker's skills and initiative. Experienced woodworkers often become supervisors responsible for the work of a group of woodworkers. Others may become full-time CNC operators, designing woodwork using computer aided design software. Still others become inspec-

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tors, making sure that products are built to proper specifications. Production workers can advance into these positions by assuming additional responsibilities and attending workshops, seminars, or college programs. Those who are highly skilled may set up their own woodworking shops.

Employment

Woodworkers held about 323,300 jobs in 2008. Self-employed woodworkers accounted for 12 percent of these jobs. About 76 percent of woodworkers were employed in manufacturing. About 39 percent worked in establishments manufacturing furniture and related products, and 32 percent worked in wood product manufacturing, producing a variety of raw, intermediate, and finished woodstock. Wholesale and retail lumber dealers, furniture stores, reupholstery and furniture repair shops, and construction firms also employ woodworkers.

Woodworking jobs are found throughout the country. However, lumber and wood products-related production jobs are concentrated in the Southeast, Midwest, and Northwest, close to the supply of wood. Furniture-making jobs are more prevalent in the Southeast. Custom shops can be found everywhere, but generally are concentrated in or near highly populated areas.

Job Outlook

Employment of woodworkers is expected to grow more slowly than the average for all occupations. Job prospects will be excellent for highly qualified workers

Employment change. Employment of woodworkers is expected to grow by 6 percent during the 2008-18 decade, which is slower than the average for all occupations. Increased automation in the wood products manufacturing industry has led to slow job growth for some time, but this has been tempered in recent years by increased demand for domestic wood products. Technology has become very important to this industry, and automation has greatly reduced the number of people required to produce a finished product. While this has slowed employment growth somewhat, improved efficiency has made domestic wood products more competitive with imports.

Demand for these workers will stem from increases in population, personal income, and business expenditures and from the continuing need for repair and renovation of residential and commercial properties. Therefore, opportunities should be available for workers who specialize in items such as moldings, cabinets, stairs, and windows. Firms that focus on custom woodwork will be best able to compete against imports without transferring jobs offshore.

Employment in all woodworking specialties is highly sensitive to economic cycles. During economic downturns, workers are subject to layoffs or reductions in hours.

Job prospects. Prospects should be excellent for highly qualified workers. In general, opportunities for more highly skilled woodworkers will be better than for woodworkers in specialties susceptible to automation and competition from imported wood products. The need for woodworkers with technical skills to operate their increasingly advanced computerized machinery will be especially great. Workers who know how to create and execute custom designs on a computer will be in strong demand. These jobs require an understanding of wood and a strong understanding of computers—a combination that can be somewhat difficult to find.

The number of new workers entering these occupations has declined greatly in recent years, as training programs become less available or popular. Opportunities should be best for woodworkers who, through vocational education or experience, develop highly specialized woodworking skills or knowledge of CNC machine tool operation.

Earnings

Median hourly wages of cabinetmakers and bench carpenters were $13.93 in May 2008. The middle 50 percent earned between $11.14 and $17.40. The lowest 10 percent earned less than $9.22, and the highest 10 percent earned more than $21.73.

Median hourly wages of sawing machine setters, operators, and tenders, wood were $12.41. The middle 50 percent earned between $9.96 and $15.24. The lowest 10 percent earned less than $8.35, and the highest 10 percent earned more than $18.92.

Median hourly wages of woodworking machine setters, operators, and tenders, except sawing were $11.89. The middle 50 percent earned between $9.69 and $14.73. The lowest 10 percent earned less than $8.28, and the highest 10 percent earned more than $17.89.

Median hourly wages were $12.93 for furniture finishers and $11.57 for all other woodworkers.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Woodworkers	51-7000	323,300	344,000	20,600	6
Cabinetmakers and bench carpenters	51-7011	131,700	143,700	11,900	9
Furniture finishers	51-7021	26,500	27,700	1,200	4
Model makers and patternmakers, wood	51-7030	3,500	3,500	0	-1
Model makers, wood	51-7031	1,700	1,700	0	2
Patternmakers, wood	51-7032	1,900	1,800	-100	-3
Woodworking machine setters, operators, and tenders	51-7040	138,400	145,100	6,700	5
Sawing machine setters, operators, and tenders, wood	51-7041	52,600	53,400	800	1
Woodworking machine setters, operators, and tenders, except sawing	51-7042	85,700	91,700	6,000	7
All other woodworkers	51-7099	23,300	24,000	800	3

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Related Occupations

Occupations that require similar skills include:

	Page
Carpenters	618
Computer control programmers and operators	731
Machinists	737
Sheet metal workers	665
Structural and reinforcing iron and metal workers	668

Sources of Additional Information

For information about careers and education and training programs in woodworking, contact:

➤ Architectural Woodwork Institute, 46179 Westlake Drive, Suite 120, Potomac Falls, VA 20165. Internet: **http://www.awinet.org**

➤ WoodIndustryEd.org, c/o AWFS, 500 Citadel Dr., Suite 200, Commerce, CA 90040. Internet: **http://www.woodindustryed.org**

➤ WoodLINKS USA, P.O. Box 445, Tuscola, IL 61953. Internet: **http://www.woodlinksusa.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos237.htm**

Plant and System Operators

Power Plant Operators, Distributors, and Dispatchers

Significant Points

- Overall employment is projected to experience little or no change over the next decade, but job prospects are expected to be excellent for qualified applicants as many workers retire.
- Several years of classroom and on-the-job training are required to become fully qualified.
- Familiarity with computers and a basic understanding of science and math are helpful for those entering the field.

Nature of the Work

Electricity is one of our nation's most vital resources. It powers everything from light bulbs and appliances that you use around your house to supercomputers that power the Internet. From the moment you flip the first switch each morning, you are connecting to a huge network of people, electric lines, and generating equipment. *Power plant operators* control the machinery that generates electricity. *Power plant distributors and dispatchers* control the flow of electricity as it travels through a network of transmission lines from the power plant to industrial plants and substations, and then flows through distribution lines to residential users.

Power plant operators control and monitor boilers, turbines, generators, and auxiliary equipment in power-generating plants. They distribute power among generators, regulate the output from several generators, and monitor instruments to maintain voltage and regulate electricity flows from the plant. When demand changes, power plant operators communicate with dispatchers at distribution centers to match production with system the load. On the basis of this communication, they start and stop generators, altering the amount of electricity output. They also go on rounds to check that everything in the plant is operating correctly and keep records of switching operations and loads on generators, lines, and transformers. In all of these tasks, they use computers to report unusual incidents, malfunctioning equipment, or maintenance performed during their shifts.

Nuclear power reactor operators perform similar tasks at a nuclear power plant. Most start working as equipment operators or auxiliary operators. At this stage, they help the more senior workers with equipment maintenance and operation while learning the basics of plant operation. With experience and training they may be licensed by the Nuclear Regulatory Commission as reactor operators, making them authorized to control equipment that affects the power of the reactor in a nuclear power plant. Senior reactor operators supervise the operation of all controls in the control room. At least one senior operator must be on duty during each shift to act as the plant supervisor.

Power distributors and dispatchers, also called load dispatchers or systems operators, work for utility companies, nonutility generators, and other companies that access the power grid. They control the flow of electricity through transmission lines to industrial plants and substations that supply residential and commercial needs for electricity. They monitor and operate current converters, voltage transformers, and circuit breakers. Dispatchers also monitor other distribution equipment and record readings at a map board—a diagram of the transmission grid system showing the status of transmission circuits and connections with substations and industrial plants. In doing this, they communicate closely with power plant operators, energy traders, and local utilities to route energy from generating stations to customers.

Dispatchers anticipate changes in power needs caused by weather, such as increased demand for power on a hot day or outages during a thunderstorm. They also react to changes in the structure of the grid due to transformer or transmission line failures and route current around affected areas. In substations, they operate and monitor equipment that increases or decreases

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voltage and they operate switchboard levers to control the flow of electricity in and out of the substations.

Work environment. Operators, distributors, and dispatchers who work in control rooms generally sit or stand at a control station. The work is not physically strenuous, but it does require constant attention. When operators are on rounds or performing other work outside of the control room, they may be exposed to danger from electric shock, falls, and burns. In addition, nuclear reactor operators may be exposed to small amounts of ionizing radiation during the course of their work.

Because power transmission is both vitally important and sensitive to attacks, security is a major concern for energy companies. Nuclear power plants and transmission stations have especially high security, and workers should be prepared to work in secured environments.

Because electricity is provided around the clock, operators, distributors, and dispatchers usually work one of three 8-hour shifts or one of two 12-hour shifts on a rotating basis. Shift assignments may change periodically so that all operators share less desirable shifts. Work on rotating shifts can be stressful and fatiguing because of the constant changes in living and sleeping patterns.

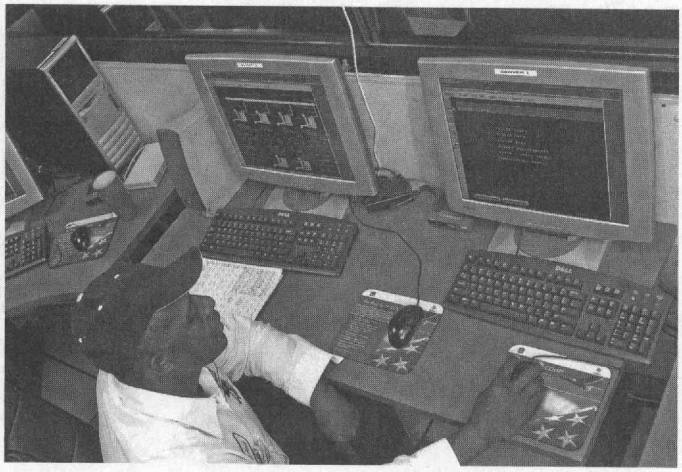
Training, Other Qualifications, and Advancement

Power plant operators, dispatchers, and distributors generally need a combination of education, on-the-job training, and experience. Candidates with strong mechanical, technical and computer skills are generally preferred.

Both operators and dispatchers are subject to random drug and alcohol tests. Nuclear reactor operators must pass a medical examination every 2 years.

Education and training. Operator and dispatcher jobs require at least a high school diploma. Workers with college or vocational school degrees will have advantages in finding a job, as well as more advancement opportunities, especially in nuclear power plants. Although it is not a prerequisite, many nuclear power reactor operators have bachelor's degrees in engineering or the physical sciences.

Workers selected for training as power plant operators or distributors undergo extensive on-the-job training and classroom instruction. Several years of training and experience are necessary to become fully qualified.



Power plant operators use computers to report unusual incidents, malfunctioning equipment, or maintenance performed during their shifts.

In addition to receiving initial training, a power plant operator, distributor, or dispatcher, is required to spend a certain number of hours each year taking refresher courses. Operators train on plant simulators designed to replicate situations that could occur at the plant. Similarly, dispatchers and system operators train extensively on power system simulators to keep skills sharp to prevent blackouts.

Licensure and certification. Some power plant operators, distributors and dispatchers must earn and maintain licenses. The specific requirements vary by job function and jurisdiction.

Power plant operators not working in a nuclear facility are often licensed as engineers or firemen by State licensing boards. Requirements vary from State to State and also depend on the specific job function of the operator and the license needed.

Nuclear power reactor operators must pass an examination and maintain licenses administered by the Nuclear Regulatory Commission (NRC). Before beginning training, a nuclear power plant operator must have 3 years of power plant experience. At least 1 of the 3 years must be at the nuclear power plant where the operator is to be licensed, and 6 months should be as a nonlicensed operator at the plant. Training generally takes at least 1 year, after which the worker must take an NRC-administered written examination and operating test. To maintain their licenses, reactor operators must pass an annual practical plant-operating exam and a biennial written exam administered by their employers. Reactor operators can upgrade their licenses to the senior-reactor-operator level after a year of licensed experience at the plant by taking another examination given by the NRC. Individuals with a bachelor's degree in engineering or the equivalent may apply for senior operator's licenses directly if they have 3 years of nuclear power plant experience, with at least 6 months at the site. Training includes simulator and on-the-job training, classroom instruction, and individual study. Experience in other power plants or with Navy nuclear-propulsion plants also is helpful. Although waivers are possible, licensed nuclear power reactor operators and senior operators generally have to pass a new written examination and operating test administered by the NRC if they transfer to another facility.

Power distributors and dispatchers who are in positions in which they could affect the power grid must be certified by the North American Energy Reliability Corporation (NERC). There are three types of certification offered by NERC: reliability coordinator, transmission operator, and balancing authority. Each of these qualifies a worker to handle a different job function. Distributors and dispatchers who distribute power within local utilities generally do not need to be licensed or certified.

Other qualifications. Electric company recruiters generally look for individuals with strong math and science backgrounds for these highly technical jobs. Understanding electricity and math—especially algebra and trigonometry—are important, although workers learn many of these concepts and skills in specialized training courses. Workers should also be good at working with tools. Problem solving is an important part of most electrical workers' jobs, so recruiters usually look for

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people who can easily figure out how things work. Successful utility workers are generally good with mechanics and enjoy fixing things.

In order to measure these aptitudes, many companies require that their workers take the Power Plant Maintenance (MASS) and Plant Operator (POSS) exams administered by the Edison Electrical Institute. These tests measure reading comprehension, understanding of mechanical concepts, spatial ability, and mathematical ability.

Advancement. After finishing work in the classroom, most entry-level workers start as helpers or laborers and advance to more responsible positions as they become comfortable in the plant. Workers are generally classified into 3-5 levels based on experience. For each level, there are training requirements, mandatory waiting times, and exams. With sufficient training and experience, workers can become shift supervisors, trainers, or consultants.

Because power plants have different systems and safety mechanisms, it can sometimes be difficult to advance by moving to a different company, although this is not always the case. Most power companies promote from within and most workers advance within a particular plant or by moving to another plant owned by the same utility.

Employment

Power plant operators, distributors, and dispatchers held about 50,400 jobs in 2008, of which 5,000 were nuclear power reactor operators, 10,000 were power distributors and dispatchers, and 35,400 were power plant operators. Jobs were located throughout the country.

Job Outlook

Overall employment of power plant operators, distributors, and dispatchers is projected to experience little or no change, but job opportunities are expected to be excellent because of the large number of retiring workers who must be replaced, an increased demand for energy, and recent legislation that paves the way for a number of new plants.

Employment change. Between 2008 and 2018, overall employment of power plant operators, distributors, and dispatchers is expected to experience little or no change. Although Americans' energy use continues to grow annually, the intense competition among generators resulting from deregulation will temper that growth.

Power plant operators in non-nuclear power plants are expected to decline by 2 percent between 2008 and 2018, representing little or no change, as energy companies continue to promote efficiency and build more efficient plants. While most of the major employment effects of deregulation have already occurred, generators continue to focus on cost cutting. As older, less efficient plants are retired, they are being replaced with new plants that have higher capacities and require fewer workers. Because the capacity of the new plants is higher, fewer are needed to produce the same amount of electricity.

Employment of nuclear power reactor operators is expected to grow by 19 percent between 2008 and 2018, faster than the average for all occupations, because of plant construction and new rules on operator fatigue. Although no new plants have been licensed since the 1990s, many sites have applied for permits which will need to be staffed before the end of the projections decade. Further, newly enacted NRC regulations on fatigue limit the length of shifts, meaning that nuclear facilities may need more operators.

On the other hand, power distributor and dispatcher employment is expected to experience little or no change, declining by 2 percent between 2008 and 2018, reflecting further industry consolidation.

Job prospects. Job opportunities are expected to be excellent for well-qualified applicants because of a large number of retirements in the electric power industry. During the 1990s, the emphasis on cost cutting among utilities led to hiring freezes and the laying off of younger workers. The result is that many power plant operators, distributors, and dispatchers are nearing retirement age. Utilities have responded by setting up new education programs at community colleges and high schools throughout the country. While many individuals are showing interest in these high-paying jobs, prospects will be best for workers with strong technical and mechanical skills and an understanding of science and mathematics.

Earnings

Median annual wages of power plant operators were $58,470 in May 2008. The middle 50 percent earned between $47,850 and $68,250. The lowest 10 percent earned less than $38,020, and the highest 10 percent earned more than $80,390.

Median annual wages of nuclear power reactor operators were $73,320 in May 2008. The middle 50 percent earned between $63,440 and $82,540. The lowest 10 percent earned less than $55,730, and the highest 10 percent earned more than $96,480.

Median annual wages of power distributors and dispatchers were $65,890 in May 2008. The middle 50 percent earned between $55,520 and $77,780. The lowest 10 percent earned less than $45,010, and the highest 10 percent earned more than $88,500.

About 40 percent of power plant operators, distributors, and dispatchers were members of unions in 2008.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Power plant operators, distributors, and dispatchers	51-8010	50,400	50,600	200	0
Nuclear power reactor operators	51-8011	5,000	6,000	1,000	19
Power distributors and dispatchers	51-8012	10,000	9,800	-200	-2
Power plant operators	51-8013	35,400	34,800	-600	-2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Related Occupations

Other workers who monitor and operate plant and system equipment include:

	Page
Stationary engineers and boiler operators	763
Water and liquid waste treatment plant and system operators	765

Other jobs working with electricity include:

Line installers and repairers	713
Electrical and electronics installers and repairers	675
Electricians	641

Sources of Additional Information

For general information about power plant operators, nuclear power reactor operators, and power plant distributors and dispatchers, contact:

➤ American Public Power Association, 1875 Connecticut Ave. NW., Suite 1200, Washington, DC 20009-5715. Internet: **http://www.appanet.org**

➤ Center for Energy Workforce Development, 701 Pennsylvania Ave. NW., Washington, DC 20004-2696. Internet: **http://www.cewd.org**

➤ International Brotherhood of Electrical Workers, 900 Seventh St NW., Washington, DC 20001. Internet: **http://www.ibew.org**

Information on licensing for nuclear reactor operators and senior reactor operators is available from:

➤ U.S. Nuclear Regulatory Commission, Washington, DC 20555-0001. Internet: **http://www.nrc.gov**

Information on certification for power distributors and dispatchers is available from:

➤ North American Electric Reliability Corporation, 116-390 Village Blvd., Princeton, NJ 08540-5721. Internet: **http://www.nerc.com**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos227.htm**

Stationary Engineers and Boiler Operators

Significant Points

- Workers usually acquire their skills through a formal apprenticeship program or through on-the-job training.
- Licensure is required in many States and is a prerequisite for many job openings.
- Employment is projected to grow more slowly than average, and applicants may face competition for jobs.

Nature of the Work

Most large office buildings, malls, warehouses, and other commercial facilities have extensive heating, ventilation, and air-conditioning systems that keep them comfortable all year long. Industrial plants often have additional facilities to provide electrical power, steam, or other services. *Stationary engineers* and *boiler operators* control and maintain these systems, which include boilers, chillers, air-conditioning and refrigeration equipment, diesel engines, turbines, generators, pumps, condensers, and compressors. The equipment that stationary engineers and boiler operators control is similar to equipment operated by locomotive or marine engineers, except that it is used to generate heat or electricity rather than to move a train or ship.

Stationary engineers and boiler operators start up, regulate, repair, and shut down equipment. They ensure that the equipment operates safely, economically, and within established limits by monitoring meters, gauges, and computerized controls. When necessary, they control equipment manually and make adjustments using hand and power tools. They watch and listen to machinery and routinely check safety devices, record data in logs, and identify any potential problems.

Routine maintenance is a regular part of the work of stationary engineers and boiler operators. Engineers use tools to perform repairs ranging from a complete overhaul to replacing defective valves, gaskets, or bearings. They lubricate moving parts, replace filters, and remove soot and corrosion that can reduce the boiler's operating efficiency. They also test the water in the boiler and add chemicals to prevent corrosion and harmful deposits.

In most facilities, stationary engineers are responsible for the maintenance and balancing of air systems, as well as hydronic systems that heat or cool buildings by circulating fluid (such as water or water vapor) in a closed system of pipes. They may check the air quality of the ventilation system and make adjustments to keep the operation of the boiler within mandated guidelines. Servicing, troubleshooting, repairing, and monitoring modern systems all require the use of sophisticated electrical and electronic test equipment.

In a large building or industrial plant, a senior stationary engineer may be in charge of all mechanical systems in the building and may supervise a team of assistant stationary engineers, turbine operators, boiler tenders, and air-conditioning and refrigeration operators and mechanics. In small buildings, there may be only one stationary engineer who operates and maintains all of the systems.

Work environment. Engine rooms, power plants, boiler rooms, mechanical rooms, and electrical rooms are usually clean and well lit. Even under the most favorable conditions, however, some stationary engineers and boiler operators are exposed to high temperatures, dust, dirt, and high noise levels from the equipment. Maintenance duties also may require contact with oil, grease, or smoke. Workers spend much of the time on their feet. They also may have to crawl inside boilers and work while crouched or kneeling to inspect, clean, or repair equipment.

Safety is a major concern for these workers. Stationary engineers and boiler operators work around hazardous machinery, and must follow procedures to guard against burns, electric shock, noise, dangerous moving parts, and exposure to hazardous materials. Despite these precautions, however, sta-

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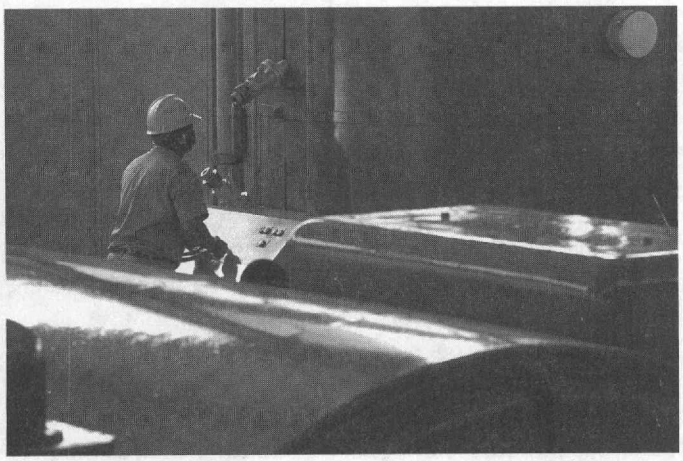

Stationary engineers and boiler operators control and maintain equipment that is used to generate heat or electricity.

tionary engineers and boiler operators have a relatively high rate of occupational injuries.

Stationary engineers and boiler operators generally have steady, year-round employment. The average workweek is 40 hours. In facilities that operate around the clock, engineers and operators usually work one of three daily 8-hour shifts on a rotating basis. Weekend and holiday work are often required, as many buildings are open 365 days a year.

Training, Other Qualifications, and Advancement

Many stationary engineers and boiler operators begin their careers in mechanic or helper positions and are trained on the job by more experienced engineers. Others begin by entering formal apprenticeships or training programs. Licensure is required in many States and jurisdictions, and is a prerequisite for many job openings.

Education and training. Most employers prefer to hire people with at least a high school diploma or the equivalent for stationary engineers and boiler operator jobs. Workers acquire their skills primarily on the job and usually start as apprentices or helpers. This practical experience may be supplemented by postsecondary vocational training in subjects such as computerized controls and instrumentation. Becoming an engineer or operator without completing a formal apprenticeship program usually requires many years of work experience.

The International Union of Operating Engineers sponsors apprenticeship programs and is the principal union for stationary engineers and boiler operators. Apprenticeships usually last 4 years and include 6,000 hours of on-the-job training. Apprentices learn to operate boilers, generators, compressors, motors, and air-conditioning and refrigerating equipment.

Apprentices also receive 600 hours of classroom instruction, studying elementary physics, practical chemistry, blueprint reading, instrumentation, and other technical subjects.

Continuing education—such as vocational school or college courses—is becoming increasingly important for stationary engineers and boiler operators, in part because of the growing complexity of the equipment with which engineers and operators now work.

Most large and some small employers encourage and pay for skill-improvement training for their employees. Training is almost always provided when new equipment is introduced or when regulations concerning some aspect of the workers' duties change.

Licensure. Many State and local governments have licensing requirements for stationary engineers and boiler operators. Applicants for licensure usually must be at least 18 years of age, reside for a specified period in the State or locality in which they wish to work, meet experience requirements, and pass a written examination. A stationary engineer or boiler operator who moves from one State or city to another may have to pass an examination for a new license because of regional differences in licensing requirements.

There are generally four or five classes of stationary engineer licenses. Each class specifies the type and size of equipment the engineer is permitted to operate without supervision. A top-level stationary engineer is qualified to run a large facility, supervise others, and operate equipment of all types and capacities. An applicant for this license may be required to have a high school education, have completed an apprenticeship or lengthy on-the-job training, and have several years of experience working with a lower class license. Engineers with licenses below this level are limited in the types or capacities of equipment they may operate without supervision.

Many job openings require that workers be licensed before starting the job, although some jobs may offer apprenticeships.

Other qualifications. In addition to training, stationary engineers and boiler operators need mechanical aptitude and manual dexterity. Most employers of entry-level workers and apprenticeship committees prefer applicants with a basic understanding of mathematics, science, computers, mechanical drawing, machine shop practice, and chemistry. Being in good physical condition is also important.

Advancement. Generally, engineers advance as they obtain higher class licenses. These licenses permit boiler operators to work with larger, more powerful, or more varied equipment. In jurisdictions where licenses are not required, workers generally advance by taking company-administered exams. Some stationary engineers and boiler operators advance to become boiler inspectors, chief plant engineers, building and plant superintendents, or building managers. A few obtain jobs as examining engineers or technical instructors.

Because most stationary engineering staffs are relatively small, workers may find it difficult to advance, especially within a company. Most high-level positions are held by experienced workers with seniority. Workers wishing to move up to these positions must often change employers or wait for older workers to retire before they can advance.

Employment

Stationary engineers and boiler operators held about 41,600 jobs in 2008. They worked throughout the country, generally in the more heavily populated areas in which large industrial and commercial establishments are located. Jobs were dispersed throughout a variety of industries. The majority of jobs were in manufacturing, Government, public and private educational services, and public and private hospitals.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Stationary engineers and boiler operators	51-8021	41,600	43,800	2,200	5

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job Outlook

Employment in this occupation is expected to grow more slowly than average through 2018. Applicants may face competition for jobs. Employment opportunities will be best for those who have apprenticeship training and are licensed in their jurisdictions.

Employment change. Employment of stationary engineers and boiler operators is expected to grow by 5 percent between 2008 and 2018, which is slower than the average for all occupations. Continuing commercial and industrial development will increase the amount of equipment to be operated and maintained. Although automated systems and computerized controls are making newly installed equipment more efficient, experienced workers will increasingly be needed to maintain and repair these complex systems.

While employment of stationary engineers and boiler operators is spread across all industries, some industries will experience more growth than others. The largest employment growth will occur in industries with the need for precise temperature control, such as hospitals.

Job prospects. People interested in working as stationary engineers and boiler operators should expect to face competition for these relatively high-paying positions. Although many opportunities will be created by the retirement of the baby-boomer generation, finding an entry-level job can be difficult—especially for inexperienced and unlicensed workers. While there are workers employed in most establishments with large buildings, the typical engineering staff is relatively small. The tendency of experienced workers to stay in a job for decades can make it difficult for entry-level workers to find a job.

Workers who have completed a training course or apprenticeship will have the best prospects. Additionally, in States and jurisdictions where licenses are required, workers who are licensed prior to beginning employment will have better opportunities.

Earnings

Median annual wages of stationary engineers and boiler operators were $49,790 in May 2008. The middle 50 percent earned between $39,390 and $61,670. The lowest 10 percent earned less than $30,630, and the highest 10 percent earned more than $74,500.

Related Occupations

Workers who monitor and operate stationary machinery include:

	Page
Chemical plant and system operators	831
Gas plant operators	831
Petroleum pump system operators, refinery operators, and gaugers	832
Power plant operators, distributors, and dispatchers	760
Water and liquid waste treatment plant and system operators	765

Other workers who maintain the equipment and machinery in a building or plant are:

Industrial machinery mechanics and millwrights 709
Maintenance and repair workers, general 716

Sources of Additional Information

Information about apprenticeships, vocational training, and work opportunities is available from State employment service offices, local chapters of the International Union of Operating Engineers, vocational schools, and State and local licensing agencies. Apprenticeship information is also available from the U.S. Department of Labor's toll-free helpline: (877) 872-5627

Specific questions about this occupation should be addressed to:

➤ International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036. Internet: **http://www.iuoe.org**

➤ National Association of Power Engineers, Inc., 1 Springfield St., Chicopee, MA 01013. Internet: **http://www.napenational.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos228.htm**

Water and Liquid Waste Treatment Plant and System Operators

Significant Points

- Employment is concentrated in local government and water, sewage, and other systems utilities.
- Because of expected much faster than average employment growth and a large number of upcoming retirements, job opportunities will be excellent.
- Completion of an associate degree or a 1-year certificate program in environmental studies or a related field may help applicants to find jobs and advance more quickly.

Nature of the Work

Water is one of our society's most important resources. While most people take it for granted, it takes a lot of work to get water from natural sources—reservoirs, streams, and groundwater—into our taps. Similarly, it is a complicated process to convert the wastewater in our drains and sewers into a form that is safe to release into the environment. *Water treatment plant and system operators* run the equipment, control the processes, and monitor the plants that treat water so that it is safe to drink.

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Liquid waste treatment plant and system operators do similar work to remove pollutants from domestic and industrial waste.

Fresh water is pumped from wells, rivers, streams, and reservoirs to water treatment plants, where it is treated and distributed to customers. Used water, also known as wastewater, travels through sewage pipes to treatment plants where it is treated and either returned to streams, rivers, and oceans, or reused for irrigation. Operators in both types of plants control equipment and monitor processes that remove or destroy harmful materials, chemicals, and microorganisms from the water. They also run tests to make sure that the processes are working correctly and keep records of water quality and other indicators.

Water and wastewater treatment plant operators operate and maintain the pumps and motors that move water and wastewater through filtration systems. They monitor the indicators at their plants and make adjustments as necessary. They read meters and gauges to make sure that plant equipment is working properly. They take samples and run tests to determine the quality of the water being produced. At times, they may adjust the amount of chemicals, such as chlorine and fluorine, being added to the water.

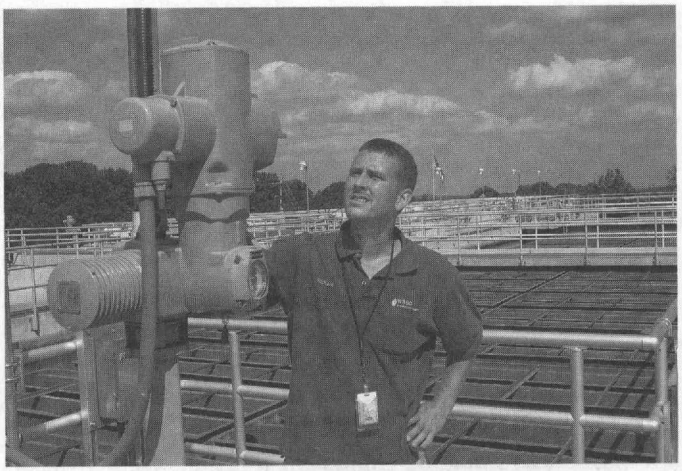
The specific duties of plant operators depend on the type and size of the plant. In a small plant, one operator may be responsible for maintaining all of the systems. This operator would most likely work during the day and be on call during nights and weekends. In medium-size plants, operators may work in shifts to monitor the plant at all hours of the day. In large plants, multiple operators work the same shifts and are more specialized in their duties, often relying on computerized systems to help monitor plant processes.

Occasionally, operators must work during emergencies. Weather conditions may cause large amounts of storm water and wastewater to flow into sewers, exceeding a plant's capacity. Emergencies also may be caused by malfunctions within a plant, such as chemical leaks or oxygen deficiencies. Operators are trained in emergency management procedures and use safety equipment to protect their health, as well as that of the public.

Both tap water and wastewater are highly regulated by the U.S. Environmental Protection Agency. Plant operators must be familiar with these regulations and ensure that their high standards are met. Operators are also responsible for keeping records that document compliance and for being aware of new regulations that are enacted.

Work environment. Water and wastewater treatment plant and system operators work both indoors and outdoors and may be exposed to noise from machinery and to unpleasant odors. Operators' work is physically demanding and often is performed in locations that are difficult to access or unclean. They must pay close attention to safety procedures because of the presence of hazardous conditions, such as slippery walkways, dangerous gases, and malfunctioning equipment. As a result, operators have a higher-than-average occupational injury rate.

Plants operate 24 hours a day, 7 days a week. In small plants, operators may work during the day and be on call in the evening, at night, and on weekends. Medium-size and large plants that require constant monitoring may employ workers in three 8-hour shifts. Because larger plants require constant monitoring, weekend and holiday work is generally required. Operators may be required to work overtime.



Water and liquid waste treatment plant and system operators read meters and gauges to make sure that plant equipment is working properly.

Training, Other Qualifications, and Advancement

Employers usually hire high school graduates who are trained on the job. Completion of a training program may enhance an applicant's competitiveness in the job market.

Education and training. A high school diploma is usually required for an individual to become a water or wastewater treatment plant operator. Some applicants complete certificate or associate degree programs in water-quality and wastewater-treatment technology. Employers prefer to hire such candidates, because completion of a program minimizes the training needed at the plant and also shows a commitment to working in the industry. These programs are offered by community colleges, technical schools, and trade associations, and can be found throughout the country. In some cases, a degree or certificate program can be substituted for experience, allowing a worker to become licensed at a higher level more quickly.

Trainees usually start as attendants or operators-in-training and learn their skills on the job under the direction of an experienced operator. They learn by observing and doing routine tasks such as recording meter readings, taking samples of wastewater and sludge, and performing simple maintenance and repair work on pumps, electric motors, valves, and other plant equipment. Larger treatment plants generally combine this on-the-job training with formal classroom or self-paced study programs.

Licensure and certification. Both water and liquid waste plant and system operators must be certified by their States. Requirements and standards vary widely depending on the State. Most States have four different levels of certification, depending on the operator's experience and training. Although some States will honor licenses from other States, operators who move may have to take a new set of exams to become certified in a different State. The Association of Boards of Certification (ABC) offers a certificate program that may be helpful for operators who plan to move to a different State.

Other qualifications. Water and wastewater treatment plant operators need mechanical aptitude and the ability to solve problems intuitively. They also should be competent in basic mathematics, chemistry, and biology. They must have the ability to apply data to formulas that determine treatment requirements, flow levels, and concentration levels. Some basic familiarity with

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computers also is necessary, because operators generally use them to record data. Some plants also use computer-controlled equipment and instrumentation.

Advancement. Most States have four levels of certification for water and liquid waste treatment plant and system operators. On the basis of criteria such as the size of the plant and the treatment processes employed, each plant is given a corresponding level. A small system may only require the lowest level of certification. An operator who has that certification would be able to operate the plant without any supervision. In some States, operators in small plants can earn higher certifications through knowledge tests, while in other States, experience in a larger plant is required. Either way, operators in these plants will find it difficult to advance in their careers without moving to a larger plant.

As plants get larger and more complicated, operators need more skills before they are allowed to work without supervision. At the largest plants, operators who have the highest level of certification work as shift supervisors and may be in charge of large teams of operators. Operators in these plants can start as trainees and work through the different levels of certification until they advance to the level of shift supervisor.

Some experienced operators get jobs as technicians with State drinking-water-control or water-pollution- control agencies. In that capacity, they monitor and provide technical assistance to plants throughout the State. Vocational-technical school or community-college training generally is preferred for technician jobs. Experienced operators may transfer to related jobs with industrial liquid-waste treatment plants, water or liquid waste treatment equipment and chemical companies, engineering consulting firms, or vocational-technical schools.

Employment

Water and wastewater treatment plant and system operators held about 113,400 jobs in 2008. About 78 percent of all operators worked for local governments. Others worked primarily for water, sewage, and other systems utilities and for waste treatment and disposal and waste management services. Jobs were located throughout the country.

Job Outlook

Water and wastewater treatment plant and system operator jobs are expected to grow much faster than the average for all occupations. Job opportunities should be excellent for qualified workers.

Employment change. Employment of water and liquid waste treatment plant and system operators is expected to grow by 20 percent between 2008 and 2018, which is much faster than the average for all occupations. A growing population and the increasingly suburban geography of the United States are expected to boost demand for water and wastewater-treatment services. As new plants are constructed to meet this demand, new water and wastewater treatment plant and system operator jobs will arise.

Local governments are the largest employers of water and wastewater treatment plant and system operators. Employment in privately owned facilities will grow faster, because Federal certification requirements have increased utilities' reliance on private firms specializing in the operation and management of water- and wastewater-treatment facilities.

Job prospects. Job opportunities should be excellent, both because of the expected much faster than average employment growth and because the retirement of the baby-boomer generation will require that many operators be replaced. Further, the number of applicants for these jobs is normally low, primarily because of the physically demanding and unappealing nature of some of the work. Opportunities should be best for people with mechanical aptitude and problem-solving skills.

Earnings

Median annual wages of water and wastewater treatment plant and system operators were $38,430 in May 2008. The middle 50 percent earned between $30,040 and $48,640. The lowest 10 percent earned less than $23,710, and the highest 10 percent earned more than $59,860. Median annual wages of water and liquid waste treatment plant and systems operators in May 2008 were $38,510 in local government and $37,620 in water, sewage, and other systems.

In addition to their annual salaries, water and wastewater treatment plant and system operators usually receive benefits that may include health and life insurance, a retirement plan, and educational reimbursement for job-related courses.

Related Occupations

Other workers whose main activity consists of operating a system of machinery to process or produce materials include:

	Page
Chemical plant and system operators	831
Gas plant operators	831
Petroleum pump system operators, refinery operators, and gaugers	832
Power plant operators, distributors, and dispatchers	760
Stationary engineers and boiler operators	763

Sources of Additional Information

For information on employment opportunities, contact State or local water pollution control agencies, State water and liquid waste operator associations, State environmental training centers, or local offices of the State employment service.

For information on certification, contact:

➤ Association of Boards of Certification, 208 Fifth St., Suite 201, Ames, IA 50010-6259. Internet: **http://www.abccert.org**

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Water and liquid waste treatment plant and system operators	51-8031	113,400	135,900	22,500	20

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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For educational information related to a career as a water or liquid waste treatment plant and system operator, contact:

➤ American Water Works Association, 6666 West Quincy Ave., Denver, CO 80235. Internet: **http://www.awwa.org**

➤ National Rural Water Association, 2915 S. 13th St., Duncan, OK 73533. Internet: **http://www.nrwa.org**

➤ Water Environment Federation, 601 Wythe St., Alexandria, VA 22314-1994. Internet: **http://www.wef.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos229.htm**

Miscellaneous Production Occupations

Inspectors, Testers, Sorters, Samplers, and Weighers

Significant Points

- About 69 percent are employed in manufacturing establishments.
- Although a high school diploma is sufficient for the basic testing of products, complex precision-inspecting positions are filled by experienced workers.
- Employment is expected to decline slowly.

Nature of the Work

Inspectors, testers, sorters, samplers, and weighers, often called *quality-control inspectors* or another, similar name, ensure that your food will not make you sick, that your car will run properly, and that your pants will not split the first time you wear them. These workers monitor or audit quality standards for virtually all manufactured products, including foods, textiles, clothing, glassware, motor vehicles, electronic components, computers, and structural steel. As product quality becomes increasingly important to the success of many manufacturing firms, daily duties of inspectors place more focus on this aspect of their jobs.

Regardless of title, all inspectors, testers, sorters, samplers, and weighers work to guarantee the quality of the goods their firms produce. Specific job duties vary across the wide range of industries in which these workers are found. Materials inspectors may check products by sight, sound, feel, smell, or even taste to locate imperfections such as cuts, scratches, missing pieces, or crooked seams. These workers may verify dimensions, color, texture, strength, or other physical characteristics of objects. Mechanical inspectors generally verify that parts fit, move correctly, and are properly lubricated; check the pressure of gases and the level of liquids; test the flow of electricity; and do a test run to check for proper operation of a machine or piece of equipment. Some jobs involve only a quick visual inspection; others require a longer, detailed one. Sorters may separate goods according to length, size, fabric type, or color, while samplers test or inspect a sample taken from a batch or production run for malfunctions or defects. Weighers weigh quantities of materials for use in production. Testers repeatedly test existing products or prototypes under real-world conditions. Through these tests, companies determine how long a product will last, what parts will break down first, and how to improve durability.

Quality-control workers are involved at every stage of the production process. Some examine materials received from a supplier before sending them to the production line. Others inspect components and assemblies or perform a final check on the finished product. Depending on their skill level, inspectors also may set up and test equipment, calibrate precision instruments, repair defective products, or record data.

These workers rely on a number of tools to perform their jobs. Although some still use hand-held measurement devices such as micrometers, calipers, and alignment gauges, it is more common for them to operate electronic inspection equipment, such as coordinate-measuring machines (CMMs). These machines use sensitive probes to measure a part's dimensional accuracy and allow the inspector to analyze the results with computer software. Inspectors testing electrical devices may use voltmeters, ammeters, and ohmmeters to test potential difference, current flow, and resistance, respectively. All the tools that inspectors use are maintained by calibration technicians, who ensure that they work properly and generate accurate readings.

Inspectors mark, tag, or note problems. They may reject defective items outright, send them for repair, or fix minor problems themselves. If the product is acceptable, the inspector will certify it. Quality-control workers record the results of their inspections, compute the percentage of defects and other statistical measures, and prepare inspection and test reports. Some electronic inspection equipment automatically provides test reports containing these inspection results. When defects are found, inspectors notify supervisors and help to analyze and correct the production problems.

The emphasis on finding the root cause of defects is a basic tenet of modern management and production philosophies. Current philosophies emphasize constant quality improvement through analysis and correction of the causes of defects. The nature of inspectors' work has changed from merely checking for defects to determining the cause of those defects.

This increased emphasis on quality means that companies now have integrated teams of inspection and production workers who jointly review and improve product quality. In addition, many companies use self-monitoring production machines to ensure that the output is produced within quality standards. These machines not only can alert inspectors to production problems, but also sometimes automatically repair defects.

Some firms have completely automated inspection with the help of advanced vision inspection systems using machinery installed at one or several points in the production process.

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Working conditions for inspectors, testers, sorters, samplers and weighers vary by industry and establishment size.

Inspectors in these firms monitor the equipment, review output, and perform random product checks.

Work environment. Working conditions vary by industry and establishment size. As a result, some inspectors examine similar products for an entire shift, whereas others examine a variety of items.

In manufacturing, it is common for most inspectors to remain at one workstation. Inspectors in some industries may be on their feet all day and may have to lift heavy objects, whereas in other industries they sit during most of their shift and read electronic printouts of data. Workers in heavy manufacturing plants may be exposed to the noise and grime of machinery; in other plants, inspectors work in clean, air-conditioned environments suitable for carrying out controlled tests. As a result of these varied working conditions, injuries are not uncommon for this occupation, and workers must follow proper procedures to minimize risks.

Some inspectors work evenings, nights, or weekends. Shift assignments generally are made on the basis of seniority. Overtime may be required to meet production goals.

Training, Other Qualifications, and Advancement

Although a high school diploma is sufficient for the basic testing of products, complex precision-inspecting positions are filled by experienced workers.

Education and training. Training requirements vary with the responsibilities of the quality-control worker. For workers who perform simple "pass/fail" tests of products, a high school diploma generally is sufficient, together with limited in-house training. Training for new inspectors may cover the use of special meters, gauges, computers, and other instruments; quality-control techniques; blueprint reading; safety; and reporting requirements. There are some postsecondary training programs, but many employers prefer to train inspectors on the job.

The chances of finding work in this occupation can be improved by studying industrial trades, including computer-aided design, in high school or in a postsecondary vocational program. Laboratory work in the natural or biological sciences also may improve one's analytical skills and increase one's chances of finding work in medical or pharmaceutical labs, where many of these workers are employed.

As companies implement more automated inspection techniques that require less manual inspection, workers in this occupation will have to learn to operate and program more sophisticated equipment and learn software applications. Because these operations require additional skills, the need for higher education may be necessary. To address this need, some colleges are offering associate's degrees in fields such as quality control management.

Other qualifications. In general, inspectors, testers, sorters, samplers, and weighers need mechanical aptitude, math and communication skills, and good hand-eye coordination and vision. Another important skill is the ability to analyze and interpret blueprints, data, manuals, and other material to determine specifications, inspection procedures, formulas, and methods for making adjustments.

Certification and advancement. The American Society for Quality offers 15 different types of certifications for workers in quality control. These certifications may assist workers in advancing within the occupation. They generally require a certain number of years of experience in the field and passage of an exam.

Advancement for workers with the necessary skills frequently takes the form of additional duties and responsibilities. Complex inspection positions are filled by experienced assemblers, machine operators, or mechanics who already have a thorough knowledge of the products and production processes. To advance to these positions, experienced workers may need training in statistical process control, new automation, or the company's quality assurance policies. Because automated inspection equipment and electronic recording of results are becoming common, computer skills also are important.

Employment

Inspectors, testers, sorters, samplers, and weighers held about 464,700 jobs in 2008. About 69 percent worked in manufacturing establishments that produced such products as motor vehicle parts, plastics products, semiconductor and other electronic components, and aerospace products and parts. Inspectors, testers, sorters, samplers, and weighers also were found in employment services; wholesale trade; and professional, scientific, and technical services.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Inspectors, testers, sorters, samplers, and weighers	51-9061	464,700	447,800	-16,900	-4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job Outlook

Like many other occupations concentrated in manufacturing industries, employment is expected to decline slowly, primarily because of the growing use of automated inspection and the redistribution of some quality-control responsibilities from inspectors to production workers.

Employment change. Employment of inspectors, testers, sorters, samplers, and weighers is expected to decline by 4 percent between 2008 and 2018. Because the majority of these employees work in the manufacturing sector, their outlook is greatly affected by what happens to manufacturing companies. The emphasis on improving quality and productivity has led many manufacturers to invest in automated inspection equipment and to take a more systematic approach to quality inspection. Continued improvements in technologies allow firms to automate inspection tasks, increasing workers' productivity and reducing the demand for inspectors.

In addition, work in many manufacturing companies continues to move abroad. As more production moves offshore, the number of quality-control workers is expected to decline as well.

Firms increasingly are integrating quality control into the production process. Many inspection duties are being redistributed from specialized inspectors to fabrication and assembly workers, who monitor quality at every stage of the production process. In addition, the growing implementation of statistical process control is resulting in "smarter" inspection. Using this system, firms survey the sources and incidence of defects so that they can better focus their efforts on reducing the number of defective products manufactured.

In some industries, however, automation is not a feasible alternative to manual inspection. Where key inspection elements are oriented toward size, such as length, width, or thickness, automation will become more important in the future. But where taste, smell, texture, appearance, complexity of fabric, or performance of the product is important, inspection will continue to be done by workers.

Job prospects. Although numerous job openings will arise through the need to replace workers who move out of this large occupation, many of these jobs will be open only to experienced workers with advanced skills. There will be better opportunities in the employment services industry, as more manufacturers use contract inspection workers, and in growing manufacturing industries, such as medical equipment and pharmaceuticals.

Earnings

Median hourly wages of inspectors, testers, sorters, samplers, and weighers were $15.02 in May 2008. The middle 50 percent earned between $11.58 and $19.52 an hour. The lowest 10 percent earned less than $9.28 an hour, and the highest 10 percent earned more than $25.47 an hour. Median hourly wages in the industries employing the largest numbers of inspectors, testers, sorters, samplers, and weighers in May 2008 were as follows:

Aerospace product and parts manufacturing	$22.10
Motor vehicle parts manufacturing	16.39
Semiconductor and other electronic component manufacturing	14.22
Plastics product manufacturing	13.87
Employment services	11.64

Related Occupations

Other workers who conduct inspections include the following:

	Page
Agricultural inspectors	612
Construction and building inspectors	628
Fire inspectors and investigators	525
Occupational health and safety specialists	428
Occupational health and safety technicians	431
Transportation inspectors	833

Sources of Additional Information

For general information about inspection, testing, and certification, contact:

➤ American Society for Quality, 600 North Plankinton Ave., Milwaukee, WI 53203. Internet: **http://www.asq.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos220.htm**

Jewelers and Precious Stone and Metal Workers

Significant Points

- About 54 percent of all jewelers and precious stone and metal workers are self-employed.
- Jewelers usually learn their trade in vocational or technical schools, through distance-learning centers, or on the job.
- Prospects for bench jewelers and other skilled jewelers should be favorable; keen competition is expected for lower skilled manufacturing jobs, such as assemblers and polishers.

Nature of the Work

Jewelers and precious stone and metal workers use a variety of common and specialized equipment to design and manufacture

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new pieces of jewelry; cut, set, and polish gem stones; repair or adjust rings, necklaces, bracelets, earrings, and other jewelry; and appraise jewelry, precious metals, and gems. Jewelers usually specialize in one or more of these areas and may work for large jewelry manufacturing firms, for small retail jewelry shops, or as owners of their own businesses. Regardless of the type of work done or the work setting, jewelers need a high degree of skill, precision, and attention to detail.

Some jewelers design or make their own jewelry. Following their own designs or those created by designers or customers, they begin by shaping the metal or by carving wax to make a model for casting the metal. Individual parts then are soldered together, and the jeweler may mount a diamond or other gem or may engrave a design into the metal. Other jewelers do finishing work, such as setting stones, polishing, or engraving, or make repairs. Typical repair work includes enlarging or reducing ring sizes, resetting stones, and replacing broken clasps and mountings.

Bench jewelers usually work in jewelry retailers. They perform a wide range of tasks, from simple jewelry cleaning and repair to moldmaking and fabricating pieces from scratch. In larger manufacturing businesses, jewelers usually specialize in a single operation. *Mold and model makers* create models or tools for the jewelry that is to be produced. *Assemblers* solder or fuse jewelry and their parts; they also may set stones. *Engravers* etch designs into metal with specialized tools, and *polishers* bring a finished luster to the final product.

Jewelers typically do the handiwork required to produce a piece of jewelry, while *gemologists* and laboratory graders analyze, describe, and certify the quality and characteristics of gem stones. Gemologists may work in gemological laboratories or as quality control experts for retailers, importers, or manufacturers. After using microscopes, computerized tools, and other grading instruments to examine gem stones or finished pieces of jewelry, they write reports certifying that the items are of a particular quality. Many jewelers also study gemology to become familiar with the physical properties of the gem stones with which they work.

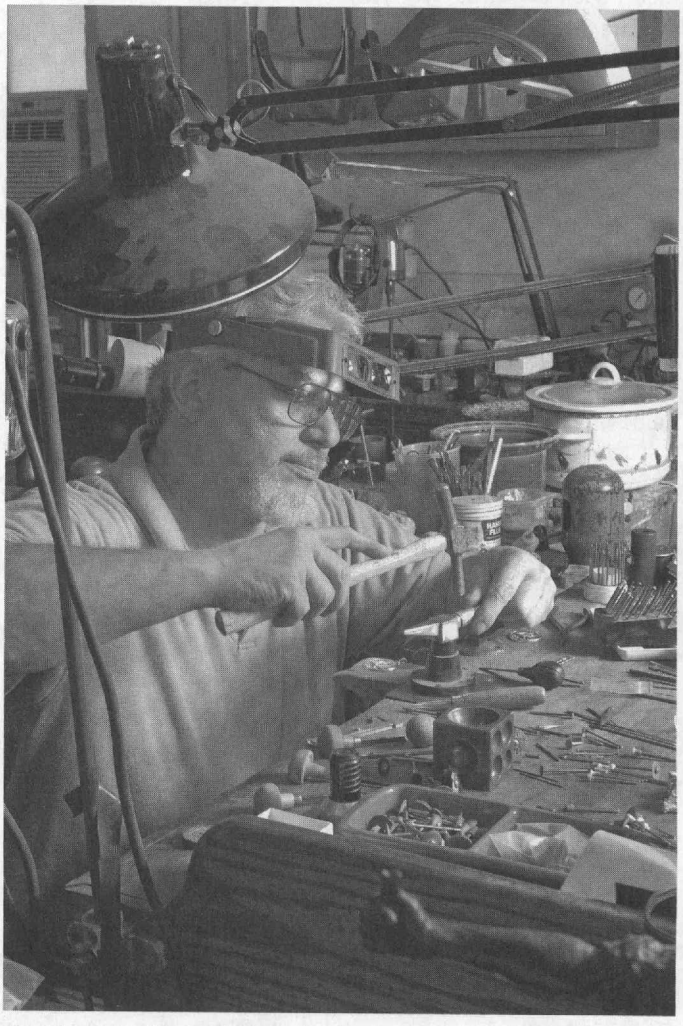
Jewelry appraisers carefully examine jewelry to determine its value, after which they write appraisal documents. They determine the value of a piece by researching the jewelry market and by using reference books, auction catalogs, price lists, and the Internet. They may work for jewelry stores, appraisal firms, auction houses, pawnbrokers, or insurance companies. Many gemologists also become appraisers.

In small retail stores or repair shops, jewelers and appraisers may be involved in all aspects of the work. Those who own or manage stores or shops also hire and train employees; order, market, and sell merchandise; and perform other managerial duties.

New technology is helping to produce jewelry of high quality at a reduced cost and in a shorter amount of time. For example, lasers are often used for cutting and improving the quality of stones, for applying intricate engraving or design work, and for inscribing personal messages or identification on jewelry. Jewelers also use lasers to weld metals together in milliseconds with no seams or blemishes, improving the quality and appearance of jewelry.

Some manufacturing firms use computer-aided design and manufacturing (CAD/CAM) to facilitate product design and automate some steps in the moldmaking and modelmaking process. CAD allows jewelers to create a virtual-reality model of a piece of jewelry. Using CAD, jewelers can modify the design, change the stone, or try a different setting and see the contemplated changes on a computer screen before cutting a stone or performing other costly steps. Once they are satisfied with the model, they use CAM to produce a mold. After the mold is made, it is easier for manufacturing firms to produce numerous copies of a given piece of jewelry, which can be distributed to retail establishments across the country. Similar techniques may be used in the retail setting, allowing customers to review their jewelry designs with the jeweler and make modifications before committing themselves to the expense of a customized piece of jewelry.

Work environment. A jeweler's work involves a great deal of concentration and attention to detail. Trying to satisfy customers' and employers' demands for speed and quality while working on precious stones and metal can cause fatigue and stress. However, the use of more ergonomically correct jewelers' benches has eliminated most of the strain and discomfort caused by spending long periods over a workbench.



Jewelers need a high degree of skill and must pay attention to detail.

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Lasers require both careful handling to avoid injury and steady hands to direct precision tasks. In larger manufacturing plants and some smaller repair shops, chemicals, sharp or pointed tools, and jewelers' torches pose safety threats and may cause injury if proper care is not taken. Most dangerous chemicals, however, have been replaced with synthetic, less toxic products to meet safety requirements.

In repair shops, jewelers usually work alone with little supervision. In retail stores, they may talk with customers about repairs, perform custom design work, and even do some selling. Because many of their materials are valuable, jewelers must observe strict security procedures, including working behind locked doors that are opened only by a buzzer, working on the other side of barred windows, making use of burglar alarms, and, in larger jewelry establishments, working in the presence of armed guards.

Training, Other Qualifications, and Advancement

Jewelers usually learn their trade on-the-job over the course of several months; however, vocational or technical schools or distance-learning centers are becoming more common ways for workers to learn their skills. Formal training enhances employment and advancement opportunities.

Education and training. Jewelers have traditionally learned their trade through several months of on-the-job training; while this method is still common, particularly in manufacturing plants, many are also learning their skills in vocational or technical schools or through distance-learning centers. Computer-aided design is becoming increasingly important to retail jewelers and students may wish to obtain training in it. This skill can usually be obtained through technical school; however, some employers may provide training in it, as well.

In jewelry manufacturing plants, workers traditionally develop their skills through informal apprenticeships and on-the-job training. The apprenticeship or training period lasts up to 1 year, depending on the difficulty of the specialty. Training usually focuses on casting, setting stones, making models, or engraving.

There are also many technical schools offering training designed for jewelers. Some manufacturers prefer graduates because they require less on-the-job training. Course topics can include blueprint reading, math, and shop theory.

For jewelers who work in retail stores or repair shops, vocational training or college courses offer the best job preparation. These programs may vary in length from 6 months to a year and teach jewelry making and repairing skills, such as designing, casting, setting and polishing stones, as well as the use and care of jeweler's tools and equipment.

There are various institutes that offer courses and programs in gemology. These programs cover a wide range of topics, including the identification and grading of diamonds and gem stones.

While it is not required, some students may wish to obtain a higher level degree. For them, art and design schools offer programs leading to the degree of bachelor of fine arts or master of fine arts in jewelry design.

Other qualifications. The precise and delicate nature of jewelry work requires finger and hand dexterity, good hand-eye coordination, patience, and concentration. Artistic ability and fashion consciousness are major assets, particularly in jewelry design and jewelry shops, because jewelry must be stylish and attractive. Those who work in jewelry stores have frequent contact with customers and should be neat, personable, and knowledgeable about the merchandise. In addition, employers require workers of good character because jewelers work with valuable materials.

Certification and advancement. Jewelers of America offers four credentials, ranging from Certified Bench Jeweler Technician to Certified Master Bench Jeweler, for bench jewelers who pass a written and practical exam. Certification is not required to work as a bench jeweler, but it may help jewelers to show expertise and to advance.

Advancement opportunities are limited and depend greatly on an individual's skill and initiative. In manufacturing, some jewelers advance to supervisory jobs, such as master jeweler or head jeweler. Jewelers who work in jewelry stores or repair shops may become managers; some open their own businesses.

Those interested in starting their own business should first establish themselves and build a reputation for their work within the jewelry trade. Once they obtain sufficient credit from jewelry suppliers and wholesalers, they can acquire the necessary inventory. Also, because the jewelry business is highly competitive, jewelers who plan to open their own store should have sales experience and knowledge of marketing and business management. Courses in these subjects often are available from technical schools and community colleges.

Employment

Jewelers and precious stone and metal workers held about 52,100 jobs in 2008. About 54 percent of these workers were self-employed; many operated their own store or repair shop, and some specialized in designing and creating custom jewelry.

About 21 percent of salaried jobs for jewelers and precious stone and metal workers were in retail trade, primarily in jewelry, luggage, and leather goods stores. Another 15 percent of jobs were in jewelry and silverware manufacturing. A small number of jobs were with merchant wholesalers of miscellaneous durable goods and in repair shops providing repair and maintenance of personal and household goods. Although jewelry stores and repair shops were found in every city and in many small towns, most jobs were in larger metropolitan areas.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Jewelers and precious stone and metal workers	51-9071	52,100	54,800	2,800	5

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Job Outlook

Employment is expected to grow more slowly than average. Prospects for bench jewelers and other skilled jewelers should be favorable; keen competition is expected for lower skilled manufacturing jobs, such as assemblers and polishers.

Employment change. Employment of jewelers and precious stone and metal workers is expected to grow by 5 percent between 2008 and 2018, more slowly than the average for all occupations. Most jewelry is currently imported, and continued growth in imports will limit demand, particularly for lower-skilled workers. However, demand for bench jewelers or other skilled jewelers will grow as consumers seek more customized jewelry.

Additionally, the consolidation and increased online presence of many jewelry outlets will constrain employment growth in the near future. Although nontraditional jewelry marketers, such as Internet retailers and discount stores, have expanded in recent years, many traditional retailers have countered with their own successful online presence. Since nontraditional retailers require fewer sales staff, which limits employment opportunities for jewelers, any slowdown in their expansion at the expense of jewelry shops is a positive sign for employment growth.

Traditional jewelers may continue to lose some of their market share to nontraditional outlets, but they will maintain a large customer base. Many buyers prefer to see and try on jewelry before purchasing it, or to enjoy the experience of shopping in a store. Jewelry stores also have the advantage of being able to offer personalized service and build client relationships. Additionally, new jewelry sold by nontraditional retailers will create demand for skilled jewelers for sizing, cleaning, and repair work.

Job prospects. Despite limited employment growth, opportunities should be favorable for bench jewelers and other skilled jewelers. New jewelers will be needed to replace those who retire or who leave the occupation for other reasons. When master jewelers retire, they take with them years of experience that require substantial time and financial resources to replace. Many employers have difficulty finding and retaining jewelers with the right skills and the necessary knowledge. Opportunities in jewelry stores and repair shops will be best for graduates from training programs for jewelers or gemologists and for those workers with training in CAD/CAM.

Keen competition is expected for lower skilled manufacturing jobs that are amenable to automation, such as assemblers and polishers. Jewelry designers who wish to create their own jewelry lines should expect intense competition. Although demand for customized and boutique jewelry is strong, it is difficult for independent designers to establish themselves.

The jewelry industry can be cyclical. During economic downturns, demand for jewelry products and for jewelers tends to decrease. However, demand for repair workers should remain strong even during economic slowdowns because maintaining and repairing jewelry is an ongoing process. In fact, demand for jewelry repair may increase during recessions, as people repair or restore existing pieces rather than purchase new ones.

Earnings

Median annual wages for jewelers and precious stone and metal workers were $32,940 in May 2008. The middle 50 percent earned between $24,370 and $43,440. The lowest 10 percent earned less than $19,000, and the highest 10 percent earned more than $55,130.

Most jewelers start out with a base salary, but once they become more proficient, they may begin charging by the number of pieces completed. Jewelers who work in retail stores may earn a commission for each piece of jewelry sold. Many jewelers also enjoy a variety of benefits, including reimbursement from their employers for work-related courses and discounts on jewelry purchases.

Related Occupations

Jewelers and precious stone and metal workers do precision handwork. Other skilled workers who do similar jobs include:

	Page
Welding, soldering, and brazing workers	743
Woodworkers	757

Some jewelers and precious stone and metal workers create their own jewelry designs. Other occupations that require visual arts abilities include:

Artists and related workers	301
Commercial and industrial designers	304
Fashion designers	307

Some jewelers and precious stone and metal workers are involved in the buying and selling of stones, metals, or finished pieces of jewelry. Similar occupations include:

Retail salespersons	543
Sales representatives, wholesale and manufacturing	547

Sources of Additional Information

Information on job opportunities and training programs for jewelers and gemologists is available from:

➤ Gemological Institute of America, 5345 Armada Dr., Carlsbad, CA 92008. Internet: **http://www.gia.edu**

For more information about bench jeweler certification and careers in jewelry design and retail, including different career paths, training options, and schools, contact:

➤ Jewelers of America, 52 Vanderbilt Ave., 19th Floor, New York, NY 10017. Internet: **http://www.jewelers.org**

For information on jewelry design and manufacturing, training, and schools offering jewelry-related programs and degrees by State, contact:

➤ Manufacturing Jewelers and Suppliers of America, 57 John L. Dietsch Square Attleboro Falls, MA 02763. Internet: **http://www.mjsa.org**

To receive a list of accredited technical schools that have programs in gemology, contact:

➤ Accrediting Commission of Career Schools and Colleges, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: **http://www.accsc.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos222.htm**

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Medical, Dental, and Ophthalmic Laboratory Technicians

Significant Points

- Around 58 percent of jobs were in medical equipment and supplies manufacturing, usually in small, privately owned businesses.
- Most technicians learn their craft on the job, but many employers prefer to hire those with formal training.
- Faster than average employment growth is expected for dental and ophthalmic laboratory technicians, while average employment growth is expected for medical appliance technicians.
- Job opportunities should be favorable because few people seek these positions.

Nature of the Work

When patients require a medical device to help them see clearly, chew and speak well, or walk, their healthcare providers send requests to medical, dental, and ophthalmic laboratory technicians. These technicians produce a variety of implements to help patients.

Medical appliance technicians construct, fit, maintain, and repair braces, artificial limbs, joints, arch supports, and other surgical and medical appliances. They follow prescriptions or detailed instructions from podiatrists, orthotists, prosthetists or other healthcare professionals for patients who need them because of a birth defect, disease, accident, or amputation. Podiatrists or orthotists request orthoses—braces, supports, corrective shoes, or other devices; while prosthetists order prostheses—replacement limbs, such as an arm, leg, hand, or foot. Medical appliance technicians who work with these types of devices are called *orthotic and prosthetic (O&P) technicians*. Other medical appliance technicians work with appliances, such as hearing aids, that help correct other medical problems.

For O&P technicians, creating orthoses and prostheses takes several steps. First, technicians construct or receive a plaster cast of the patient's limb or foot to use as a pattern. Increasingly, technicians are using digital files sent by the prescribing practitioner who uses a scanner and uploads the images using computer software. When fabricating artificial limbs or braces, O&P technicians utilize many different materials including plaster, thermoplastics, carbon fiber, acrylic and epoxy resins. More advanced prosthetic devices are electronic, using information technology. Next, O&P technicians carve, cut, or grind the material using hand or power tools. Then they weld the parts together and use grinding and buffing wheels to smooth and polish the devices. Next, they may cover or pad the devices with leather, felt, plastic, or another material. Finally, technicians may mix pigments according to formulas to match the patient's skin color and apply the mixture to create a cosmetic cover for the artificial limb.

After fabrication, medical appliance technicians test devices for proper alignment, movement, and biomechanical stability using meters and alignment fixtures. Over time the appliance will wear down, so technicians must repair and maintain the device. They also may service and repair the machinery used for the fabrication of orthotic and prosthetic devices.

Dental laboratory technicians fill prescriptions from dentists for crowns, bridges, dentures, and other dental prosthetics. First, dentists send a prescription or work authorization for each item to be manufactured, along with an impression or mold of the patient's mouth or teeth. With new technology, a technician may receive a digital impression rather than a physical mold. Then dental laboratory technicians, also called dental technicians, create a model of the patient's mouth by pouring plaster into the impression and allowing it to set. They place the model on an apparatus that mimics the bite and movement of the patient's jaw. The model serves as the basis of the prosthetic device. Technicians examine the model, noting the size and shape of the adjacent teeth, as well as gaps within the gumline. Based upon these observations and the dentist's specifications, technicians build and shape a wax tooth or teeth model, using small hand instruments called wax spatulas and wax carvers. The wax model is used to cast the metal framework for the prosthetic device.

After the wax tooth has been formed, dental technicians pour the cast and form the metal and, using small hand-held tools, prepare the surface to allow the metal and porcelain to bond. They then apply porcelain in layers to mimic the precise shape and color of a tooth. Technicians place the tooth in a porcelain furnace to bake the porcelain onto the metal framework, and then they adjust the shape and color with subsequent grinding and addition of porcelain to achieve a sealed finish. The final product is a nearly exact replica of the lost tooth or teeth.

In some laboratories, technicians perform all stages of the work, whereas in other labs, each technician does only a few. Dental laboratory technicians can specialize in one of five areas—orthodontic appliances, crowns and bridges, complete dentures, partial dentures, or ceramics. Job titles can reflect specialization in these areas. For example, technicians who make porcelain and acrylic restorations are called *dental ceramists*.

Ophthalmic laboratory technicians—also known as manufacturing opticians, optical mechanics, or optical goods workers—make prescription eyeglass or contact lenses. Ophthalmic laboratory technicians cut, grind, edge, polish, and finish lenses according to specifications provided by dispensing opticians, optometrists, or ophthalmologists. Although some lenses still are produced by hand, technicians are increasingly using automated equipment to make lenses. To make a pair of glasses, typically the technician cuts the prescription lenses, bevels the edges to fit the frame, dips each lens into dye if the prescription calls for tinted or coated lenses, polishes the edges, and combines the lenses and frame parts. Some ophthalmic laboratory technicians manufacture lenses for other optical instruments, such as telescopes and binoculars.

In small laboratories, technicians usually handle every phase of the operation. In large ones, in which virtually every phase of the operation is automated, technicians may be responsible for operating computerized equipment. Technicians also inspect the final product for quality and accuracy.

Ophthalmic laboratory technicians should not be confused with workers in other vision care occupations, such as ophthalmologists, optometrists, and dispensing opticians. (See the

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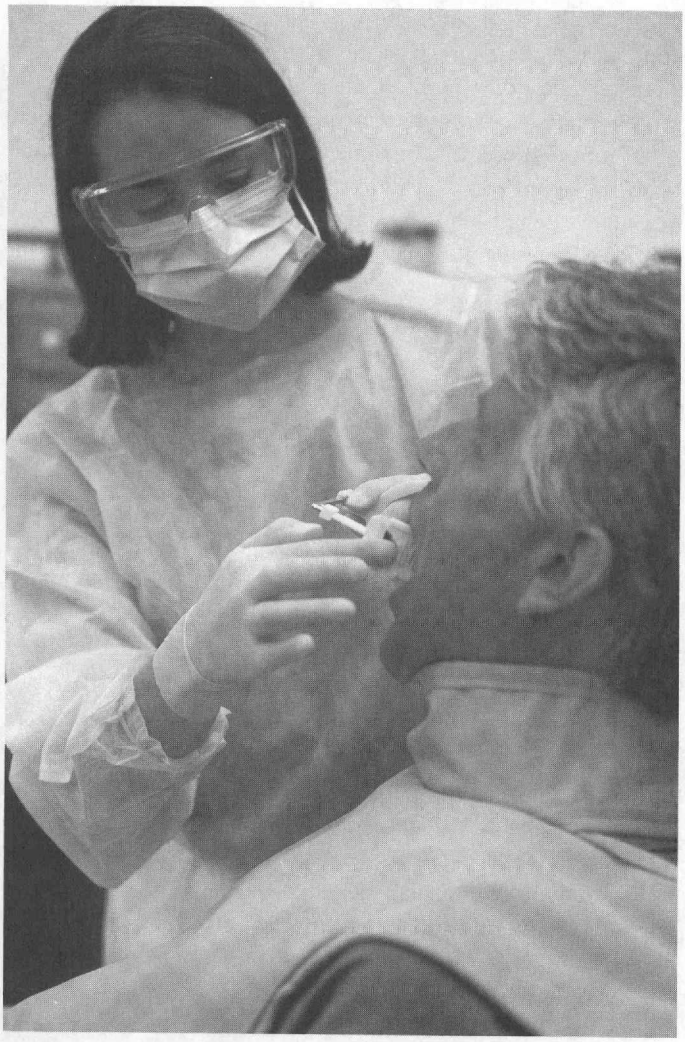

Dental laboratory technicians create crowns, bridges, dentures, and other dental prosthetics.

statement on physicians and surgeons, which includes ophthalmologists, as well as the statements on optometrists and opticians, dispensing, elsewhere in the *Handbook*.)

Work environment. Medical, dental, and ophthalmic laboratory technicians generally work in clean, well-lighted, and well-ventilated laboratories. They have limited contact with the public. Most salaried laboratory technicians work 40 hours a week, but a few work part time. At times, technicians wear goggles to protect their eyes, gloves to handle hot objects, or masks to avoid inhaling dust. They may spend a great deal of time standing. Medical appliance technicians should be particularly careful when working with tools because there is a risk of injury.

Dental technicians usually have their own workbenches, which can be equipped with Bunsen burners, grinding and polishing equipment, and hand instruments, such as wax spatulas and wax carvers. Some dental technicians have computer-aided milling equipment to assist them with creating artificial teeth.

Training, Other Qualifications, and Advancement

Most medical, dental, and ophthalmic laboratory technicians learn their craft on the job. Many employers prefer to hire those with formal training or at least a high school diploma.

Education and training. Although there are no formal education or training requirements to become a medical, dental, or ophthalmic laboratory technician, having a high school diploma is typically the standard requirement for obtaining a job. High school students interested in becoming medical, dental, or ophthalmic laboratory technicians should take courses in mathematics and science. Courses in metal and wood shop, art, drafting, and computers are recommended. Courses in management and business may help those wishing to operate their own laboratories.

Most medical, dental, and ophthalmic laboratory technicians are hired with a high school diploma and learn their tasks through on-the-job training. They usually begin as helpers and gradually learn new skills as they gain experience. For example, dental laboratory technicians begin by pouring plaster into an impression, and progress to more complex procedures, such as making porcelain crowns and bridges. Ophthalmic laboratory technicians may start by marking or blocking lenses for grinding and move onto grinding, cutting, edging, and beveling lenses as they progress.

The length of time spent in on-the-job training varies for each of these occupations. For example, medical appliance technicians usually receive long-term training, while ophthalmic laboratory technicians usually spend less time in training. The length of the training period also varies by the laboratory where the technician is employed, since each laboratory operates differently.

Formal training also is available. In 2008, there were 5 orthotic- and prosthetic-technician programs accredited by the National Commission on Orthotic and Prosthetic Education (NCOPE). These programs offer either an associate degree or a 1-year certificate for orthotic or prosthetic technicians.

Training in dental laboratory technology is available through universities, community and junior colleges, vocational-technical institutes, and the Armed Forces. In 2008, 20 programs in dental laboratory technology were accredited by the Commission on Dental Accreditation in conjunction with the American Dental Association. Accredited programs normally take 2 years to complete, although a few programs can take up to 4 years to complete.

A few ophthalmic laboratory technicians learn their trade in the Armed Forces or in the few programs in optical technology offered by vocational-technical institutes or trade schools. In 2008, there were two programs in ophthalmic technology accredited by the Commission on Opticianry Accreditation (COA).

Licensure and certification. Three States–Kentucky, South Carolina, and Texas–require a dental laboratory to employ at least one Certified Dental Technician in order to operate. This certification is administered by the National Board for Certification in Dental Laboratory Technology (NBC) and the requirements are discussed under Certification and Advancement. In Florida, laboratories must register with the State and at least one dental technician in each dental laboratory must complete 18 hours of continuing education every two years.

Other qualifications. A high degree of manual dexterity, good vision, and the ability to recognize very fine color shadings and variations in shape are necessary for medical, dental, and

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ophthalmic laboratory technicians. An artistic aptitude for detailed work also is important. Computer skills are valuable for technicians using automated systems.

Certification and advancement. Certification may increase chances of advancement. Voluntary certification for orthotic and prosthetic technicians is available through the American Board for Certification in Orthotics and Prosthetics (ABC). Applicants are eligible for an exam after completing a program accredited by NCOPE or obtaining 2 years of experience as a technician under the direct supervision of an ABC-certified practitioner. After successfully passing the appropriate exam, technicians receive the Registered Orthotic Technician, Registered Prosthetic Technician, or Registered Prosthetic-Orthotic Technician credential.

With additional formal education, medical appliance technicians who make orthotics and prostheses can advance to become orthotists or prosthetists—practitioners who work with patients who need braces, prostheses, or related devices and help to determine the specifications for those devices.

Dental laboratory technicians may obtain the Certified Dental Technician designation from the National Board for Certification in Dental Laboratory Technology (NBC), an independent board established by the National Association of Dental Laboratories. Certification, which is voluntary except in three States, can be obtained in five specialty areas: crowns and bridges, ceramics, partial dentures, complete dentures, and orthodontic appliances. To qualify for the CDT credential, technicians must meet educational requirements and pass two written exams and one practical exam. The educational requirement may be obtained through graduation from a dental technology program or at least 5 years of experience as a dental laboratory technician. CDT's must complete twelve hours of continuing education each year to maintain their certification. Dental technicians who only perform certain tasks in a laboratory can take a written and practical exam in modules of dental technology. These result in a Certificate of Competency in a specific skill area and do not require continuing education.

In large dental laboratories, dental technicians may become supervisors or managers. Experienced technicians may teach or take jobs with dental suppliers in such areas as product development, marketing, and sales. Opening one's own laboratory is another, and more common, way to advance and earn more.

Ophthalmic laboratory technicians also can become supervisors and managers. Some become dispensing opticians, although further education or training is generally required to advance.

Employment

Medical, dental, and ophthalmic laboratory technicians held about 95,200 jobs in 2008. About 58 percent of jobs were in medical equipment and supplies manufacturing, which usually are small, privately owned businesses with fewer than five employees. However, some laboratories are large; a few employ more than 1,000 workers. The following tabulation shows employment by occupation:

Dental laboratory technicians	46,000
Opthalmic laboratory technicians	35,200
Medical appliance technicians	13,900

In addition to manufacturing laboratories, many medical appliance technicians worked in health and personal care stores, while others worked in public and private hospitals, professional and commercial equipment and supplies merchant wholesalers, or consumer goods rental centers. Some were self-employed. In addition to manufacturing laboratories, many dental laboratory technicians worked in offices of dentists. Some dental laboratory technicians open their own offices.

Most ophthalmic laboratory technician jobs were in medical equipment and supplies manufacturing laboratories. Others worked in health and personal care stores, offices of optometrists, and professional and commercial equipment and supplies merchant wholesalers.

Job Outlook

Overall employment of medical, dental, and ophthalmic laboratory technicians is expected to grow faster than the average, but varies by detailed occupation. Job opportunities should be favorable because few people seek these positions.

Employment change. Overall employment for these occupations is expected to grow 14 percent from 2008 to 2018, which is faster than the average for all occupations. Medical appliance technicians will grow at 11 percent, about as fast as the average for all occupations, because of the increasing prevalence of the two leading causes of limb loss—diabetes and cardiovascular disease—and because of the increasing rate of obesity. The demand for orthotic devices, such as braces and orthopedic footwear, will increase as more people will need these support devices. In addition, advances in technology may spur demand for prostheses that allow for greater movement.

Employment of dental laboratory technicians is expected to grow 14 percent, which is faster than the average for all occupations. During the last few years, increased demand has arisen from an aging public that is growing increasingly interested in cosmetic prostheses. For example, many dental laboratories are filling orders for composite fillings that are the same shade of white as natural teeth to replace older, less attractive fillings. Additionally, the growing and aging population will require more dental products fabricated by dental technicians, such as bridges and crowns, since more people are retaining their original teeth. This job growth will be limited, however, by productivity gains stemming from continual technological advancements in laboratories.

Ophthalmic laboratory technicians are expected to experience employment growth of 15 percent, faster than the average for all occupations. Demographic trends make it likely that many more Americans will need vision care in the years ahead. Not only will the population grow, but also the proportion of middle-aged and older adults is projected to increase rapidly. Middle age is a time when many people use corrective lenses for the first time, and the need for vision care continues to increase with age. However, the increasing use of automated machinery will temper job growth for ophthalmic laboratory technicians.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Medical, dental, and ophthalmic laboratory technicians	51-9080	95,200	108,300	13,100	14
Dental laboratory technicians	51-9081	46,000	52,400	6,400	14
Medical appliance technicians	51-9082	13,900	15,400	1,500	11
Ophthalmic laboratory technicians	51-9083	35,200	40,400	5,200	15

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Job prospects. Job opportunities for medical, dental, and ophthalmic laboratory technicians should be favorable, due to expected faster than average growth. Few people seek these jobs, reflecting the relatively limited public awareness and low starting wages. Those with formal training in a medical, dental, or ophthalmic laboratory technology program will have the best job prospects. In addition to openings from job growth, many job openings also will arise from the need to replace technicians who transfer to other occupations or who leave the labor force.

Earnings

Median annual wages of wage and salary medical appliance technicians were $34,460 in May 2008. The middle 50 percent earned between $26,600 and $47,210. The lowest 10 percent earned less than $21,720, and the highest 10 percent earned more than $63,750.

Median annual wages of wage and salary dental laboratory technicians were $34,170 in May 2008. The middle 50 percent earned between $26,260 and $44,790. The lowest 10 percent earned less than $20,740, and the highest 10 percent earned more than $58,140. In the two industries that employed the most dental laboratory technicians—medical equipment and supplies manufacturing and offices of dentists—median annual wages were $33,700 and $35,000, respectively.

Median annual wages of wage and salary ophthalmic laboratory technicians were $27,210 in May 2008. The middle 50 percent earned between $21,580 and $34,810. The lowest 10 percent earned less than $18,080, and the highest 10 percent earned more than $42,890. Median annual wages were $25,250 in medical equipment and supplies manufacturing and $25,580 in health and personal care stores, the two industries that employ the most ophthalmic laboratory technicians.

Related Occupations

Medical, dental, and ophthalmic laboratory technicians manufacture and work with the same devices that are used by:

	Page
Dentists	363
Opticians, dispensing	434
Optometrists	371
Orthotists and prosthetists	825

Other occupations that work with or manufacture goods using similar tools and skills include:

Medical equipment repairers	718
Textile, apparel, and furnishings occupations	753

Sources of Additional Information

For information on careers in orthotics and prosthetics, contact:

➤ American Academy of Orthotists and Prosthetists, 1331 H St. NW., Suite 501, Washington, DC 20005. Internet: **http://www.opcareers.org**

For a list of accredited programs for orthotic and prosthetic technicians, contact:

➤ National Commission on Orthotic and Prosthetic Education, 330 John Carlyle St., Suite 200, Alexandria, VA 22314. Internet: **http://www.ncope.org**

For information on requirements for certification of orthotic and prosthetic technicians, contact:

➤ American Board for Certification in Orthotics, Prosthetics, and Pedorthics, 330 John Carlyle St., Suite 210, Alexandria, VA 22314. Internet: **http://www.abcop.org**

For a list of accredited programs in dental laboratory technology, contact:

➤ Commission on Dental Accreditation, American Dental Association, 211 E. Chicago Ave., Chicago, IL 60611. Internet: **http://www.ada.org/prof/ed/accred/commission/index.asp**

For information on requirements for certification of dental laboratory technicians, contact:

➤ National Board for Certification in Dental Laboratory Technology, 325 John Knox Rd., L103, Tallahassee, FL 32303. Internet: **http://www.nbccert.org**

For information on career opportunities in commercial dental laboratories, contact:

➤ National Association of Dental Laboratories, 325 John Knox Rd., L103, Tallahassee, FL 32303. Internet: **http://www.nadl.org**

For information on an accredited program in ophthalmic laboratory technology, contact:

➤ Commission on Opticianry Accreditation, P.O. Box 142 Florence, IN 47020. Internet: **http://www.coaccreditation.com**

General information on grants and scholarships is available from individual schools. State employment service offices can provide information about job openings for medical, dental, and ophthalmic laboratory technicians.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos238.htm**

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Painting and Coating Workers, except Construction and Maintenance

Significant Points

- About 2 out of 3 jobs are in manufacturing establishments.
- Most workers acquire their skills on the job; training usually lasts from a few days to several months, but becoming skilled in all aspects of painting can require 1 to 2 years of experience and training.
- Overall employment is projected to grow.
- Good job prospects are expected for skilled workers with painting experience.

Nature of the Work

Millions of items ranging from cars to candy are covered by paint, plastic, varnish, chocolate, or some other type of coating solution. Painting or coating is used to make a product more attractive or protect it from the elements. The paint finish on an automobile, for example, makes the vehicle more attractive and provides protection from corrosion. Achieving this end result is the work of *painting and coating workers*.

Before painting and coating workers can begin to apply the paint or other coating, they often need to prepare the surface. A metal, wood, or plastic part may need to be sanded or ground to correct imperfections or rough up a surface so that paint will stick to it. After preparing the surface, the product is carefully cleaned to prevent any dust or dirt from becoming trapped under the paint. Metal parts are often washed or dipped in chemical baths to prepare the surface for painting and protect against corrosion. If the product has more than one color or has unpainted parts, masking is required. Masking normally involves carefully covering portions of the product with tape and paper.

After the product is prepared for painting, coating, or varnishing, a number of techniques may be used to apply the paint. Perhaps the most straightforward technique is simply dipping an item in a large vat of paint or other coating. This is the technique used by *dippers*, who immerse racks or baskets of articles in vats of paint, liquid plastic, or other solutions by means of a power hoist. This technique is commonly used for small parts in electronic equipment, such as cell phones.

Spraying products with a solution of paint or some other coating is also quite common. *Spray machine operators* use spray guns to coat metal, wood, ceramic, fabric, paper, and food products with paint and other coating solutions. Following a formula, operators fill the machine's tanks with a mixture of paints or chemicals, adding prescribed amounts of solution. Then they adjust nozzles on the spray guns to obtain the proper dispersion of the spray and hold or position the guns to direct the spray onto the article. Operators also check the flow and viscosity of the paint or solution and visually inspect the quality of the coating. When products are drying, these workers often must regulate the temperature and air circulation in drying ovens.

Some factories use automated painting systems that are operated by *coating, painting,* and *spraying machine setters, operators, and tenders*. When setting up these systems, operators position the automatic spray guns, set the nozzles, and synchronize the action of the guns with the speed of the conveyor carrying articles through the machine and drying ovens. The operator also may add solvents or water to the paint vessel to prepare the paint for application. During the operation of the painting machines, these workers tend the equipment, observe gauges on the control panel, and check articles for evidence of any variation from specifications. The operator uses a manual spray gun to "touch up" flaws.

Individuals who paint, coat, or decorate articles such as furniture, glass, pottery, toys, cakes, and books are known as *painting, coating, and decorating workers*. Some workers coat confectionery, bakery, and other food products with melted chocolate, cheese, oils, sugar, or other substances. Paper is often coated to give it its gloss or finish and silver, tin, and copper solutions are often sprayed on glass to make mirrors.

The best known group of painting and coating workers are those who refinish old or damaged cars, trucks, and buses in automotive body repair and paint shops. *Transportation equipment painters* who work in repair shops are among the most highly skilled manual spray operators, because they perform intricate, detailed work and mix paints to match the original color, a task that is especially difficult if the color has faded. The preparation work on an old car is similar to painting other metal objects. The paint is normally applied with a manually controlled spray gun.

Transportation equipment painters who work on new cars oversee several automated steps. A modern car is first dipped in an anti-corrosion bath, then coated with colored paint, and then painted in several coats of clear paint, which prevents scratches from damaging the colored paint.

Most other transportation equipment painters either paint equipment too large to paint automatically—such as ships or giant construction equipment—or perform touch-up work to



Automotive painters wear ventilators to ensure safety.

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repair flaws in the paint caused either by damage during assembly or flaws during the automated painting process.

With all types of coating, it is common for the painting process to be repeated several times to achieve a thick, smooth, protective coverage.

Work environment. Painting and coating workers typically work indoors and may be exposed to dangerous fumes from paint and coating solutions, although in general, workers' exposure to hazardous chemicals has decreased because of regulations limiting emissions of volatile organic compounds and other hazardous air pollutants. Painting usually is done in special ventilated booths with workers typically wearing masks or respirators that cover their noses and mouths. More sophisticated paint booths and fresh-air systems are increasingly used to provide a safer work environment.

Operators have to stand for long periods, and when using a spray gun, they may have to bend, stoop, or crouch in uncomfortable positions to reach different parts of the products.

Most painting and coating workers work a normal 40-hour week, but automotive painters in repair shops can work more than 50 hours a week, depending on the number of vehicles that need repainting.

Training, Other Qualifications, and Advancement

A high school diploma or equivalent is required for most workers; training for new workers usually lasts from a few days to several months, but becoming skilled in all aspects of painting can require 1 to 2 years of experience.

Education and training. Painting and coating workers employed in the manufacturing sector are usually required to have a high school degree or equivalent; employers in other sectors may be willing to hire workers without a high school diploma. Training for beginning painting and coating machine setters, operators, and tenders and for painting, coating, and decorating workers, may last from a few days to a couple of months. Coating, painting, and spraying machine setters, operators, and tenders who modify the operation of computer-controlled equipment may require additional training in computer operations and minor programming. Transportation equipment painters typically learn their jobs through either apprenticeships as helpers or postsecondary education in painting.

Becoming skilled in all aspects of painting usually requires 1 to 2 years of experience and sometimes requires some formal classroom instruction and on-the-job training. Beginning helpers usually remove trim, clean, and sand surfaces to be painted; mask surfaces they do not want painted; and polish finished work. As helpers gain experience, they progress to more complicated tasks, such as mixing paint to achieve a good match and using spray guns to apply primer coats or final coats to small areas.

Additional instruction in safety, equipment, and techniques is offered at some community colleges and vocational or technical schools. Employers also sponsor training programs to help their workers become more productive. Additional training is available from manufacturers of chemicals, paints, or equipment, explaining their products and giving tips about techniques.

Other qualifications. Painting and coating workers in factories need to be able to read and follow detailed plans or blueprints. Some workers also need artistic talent to paint furniture, decorate cakes, or make sure that the paint on a car or other object is the right color. Applicants should be able to breathe comfortably wearing a respirator.

Certification and advancement. Voluntary certification by the National Institute for Automotive Service Excellence (ASE) is recognized as the standard of achievement for automotive painters. For certification, painters must pass a written examination and have at least 2 years of experience in the field. High school, trade or vocational school, or community or junior college training in automotive refinishing that meets ASE standards may substitute for up to 1 year of experience. To retain the certification, painters must retake the examination at least every 5 years. Outside of automobile painters, few receive certifications.

Some automotive painters go to technical schools to learn the intricacies of mixing and applying different types of paint. Such programs can improve employment prospects and speed up promotion. Experienced painting and coating workers with leadership ability may become team leaders or supervisors. Many become paint and coating inspectors. Those who get practical experience or formal training may become sales or technical representatives for chemical or paint companies. Some automotive painters eventually open their own shops.

Employment

Painting and coating workers held about 192,700 jobs in 2008. Coating, painting, and spraying machine setters, operators, and tenders accounted for about 107,800 jobs, while transportation equipment painters constituted about 52,200. Another 32,700 jobs were held by painting, coating, and decorating workers.

Approximately 2 out of 3 workers were employed by manufacturing establishments, particularly those that manufacture fabricated metal products, transportation equipment, industrial machines, household and office furniture, and plastic, wood, and paper products. Outside manufacturing, workers were

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Painting workers	51-9120	192,700	199,900	7,300	4
Coating, painting, and spraying machine setters, operators, and tenders	51-9121	107,800	111,300	3,500	3
Painters, transportation equipment	51-9122	52,200	52,600	400	1
Painting, coating, and decorating workers	51-9123	32,700	36,000	3,300	10

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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employed by independent automotive repair shops and by motor vehicle dealers. About 6 percent were self-employed.

Job Outlook

Overall employment is expected to grow slower than the average for all occupations, but employment change will vary by specialty. Good job prospects are expected for skilled workers with painting experience.

Employment change. Overall employment of painting and coating workers is expected to increase by 4 percent from 2008-2018, which is slower than the average for all occupations. This growth will be driven primarily by the increasing number of goods requiring painting or coating. However, growth will be limited by gains in efficiency from automation and other processes. For example, operators will be able to coat goods more rapidly as sophisticated industrial machinery moves and aims spray guns more efficiently. Much of the growth in these occupations will be seen in the retail sector, as automation is less common in this industry.

Job prospects. Like many manufacturing occupations, employers report difficulty finding qualified workers. Opportunities should be good for those with painting experience. Job openings will result from the need to replace workers who leave the occupation and from increased specialization in manufacturing.

Earnings

Median hourly wages coating, painting, and spraying machine setters, operators, and tenders were $13.66 in May 2008. The middle 50 percent earned between $11.00 and $16.97 an hour. The lowest 10 percent earned less than $9.18, and the highest 10 percent earned more than $20.35 an hour.

Median hourly wages transportation equipment painters were $17.86 in May 2008. The middle 50 percent earned between $13.99 and $24.01 an hour. The lowest 10 percent earned less than $11.31, and the highest 10 percent earned more than $29.93 an hour. Median hourly wages of transportation equipment painters were $17.86 in automotive repair and maintenance shops and $26.61 in motor vehicle manufacturing.

Median hourly wages of painting, coating, and decorating workers were $11.57 in May 2008. The middle 50 percent earned between $9.46 and $14.60 an hour. The lowest 10 percent earned less than $8.15, and the highest 10 percent earned more than $18.55 an hour.

Many automotive painters employed by motor vehicle dealers and independent automotive repair shops receive a commission, based on the labor cost charged to the customer. Under this method, earnings depend largely on the amount of work a painter does and how fast it is completed. Employers frequently guarantee commissioned painters a minimum weekly salary. Helpers and trainees usually receive an hourly rate until they become sufficiently skilled to work on commission. Trucking companies, bus lines, and other organizations that repair and refinish their own vehicles usually pay by the hour.

Some painting and coating machine operators belong to unions, including the United Auto Workers and the International Brotherhood of Teamsters. Most union operators work for manufacturers and large motor vehicle dealers.

Related Occupations

The work performed by the following occupations is similar to the duties of painting and coating workers:

	Page
Automotive body and related repairers	687
Machine setters, operators, and tenders—metal and plastic	734
Painters and paperhangers	656

Sources of Additional Information

For more details about work opportunities, contact local manufacturers, automotive body repair shops, motor vehicle dealers, vocational schools, locals of unions representing painting and coating workers, or the local offices of your State employment service. The State employment service also may be a source of information about training programs.

For a directory of certified automotive painting programs, contact:

➤ National Automotive Technician Education Foundation, 101 Blue Seal Dr., Suite 101, Leesburg, VA 20175. Internet: **http://www.natef.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos240.htm**

Semiconductor Processors

Significant Points

- Employment is expected to decline rapidly over the next 10 years, despite increased demand for semiconductor products.
- Opportunities will be best for applicants who have an associate degree in a relevant subject and work experience in high-tech manufacturing.
- Although applicants may face competition, many skills learned in this occupation are transferable to other high-tech manufacturing jobs.

Nature of the Work

Semiconductors are unique substances, which, under different conditions, can act as either conductors or insulators of electricity. Semiconductor processors turn one of these substances—silicon—into integrated circuits, also known as microchips. These integrated circuits contain anywhere from dozens to millions of tiny electronic components, and are used in a wide range of products, from personal computers and cellular telephones to airplanes and missile guidance systems.

Semiconductor processors—often referred to in the industry as *technicians* or *process technicians*—oversee the manufacturing process of microchips. This process begins with the production of cylinders of silicon called ingots. The ingots then are sliced into thin wafers. Using automated equipment, robots polish the wafers, imprint precise microscopic patterns of the

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circuitry onto them using photolithography, etch out patterns with acids, and replace the patterns with conductors, such as aluminum or copper. The wafers then receive a chemical bath to make them smooth, and the imprint process begins again on a new layer with the next pattern. A complex chip may contain more than 20 layers of circuitry. Once the process is complete, wafers are then cut into individual chips, which are enclosed in a casing and shipped to equipment manufacturers.

The manufacturing and slicing of wafers to create semiconductors takes place in clean rooms—production areas that are kept free of all airborne matter, because the circuitry on a chip is so small that even microscopic particles can make it unusable. All semiconductor processors working in clean rooms must wear special lightweight outer garments known as "bunny suits." These garments fit over clothing to prevent lint and other particles from contaminating the clean room.

Semiconductor processors troubleshoot production problems and make equipment adjustments and repairs. They take the lead in assuring quality control and in maintaining equipment. They also test completed chips to make sure they work properly. To keep equipment repairs to a minimum, technicians perform diagnostic analyses and run computations. For example, technicians may determine if a flaw in a chip is due to contamination and peculiar to that wafer, or if the flaw is inherent in the manufacturing process.

Work environment. Workers begin their shift by putting on a bunny suit. For new workers, this often can take as much as 40 minutes, but experienced workers can generally do it in 5 minutes or less. The work pace in clean rooms is deliberately slow. Limited movement keeps the air in clean rooms as free as possible of dust and other particles, which can destroy microchips during their production. Because the machinery sets the operators' rate of work, workers maintain a relaxed pace. Technicians are on their feet most of the day, walking through the clean room to oversee production activities.

The temperature in the clean rooms must be kept within a narrow range and generally is comfortable for workers. Although bunny suits cover virtually the entire body, their lightweight fabric keeps the temperature inside fairly comfortable. Entry and exit of workers from the clean room are controlled to minimize contamination, and workers must be reclothed in a clean bunny suit and decontaminated each time they return to the clean room.



Semiconductor processors troubleshoot problems in the production of microchips and make equipment adjustments and repairs.

Semiconductor fabricating plants operate around the clock. Night and weekend work is common. In some plants, workers maintain standard 8-hour shifts, 5 days a week. In other plants, employees are on duty for 12-hour shifts to minimize the disruption of clean room operations brought about by changes. Managers also may allow workers to alternate schedules, thereby distributing the overnight shift equitably.

Training, Other Qualifications, and Advancement

Semiconductor processors typically have associate degrees or technical school certificates, as well as math and science skills.

Education and training. For semiconductor processor jobs, employers prefer applicants who have completed associate degrees in highly automated systems, electromechanical automation, or electronics. However, completion of a 1-year certificate program in semiconductor technology or high-tech manufacturing, offered by some community colleges, may be sufficient. Some semiconductor technology programs at community colleges include internships at semiconductor fabricating plants. Hands-on training is an important part of degree and certificate programs.

To ensure that operators and technicians keep their skills current, employers provide regular on-the-job training. Some employers also provide financial assistance to employees who want to earn associate or bachelor's degrees, especially if the employee is working toward becoming a technician.

Other qualifications. People interested in becoming semiconductor processors—either operators or technicians—need strong technical skills, an ability to solve problems intuitively, and an ability to work in teams. Mathematics, including statistics, and physical science knowledge are useful. Communication skills and an understanding of manufacturing principles also are very important.

Advancement. Workers advance as they become more comfortable with the equipment and better understand the manufacturing process. Employees train workers for several months, after which they become entry-level operators or technicians. After a few years, as they become more knowledgeable about the operations of the plant, they generally advance to the intermediate level. This entails greater responsibilities. Over time, usually 7 to 10 years, workers may become senior technicians, who lead teams of technicians and work directly with engineers to develop processes in the plant.

Employment

Semiconductor processors held approximately 31,600 jobs in 2008. Nearly all of them were employed in the computer and electronic product manufacturing industry.

Job Outlook

Employment of semiconductor processors is projected to decline rapidly through 2018. Opportunities will be best for those with associate degrees and experience working in high-tech manufacturing.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Semiconductor processors	51-9141	31,600	21,600	-10,000	-32

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

Employment change. Employment of semiconductor processors is projected to decline by 32 percent between 2008 and 2018. This reflects a changing manufacturing environment in which technological advances have reduced the need for workers.

Most of the microchips produced in the United States are highly complex. The success of these chips depends chiefly on their speed and flexibility. Meeting both of these goals requires smaller individual components, which are now measured in nanometers (one millionth of a millimeter). Because the components are so small, it is now impossible for humans to handle chips in production, since these chips are so sensitive to dust and other particles. As a result, there has been a decline in semiconductor processor employment for many years, despite a strong domestic industry. As technology advances, the decline in employment is expected to continue.

Job prospects. Jobseekers can expect competition for these positions, in response to the rapid decline in employment. Nonetheless, some jobs will open up due to the need to replace workers who leave the occupation. Prospects will be best for applicants with associate degrees and experience in high-tech manufacturing. Like most manufacturing industries, the semiconductor industry is highly sensitive to economic downturns.

Despite competition for these jobs, however, people who are interested in this type of work should be aware that the duties of semiconductor processors closely resemble those of other high-tech manufacturing jobs. Many of the skills learned in an associate degree or technical school program—as well as on the job—are transferable to other occupations.

Earnings

Median annual wages of wage-and-salary semiconductor processors were $32,230 in May 2008. The middle 50 percent earned between $26,650 and $40,220. The lowest 10 percent earned less than $21,980, and the top 10 percent earned more than $50,400.

Technicians with associate degrees in a related field generally start at higher salaries than those with less education.

Semiconductor processors generally received good benefits packages, including healthcare, disability plans and life insurance, stock options and retirement.

Related Occupations

Other occupations involved in high-tech manufacturing production include:

	Page
Assemblers and fabricators	723
Electrical engineers	161
Engineering technicians	173
Inspectors, testers, sorters, samplers, and weighers	768
Science technicians	230
Tool and die makers	740

Sources of Additional Information

For more information on semiconductor processor careers, contact:

➤ Maricopa Advanced Technology Education Center, 4110 E. Wood St., Suite 1, Phoenix, AZ 85040. Internet: **http://www.matec.org**

➤ SEMI, 3081 Zanker Rd., San Jose, CA 95134. Internet: **http://www.semi.org**

➤ Semiconductor Industry Association, 181 Metro Dr., Suite 450, San Jose, CA 95110. Internet: **http://www.sia-online.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos257.htm**

Other Production Occupations

Photographic Process Workers and Processing Machine Operators

Nature of the Work

Photographic processing machine operators use various machines to create prints from film or digital photographs. Most digital processing is done automatically by computer software. *Photographic process workers* perform more delicate tasks, such as retouching photographic negatives, prints, and images to emphasize or correct specific features.

Education and Training

Most skills needed for these jobs can be learned on-the-job in a few months.

Job Outlook

Current and projected employment:

2008 Employment	73,000
2018 Employment	61,200
Employment change	-11,800
Growth rate	-16%

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Employment change. Employment is expected to decline rapidly. Self-service machines, home printers, and online ordering services will be able to meet most of the demand for digital prints, but there still will be some demand for professionals to operate the machines, and to develop and print photos from people who continue to use film cameras. Using digital cameras and technology, consumers who have a personal computer are able to edit and to retouch pictures on their computers.

Job prospects. Job opportunities will be best for individuals with experience using computers and digital technology.

Earnings

Median annual wages in May 2008 were as follows:

Photographic process workers	$26,010
Photographic processing machine operators	20,360

Related Occupations

	Page
Clinical laboratory technologists and technicians	411
Computer operators	589
Jewelers and precious stone and metal workers	770
Prepress technicians and workers	748
Printing machine operators	750
Science technicians	230

Sources of Additional Information

➤ Photo Marketing Association International, 3000 Picture Pl, Jackson, MI 49201. Internet: **http://www.pmai.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos241.htm**

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Transportation and Material Moving Occupations

Air Transportation Occupations

Air Traffic Controllers

Significant Points

- The vast majority of air traffic controllers are employed by the Federal Aviation Administration (FAA), an agency of the Federal Government.
- Applicants without prior air traffic control experience must be 30 years of age or younger.
- Replacement needs will continue to account for most job openings, reflecting the large number of air traffic controllers who will be eligible to retire over the next decade.
- Competition for jobs will remain keen.

Nature of the Work

The National Airspace System (NAS) is a vast network of people and equipment that ensures the safe operation of commercial and private aircraft. *Air traffic controllers* work within the NAS to coordinate the movement of air traffic to make certain that planes stay a safe distance apart. Their immediate concern is safety, but controllers also must direct planes efficiently to minimize delays. Some regulate airport traffic through designated airspaces; others regulate airport arrivals and departures.

Terminal controllers watch over all planes traveling in an airport's airspace. Their main responsibility is to organize the flow of aircraft into and out of the airport. They work in either the control tower or the terminal radar approach control (TRACON) room or building. Relying on visual observation, the *tower local controllers* sequence arrival aircraft for landing and issue departure clearances for those departing from the airport. Other controllers in the tower control the movement of aircraft on the taxiways, handle flight data, and provide flight plan clearances. *Terminal radar controllers* manage aircraft departing from or arriving to an airport by monitoring each aircraft's movement on radar to ensure that a safe distance is maintained between all aircraft under their control. In addition, terminal controllers keep pilots informed about weather and runway conditions.

Many different controllers are involved in the departure of an airplane. If the plane is flying under instrument flight rule conditions, a flight plan is filed prior to departure. The *tower flight data controller* receives the flight plan in the form of a flight strip, which is output from a computer, and arranges it in sequence. When an aircraft calls for clearance the *clearance delivery controller* issues the clearance and moves the strip over to the *ground controller* who manages the movement of aircraft on the airport surface, except the active runway. When the aircraft arrives at the active runway the strip is moved to the local controller who issues the departure clearance, observes the takeoff and turns the plane over to the departure controller. The TRACON departure controller identifies the plane on radar, climbs it, and directs it on course.

After each plane departs, terminal controllers notify *en route controllers*, who take charge next. There are 20 air route traffic control centers located around the country, each employing 300 to 700 controllers, with more than 150 on duty during peak hours at the busiest facilities. Airplanes usually fly along designated routes; each center is assigned a certain airspace containing many different routes. En route controllers work either individually or in teams of two, depending on how heavy traffic is; each team is responsible for a sector of the center's airspace.

As the plane proceeds on its flight plan to its destination it is handed off from sector to sector both within the center and to adjoining centers. To prepare for planes about to enter the team's sector, the *radar associate controller* organizes flight plans output from a printer into strip bays. If two planes are scheduled to enter the team's sector in conflict, the controller may arrange with the preceding sector unit for one plane to change its flight path or altitude. As a plane approaches a team's airspace, the radar controller accepts responsibility for the plane from the previous sector. The controller also delegates responsibility for the plane to the next sector when the plane leaves the team's airspace.

When the plane is approximately 50 miles from the destination airport, it is handed off to that airport's *terminal radar arrival controller* who sequences it with other arrivals, and issues an approach clearance. As the plane nears the runway, the pilot is issued a clearance to contact the tower. The local controller issues the landing clearance. Once the plane has landed, the ground controller directs it along the taxiways to its assigned gate. The local and ground controllers usually work entirely by sight, but may use airport surface radar if visibility is very poor.

Both airport tower and en route controllers usually control several planes at a time, often making quick decisions about completely different activities. For example, a controller might direct a plane on its landing approach and at the same time provide pilots entering the airport's airspace with information about conditions at the airport. While instructing these pilots, the controller also might observe other planes in the vicinity, such as those in a holding pattern waiting for permission to land, to ensure that they remain well separated.

In addition to airport towers and en route centers, air traffic controllers also work in flight service stations at 17 locations in Alaska. These *flight service specialists* provide pilots with

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Competition for air traffic controller jobs is expected to remain keen.

preflight and in-flight weather information, suggested routes, and other aeronautical information important to the safety of a flight. Flight service specialists relay air traffic control clearances to pilots not in direct communications with a tower or center, assist pilots in emergency situations, and initiate and coordinate searches for missing or overdue aircraft. At certain locations where there is no airport tower or the tower has closed for the day, flight service specialists provide airport advisory services to landing and departing aircraft. However, they are not involved in actively managing and separating air traffic.

Some air traffic controllers work at the FAA's Air Traffic Control Systems Command Center in Herndon, VA, where they oversee the entire system. They look for situations that will create bottlenecks or other problems in the system and then respond with a management plan for traffic into and out of the troubled sector. The objective is to keep traffic levels in the trouble spots manageable for the controllers working at en route centers.

Work environment. During busy times, controllers must work rapidly and efficiently. Total concentration is required to keep track of several planes at the same time and to make certain that all pilots receive correct instructions. The mental stress of being responsible for the safety of several aircraft and their passengers can be exhausting. Unlike tower controllers, radar controllers also have the extra stress of having to work in semidarkness, never seeing the actual aircraft they control except as a small "blip" on the radarscope. Controllers who work in flight service stations work in offices close to the communications and computer equipment.

Controllers work a basic 40-hour week; however, they may work additional hours, for which they receive overtime, or premium pay, or equal time off. Because most control towers and centers operate 24 hours a day, 7 days a week, controllers rotate night and weekend shifts. Contract towers and flight service station working conditions may vary somewhat from the FAA.

Training, Other Qualifications, and Advancement

To become an air traffic controller with the FAA, a person must achieve a qualifying score on the FAA-authorized preemployment test and meet the basic qualification requirements in accordance with Federal law. Those without prior air traffic control experience must be 30 years of age or younger.

Education and training. There are three main pathways to become an air traffic controller with the FAA. The first is air traffic controllers with prior experience through either the FAA or the Department of Defense as a civilian or veteran. Second are applicants from the general public. These applicants must have 3 years of progressively responsible full-time work experience, have completed a full 4 years of college, or a combination of both. In combining education and experience, 1 year of undergraduate study—30 semester or 45 quarter hours—is equivalent to 9 months of work experience. The third way is for an applicant to have successfully completed an aviation-related program of study through the FAA's Air Traffic-Collegiate Training Initiative (AT-CTI) program. In 2008, there were 31 schools in the AT-CTI program.

AT-CTI program schools offer 2–year or 4-year non-engineering degrees that teach basic courses in aviation and air traffic control. In addition to graduation, AT-CTI candidates need a recommendation from their school before being considered for employment as an air traffic controller by the FAA.

Candidates with prior experience as air traffic controllers are automatically qualified for FAA air traffic controller positions. However, applicants from the general public and the AT-CTI program must pass the FAA-authorized pre-employment test that measures their ability to learn the duties of a controller. The test is administered by computer and takes about 8 hours to complete. To take the test, an applicant must apply under an open advertisement for air traffic control positions and be chosen to take the examination. When there are many more applicants than available testing positions, applicants are selected randomly. However, the FAA guarantees that all AT-CTI students in good standing in their programs will be given the FAA pre-employment test. Those who achieve a qualifying score on the test become eligible for employment as an air traffic controller. Candidates must be granted security and medical clearance and are subject to drug screening. Additionally, applicants must meet other basic qualification requirements in accordance with Federal law. These requirements include United States citizenship and the ability to speak English.

Upon selection, employees attend the FAA Academy in Oklahoma City, OK, for 12 weeks of training, during which they learn the fundamentals of the airway system, FAA regulations, controller equipment, and aircraft performance characteristics, as well as more specialized tasks. Graduates of the AT-CTI program are eligible to bypass the Air Traffic Basics Course, which is the first 5 weeks of qualification training at the FAA Academy.

After graduation from the FAA Academy in Oklahoma City, candidates are assigned to an air traffic control facility and are classified as "developmental controllers" until they complete all requirements to be certified for all of the air traffic control positions within a defined area of a given facility. Generally, it takes new controllers with only initial controller training between 2 and 4 years, depending on the facility and the availability of facility staff or contractors to provide on-the-job training, to complete all the certification requirements to become certified professional controllers. Individuals who have had prior

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controller experience normally take less time to become fully certified. Controllers who fail to complete either the academy or the on-the-job portions of the training usually are dismissed. Controllers must pass a physical examination each year and a job performance examination twice each year. Failure to become certified in any position at a facility within a specified time also may result in dismissal. Controllers also are subject to drug screenings as a condition of continuing employment.

Other qualifications. Air traffic controllers must be articulate to give pilots directions quickly and clearly. Intelligence and a good memory also are important because controllers constantly receive information that they must immediately grasp, interpret, and remember. Decisiveness also is required because controllers often have to make quick decisions. The ability to concentrate is crucial because controllers must make these decisions in the midst of noise and other distractions.

Advancement. At airports, new controllers begin by supplying pilots with basic flight data and airport information. They then advance to the position of ground controller, local controller, departure controller, and, finally, arrival controller. At an air route traffic control center, new controllers first deliver printed flight plans to teams, gradually advancing to radar associate controller and then to radar controller.

Controllers can transfer to jobs at different locations or advance to supervisory positions, including management or staff jobs—such as air traffic control data systems computer specialist—in air traffic control, and top administrative jobs in the FAA. However, there are only limited opportunities for a controller to switch from a position in an en route center to a tower.

Employment

Air traffic controllers held about 26,200 jobs in 2008. The vast majority were employed by the FAA, while a small number of civilian controllers also work for the U.S. Department of Defense. In addition to controllers employed by the Federal Government, some work for private air traffic control companies providing service to non-FAA towers and contract flight service stations.

Job Outlook

Air traffic controllers should experience about as fast as average employment growth, but most opportunities are expected to result from the need to replace workers who retire or leave the occupation for other reasons. Keen competition is expected for air traffic controller positions.

Employment change. Employment of air traffic controllers is projected to grow by 13 percent from 2008 to 2018, which is about as fast as the average for all occupations. Increasing air traffic will require more controllers to handle the additional work. Job growth, however, is not expected to keep pace with the increasing number of aircraft flying due to advances in technology.

The FAA is implementing an automated air traffic control system that will allow controllers to more efficiently deal with the demands of increased air traffic. It includes the replacement of aging equipment and the introduction of new systems, technologies, and procedures to enhance safety and security and support future aviation growth. Future developments will include the use of the Global Positioning System (GPS) to eliminate radar-based air traffic control and give controllers real-time displays of aircraft locations. This will allow for more efficient flight paths and reduced air traffic congestion, and it will also allow controllers to handle more traffic, increasing their productivity.

Job prospects. Most job opportunities are expected as the result of replacement needs from workers leaving the occupation. The majority of today's air traffic controllers will be eligible to retire over the next decade, although not all are expected to do so. Despite the increasing number of job openings for air traffic controllers, competition to get into the FAA Academy is expected to remain keen, as there generally are many more test applicants than there are openings.

Air traffic controllers who continue to meet the proficiency and medical requirements enjoy more job security than do most workers. While demand for air transportation declines during recessions, controllers are rarely laid off.

Earnings

Air traffic controllers earn relatively high pay and have good benefits. Median annual wages of air traffic controllers in May 2008 were $111,870. The middle 50 percent earned between $71,050 and $143,780. The lowest 10 percent earned less than $45,020, and the highest 10 percent earned more than $161,010. The average annual salary, excluding overtime earnings, for air traffic controllers in the Federal Government—which employs 90 percent of all controllers—was $109,218 in March 2009.

The Air Traffic Control pay system classifies each air traffic facility into one of eight levels with corresponding pay bands. Under this pay system, controllers' salaries are determined by the rating of the facility. Higher ratings usually mean higher controller salaries and greater demands on the controller's judgment, skill, and decision-making ability.

Depending on length of service, air traffic controllers receive 13 to 26 days of paid vacation and 13 days of paid sick leave each year, in addition to life insurance and health benefits. Controllers also can retire at an earlier age and with fewer years of service than other Federal employees. Air traffic controllers are eligible to retire at age 50 with 20 years of service as an active air traffic controller or after 25 years of active service at any age. There is a mandatory retirement age of 56 for controllers who manage air traffic. However, Federal law provides for exemptions to the mandatory age of 56, up to age 61 in certain cases, but controllers must have exceptional skills and experience. Earnings and benefits for controllers working in contract towers or flight service stations

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Air traffic controllers	53-2021	26,200	29,600	3,400	13

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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may vary. Many air traffic controllers hold union membership, primarily with the National Air Traffic Controllers Association.

Related Occupations

Another occupation involved in the direction and control of traffic in air transportation is:

Airfield operations specialists 832

Sources of Additional Information

For further information on how to qualify and apply for a job as an air traffic controller, contact the FAA:

➤ Federal Aviation Administration, 800 Independence Ave. SW., Washington, DC 20591. Internet: **http://www.faa.gov**

For further information on air traffic controllers, contact:

➤ National Air Traffic Controllers Association, 1325 Massachusetts Ave. NW., Washington, DC 20005. Internet: **http://www.natca.org/**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos108.htm**

Aircraft Pilots and Flight Engineers

Significant Points

- Regional and low-cost airlines offer the best opportunities; pilots face strong competition for jobs at the major airlines, which offer better pay and benefits.
- Many pilots have learned to fly in the military, but growing numbers have college degrees with flight training from civilian flying schools that are certified by the Federal Aviation Administration (FAA).
- Newly hired pilots at major airlines typically have about 4,000 hours of flight experience.

Nature of the Work

Pilots are highly trained professionals who fly airplanes or helicopters to carry out a wide variety of tasks. Most are *airline pilots, copilots*, and *flight engineers* who transport passengers and cargo. However, 34 percent are commercial pilots involved in dusting crops, spreading seed for reforestation, testing aircraft, flying passengers and cargo to areas not served by regular airlines, directing firefighting efforts, tracking criminals, monitoring traffic, and rescuing and evacuating injured persons.

Except on small aircraft, two pilots usually make up the cockpit crew. Generally, the most experienced pilot, the *captain*, is in command and supervises all other crew members. The pilot and the copilot, often called the *first officer*, share flying and other duties, such as communicating with air traffic controllers and monitoring the instruments. Some large aircraft have a third crewmember, the flight engineer, who assists the pilots by monitoring and operating many of the instruments and systems, making minor in-flight repairs, and watching for other aircraft. The flight engineer also assists the pilots with the company, air traffic control, and cabin crew communications. New technology can perform many flight tasks, however, and virtually all new aircraft now fly with only two pilots, who rely more heavily on computerized controls.

Before departure, pilots plan their flights carefully. They thoroughly check their aircraft to make sure that the engines, controls, instruments, and other systems are functioning properly. They also make sure that baggage or cargo has been loaded correctly. They confer with flight dispatchers and aviation weather forecasters to find out about weather conditions en route and at their destination. Based on this information, they choose a route, altitude, and speed that will provide the safest, most economical, and smoothest flight. When flying under instrument flight rules—procedures governing the operation of the aircraft when there is poor visibility—the pilot in command, or the company dispatcher, normally files an instrument flight plan with air traffic control so that the flight can be coordinated with other air traffic.

Takeoff and landing are the most difficult parts of the flight, and require close coordination between the two pilots. For example, as the plane accelerates for takeoff, the pilot concentrates on the runway while the copilot, scans the instrument panel. To calculate the speed they must attain to become airborne, pilots consider the altitude of the airport, outside temperature, weight of the plane, and speed and direction of the wind. The moment the plane reaches takeoff speed, the copilot informs the pilot, who then pulls back on the controls to raise the nose of the plane. Captains and first officers usually alternate flying each leg from takeoff to landing.

Unless the weather is bad, the flight itself is relatively routine. Airplane pilots, with the assistance of autopilot and the flight management computer, steer the plane along their planned route and are monitored by the air traffic control stations they pass along the way. They regularly scan the instrument panel to check their fuel supply; the condition of their engines; and the air-conditioning, hydraulic, and other systems. Pilots may request a change in altitude or route if circumstances dictate. For example, if the ride is rougher than expected, pilots may ask air traffic control if pilots flying at other altitudes have reported better conditions; if so, they may request an altitude change. This procedure also may be used to find a stronger tailwind or a weaker headwind to save fuel and increase speed. In contrast, because helicopters are used for short trips at relatively low altitude, helicopter pilots must be constantly on the lookout for trees, bridges, power lines, transmission towers, and other dangerous obstacles as well as low-flying general aviation aircraft. Regardless of the type of aircraft, all pilots must monitor warning devices designed to help detect sudden shifts in wind conditions that can cause crashes.

Pilots must rely completely on their instruments when visibility is poor. On the basis of altimeter readings, they know how high above ground they are and whether they can fly safely over mountains and other obstacles. Special navigation radios give pilots precise information that, with the help of special charts, tells them their exact position. Other very sophisticated equipment provides directions to a point just above the end of a runway and enables pilots to land completely without an outside visual reference. Once on the ground, pilots must complete

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Before every flight, pilots inspect the aircraft.

records on their flight and the aircraft maintenance status for their company and the FAA.

The number of nonflying duties that pilots have depends on the employment setting. Airline pilots have the services of large support staffs and, consequently, perform few nonflying duties. However, because of the large numbers of passengers, airline pilots may be called upon to coordinate handling of disgruntled or disruptive passengers. Also, under the Federal Flight Deck Officer program airline pilots who undergo rigorous training and screening are deputized as Federal law enforcement officers and are issued firearms to protect the cockpit against intruders and hijackers. Pilots employed by other organizations, such as charter operators or businesses, have many other duties. They may load the aircraft, handle all passenger luggage to ensure a balanced load, and supervise refueling; other nonflying responsibilities include keeping records, scheduling flights, arranging for major maintenance, and performing minor aircraft maintenance and repairs.

Some pilots are flight instructors. They teach their students in ground-school classes, in simulators, and in dual-controlled planes and helicopters. A few specially trained pilots are examiners or check pilots. They periodically fly with other pilots or pilot's license applicants to make sure that they are proficient.

Work environment. Most pilots spend a considerable amount of time away from home because the majority of flights involve overnight layovers. According to the Airline Pilot's Association, pilots spend approximately 360 hours a month away from their home base. When pilots are away from home, the airlines provide hotel accommodations, transportation between the hotel and airport, and an allowance for meals and other expenses.

Airline pilots, especially those on international routes, often experience jet lag—fatigue caused by many hours of flying through different time zones. To guard against pilot fatigue, which could result in unsafe flying conditions, the FAA requires airlines to allow pilots at least 8 hours of uninterrupted rest in the 24 hours before finishing their flight duty.

Commercial pilots face other types of job hazards. The work of test pilots, who check the flight performance of new and experimental planes, may be dangerous. Pilots who are crop dusters may be exposed to toxic chemicals and seldom have the benefit of a regular landing strip. Helicopter pilots involved in rescue and police work may be subject to personal injury. All pilots face the potential risk of hearing loss due to prolonged exposure to the constant noise coming from an aircraft's engines.

Although flying does not involve much physical effort, the mental stress of being responsible for a safe flight, regardless of the weather, can be tiring. Pilots must be alert and quick to react if something goes wrong, particularly during takeoff and landing.

FAA regulations limit flying time of airline pilots of large aircraft to a maximum of 100 hours a month and 1,000 hours a year. Most airline pilots fly an average of 75 hours a month and work an additional 140 hours a month performing nonflying duties, which includes waiting for delays to clear and their aircraft to arrive. Most pilots have variable work schedules, working several days on, then several days off. Airlines operate flights at all hours of the day and night, so work schedules often are irregular. Flight assignments are based on seniority; the sooner pilots are hired, the stronger their bidding power is for preferred assignments.

Commercial pilots also may have irregular schedules, flying 30 hours one month and 90 hours the next. Because these pilots frequently have many nonflying responsibilities, they have much less free time than do airline pilots. Except for corporate flight department pilots, most commercial pilots do not remain away from home overnight, although they may work odd hours. However, if the company owns a fleet of planes, pilots may fly a regular schedule.

Flight instructors may have irregular and seasonal work schedules, depending on their students' available time and the weather. Instructors frequently work in the evening or on weekends.

Training, Other Qualifications, and Advancement

Many pilots have learned to fly in the military, but growing numbers have college degrees with flight training from civilian flying schools that are certified by the FAA. All pilots who are paid to transport passengers or cargo must have a commercial pilot's license.

Education and training. Although some small airlines hire high school graduates, most airlines require at least 2 years of college and prefer to hire college graduates. In fact, most entrants to this occupation have a college degree. Because the number of college-educated applicants continues to increase, many employers are making a college degree an educational requirement. Preferred courses in preparation for a career as an airline pilot include English, mathematics, physics, and aeronautical engineering.

Pilots also need flight experience to qualify for a license. The U.S. Armed Forces have always been an important source of experienced pilots because of the extensive flying time and experience on jet aircraft and helicopters. However, an increasing number of people are becoming pilots by attending flight schools or by taking lessons from FAA-certified flight instructors. Completing classes at a flight school approved by the FAA can reduce the amount of flight experience required for a pilot's license. In 2009, the FAA certified about 600 civilian flying schools, including some colleges and universities that offer degree credit for pilot training. Initial training for airline pilots typically includes a week of company indoctrination; 3 to 6 weeks of ground school and simulator training; and 25 hours of initial operating experience, including a check-ride with an

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FAA aviation safety inspector. Once trained, pilots are required to attend recurrent training and simulator checks once or twice a year throughout their career.

Licensure. To qualify for FAA licensure, applicants must be at least 18 years old and have at least 250 hours of flight experience. Applicants also must pass a strict physical examination to make sure that they are in good health and have 20/20 vision with or without corrective lenses, good hearing, and no physical handicaps that could impair their performance. They must pass a written test that includes questions on the principles of safe flight, navigation techniques, and FAA regulations, and must demonstrate their flying ability to FAA or designated examiners.

To fly during periods of low visibility, pilots must be rated by the FAA to fly by instruments. Pilots may qualify for this rating by having the required hours of flight experience, including 40 hours of experience in flying by instruments; they also must pass a written examination on procedures and FAA regulations covering instrument flying and demonstrate to an examiner their ability to fly by instruments. Requirements for the instrument rating vary depending on the certification level of flight school.

Airline pilots must fulfill additional requirements. Captains must have an air transport pilot's license. Applicants for this license must be at least 23 years old and have a minimum of 1,500 hours of flying experience, including cross country, night, and instrument flying, and must pass FAA written and flight examinations. Usually, they also have one or more advanced ratings depending on the requirements of their particular job. Because pilots must be able to make quick decisions and accurate judgments under pressure, many airline companies reject applicants who do not pass required psychological and aptitude tests. All licenses are valid so long as a pilot can pass the periodic physical and eye examinations and tests of flying skills required by the FAA and company regulations.

Other qualifications. Depending on the type of aircraft, new airline pilots start as first officers or flight engineers. Although some airlines favor applicants who already have a flight engineer's license, they may provide flight engineer training for those who have only the commercial license. Many pilots begin with smaller regional or commuter airlines, where they obtain experience flying passengers on scheduled flights into busy airports in all weather conditions. These jobs often lead to higher paying jobs with bigger, national or major airlines. Newly hired pilots at major airlines typically have about 4,000 hours of flight experience.

Companies other than airlines usually require less flying experience. However, a commercial pilot's license is a minimum requirement, and employers prefer applicants who have experience in the type of craft they will be flying. New employees usually start as first officers, or fly less sophisticated equipment.

Advancement. Advancement for pilots usually is limited to other flying jobs. Many pilots start as flight instructors, building up their flying hours while they earn money teaching. As they become more experienced, these pilots occasionally fly charter planes or perhaps get jobs with small air transportation firms, such as air-taxi companies. Some advance to flying corporate planes. A small number get flight engineer jobs with the airlines.

In the airlines, advancement usually depends on seniority provisions of union contracts. After 1 to 5 years, flight engineers advance according to seniority to first officer and, after 5 to 15 years, to captain. Seniority also determines which pilots get the more desirable routes. In a nonairline job, a first officer may advance to captain and, in large companies, to chief pilot or director of aviation in charge of aircraft scheduling, maintenance, and flight procedures.

Employment

Civilian aircraft pilots and flight engineers held about 116,000 jobs in 2008. About 76,800 worked as airline pilots, copilots, and flight engineers. The rest were commercial pilots who worked as flight instructors at local airports or for large businesses that fly company cargo and executives in their own airplanes or helicopters. Some commercial pilots flew small planes for air-taxi companies, usually to or from lightly traveled airports not served by major airlines. Others worked for a variety of businesses, performing tasks such as dusting crops, inspecting pipelines, or conducting sightseeing trips.

Pilots are located across the country, but airline pilots usually are based near major metropolitan airports or airports operating as hubs for the major airlines.

Job Outlook

Aircraft pilots and flight engineers are expected to grow about as fast as the average for all occupations. Regional airlines and low-cost carriers will present the best opportunities; pilots attempting to get jobs at the major airlines will face strong competition.

Employment change. Employment of aircraft pilots and flight engineers is projected to grow 12 percent from 2008 to 2018, which is about as fast as the average for all occupations. Population growth and an expanding economy in the long run are expected to boost the demand for air travel, contributing to job growth. New jobs will be created as airlines expand their capacity to meet this rising demand by increasing the number of planes in operation and the number of flights offered.

Job prospects. Job opportunities are expected to be best for experienced pilots with the regional airlines and low-cost carriers, which are expected to grow faster than the major air-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Aircraft pilots and flight engineers	53-2010	116,000	129,700	13,700	12
Airline pilots, copilots, and flight engineers	53-2011	76,800	83,300	6,400	8
Commercial pilots	53-2012	39,200	46,500	7,300	19

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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lines. Opportunities with air cargo carriers also should arise because of increasing security requirements for shipping freight on passenger airlines, growth in electronic commerce, and increased demand for global freight. Business, commuter, corporate, and on-demand air taxi travel also should provide some new jobs for pilots.

Pilots attempting to get jobs at the major airlines will face strong competition, as those firms tend to attract many more applicants than the number of job openings. Applicants also will have to compete with laid-off pilots for any available jobs. Pilots who have logged the greatest number of flying hours using sophisticated equipment typically have the best prospects. For this reason, military pilots often have an advantage over other applicants.

In addition to job openings arising from employment growth, opportunities will result from the need to replace workers transferring to other occupations or leaving the labor force. Additional openings will result from the mandatory retirement of commercial airline pilots at age 65.

Employment of pilots is sensitive to cyclical swings in the economy. During recessions, when a decline in the demand for air travel forces airlines to ground planes and curtail the number of flights, airlines may temporarily furlough some pilots.

Earnings

Earnings of aircraft pilots and flight engineers vary greatly depending whether they work as airline or commercial pilots. Earnings also depend on factors such as rank, seniority, and the size and type of aircraft flown. For example, pilots who fly jet aircraft usually earn higher salaries than pilots who fly turboprops. Airline pilots and flight engineers may earn extra pay for night and international flights. In May 2008, median annual wages of airline pilots, copilots, and flight engineers were $111,680. The middle 50 percent earned between $81,580 and $150,480.

Median annual wages of commercial pilots were $65,340 in May 2008. The middle 50 percent earned between $45,680 and $89,540. The lowest 10 percent earned less than $32,020, and the highest 10 percent earned more than $129,580.

Airline pilots usually are eligible for life and health insurance plans. They also receive retirement benefits and, if they fail the FAA physical examination at some point in their careers, they get disability payments. In addition, pilots receive an expense allowance, or "per diem," for every hour they are away from home. Some airlines also provide allowances to pilots for purchasing and cleaning their uniforms. As an additional benefit, pilots and their immediate families usually are entitled to free or reduced-fare transportation on their own and other airlines.

More than half of all aircraft pilots are members of unions. Most of the pilots who fly for the major airlines are members of the Air Line Pilots Association, International, but those employed by one major airline are members of the Allied Pilots Association.

Related Occupations

Although they are not in the cockpit, other occupations that also play an important role in making sure flights are safe and on schedule, and participate in many of the decisions that pilots must make, include:

	Page
Air traffic controllers	784
Airfield operations specialists	832

Sources of Additional Information

For information about job opportunities, salaries, and qualifications, write to the personnel manager of the particular airline.

For information on pilots, contact:

➤ Federal Aviation Administration, 800 Independence Ave. SW., Washington, DC 20591. Internet: **http://www.faa.gov**

For information on airline pilots, contact:

➤ Air Line Pilots Association, International, 1625 Massachusetts Ave. NW., Washington, DC 20036. Internet: **http://www.clearedtodream.org**

For information on helicopter pilots, contact:

➤ Helicopter Association International, 1635 Prince St., Alexandria, VA 22314. Internet: **http://www.rotor.com**

For information about job opportunities in companies other than airlines, consult the classified section of aviation trade magazines and apply to companies that operate aircraft at local airports.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos107.htm**

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Motor Vehicle Operators

Bus Drivers

Significant Points

- Opportunities should be good, although applicants for higher paying public transit bus driver positions may encounter competition.
- State and Federal governments establish bus driver qualifications and standards, which include a commercial driver's license.
- Work schedules vary considerably among various types of bus drivers.
- Bus drivers must possess strong customer service skills, including communication skills and the ability to manage large groups of people with varying needs.

Nature of the Work

Bus drivers provide transportation for millions of people, from commuters to school children to vacationers. There are two major kinds of bus drivers. *Transit and intercity bus drivers* transport people within or across States, along routes run within a metropolitan area or county, or on chartered excursions and tours. *School bus drivers* take children to and from schools and school-related activities.

Bus drivers pick up and drop off passengers at bus stops, stations, or—in the case of students—at regularly scheduled neighborhood locations and school, all according to strict time schedules. Drivers must operate vehicles safely, sometimes in heavy traffic. They also cannot let light traffic put them ahead of schedule so that they miss passengers. Bus drivers drive a range of vehicles from 15-passenger buses to 60-foot articulated buses that can carry more than 100 passengers.

Transit and intercity bus drivers can be further divided into those who work for local transportation agencies, those who drive on regularly scheduled intercity routes, and those who operate motor coaches. Both transit and regularly scheduled intercity service drivers begin a day's work at their garage or bus terminal. There, they may stock up on tickets or transfers and prepare trip reports before starting their first scheduled routes. In some transportation firms, maintenance departments are responsible for keeping vehicles in good condition; in others, drivers check their vehicles' tires, brakes, windshield wipers, lights, oil, fuel, and water supplies before beginning their routes. Drivers usually verify that buses have proper safety equipment, such as fire extinguishers, first aid kits, and emergency reflectors.



Bus drivers must be alert, especially in heavy traffic or in bad weather, to prevent accidents.

Local transit and intercity bus drivers collect fares; answer questions about schedules, routes, and transfer points; and sometimes announce stops. Intercity bus drivers may make only one to two stops between distant cities, or they may stop at towns just a few miles apart. Local transit bus drivers usually cover several routes each day over the same city and suburban streets, stopping as frequently as every few blocks or whenever passengers request stops.

Local transit bus drivers submit daily trip reports with a record of trips, significant schedule delays, and mechanical problems. Intercity drivers who drive across State or national boundaries must comply with U.S. Department of Transportation reporting regulations, including vehicle inspection reports, distances traveled and the time they spend driving.

Motor coach operators transport passengers on chartered trips and sightseeing tours. Whereas other bus drivers make predetermined stops on a schedule, these drivers work at the convenience of the groups they transport. Drivers routinely interact with customers and tour guides to make the trip as comfortable and informative as possible. They are directly responsible for making sure tours stay on-time and ensuring the overall success of each trip. These drivers act as customer service representatives, tour guides, program directors, and safety guides. Trips frequently last more than a day, so coach operators may spend extended periods away from home.

School bus drivers usually drive the same routes each day, stopping to pick up pupils in the morning and returning them to their homes in the afternoon. Some school bus drivers also transport students and teachers on field trips or to sporting events. In addition to driving, some school bus drivers work part time in the school system as janitors, mechanics, or classroom assistants, when not driving buses.

Bus drivers must be alert, especially in heavy traffic or in bad weather to prevent accidents, and to avoid sudden stops or swerves that jar passengers. School bus drivers must exercise particular caution when children are getting on or off the bus. They must maintain order on their bus and enforce school safety standards by allowing only students to board. In addition, they must know and enforce the school system's rules regarding student conduct. As the number of students with physical or behavioral disabilities increases, school bus drivers must learn how to accommodate their special needs.

Some school bus drivers can take their bus home or park it in a more convenient area, rather than reporting to an assigned terminal or garage. School bus drivers do not collect fares. In-

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stead, they prepare weekly reports on the number of students, trips or "runs," work hours, miles, and fuel consumption. Their supervisors set time schedules and routes for the day or week.

Work environment. Driving a bus through heavy traffic while dealing with passengers is more stressful and fatiguing than physically strenuous. Many drivers enjoy the opportunity to work without direct supervision, with full responsibility for their bus and passengers. To improve working conditions and retain drivers, many bus lines provide ergonomically designed seats and controls for drivers.

Transit and intercity bus drivers are often at high risk, mainly because they work alone and some passengers may be dangerous. Data from the U.S. Bureau of Labor Statistics show that transit and intercity bus drivers experienced a work-related injury and illness rate that was higher than the national average. School bus drivers, in contrast, have an average rate of non-fatal occupational injuries similar to all other occupations.

About 35 percent of all bus drivers worked part time in 2008. School bus drivers work only when schools are in session. Some work 20 hours a week or less, driving one or two routes in the morning and afternoon. Drivers taking field or athletic trips, or who also have midday kindergarten routes, may work more hours a week.

Regular local transit and intercity bus drivers usually have a 5 or 6 day workweek. They may have to work one or both weekend days on a regular basis. Some drivers work in the early morning, in the evening, or after midnight. To accommodate commuters, many work "split shifts"—for example, 6 a.m. to 10 a.m. and 3 p.m. to 7 p.m., with time off in between. Depending on the length of their routes, intercity bus drivers may spend one or more nights away from home at a time. Others may make a round-trip (or several round-trips) during a single day and come home at the end of each shift.

Motor coach operators may work any day and all hours of the day, including weekends and holidays. Their hours are dictated by the destinations, schedules, and itineraries of chartered tours. Like all commercial drivers, their weekly hours must be consistent with the Department of Transportation's rules and regulations concerning hours of service and they are required to document their time in a logbook.

Training, Other Qualifications, and Advancement

State and Federal governments establish bus driver qualifications and standards, which include a commercial driver's license (CDL) with the proper endorsements. Many employers provide several weeks of training and help new employees obtain their CDL.

Education and training. Some employers prefer high school graduates and require a written test of ability to follow complex bus schedules, but the ability to drive and a clean license are usually more important.

Most companies give driver trainees 2 to 8 weeks of classroom and behind-the-wheel instruction. In the classroom, trainees learn Department of Transportation and company work rules, safety regulations, State and municipal driving regulations, and safe driving practices. They also learn to read schedules, determine fares, keep records, and deal courteously with passengers.

During training, all bus drivers practice driving on set courses. They practice turns and zigzag maneuvers, backing up, and driving in narrow lanes. Then, they drive in light traffic and, eventually, on congested highways and city streets. They also make trial runs without passengers to improve their driving skills and learn the routes. Local transit trainees memorize and drive each of the runs operating out of their assigned garage. New drivers make regularly scheduled trips with passengers, accompanied by an experienced driver who gives helpful tips, answers questions, and evaluates the new driver's performance. Most bus drivers get brief supplemental training periodically to stay informed of safety issues and regulatory changes.

Licensure. All bus drivers must obtain commercial driver's licenses (CDL) with the proper endorsements. Qualifications and standards for drivers are established by State and Federal regulations. Bus drivers are responsible for complying with regulations within their own States, as well as those of other States (or countries) where they operate.

To qualify for a commercial driver's license, applicants must pass a knowledge test on rules and regulations and then demonstrate in a skills test that they can operate a bus safely. The Department of Transportation keeps a national database of all driving violations incurred by CDL holders, and a State may not issue a license to a person who has already had a license suspended or revoked in another State. Drivers may only hold one license at a time, and must surrender all other driver's licenses upon receiving their new CDLs.

Bus drivers must also have passenger endorsements for their licenses. Transit, intercity, and motor coach operators must have a passenger vehicle (P) endorsement, while school bus drivers must have both a passenger (P) and a school bus (S) endorsement. Both of these endorsements require a passing score on knowledge and skills tests administered by the State licensing agency or partner institution. The knowledge test is a written exam that covers laws of the road, whereas the skills test is administered by a certified examiner in the appropriate commercial vehicle. Information on how to apply for a commercial driver's license and each type of endorsement can be obtained from State motor vehicle administrations and the Federal Motor Carrier Safety Administration.

Although many States allow those who are 18 years of age and older to drive buses within State borders, the U.S. Department of Transportation establishes minimum qualifications for bus drivers engaged in interstate commerce. Federal Motor Carrier Safety Regulations require drivers to be at least 21 years old and to pass a physical examination once every 2 years. All drivers also must be able to read and speak English well enough to read road signs, prepare reports, and communicate with law enforcement officers and the public.

The main physical requirements include good hearing, at least 20/40 vision with or without glasses or corrective lenses, and a 70-degree field of vision in each eye. Drivers must also be able to distinguish the colors on a traffic light and hear a forced whisper in one ear at not less than 5 feet (with a hearing aid, if necessary). Drivers must have normal blood pressure and normal use of their arms and legs. They may not use any controlled substances, unless prescribed by a licensed physician.

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People with epilepsy or with diabetes controlled by insulin are not permitted to be interstate bus drivers.

Federal regulations also require employers to test their drivers for alcohol and drug use as a condition of employment and require periodic random tests of the drivers while they are on duty. In addition, a driver must not have been convicted of a felony involving the use of a motor vehicle or a crime involving drugs, driving under the influence of drugs or alcohol, refusing to submit to an alcohol test required by a State or its implied consent laws or regulations, leaving the scene of a crime, or causing a fatality through negligent operation of a commercial vehicle.

Other qualifications. Many employers prefer applicants who are at least 24 years old. Because bus drivers deal with passengers, they must be courteous. They need an even temperament and emotional stability because driving in heavy, fast-moving, or stop-and-go traffic and dealing with passengers can be stressful. Drivers must have strong customer service skills, including communication skills and the ability to coordinate and manage large groups of people. In some States, school bus drivers must pass a background investigation to uncover any criminal record or history of mental problems.

Advancement. New intercity and local transit drivers usually are placed on an "extra" list to drive chartered runs, extra buses on regular runs, and special runs, such as those during morning and evening rush hours and to sports events. New drivers also substitute for regular drivers who are ill or on vacation. New drivers remain on the extra list and may work only part time, perhaps for several years, until they have enough seniority to get a regular run.

Senior drivers may bid for the runs that they prefer, such as those with more work hours, lighter traffic, weekends off, or—in the case of intercity bus drivers—higher earnings or fewer workdays per week.

Opportunities for promotion are generally limited, but experienced drivers may become supervisors or dispatchers. In transit agencies with rail systems, drivers may become train operators or station attendants. Some bus drivers become either instructors of new bus drivers or master-instructors, who train new instructors. Few drivers become managers. Promotion in publicly owned bus systems is often determined by competitive civil service examination. Some motor coach drivers purchase their own equipment and open their own business.

Employment

Bus drivers held about 647,500 jobs in 2008. Around 70 percent of all bus drivers were school bus drivers working primarily for school systems or for companies providing school bus services under contract. Most of the remainder worked for private and local government transit systems; some also worked for intercity and charter bus lines.

Job Outlook

Bus drivers should expect average job growth and good employment opportunities. Those seeking higher paying public transit bus driver positions may encounter competition. Individuals who have clean driving records and who are willing to work part-time or irregular schedules will have the best job prospects.

Employment change. Overall employment of bus drivers is expected to grow by 7 percent between 2008 and 2018, which is about as fast as the average for all occupations. This growth will be spread among the various occupational specialties.

Employment growth for local transit and intercity bus drivers is projected to be 8 percent over the 2008-18 decade, about as fast as the average for all occupations, mainly as a result of a changing attitude toward public transit in the U.S. High gas prices in recent years have convinced many people to use public transportation. At the same time, public transportation is seen as an environmentally friendly alternative to driving. As a result, many State and local governments have increased funding for public transportation. This trend is expected to continue, and will lead to incrementally higher employment of transit bus drivers over the course of the projections decade. At the same time, however, inexpensive airline tickets and competition from train services will limit the growth of intercity bus travel.

Employment of school bus drivers is expected to grow by 6 percent over the 2008-18 decade, which is slower than the average for all occupations. The growth that does occur will be in response to an increase in the number of school-age children in the U.S. While enrollment continues to increase, however, growth will be tempered by budget cuts by local school districts, which has led to service reductions and greater emphasis on route efficiency.

Job prospects. People seeking jobs as bus drivers likely will have good opportunities. New jobs will be created, but most job openings are expected because of the need to replace workers who take jobs in other occupations or retire. School bus driving jobs, particularly in rapidly growing suburban areas, should be plentiful because most are part-time positions with high turnover. Those seeking higher paying public transit bus driver positions may encounter competition.

Individuals who have clean driving records and who are willing to work a part-time or irregular schedule probably will have the best job prospects. Opportunities for intercity driving positions should be good, although employment prospects for motor coach drivers will depend on tourism, which fluctuates with the economy.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018	
				Number	Percent
Bus drivers	53-3020	647,500	691,400	43,900	7
Bus drivers, transit and intercity	53-3021	193,900	209,900	16,000	8
Bus drivers, school	53-3022	453,600	481,500	27,900	6

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Full-time bus drivers rarely are laid off during recessions, but competition for jobs increases significantly during periods of high unemployment. The majority of workers in this occupation are employed by local governments and schools. The number of students who need transportation to school does not change during times of economic distress, and mass transit ridership often goes up. However, during recessions, when workers in other industries lose their jobs, many try to become bus drivers, as it is a relatively high-paying job given that it requires so little training. As a result, people who want to become bus drivers during such times may face keen competition for jobs. In contrast, during times when unemployment is low, employers may have difficulty attracting enough people to this occupation.

Earnings

Median hourly wages for wage-and-salary transit and intercity bus drivers were $16.32 in May 2008. The middle 50 percent earned between $12.44 and $21.58 per hour. The lowest 10 percent earned less than $9.82, and the highest 10 percent earned more than $26.74 per hour.

Median hourly wages of wage-and-salary school bus drivers were $12.79 in May 2008. The middle 50 percent earned between $9.61 and $15.78 per hour. The lowest 10 percent earned less than $7.38, and the highest 10 percent earned more than $19.11 per hour.

Bus drivers generally receive good benefits from their employers. Most intercity and local transit bus drivers receive paid health and life insurance, sick leave, vacation leave, and free bus rides on any of the regular routes of their line or system. School bus drivers receive sick leave, and many are covered by health and life insurance and pension plans. Because they generally do not work when school is not in session, they do not get vacation leave.

About 38 percent of bus drivers were members of unions or were covered by union contracts in 2008. Many intercity and local transit bus drivers are members of the Amalgamated Transit Union or Transport Workers Union of America.

Related Occupations

Other occupations that involve driving a vehicle include:

	Page
Rail transportation occupations	801
Taxi drivers and chauffeurs	794
Truck drivers and driver/sales workers	797

Sources of Additional Information

For information on employment opportunities, contact local transit systems, intercity bus lines, school systems, or the local offices of the State employment service.

Information on Federal regulations for drivers of commercial vehicles can be obtained from:

➤ Federal Motor Carrier Safety Administration, 1200 New Jersey Ave. SE., Washington, DC 20590. Internet: **http://www.fmcsa.dot.gov**

Information on school bus driving is available from:

➤ National Association of State Directors of Pupil Transportation Services, P.O. Box 5446, Steamboat Springs, CO 80477. Internet: **http://www.nasdpts.org**

➤ National School Transportation Association, 113 South West St., 4th Floor, Alexandria, VA 22314. Internet: **http://www.yellowbuses.org**

Information on public transit bus driving is available from:

➤ American Public Transportation Association, 1666 K St. NW., Washington DC 20006. Internet: **http://www.apta.com**

General information on motor coach driving is available from:

➤ United Motorcoach Association, 113 South West St., 4th Floor, Alexandria, VA 22314. Internet: **http://www.uma.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos242.htm**

Taxi Drivers and Chauffeurs

Significant Points

- Taxi drivers and chauffeurs may work any schedule, including full time, part time, night, evening, weekend, and on a seasonal basis.
- Very few drivers are paid an hourly wage; most rent their vehicles from a cab fleet, although many own their vehicles.
- Local taxi commissions set licensing standards for driving experience and training.
- Job opportunities should be plentiful.

Nature of the Work

Taxi and limousine services make it easy for customers to get around when driving their own cars or using public transportation is inconvenient. *Taxi drivers* and *chauffeurs* take passengers to and from their homes, workplaces, and recreational pursuits, such as dining, entertainment, and shopping, and to and from business-related events. These professional drivers help both residents and out-of-town guests get around a city or urban area. In addition to regular point-to-point services, some drivers offer sight-seeing services around their cities.

Drivers must be alert to conditions on the road, especially in heavy and congested traffic or in bad weather. They must take precautions to prevent accidents and avoid sudden stops, turns, and other driving maneuvers that would jar passengers.

The majority of people in this occupation work as taxi drivers. Typically, taxi drivers own their vehicles or rent them from a company called a fleet. Drivers who rent their vehicles usually report to a garage where they are assigned a vehicle, most frequently a large, conventional automobile modified for commercial passenger transport. Drivers check their cabs' fuel and oil levels and make sure that the lights, brakes, and windshield wipers are in good working order. If anything is not working properly, the driver who discovers the problem reports it to a dispatcher or company mechanic. Some drivers own their own cabs. Generally, they park at their homes overnight, so they

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simply drive to their first pickup when they start working. Like other car owners, they are responsible for their own insurance, maintenance, and for making sure that the car is in good working order.

Taxi drivers usually find fares in one of three ways. Most commonly, they work with dispatch services, which allow customers to call in a request for a cab. Dispatchers relay the information to drivers by two-way radio, cellular telephone, or onboard computer. This is the most common method in smaller cities, late at night, or in low-traffic areas. Drivers may also pick up passengers waiting at cabstands or in taxi lines at airports, train stations, hotels, restaurants, and other places where people frequently seek taxis. In major cities, drivers "cruise" the streets looking for fares, although this is not legal in all jurisdictions.

Good drivers are familiar with streets in the areas they serve so they can choose the most efficient route to destinations and avoid traffic. They know the locations of frequently requested destinations, such as airports, bus and railroad terminals, convention centers, hotels, and other points of interest. In case of emergency, drivers should know the location of fire and police stations, as well as hospitals.

Upon arrival at the final destination, the driver determines the fare and announces it to the passenger. Each jurisdiction has its own regulations that set the structure of the fare system covering licensed taxis. In most areas, a taximeter measures the fare based on the distance covered and the amount of time spent in traffic. Drivers start their meters when passengers enter the cab and turn them off when they reach their final destinations. The fare may also include surcharges, such as base fares, dispatcher fees, or fees for additional passengers, tolls, luggage, or other services. Passengers usually add a tip or gratuity to the fare. The amount of the gratuity depends, in part, on the passengers' satisfaction with the quality and efficiency of the ride and the courtesy of the driver. Drivers issue receipts upon request. They may also fill out logs for use by their fleets.

Chauffeurs operate limousines, vans, and private cars. They may work for hire, as taxicabs do; or they may work for private businesses, government agencies, or wealthy individuals. Chauffeur services differ from taxi services in that all trips are prearranged. Many chauffeurs transport customers in large vans between hotels and airports, bus terminals, or train stations. Others drive luxury automobiles, such as private cars or limousines.

At the beginning of each workday, chauffeurs prepare their automobiles or vans for use. They inspect their vehicles for cleanliness and, when needed, clean the interior and wash the exterior body, windows, and mirrors. They check fuel and oil levels and make sure the lights, tires, brakes, and windshield wipers work. Chauffeurs may perform routine maintenance and make minor repairs, such as changing tires or adding oil and other fluids. If a vehicle requires a more complicated repair, they take it to a professional mechanic.

Chauffeurs cater to passengers by providing attentive customer service and paying attention to detail. They help riders into the car by holding open doors, holding umbrellas when it is raining, and loading packages and luggage into the trunk of the car. Chauffeurs may perform errands for their employers such as delivering packages or picking up clients arriving at airports. To ensure a pleasurable ride in their limousines, many chauffeurs offer conveniences and luxuries such as newspapers, magazines, music, drinks, televisions, and telephones. Increasingly, chauffeurs work as full-service executive assistants, simultaneously acting as driver, secretary, and itinerary planner.

Some drivers transport individuals with special needs, such as those with disabilities and the elderly. These drivers, known as *paratransit drivers*, operate specially equipped vehicles designed to accommodate a variety of needs in non-emergency situations. Although special certification is not necessary, some additional training on the equipment and passenger needs may be required.

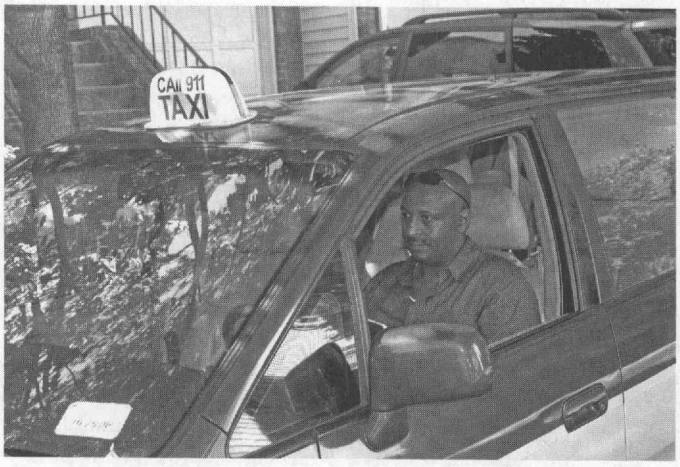
Work environment. Driving for long periods can be tiring and stressful, especially in densely populated urban areas. Being seated in the same position for most of the day can also be very uncomfortable. Taxi drivers and chauffeurs often have to load and unload heavy luggage and packages. They are also at high risk for robbery, because they work alone and often carry large amounts of cash. Data from the U.S. Bureau of Labor Statistics show that taxi drivers and chauffeurs experienced a work-related injury and illness rate that was much higher than the national average.

Work hours of taxi drivers and chauffeurs vary greatly. Some jobs offer full-time or part-time employment with work hours that can change from day to day or remain the same. It is often necessary for drivers to report to work on short notice. Chauffeurs who work for a single employer may be on call much of the time. Evening and weekend work is common for drivers and chauffeurs employed by limousine and taxicab services.

Whereas the needs of the client or employer dictate the work schedule for chauffeurs, the work of taxi drivers is much less structured. Working free of supervision, they may break for a meal or a rest whenever their vehicle is unoccupied. Many taxi drivers like the independent, unsupervised work of driving.

This occupation is attractive to individuals, such as college and postgraduate students, seeking flexible work schedules and to anyone seeking a second source of income. Other service workers, such as ambulance drivers and police officers, sometimes moonlight as taxi drivers or chauffeurs.

Full-time taxi drivers usually work one shift a day, which may last 8 to 12 hours. Part-time drivers may work half a shift



Job opportunities for taxi drivers and chauffeurs should be plentiful.

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Taxi drivers and chauffeurs	53-3041	232,300	268,400	36,100	16

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

each day, or work a full shift once or twice a week. Drivers may work shifts at all times of the day and night, because most taxi companies offer services 24 hours a day. Early morning and late night shifts are not uncommon. Drivers work long hours during holidays, weekends, and other special times when demand for their services is heavier. Independent drivers set their own hours and schedules.

Training, Other Qualifications, and Advancement

Local governments set licensing standards and requirements for taxi drivers and chauffeurs, which may include minimum amounts of driving experience and training.

Education and training. Little formal education is needed for taxi drivers or chauffeurs, but many have at least a high school diploma, GED, or its equivalent. Drivers need to be able to communicate effectively, read maps, and use basic math. A basic understanding of auto mechanics can also be very useful.

Most taxi and limousine companies give new drivers on-the-job training. This training generally only lasts about a week or two, and is required by law in some jurisdictions. Companies show drivers how to operate the taximeter and communications equipment and how to complete paperwork. Other topics covered include driver safety, customer service, and the best routes to popular sightseeing and entertainment destinations.

Many companies have contracts with social service agencies and transportation services to transport elderly and disabled citizens in non-emergency situations. To support these services, new drivers may get special training in how to handle wheelchair lifts and other mechanical devices.

Licensure. Taxicab or limousine drivers must first have a regular automobile driver's license. In many States, applicants must get a taxi driver or chauffeur's license, commonly called a "hack" license. The Federal Motor Carrier Safety Administration requires a commercial driver's license (CDL) with a passenger (P) endorsement for drivers transporting 16 or more passengers (including the driver). While this is not a concern for taxi drivers, some stretch limousines and other such vehicles may be large enough to require a CDL.

While States set licensing requirements, local regulatory bodies set other terms and conditions. Most cities and urban areas have taxi commissions. These commissions set requirements for drivers, license vehicles to be used as cabs, and even set the rates that drivers are allowed to charge. In many cases, these regulations do not affect chauffeurs.

In most areas, taxis must have medallions that certify them as legally recognized cabs. Passengers generally prefer cars with medallions, as they are guaranteed to be law-abiding by local commissions. Drivers who receive too many complaints can lose their medallions, which discourages unethical behavior.

Regulations can vary greatly among localities. Some areas require new drivers to enroll in up to 80 hours of classroom instruction, to take an exam, or both before they are allowed to work. Some localities require an English proficiency test, usually in the form of listening comprehension; applicants who do not pass the English exam must take an English course, in addition to any formal driving programs.

Other qualifications. Taxi drivers and chauffeurs work almost exclusively with the public, and should be able to get along with many different types of people. They must be patient when waiting for passengers and when dealing with rude customers. It also is helpful for drivers to be tolerant and level-headed when driving in heavy and congested traffic. Drivers should be dependable, since passengers expect to be picked up at a prearranged time and taken to the correct destinations. Drivers must be responsible and self-motivated, because they work with little supervision. Increasingly, companies encourage drivers to develop loyal customers to improve their business.

Many municipalities and taxicab and chauffeur companies require drivers to have a neat appearance. Many chauffeurs wear formal attire, such as tuxedos, suits, dresses, or uniforms.

Advancement. Taxi drivers and chauffeurs have limited advancement opportunities. Experienced drivers may obtain preferred routes or shifts. Some advance to become lead drivers, who help to train new drivers. Others take dispatching and managerial positions. Some drivers become managers at taxi or limousine fleets. Some people start their own taxi or limousine companies.

In many communities, drivers can purchase their own taxis or limousines and go into business for themselves. Independent owner-drivers need an additional permit allowing them to operate as a business. Some big cities limit the number of operating permits, which keeps many owner-drivers out of the market. In these cities, drivers become owner-drivers by buying or renting permits from owner-drivers who leave the business. Although many owner-drivers are successful, some fail to cover expenses and eventually lose their permits and automobiles. Individuals starting their own taxi companies face many obstacles because of the difficulty in running a small fleet. The lack of dispatch and maintenance facilities often is hard for an owner to overcome. Chauffeurs often have a good deal of success as owner-drivers and many companies begin as individually owned and operated businesses.

For both taxi and limousine service owners, good business sense and courses in accounting, business, and business arithmetic can help an owner-driver be successful. Knowledge of mechanics enables owner-drivers to perform their own routine maintenance and minor repairs to cut expenses.

Employment

Taxi drivers and chauffeurs held about 232,300 jobs in 2008. About 26 percent of taxi drivers and chauffeurs were self-employed. Jobs were located throughout the country, but were

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concentrated in large cities. Metropolitan areas with the largest employment of taxi drivers and chauffeurs in May 2008 were:

New York-Northern New Jersey-Long Island, NY-NJ-PA	16,360
Las Vegas-Paradise, NV	10,160
Los Angeles-Long Beach-Santa Ana, CA	7,510
Chicago-Naperville-Joliet, IL-IN-WI	5,300
Boston-Cambridge-Quincy, MA-NH	5,040

Job Outlook

Employment of taxi drivers and chauffeurs is expected to grow faster than the average for all occupations. Job opportunities should be plentiful. Applicants with good driving records, good customer service instincts, and the ability to work flexible schedules should have the best prospects.

Employment change. Employment of taxi drivers and chauffeurs is expected to grow 16 percent during the 2008–18 projection period, faster than the average for all occupations. Drivers should see increased business as a result of growth in tourism and business travel. Also, as the number of elderly people increases, taxis will be needed to take them around town. Some growth will stem from Federal legislation requiring increased services for people with disabilities.

Because the demand for taxi and limousine services is very sensitive to economic cycles, drivers may see declining demand for their services during economic downturns. This is especially true for chauffeurs, as expensive limousine services are considered a luxury. Chauffeurs who work for private companies or individuals may face layoffs or reduced hours during times of economic distress.

Job prospects. Opportunities for taxi drivers and chauffeurs are expected to be plentiful, because of the need to replace the many people who work in this occupation for short periods and then leave. Also, the occupation has very low barriers to entry. Because most drivers are paid strictly based on fares, companies take on very little risk when they hire a new driver. Applicants who have clean driving records and who are willing to work flexible schedules should have the best prospects. People who are easy going and make their passengers comfortable will be most likely to succeed, as a significant part of drivers' salaries come from the tips they receive.

Opportunities fluctuate significantly with the overall movements of the economy, because the demand for transportation depends on business travel and tourism. Because most drivers own or rent their vehicles, taxi drivers are seldom laid off, but they may have to increase their work hours, and earnings may decline. When the economy is strong, many drivers transfer to other occupations, which often leads to fewer cabs on the road. Extra drivers may be hired during holiday seasons, as well as during peak travel and tourist times.

Rapidly growing metropolitan areas and cities experiencing economic growth should offer the best job opportunities.

Earnings

Earnings of taxi drivers and chauffeurs vary greatly, depending on factors such as the number of hours worked, regulatory conditions, customer tips, and geographic location. Hybrid vehicles, which have improved gas mileage, offer taxi drivers better earnings, because drivers pay for their gas out of pocket. Median annual wages of wage and salary taxi drivers and chauffeurs, including tips, were $21,550 in May 2008. The middle 50 percent earned between $17,770 and $26,800. The lowest 10 percent earned less than $15,620, and the highest 10 percent earned more than $34,210.

Many taxi drivers pay a daily, weekly, or monthly fee to the company allowing them to lease their vehicles and depend on fares for their livelihood. The fee also may include charges for vehicle maintenance, insurance, and a deposit on the vehicle. This occupation includes many self-employed drivers. BLS does not have data on earnings for self-employed taxi and limousine drivers.

Most taxi drivers and chauffeurs do not receive benefits. Drivers may wish to purchase private health insurance.

Related Occupations

Other workers who have similar jobs include:

	Page
Bus drivers	791
Truck drivers and driver/sales workers	797

Sources of Additional Information

Information on necessary permits and the registration of taxi drivers and chauffeurs is available from local taxi commissions. Questions regarding licensing should be directed to your State motor vehicle administration. For information about work opportunities as a taxi driver or chauffeur, contact local taxi or limousine companies or State employment service offices in your area.

For general information about the work of taxi drivers, chauffeurs, and paratransit drivers, contact:

➤ Taxicab, Limousine and Paratransit Association, 3200 Tower Oaks Blvd., Suite 220, Rockville, MD 20852. Internet: **http://www.tlpa.org**

For general information about the work of limousine drivers, contact:

➤ National Limousine Association, 49 South Maple Ave., Marlton, NJ 08053. Internet: **http://www.limo.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos245.htm**

Truck Drivers and Driver/Sales Workers

Significant Points

- Truck drivers and driver/sales workers comprise one of the largest occupations, holding 3.2 million jobs.
- Overall job opportunities should be favorable, especially for long-haul drivers.
- A commercial driver's license is the most important qualification for most jobs.

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Nature of the Work

Almost every product sold in the United States spends at least some time in a truck. While planes, trains, and ships are also used to transport goods, no other form of transportation has the same level of flexibility as a truck. As a result, trucks are used to transport everything from canned food to automobiles. *Truck drivers* and *driver/sales workers* operate these vehicles.

Drivers are responsible for picking up and delivering freight from one place to another. This may be from a manufacturer to a distribution center, from a distribution center to a customer, or between distribution centers. In addition, drivers may be responsible for loading and unloading their cargo. They are also responsible for following applicable laws, keeping logs of their activities, and making sure that their equipment is in good working condition.

Heavy truck and tractor-trailer drivers operate trucks or vans with a capacity of at least 26,001 pounds gross vehicle weight (GVW). The vast majority of these are *over-the-road* or *long-haul drivers*, meaning they deliver goods over intercity routes that may span several States. Some drivers have regular routes or regions where they drive the most, while others take on routes throughout the country or even to Canada and Mexico.

Long-haul drivers are often responsible for planning their own routes. In most cases, operators are given a delivery location and deadline, and they must determine how to get the shipment to its destination on time. This can be difficult, as drivers must find routes that allow large trucks, and must work within the rules imposed by the U.S. Department of Transportation. Drivers must fill out logs to show that they have followed these rules, which mandate maximum driving times and rest periods between shifts. Companies sometimes use two drivers on long runs to minimize downtime. On these "sleeper" runs, one driver sleeps in a berth behind the cab while the other operates the truck.

Light or *delivery services truck drivers*, often called *pick-up and delivery* or *P&D drivers* deliver goods within an urban area or small region. In most cases, they carry shipments from distribution centers to businesses or households. Drivers who work for package delivery services may have a single load and make many stops over the course of the day, while other drivers might have several loads in the course of a day. Depending on the load, drivers may have helpers who load and unload their vehicles. When making deliveries, they may accept payments for cash-on-delivery shipments, or handle paperwork, such as delivery confirmations and receipts.

Specialized truck drivers work with unusual loads. While most trucks carry freight loads in semi-trailers or vans, some carry liquids, oversized loads, or cars. Others carry hazardous materials, such as dangerous chemicals needed for industrial purposes, or waste from chemical processes that must be stored in approved facilities. Drivers who work with these types of loads must follow strict procedures to make sure their loads are delivered safely.

Some drivers, called *driver/sales workers* or *route drivers*, have sales responsibilities. For example, many driver/sales workers deliver and arrange goods to be sold in grocery stores. They may recommend that a store increase their inventory or encourage store managers to sell new products. Companies that rent linens, towels, or uniforms employ driver/sales workers to visit businesses regularly to replace soiled laundry. Driver/sales workers may also be responsible for soliciting new customers along their routes.



Heavy truck and tractor-trailer drivers are often responsible for planning their own routes to their shipment destinations.

Work environment. Despite new technologies such as power steering, driving a truck is still a physically demanding job. Driving for many hours at a stretch, loading and unloading cargo, and making many deliveries can be tiring. Making the decision to work as a long-haul driver is a major lifestyle choice—drivers may be away from home for days or weeks at a time, and they often spend a great deal of time alone. Local truck drivers usually return home in the evening.

The U.S. Department of Transportation regulates work hours and other working conditions of truck drivers engaged in interstate commerce. A long-distance driver may drive for no more than 11 hours per day, and work a total of no more than 14 hours—including driving and non-driving duties. Between working periods, a driver must have at least 10 hours off duty. Drivers also cannot work more than 60 hours in a week without being off-duty for at least 34 hours straight. Drivers are required to document their time in a log, which shows working hours and mileage by day. Many drivers, particularly on long runs, work close to the maximum time permitted because they are usually compensated according to the number of miles they drive. Drivers on long runs face boredom, loneliness, and fatigue. Drivers often travel nights, holidays, and weekends.

Local truck drivers frequently work 50 or more hours a week. Drivers who handle food for chain grocery stores, produce markets, or bakeries typically work long hours—often late at night or early in the morning. Most drivers have regular routes, although some have different routes each day. Many local truck drivers—particularly driver/sales workers—do a considerable amount of lifting, carrying, and walking.

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Training, Other Qualifications, and Advancement

Drivers who operate trucks with a gross vehicle weight of 26,001 pounds, or who operate a vehicle carrying hazardous materials or oversized loads, need a commercial driver's license (CDL). Training for the CDL is offered by many private and public vocational-technical schools. A standard driver's license is required to drive all other trucks. Many jobs driving smaller trucks require only brief on-the-job training.

Education and training. Most prospective truck drivers take driver-training courses at a technical or vocational school to prepare for CDL testing. Driver-training courses teach students how to maneuver large vehicles on crowded streets and in highway traffic. These courses also train drivers how to properly inspect trucks and freight for compliance with regulations.

Some States require prospective drivers to complete a training course in basic truck driving before getting their CDL. Some companies have similar requirements. People interested in attending a driving school should check with local trucking companies to make sure the school's training is acceptable. The Professional Truck Driver Institute (PTDI) certifies driver-training courses at truck driver training schools that meet industry standards and Federal Highway Administration guidelines for training tractor-trailer drivers.

Employers usually have training programs for new drivers who have already earned their CDL. This is often informal and may consist of only a few hours of instruction from an experienced driver. Some companies give 1 to 2 days of classroom instruction covering general duties, the operation and loading of a truck, company policies, and the preparation of delivery forms and company records. New drivers may also ride with and observe experienced drivers before getting their own assignments. Drivers receive additional training to drive special types of trucks or handle hazardous materials. Driver/sales workers receive training on the various types of products their company carries so that they can effectively answer questions about the products and more easily market them to their customers.

Licensure. Federal and State regulations govern the qualifications and standards for truck drivers. Drivers must comply with all Federal regulations and any State regulations that are in excess of those Federal requirements when under that State's jurisdiction.

Truck drivers must have a driver's license issued by the State in which they live. Drivers of trucks with a GVW of 26,001 pounds or more—including most tractor-trailers, as well as bigger straight trucks—must obtain a CDL. All drivers who operate trucks transporting hazardous materials or oversized loads must obtain a CDL and a special endorsement, regardless of truck capacity. In order to receive the hazardous materials endorsement, a driver must be fingerprinted and submit to a criminal background check by the Transportation Security Administration. In many States, a regular driver's license is sufficient for driving light trucks and vans.

To qualify for a CDL, applicants must have clean driving records, pass written tests on rules and regulations, and demonstrate that they can operate commercial trucks safely. A national database permanently records all driving violations committed by those with a CDL, and issuing authorities reject applicants who have suspended or revoked licenses in other States. Licensed drivers must accompany trainees until they get their own CDLs. A person may not hold more than one driver's license at a time and must surrender any other licenses when issued a CDL. Information on how to apply for a CDL may be obtained from State motor vehicle administrations.

Although many States allow 18 year-olds to drive trucks within their borders, a driver must be at least 21 years of age to cross State lines or get special endorsements. Regulations also require drivers to pass a physical examination every 2 years. Physical qualifications include good hearing, at least 20/40 vision with glasses or corrective lenses, and a 70-degree field of vision in each eye. They must also be able to distinguish between colors on traffic lights. Drivers must also have normal use of arms and legs and normal blood pressure. People with epilepsy or diabetes controlled by insulin are not permitted to be interstate truck drivers.

Other qualifications. Federal regulations require employers to test their drivers for alcohol and drug use as a condition of employment and require periodic random tests of the drivers while they are on duty. Drivers may not use any controlled substances, unless prescribed by a licensed physician. A driver must not have been convicted of a felony involving the use of a motor vehicle or a crime involving drugs, driving under the influence of drugs or alcohol, refusing to submit to an alcohol test required by a State or its implied consent laws or regulations, leaving the scene of a crime, or causing a fatality through negligent operation of a motor vehicle. All drivers must be able to read and speak English well enough to read road signs, prepare reports, and communicate with law enforcement officers and the public.

Many trucking companies have higher standards than those required by Federal and State regulations. For example, firms often require that drivers be at least 22 years old, be able to lift heavy objects, and have driven trucks for 3 to 5 years. They may also prefer to hire high school graduates and require annual physical examinations.

Drivers must get along well with people because they often deal directly with customers. Employers seek driver/sales workers who speak well and have self-confidence, initiative, tact, and a neat appearance. Employers also look for responsible, self-motivated individuals who are able to work well with little supervision.

Advancement. Although most new truck drivers are assigned to regular driving jobs immediately, some start as extra drivers—substituting for regular drivers who are ill or on vacation. Extra drivers receive a regular assignment when an opening occurs.

Truck drivers can advance to jobs that provide higher earnings, preferred schedules, or better working conditions. Long-haul truck drivers primarily look for new contracts that offer better pay per mile or higher bonuses. Because companies entrust drivers with millions of dollars worth of equipment and freight, drivers who have a long record of safe driving earn far more than new drivers. Local truck drivers may advance to driving heavy or specialized trucks or transfer to long-distance truck driving. Truck drivers occasionally advance to become dispatchers or managers.

Some long-haul truck drivers—called owner-operators—purchase or lease trucks and go into business for themselves.

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Although some are successful, others fail to cover expenses and go out of business. Owner-operators should have good business sense as well as truck driving experience. Courses in accounting, business, and business mathematics are helpful. Knowledge of truck mechanics can enable owner-operators to perform their own routine maintenance and minor repairs.

Employment

Truck drivers and driver/sales workers held about 3.2 million jobs in 2008. Of these workers, 56 percent were heavy truck and tractor-trailer drivers; 31 percent were light or delivery services truck drivers; and 13 percent were driver/sales workers. Most truck drivers find employment in large metropolitan areas or along major interstate roadways where trucking, retail, and wholesale companies tend to have their distribution outlets. Some drivers work in rural areas, providing specialized services such as delivering newspapers to customers.

The truck transportation industry employed 27 percent of all truck drivers and driver/sales workers in the United States. Another 26 percent worked for companies engaged in wholesale or retail trade. The remaining truck drivers and driver/sales workers were distributed across many industries, including construction and manufacturing.

Around 8 percent of all truck drivers and driver/sales workers were self-employed. Of these, a significant number were owner-operators who either served a variety of businesses independently or leased their services and trucks to a trucking company.

Job Outlook

Overall job opportunities should be favorable for truck drivers, especially for long-haul drivers. However, opportunities may vary greatly in terms of earnings, weekly work hours, number of nights spent on the road, and quality of equipment. Competition is expected for jobs offering the highest earnings or most favorable work schedules. Average employment growth is expected.

Employment change. Overall employment of truck drivers and driver/sales workers is expected to grow 9 percent over the 2008-18 decade, which is about as fast as the average for all occupations. As the economy grows, the demand for goods will increase, which will lead to more job opportunities. Because it is such a large occupation, 291,900 new jobs will be created over the 2008-18 period.

The number of heavy and tractor-trailer truck drivers is expected to grow 13 percent between 2008 and 2018, which is about as fast as average, mainly as a result of increasing demand for goods in the U.S. As the economy continues to grow, companies and households will continue to increase their spending on these products, many of which must be shipped over long distances.

Employment of light or delivery services truck drivers should grow 4 percent over the projections decade, which is more slowly than average. Though experiencing slower growth than heavy trucking, light and delivery trucking will similarly be closely tied to the state of the economy. As economic growth occurs, there will be an increasing need for light trucking services, from the distribution of goods from warehouses to the package delivery to households. The number of driver/sales workers is also expected to grow 4 percent between 2008 and 2018, more slowly than average, for the same basic reasons.

Job prospects. Job opportunities should be favorable for truck drivers, especially for long-haul drivers. In addition to occupational growth, numerous job openings will occur as experienced drivers leave this large occupation to transfer to other fields of work, retire, or leave the labor force. As workers leave these jobs, employers work hard to recruit experienced drivers from other companies. As a result, there may be competition for the jobs with the highest earnings and most favorable work schedules. Jobs with local carriers are often more competitive than those with long-distance carriers because of the more desirable working conditions of local carriers.

Despite projected employment growth, the demand for workers may vary greatly depending on the performance of the American economy. During times of expansion, companies may be forced to pay premiums to attract drivers, while during recessions even experienced drivers may find difficulty keeping steady work. Independent owner-operators will be particularly vulnerable to slowdowns. Industries least likely to be affected by economic fluctuation, such as grocery stores, will be the most stable employers of truck drivers and driver/sales workers.

Earnings

Median hourly wages of heavy truck and tractor-trailer drivers were $17.92 in May 2008. The middle 50 percent earned between $14.21 and $22.56. The lowest 10 percent earned less than $11.63, and the highest 10 percent earned more than $27.07.

Median hourly wages of light or delivery services truck drivers were $13.27 in May 2008. The middle 50 percent earned between $10.07 and $17.74. The lowest 10 percent earned less than $8.10, and the highest 10 percent earned more than $24.15.

Median hourly wages of driver/sales workers, including commissions, were $10.70 in May 2008. The middle 50 percent earned between $7.74 and $15.82. The lowest 10 percent earned less than $7.09, and the highest 10 percent earned more than $21.32.

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Driver/sales workers and truck drivers	53-3030	3,189,300	3,481,200	291,900	9
Driver/sales workers	53-3031	406,400	424,100	17,700	4
Truck drivers, heavy and tractor-trailer	53-3032	1,798,400	2,031,300	232,900	13
Truck drivers, light or delivery services	53-3033	984,500	1,025,900	41,400	4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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Employers typically pay long-haul drivers by the mile, with bonus opportunities available for drivers who save the company money. Local truck drivers tend to be paid by the hour, with extra pay for working overtime. The per-mile rate can vary greatly from employer to employer and may even depend on the type of cargo being hauled. Some long-distance drivers—especially owner-operators—are paid a share of the revenue from shipping. Typically, pay increases with experience, seniority, and the size and type of truck driven. Most driver/sales workers receive commissions based on their sales in addition to their wages.

Many truck drivers are members of the International Brotherhood of Teamsters. Some truck drivers employed by companies outside the trucking industry are members of unions representing the plant workers of the companies for which they work. In 2008, about 16 percent of truck drivers and driver/sales workers were union members or covered by union contracts.

Related Occupations

Other driving occupations include:

	Page
Bus drivers	791
Postal Service mail carriers	575
Taxi drivers and chauffeurs	794

An occupation involving similar sales duties is:

Sales representatives, wholesale and manufacturing	547

Sources of Additional Information

Information on truck driver employment opportunities is available from local trucking companies and local offices of the State employment service.

Information on career opportunities in truck driving may be obtained from:

➤ American Trucking Associations, Inc., 950 North Glebe Rd., Suite 210, Arlington, VA 22203. Internet: **http://www.truckline.com**

Information on becoming a truck driver may be obtained from the American Trucking Associations, Inc. industry recruiting page: **http://www.gettrucking.com**

Information on Federal regulations for drivers of commercial vehicles can be obtained from:

➤ Federal Motor Carrier Safety Administration, 1200 New Jersey Ave. SE, Washington, DC 20590. Internet: **http://www.fmcsa.dot.gov**

A list of certified tractor-trailer driver training courses may be obtained from:

➤ Professional Truck Driver Institute, 555 E. Braddock Rd., Alexandria, VA 22314. Internet: **http://www.ptdi.org**

Information on union truck driving can be obtained from:

➤ The International Brotherhood of Teamsters, 25 Louisiana Ave. NW, Washington, DC 20001. Internet: **http://www.teamster.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos246.htm**

Rail Transportation Occupations

Significant Points

- Opportunities are expected to be good for qualified applicants since a large number of workers are expected to retire or leave these occupations from 2008 to 2018.
- 76 percent of these workers are members of unions, and earnings are relatively high.

Nature of the Work

Rail transportation workers are employed by three types of railroads: freight, passenger, and urban transit (subway and light rail). Freight railroads transport billions of tons of goods to destinations within the United States and to ports to be shipped abroad. Passenger railroads deliver millions of passengers and long-distance commuters to destinations throughout the country. Subways and light-rail systems move passengers within metropolitan areas and their surrounding suburbs. All of these modes of rail transportation require employees to operate, oversee, and assist in rail operations. Rail transportation workers not only work on trains, but also can be found working in rail yards where railcars are inspected, repaired, coupled, and uncoupled.

Locomotive engineers operate large trains carrying cargo or passengers between stations. Most engineers run diesel-electric locomotives, although a few operate locomotives powered by battery or externally supplied electricity. Before each run, engineers check the mechanical condition of their locomotives, making any necessary minor adjustments and documenting issues that require more thorough inspection. While trains are in motion, engineers move controls such as throttles and airbrakes. They also monitor instruments that measure speed, amperage, battery charge, and air pressure, both in the brake lines and in the main reservoir. Engineers must have thorough knowledge of their routes and must be constantly aware of the condition and makeup of their train, because trains react differently to the grade and condition of the rail, the number of cars, the ratio of empty cars to loaded cars, and the amount of slack in the train.

Railroad conductors coordinate all activities of freight or passenger train crews. Conductors assigned to freight trains review schedules, switching orders, waybills, and shipping records to obtain loading and unloading information regarding their cargo.

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In addition, they are responsible for the distribution of tonnage in the train and the operation of freight cars within rail yards and terminals that use remote control locomotive technology. Conductors assigned to passenger trains also ensure passenger safety and comfort as they go about collecting tickets and fares, making announcements for the benefit of passengers, and coordinating the activities of the crew.

Before trains leave a terminal, the conductor and the engineer discuss any concerns regarding the train's route, timetable, and cargo. During runs and in rail yards, engineers and conductors interface with traffic-control-center personnel, dispatchers, and personnel on other trains to issue or receive information concerning stops, delays, and the locations of trains. While engineers interpret and comply with orders, signals, speed limits, and railroad rules and regulations, conductors use dispatch or electronic monitoring devices to relay information about equipment problems on the train or the rails. Conductors may arrange for the removal of defective cars from the train for repairs at the nearest station or stop, and discuss alternative routes with the engineer and dispatcher if there is a defect in, or obstruction on, the rails.

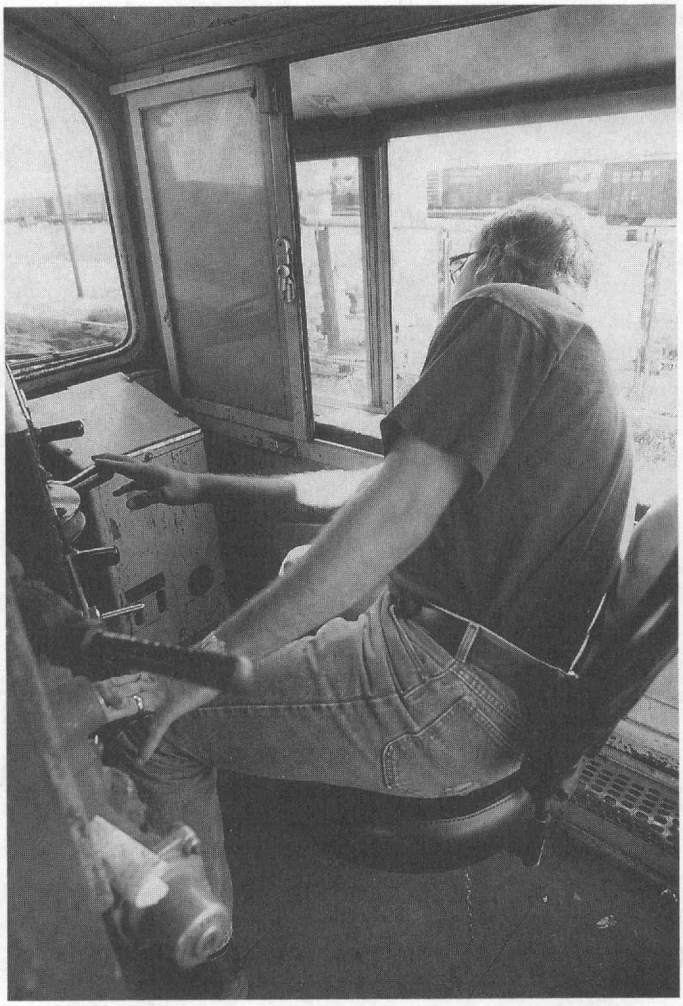
Railroad brake operators assist with the coupling and uncoupling of cars and operate some switches. In an effort to reduce costs, most railroads have phased out brake operators, and many trains use only an engineer and a conductor. *Signal operators* install, maintain, and repair the signals on tracks and in yards.

Yardmasters, where present, coordinate the activities of workers engaged in railroad yard operations. These activities, which are also performed by conductors, include making up or breaking up trains and switching inbound or outbound traffic to a specific section of the line. Some cars are sent to unload their cargo on special tracks, while others are moved to different tracks to await assembly into new trains on the basis of their destinations. Yardmasters tell yard engineers or other personnel where to move the cars to fit the planned train configuration. Switches—many of them operated remotely by computer—divert trains or railcars to the proper track for coupling and uncoupling.

Also included in rail transportation occupations are several less prevalent occupations. *Switch operators* control the track switches within a rail yard. In rail yards without remote control technology, *rail yard engineers* operate engines within the rail yard. Similarly, *hostlers* operate engines—without attached cars—within the yard, and drive them to and from maintenance shops.

In contrast to other rail transportation workers, subway and streetcar operators generally work for public transit authorities instead of railroads. *Subway operators* control trains that transport passengers through cities and their suburbs. The trains run in underground tunnels, on the surface, or on elevated tracks. Operators must stay alert to observe signals along the track that indicate when they must start, slow, or stop their trains. They also make announcements to riders, may open and close the doors of the train, and ensure that passengers get on and off the subway safely. Increasingly, the train's speed and the amount of time spent at each station are controlled by computers and not by the operator. During breakdowns or emergencies, operators contact their dispatcher or supervisor and may have to evacuate cars.

Streetcar operators drive electric-powered streetcars, trolleys, or light-rail vehicles that transport passengers around metropolitan areas. Some tracks may be built directly into street pavement or have grade crossings, so operators must observe traffic signals and cope with car and truck traffic. Operators start, slow, and stop their cars so that passengers may get on and off easily. Operators may collect fares and issue change and transfers. They also interact with passengers who have questions about fares, schedules, or routes.



Many rail transportation employees work more than 40 hours per week, although minimum rest hours are mandated by Federal regulations.

Work environment. Rail transportation employees work nights, weekends, and holidays to operate trains that run 24 hours a day, 7 days a week. Many work more than 40 hours per week, although minimum rest hours are mandated by Federal regulations. Engineers and conductors may be placed on an "extra board" on which workers receive assignments only when a railroad needs substitutes for workers who are absent because of vacation, illness, or other reasons. Seniority usually dictates who receives the more desirable shifts, as do union agreements at large unionized railroads. Working conditions also vary by the mode of rail transport.

Freight trains generally are dispatched according to the needs of customers. As a result, train crews may have irregular schedules. It is common for workers to place their name on a list and wait for their turn to work. Jobs usually are assigned on short notice and often at odd hours. Working weekends is common in freight train transportation. Those who work on trains operating between

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Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Rail transportation occupations	–	130,500	86,200	6,900	9
Locomotive engineers and operators	53-4010	51,100	56,200	5,100	10
Railroad brake, signal, and switch operators	53-4021	25,600	28,000	2,400	9
Railroad conductors and yardmasters	53-4031	41,300	44,100	2,800	7
Subway and streetcar operators	53-4041	7,700	9,100	1,400	19
Rail transportation workers, all other	53-4099	4,800	5,000	200	4

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

points hundreds of miles apart may spend consecutive nights away from home. Because of the distances involved on some routes, many railroad employees work without direct supervision.

Workers on passenger trains ordinarily have regular and reliable shifts. Also, the appearance, temperature, and accommodations of passenger trains are more comfortable than those of freight trains.

Rail yard workers spend most of their time outdoors and work regardless of weather conditions. These workers climb up and down equipment, which can be strenuous and can also be dangerous if safety rules are not followed. The work of conductors and engineers on local runs, on which trains frequently stop at stations or local rail yards to pick up and deliver cars, is also physically demanding.

Training, Other Qualifications, and Advancement

Rail transportation workers start out in a variety of positions as they gain the experience needed for more demanding assignments. Rail transportation workers generally must begin training to become a conductor before they may be considered for an engineer position; engineer positions also require Federal licensure. Nearly all rail transportation workers complete formal classroom and hands-on training before beginning work. Most applicants must pass a drug screening, background check, and physical examination before being hired.

Education and training. Railroads require that applicants have a minimum of a high school diploma or equivalent, and most training is done through a company's formal training program and on-the-job training. Rail yard jobs usually require the successful completion of a company training program before workers are allowed to begin. For brake and signal operator jobs, railroad firms train applicants either in a company program or—especially with smaller railroads—at an outside training facility. Typical training programs combine classroom and on-site training lasting from a few weeks to a few months. Entry-level conductors are either trained by their employers or are required to complete a formal conductor training program through a community college.

Most transit systems that operate subways and streetcars also operate buses. In these systems, subway and streetcar operators usually gain experience by first driving buses. New operators then complete training programs that last from a few weeks to 6 months. After finishing classroom and on-the-job training, operators usually must pass qualifying examinations covering the operating system, troubleshooting, and evacuation and emergency procedures.

Licensure. Locomotive engineers must be federally licensed to operate freight and passenger trains. Federal regulations require beginning engineers to complete a formal engineer training program, including classroom, simulator, and hands-on instruction in locomotive operation. At the end of the training period, candidates must pass a hearing and visual acuity test, a safety conduct background check, a railroad operation knowledge test, and a skills performance test before receiving an engineer's license. Engineers must periodically pass an operational rules efficiency test to maintain their licensure. The test is an unannounced event requiring engineers to take active or responsive action in certain situations, such as maintaining a particular speed through a curve or yard or complying with a signal.

Because of recent legislation, conductors will soon be subject to Federal licensing requirements similar to those of railroad engineers. For yard occupations, a commercial driver's license may be required because these workers often operate trucks and other heavy vehicles.

Other qualifications. Rail transportation workers must have good hearing, eyesight, and color vision, as well as good hand-eye coordination, manual dexterity, and mechanical aptitude. Physical stamina is required for most rail transportation jobs. Applicants for locomotive engineer jobs and some conductor jobs must be at least 21 years old.

All applicants must have good communication skills and be able to make quick, responsible judgments. Employers require railroad transportation job applicants to pass a physical examination, drug and alcohol screening, and a criminal background check. Under Federal regulation, all people licensed to operate engines are subject to random drug and alcohol testing while on duty; engineers also must undergo periodic physical examinations.

Advancement. Most railroad transportation workers begin as laborers, brake operators, or conductors after completing training on signals, timetables, operating rules, and related subjects. Although new employees may be hired as conductors, seniority determines whether an employee may hold a conductor position full time. Employers almost always fill engineer positions with workers who have experience in other railroad-operating occupations. Subway and streetcar operators with sufficient seniority can advance to station manager or another supervisory position.

Employment

Rail transportation workers held 130,500 jobs in 2008. Employment was distributed as follows:

Locomotive engineers and operators 51,100
Railroad conductors and yardmasters 41,300
Railroad brake, signal, and switch operators 25,600
Subway and streetcar operators 7,700
Rail transportation workers, all other 4,800

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Most rail transportation workers were employed in the rail transportation industry or in support activities for the industry. Rail transportation and rail transportation support activities made up 87 percent jobs in 2008. The rest worked primarily for local governments that operate subway or streetcar systems.

Job Outlook

Employment in most railroad transportation occupations is expected to grow about as fast as average through the year 2018. Opportunities are expected to be good for qualified applicants, in large part because of the number of workers expected to retire or leave these occupations through 2018.

Employment change. Employment is expected to increase by 9 percent from 2008 through 2018, which is about as fast as the average for all occupations. This will largely be the result of expected increases in the demand for freight and passenger rail transportation as fuel costs increase and rail becomes a cheaper alternative to trucks and automobiles. Despite the slowdown in the economy, in the long term freight transportation should continue to expand as global trade expands and rail freight benefits from the shipment of more goods. However, advances such as remote control locomotive technology, discussed previously, and positive train control technology, which allows for the electronic monitoring of mechanical difficulties and track problems, will allow railroads to improve productivity and consolidate duties. To some extent, this will offset the need for new employees in occupations not essential for railroad operations.

Although demand for passenger rail service is anticipated to increase with the growing population, as is demand for public transit authorities, employment growth for workers in passenger rail will be slow because the addition of new service will be limited by the lack of track, which is not expected to increase by any great extent over the 2008–18 period. Employment of subway and streetcar operators is expected to increase modestly because more commuter and light-rail transportation systems are being proposed around the country.

A law recently passed by the U.S. Congress may have a positive impact on employment in rail transportation occupations. The Rail Safety Improvement Act of 2008 increases the number of hours that train crews must rest between shifts. It also requires more safety improvements to railroad crossings. This law may generate more jobs for engineers and conductors as well as signal operators.

Job prospects. Opportunities for rail transportation workers will be good for workers who meet basic qualifications, because a large number of older workers are expected to retire over the next decade, particularly at freight railroads. Prospects will be best for those positions that are also expected to see growth, like locomotive engineers and conductors.

Entry-level occupations such as brake operator and conductor should be plentiful for applicants with clean drug and criminal records. Opportunities for long-distance train crews are also expected to be good because many of those working in the yards prefer not to travel long distances. Subway and streetcar operators will have the best opportunities in cities where the construction of commuter or light-rail transit systems is underway.

Earnings

Median hourly wages of rail transportation occupations in May 2008 are indicated in the tabulation below. These wages were relatively high compared with $13.14 per hour, the median wage for all transportation occupations.

Subway and streetcar operators	$25.59
Railroad conductors and yardmasters	25.40
Railroad brake, signal, and switch operators	22.94
Locomotive engineers and operators	22.54
Rail tranporation workers, all other	21.12

Most railroad transportation workers are paid according to miles traveled or hours worked, whichever leads to higher earnings. Factors such as seniority, job assignments, and location affect potential earnings.

76 percent of railroad transportation workers are members of unions, compared with 12 percent for all occupations. There are many different railroad unions, and they represent various crafts on the railroads. Among the largest of the railroad employee unions are the United Transportation Union and the Brotherhood of Locomotive Engineers and Trainmen. Many subway operators are members of the Amalgamated Transit Union, while others belong to the Transport Workers Union of North America.

Related Occupations

Other transportation workers include:

	Page
Bus drivers	791
Truck drivers and driver/sales workers	797
Water transportation occupations	805

Workers who repair and maintain railroad rolling stock are included in the occupation:

Heavy vehicle and mobile equipment service technicians and mechanics	697

Workers who load and unload freight from rail cars are included in:

Material moving occupations	809

Sources of Additional Information

To obtain information on employment opportunities, contact either the employment offices of railroads and rail transit systems or State employment service offices.

General information about the rail transportation industry is available from:

➤ Association of American Railroads, 425 3rd St. SW, Suite 1000, Washington, DC 20024. Internet: **http://www.aar.org**

General information about career opportunities in passenger transportation is available from:

➤ National Railroad Passenger Corporation, 60 Massachusetts Ave. NE, 4th floor, Washington, DC 20002. Internet: **http://www.amtrak.com**

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General information on career opportunities as a locomotive engineer is available from:

➤ Brotherhood of Locomotive Engineers and Trainmen, 1370 Ontario St. Mezzanine, Cleveland, OH 44113. Internet: **http://www.ble.org**

General information on career opportunities as a conductor, yardmaster, or brake operator is available from:

➤ United Transportation Union, 14600 Detroit Ave., Cleveland, OH 44107. Internet: **http://www.utu.org**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos244.htm**

Water Transportation Occupations

Significant Points

- Some merchant mariners spend extended periods at sea; others operate boats close to port and go home at night.
- Entry, training, and educational requirements for many water transportation occupations are established and regulated by the U.S. Coast Guard.
- Excellent job opportunities are expected, especially for marine officers.

Nature of the Work

The movement of huge amounts of cargo, as well as passengers, in and out of U.S. waters and sometimes over the oceans depends on workers in water transportation occupations, also known as *merchant mariners*. They operate and maintain civilian-owned deep-sea merchant ships, tugboats, towboats, ferries, barges, offshore supply vessels, cruise ships, and other waterborne craft on the oceans, the Great Lakes, rivers, canals, and other waterways, as well as in harbors. (Workers who operate watercraft used in commercial fishing are described in the section on fishers and fishing vessel operators elsewhere in the *Handbook*.)

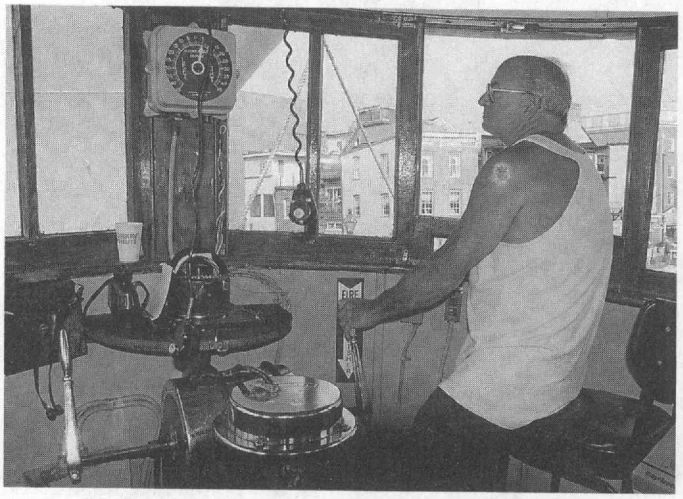
Captains, mates, and pilots of water vessels operating on domestic waterways or on U.S.-flagged deep sea ships command or supervise the operations of these ships and water vessels. *Captains* or *masters* are in overall command of the operation of a vessel, and they supervise the work of all other officers and crew. Together with their department heads, captains ensure that proper procedures and safety practices are followed, check to make sure that machinery and equipment are in good working order, and oversee the loading and discharging of cargo or passengers. They also maintain logs and other records tracking the ships' movements, efforts at controlling pollution, and cargo and passengers carried.

Deck officers or *mates* direct the routine operation of the vessel for the captain during the shifts when they are on watch. On smaller vessels, there may be only one mate (called a *pilot* on some inland towing vessels), who alternates watches with the captain. The mate would assume command of the ship if the captain became incapacitated. When more than one mate is necessary aboard a ship, they typically are designated chief mate or first mate, second mate, third mate, etc. Mates also supervise and coordinate activities of the crew aboard the ship.

Captains and mates determine the course and speed of the vessel, maneuvering to avoid hazards and continuously monitoring the vessel's position with charts and navigational aides. Captains and mates oversee crew members who steer the vessel, determine its location, operate engines, communicate with other vessels, perform maintenance, handle lines, and operate equipment on the vessel. They inspect the cargo holds during loading to ensure that the load is stowed according to specifications and regulations. Captains and mates also supervise crew members engaged in maintenance and the primary upkeep of the vessel.

Pilots guide ships in and out of harbors, through straits, and on rivers and other confined waterways where a familiarity with local water depths, winds, tides, currents, and hazards such as reefs and shoals are of prime importance. Pilots on river and canal vessels usually are regular crew members, like mates. Harbor pilots are generally independent contractors who accompany vessels while they enter or leave port. *Harbor pilots* may pilot many ships in a single day.

Ship engineers operate, maintain, and repair propulsion engines, boilers, generators, pumps, and other machinery. Merchant marine vessels usually have four engineering officers: A chief engineer and a first, second, and third assistant engineer. Assistant engineers stand periodic watches, overseeing the safe operation of engines and machinery.



Work schedules for water transportation workers vary based upon the type of ship and length of voyage.

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Marine oilers and more experienced *qualified members of the engine department*, or QMEDs, assist the engineers to maintain the vessel in proper running order in the engine spaces below decks. These workers lubricate gears, shafts, bearings, and other moving parts of engines and motors; read pressure and temperature gauges; record data; and sometimes assist with repairs and adjust machinery.

Sailors or deckhands operate the vessel and its deck equipment under the direction of the ship's officers and keep the nonengineering areas in good condition. They stand watch, looking out for other vessels and obstructions in the ship's path, as well as for navigational aids such as buoys and lighthouses. They also steer the ship, measure water depth in shallow water, and maintain and operate deck equipment such as lifeboats, anchors, and cargo-handling gear. When docking or departing, they handle lines. They also perform routine maintenance chores, such as repairing lines, chipping rust, and painting and cleaning decks or other areas. On vessels handling liquid cargo, mariners designated as *pumpmen* hook up hoses, operate pumps, and clean tanks; on tugboats or tow vessels, they tie barges together into tow units, inspect them periodically, and disconnect them when the destination is reached. Experienced sailors are designated *able seamen* on oceangoing vessels, but may be called simply deckhands on inland waters; larger vessels usually have a *boatswain*, or *head seaman*.

A typical deep-sea merchant ship has a captain, three deck officers or mates, a chief engineer and three assistant engineers, plus six or more seamen, such as able seamen, oilers, QMEDs, and a cook. The size and service of the ship determine the number of crewmembers for a particular voyage. Small vessels operating in harbors, on rivers, or along the coast may have a crew comprising only a captain and one deckhand. On smaller vessels the cooking responsibilities usually fall under the deckhands' duties.

On larger coastal ships, the crew may include a captain, a mate or pilot, an engineer, and seven or eight seamen. Unlicensed positions on a large ship may include a full-time cook, an electrician, and machinery mechanics. Some ships may have special unlicensed positions for entry-level apprentice trainees.

Motorboat operators operate small, motor-driven boats that carry six or fewer passengers. They may operate fishing charters, serve as liaisons between ships or between ship and shore, or perform area patrol.

Work environment. Water transportation workers' schedules vary based upon the type of ship and length of voyage. While on the water, crews are normally on duty for half of the day, 7 days a week.

Merchant mariners on survey and long distance cargo vessels can spend extended periods at sea. Most deep-sea mariners are hired for one or more voyages that last for several months; there is no job security after that. The length of time between voyages varies depending on job availability and personal preference.

Workers on supply vessels transport workers, supplies (water, drilling mud, fuel, and food), and equipment to oil and gas drilling platforms mostly in the Gulf of Mexico. Their voyages can last a few hours to a couple of weeks. As oil and gas exploration pushes into deeper waters, these trips take more time.

Workers on tugs and barges operate on the rivers, lakes, inland waterways, and along the coast. Most tugs have two crews and operate constantly. The crews will alternate, each working for 2-3 weeks and then taking 2-3 weeks off.

Many of those employed on Great Lakes ships work 60 days and have 30 days off, but do not work in the winter when the lakes are frozen. Others work steadily for a week or a month and then have an extended period off. Those on smaller vessels, such as tugs, supply boats and Great Lakes ships, are normally assigned to one vessel and have steady employment.

Workers on ferries transporting commuters work on weekdays in the morning and evening. Other ferries make frequent trips lasting a few hours. Ferries servicing vacation destinations often operate on seasonal schedules. Workers in harbors generally have year-round work. Work in harbors and on ferries is highly sought after because workers return home every day.

People holding water transportation jobs work in all kinds of weather, except when frozen waters make travel impossible. Although merchant mariners try to avoid severe storms while at sea, working in damp and cold conditions often is inevitable. While it is uncommon for vessels to suffer disasters such as fire, explosion, or sinking, workers face the possibility that they may have to abandon their craft on short notice if it collides with another vessel or runs aground. They also risk injury or death from falling overboard and hazards associated with working with machinery, heavy loads, and dangerous cargo. However, modern safety management procedures, advanced emergency communications, and effective international rescue systems have greatly improved mariner safety.

Many companies are working to improve the living conditions on vessels to reduce employee turnover. Most of the Nation's newest vessels are air conditioned, soundproofed to reduce machinery noise, and equipped with comfortable living quarters. Some companies have added improved entertainment systems and hired full-time cooks. These amenities lessen the difficulty of spending long periods away from home. Advances in communications, particularly e-mail, better link mariners to their families. Nevertheless, some mariners dislike the long periods away from home and the confinement aboard ship and consequently leave the occupation.

Training, Other Qualifications, and Advancement

Entry, training, and experience requirements for many water transportation occupations are established and regulated by the U.S. Coast Guard. As of April 15, 2009, mariners on board most ships have to obtain two credentials, a Transportation Worker Identification Credential (TWIC) and a Merchant Mariner Credential (MMC).

Education and training. Entry-level workers are classified as ordinary seamen or deckhands. Workers take some basic training, lasting a few days, in areas such as first aid and firefighting.

There are two paths of education and training for a deck officer or an engineer: applicants must either accumulate thousands of hours of experience while working as a deckhand, or graduate from one of seven merchant marine academies in the United States. In both cases, applicants must pass a written examination. It is difficult to pass the examination without substantial formal schooling or independent study. The academies offer a 4-year academic program leading to a bachelor-of-science degree, a MMC endorsement (issued only by the Coast Guard) as a third mate (deck officer) or third assistant engineer (engineering officer), and, if the person chooses, a commission as ensign

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in the U.S. Naval Reserve, Merchant Marine Reserve, or Coast Guard Reserve. With experience and additional training, third officers may qualify for higher rank. Generally officers on deep water vessels are academy graduates and those in supply boats, inland waterways, and rivers rose to their positions through years of experience.

Harbor pilot training usually consists of an extended apprenticeship with a towing company or a harbor pilots' association. Entrants may be able seamen or licensed officers.

In recent years, to generate interest in the maritime industry, 18 high schools have been designated "maritime high schools" with a curriculum created by the U.S. Maritime Administration. Graduation from one of these schools can help oneís entry in the academies or with jobs elsewhere in the industry.

Licensure. All mariners that are required to obtain Coast Guard credentials are required to obtain a TWIC from the U.S. Department of Homeland Security. This credential states that you are a U.S. citizen or a permanent resident and have passed a security screening.

In addition, with few exceptions, the Coast Guard requires that mariners applying for a credential after April 15, 2009, obtain a MMC. Entry level seamen or deckhands on vessels operating in harbors or on rivers or other waterways do not need a MMC. The MMC replaces the Merchant Mariner Document, the license, and Standards of Training, Certification, and Watchkeeping for Seafarers endorsement. The MMC incorporates the licenses into the credential, which varies by occupational specialty, type of vessel, and by body of water (river, inland waterway, Great Lakes, and oceans). Requirements for the credential increase as the skill level of the occupational specialty and the size of the vessel increase and applicants must pass a test in order qualify. Applicants for the credential must also pass a drug screen, take a medical exam, and meet the minimum age requirements. For more information on credentialing requirements see the Coast Guard's Web site listed in the sources of additional information.

Radio operators are licensed by the Federal Communications Commission.

Other qualifications. Most positions require excellent health, good vision, and color perception. Good general physical condition is needed because many jobs require the ability to lift heavy objects, withstand heat and cold, stand or stoop for long periods of time, dexterity to maneuver through tight spaces, and good balance on uneven and wet surfaces and in rough water.

Advancement. Experience and passing exams are required to advance. Deckhands who wish to advance must decide whether they want to work in the wheelhouse or the engine room. They will then assist the engineers or deck officers. With experience, assistant engineers and deck officers can advance to become chief engineers or captains. On smaller boats, such as tugs, a captain may choose to become self-employed by buying a boat and working as an owner-operator.

Employment

Water transportation workers held more than 81,100 jobs in 2008. The total number who worked at some point in the year was significantly larger because many merchant marine officers and seamen work only part of the year. The following tabulation shows employment in the occupations that make up this group:

Captains, mates, and pilots of water vessels	33,100
Sailors and marine oilers	32,900
Ship engineers	11,500
Motorboat operators	3,700

About 40 percent of all workers were employed in water transportation services. Another 26 percent worked in establishments related to port and harbor operations, marine cargo handling, or navigational services to shipping. Governments employed 11 percent of all water transportation workers, many of whom worked on supply ships and are civilian mariners of the Navy Department's Military Sealift Command.

Job Outlook

Employment in water transportation occupations is projected to grow faster than average. Excellent job opportunities are expected as demand for people working in the shipping industry, particularly officers, is expected to be greater than the number of people wishing to enter these occupations.

Employment change. Employment in water transportation occupations is projected to grow 15 percent over the 2008-2018 period, faster than the average for all occupations. Job growth will stem from increasing tourism and growth in offshore oil and gas production. Employment will also rise in and around major port cities due to increasing international trade.

Employment in deep-sea shipping for American mariners is expected to remain stable. A fleet of deep-sea U.S.-flagged ships is considered vital to the Nation's defense, so some receive Federal support through a maritime security subsidy and other provisions in laws that limit certain Federal cargoes to ships that fly the U.S. flag.

Employment growth also is expected in passenger cruise ships within U.S. waters. Vessels that operate between U.S. ports are required by law to be U.S.-flagged vessels. The staff-

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Water transportation occupations	53-5000	81,100	93,100	12,000	15
Sailors and marine oilers	53-5011	32,900	36,700	3,800	12
Ship and boat captains and operators	53-5020	36,800	42,800	6,000	16
Captains, mates, and pilots of water vessels	53-5021	33,100	38,800	5,700	17
Motorboat operators	53-5022	3,700	4,000	300	8
Ship engineers	53-5031	11,500	13,600	2,100	19

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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ing needs for several new U.S. flagged cruise ships that will travel to the Hawaiian Islands will create new opportunities for employment. In addition, a small, but growing interest in using ferries to handle commuter traffic around major metropolitan areas should create some opportunities.

Some growth in water transportation occupations is projected in vessels operating in the Great Lakes and inland waterways as the economy recovers from the recession. Growth will be driven by demand for bulk products, such as coal, iron ore, petroleum, sand and gravel, grain, and chemicals. Since current pipelines cannot transport ethanol, some growth will come from shipping ethanol. Problems with congestion in the rail transportation system will increase demand for inland water transportation.

Job prospects. Excellent job opportunities are anticipated over the next decade as the need to replace workers, particularly officers, will generate many job openings. High turnover, the prospect of many retirements in the water transportation industry as a whole, and growth in the level of trade occurring worldwide will cause more jobs to be created than there will be people interested in taking them. The number of graduates from maritime academies has not kept up with the demand for officers on board ships. In addition, higher regulatory and security requirements has limited the pool of potential seamen. And a limited number of berths (beds) on board ships also is making it difficult for potential seamen to get the required number of hours on board ships to qualify for certain credentials. However, as the industry acknowledges these problems, living conditions, training, and opportunities for advancement should go up to attract more people to the occupations.

Earnings

Earnings vary widely with the particular water transportation position and the worker's experience. Earnings are higher than most other occupations with similar educational requirements for entry-level positions. While wages are lower for sailors than for mates and engineers, sailors' on-board experience is important for advancing into those higher paying positions. Workers are normally paid by the day. Since companies provide food and housing at sea and it is difficult to spend money while working, sailors are able to save a large portion of their pay.

Median annual wages of captains, mates, and pilots of water vessels were $61,960 in May 2008. The middle 50 percent earned between $42,810 and $83,590. The lowest 10 percent had wages of less than $29,330, while the top 10 percent earned over $108,120. Annual pay for captains of larger vessels, such as container ships, oil tankers, or passenger ships may exceed $100,000, but only after many years of experience. Similarly, earnings of captains of tugboats are dependent on the port and the nature of the cargo.

Median annual wages of sailors and marine oilers were $34,390 in May 2008. The middle 50 percent earned between $26,550 and $44,080. The lowest 10 percent had wages of less than $21,110, while the top 10 percent earned over $51,890.

Median annual wages of ship engineers were $60,690 in May 2008. The middle 50 percent earned between $45,520 and $79,800. The lowest 10 percent had wages of less than $34,420, while the top 10 percent earned over $102,850.

Median annual wages of motorboat operators were $31,910 in May 2008. The middle 50 percent earned between $26,600 and 48,310. The lowest 10 percent had wages of less than $20,420, while the top 10 percent earned over $59,120.

The rate of unionization for these workers is about 12 percent. Unionization rates vary by region. In unionized areas, merchant marine officers and seamen, both veterans and beginners, are hired for voyages through union hiring halls or directly by shipping companies. Hiring halls rank the candidates by the length of time the person has been out of work and fill open slots accordingly. Most major seaports have hiring halls.

Related Occupations

Other occupations that make their living on the seas and coastal waters include:

Fishers and fishing vessel operators 601

Other technicians and mechanics that perform work similar to shipboard engineers, include:

Heavy vehicle and mobile equipment service technicians and mechanics 697

Employment opportunities in the Navy and Coast guard are discussed in:

Job opportunities in the armed forces 813

Sources of Additional Information

Information on a career as a mariner, including a substantial listing of training and employment information and contacts in the U.S., may be obtained through:

➤ Maritime Administration, U.S. Department of Transportation, 1200 New Jersey Ave. SE, Washington, DC 20590. Internet: **http://www.marad.dot.gov**

Information on merchant marine careers, training, and licensing requirements is available from:

➤ U.S. Coast Guard National Maritime Center, 2100 Second St. SW, Washington, DC 20593. Internet: **http://www.uscg.mil/nmc**

For information on jobs on inland and coastal waterways aboard tugboats and towboats, contact:

➤ The American Waterways Operators, 801 North Quincy St., Suite 200, Arlington, VA 22203. Internet: **http://www.americanwaterways.com**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos247.htm**

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Material Moving Occupations

Significant Points

- Despite little or no change in employment, numerous job openings will be created by the need to replace workers who leave this very large occupation.
- Most jobs require little work experience or training.
- Pay is low for many positions, and the seasonal nature of the work may reduce earnings.

Nature of the Work

Think about a common bicycle; over the course of its creation many workers have to transport a variety of materials to get it to your local store. First, the raw metal must be produced, either from a mine where an *excavator operator* digs into the earth to gather rocks with the proper minerals and places them on a conveyor operated by a *conveyor tender*; or by a *recyclable material collector* that picks up unwanted metal household goods. Next, the metal is refined in a foundry, at which point a *crane operator* or *hoist and winch operator* may place it on a trailer for shipping. After arriving at a factory, an *industrial truck operator* unloads the metal and a *machine feeder* loads it into a machine for production. After being assembled, the bicycle is placed into a box by a *hand packager* and then moved into a tractor trailer by a *truck loader*. Many products, like this bicycle, are handled by a variety of workers because, even with the use of machinery, moving goods and materials around worksites still requires significant human effort. Material moving workers are generally categorized into two groups—operators, who control the machines that move materials, and laborers, who move materials by hand.

Operators use machinery to move construction materials, earth, petroleum products, and other heavy materials. Generally, they move materials over short distances—around construction sites, factories, or warehouses. Some move materials onto or off of trucks and ships. Operators control equipment by moving levers, wheels, or foot pedals; operating switches; or turning dials. They also may set up and inspect equipment, make adjustments, and perform minor maintenance or repairs.

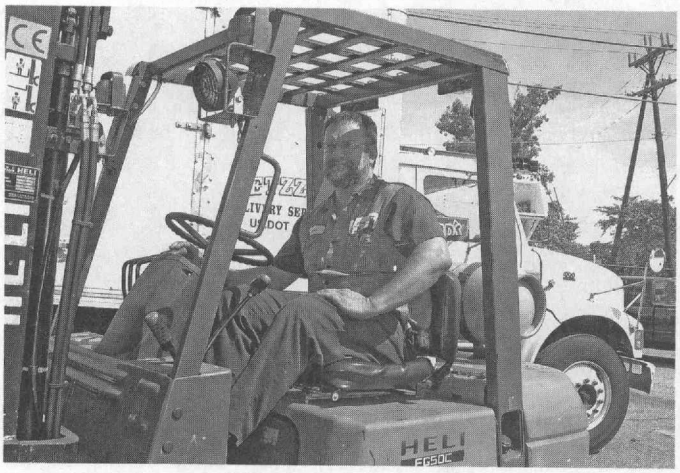
Laborers and hand material movers move freight, stock, or other materials by hand; clean vehicles, machinery, and other equipment; feed materials into or remove materials from machines or equipment; and pack or package products and materials.

Industrial truck and tractor operators drive and control industrial trucks or tractors that move materials around warehouses, storage yards, factories, construction sites, or other worksites. A typical industrial truck, often called a forklift or lift truck, has a hydraulic lifting mechanism and forks for moving heavy and large objects. Industrial truck and tractor operators also may operate tractors that pull trailers loaded with materials, goods, or equipment within factories and warehouses or around outdoor storage areas.

Excavating and loading machine and dragline operators tend or operate machinery equipped with scoops, shovels, or buckets to dig and load sand, gravel, earth, or similar materials into trucks or onto conveyors. These machines are primarily used in the construction and mining industries. *Dredge operators* excavate waterways, removing sand, gravel, rock, or other materials from harbors, lakes, rivers, and streams. Dredges are used primarily to maintain navigable channels but also are used to restore wetlands and other aquatic habitats; reclaim land; and create and maintain beaches. *Underground mining loading machine operators* load coal, ore, or rock into shuttles and mine cars or onto conveyors. Loading equipment may include power shovels, hoisting engines equipped with cable-drawn scrapers or scoops, and machines equipped with gathering arms and conveyors.

Crane and tower operators use mechanical boom and cable or tower and cable equipment to lift and move materials, machinery, and other heavy objects. Operators extend and retract horizontally mounted booms and lower and raise hooks attached to load lines. Most operators are guided by other workers using hand signals or a radio. Operators position loads from an onboard console or from a remote console at the site. Although crane and tower operators are noticeable at office building and other construction sites, the biggest group works in manufacturing industries that use heavy, bulky materials. Operators also work at major ports, loading and unloading large containers on and off ships. *Hoist and winch operators* control movement of cables, cages, and platforms to move workers and materials for manufacturing, logging, and other industrial operations. They work in positions such as derrick operators and hydraulic boom operators. Many hoist and winch operators are found in manufacturing or construction industries.

Pump operators tend, control, and operate pump and manifold systems that transfer gases, oil, or other materials to vessels or equipment. They maintain the equipment and regulate the flow of materials according to a schedule set up by petroleum engineers or production supervisors. *Gas compressor and gas pumping station operators* operate steam, gas, electric motor, or internal combustion engine-driven compressors. They transmit, compress, or recover gases, such as butane, nitrogen, hydrogen,



Material movers often work in the construction industry.

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and natural gas. *Wellhead pumpers* operate pumps and auxiliary equipment to produce flows of oil or gas from extraction sites.

Tank car, truck, and ship loaders operate ship-loading and ship-unloading equipment, conveyors, hoists, and other specialized material-handling equipment such as railroad tank car-unloading equipment. They may gauge or sample shipping tanks and test them for leaks. *Conveyor operators and tenders* control and tend conveyor systems that move materials to or from stockpiles, processing stations, departments, or vehicles. *Shuttle car operators* run diesel or electric-powered shuttle cars in underground mines, transporting materials to mine cars or conveyors.

Laborers and hand freight, stock, and *material movers* manually move materials and perform other unskilled, general labor. These workers move freight, stock, and other materials to and from storage and production areas, loading docks, delivery vehicles, ships, and containers. Their specific duties vary by industry and work setting. In factories, they may move raw materials or finished goods between loading docks, storage areas, and work areas, as well as sort materials and supplies and prepare them according to their work orders. Specialized workers within this group include baggage and cargo handlers—who work in transportation industries—and truck loaders and unloaders.

Hand packers and packagers manually pack, package, or wrap a variety of materials. They may label cartons, inspect items for defects, stamp information on products, keep records of items packed, and stack packages on loading docks. This group also includes order fillers, who pack materials for shipment, as well as gift wrappers. In grocery stores, they may bag groceries, carry packages to customers' cars, and return shopping carts to designated areas.

Machine feeders and offbearers feed materials into or remove materials from equipment or machines tended by other workers.

Cleaners of vehicles and equipment clean machinery, vehicles, storage tanks, pipelines, and similar equipment using water and cleaning agents, vacuums, hoses, brushes, or cloths.

Refuse and recyclable material collectors gather refuse and recyclables from homes and businesses into their trucks for transport to a dump, landfill, or recycling center. They lift and empty garbage cans or recycling bins by hand or, using hydraulic lifts on their vehicles, pick up and empty dumpsters. Some in this group drive the large garbage or recycling truck along the scheduled routes.

(For information on operating engineers; paving, surfacing, and tamping equipment operators; and pile-driver operators, see the statement on construction equipment operators elsewhere in the *Handbook*.)

Work environment. Material moving work tends to be repetitive and physically demanding. Workers may lift and carry heavy objects and stoop, kneel, crouch, or crawl in awkward positions. Some work at great heights and some work outdoors—regardless of weather and climate. Some jobs expose workers to fumes, odors, loud noises, harmful materials and chemicals, or dangerous machinery. To protect their eyes, respiratory systems, and hearing, these workers wear safety clothing, such as gloves, hardhats, and other safety devices such as respirators. These jobs have become less dangerous as safety equipment—such as overhead guards on lift trucks—has become common. Accidents usually can be avoided by observing proper operating procedures and safety practices.

Material movers generally work 8-hour shifts—though longer shifts are not uncommon. In industries that work around the clock, material movers may work overnight shifts. Some do

Projections data from the National Employment Matrix

Occupational Title	SOC Code	Employment, 2008	Projected Employment, 2018	Change, 2008-2018 Number	Change, 2008-2018 Percent
Material moving occupations	53-7000	4,583,700	4,537,200	-46,500	-1
Conveyor operators and tenders	53-7011	41,000	37,200	-3,800	-9
Crane and tower operators	53-7021	43,900	40,900	-3,000	-7
Dredge, excavating, and loading machine operators	53-7030	82,300	88,600	6,300	8
Dredge operators	53-7031	2,200	2,400	200	7
Excavating and loading machine and dragline operators	53-7032	75,700	82,100	6,500	9
Loading machine operators, underground mining	53-7033	4,400	4,100	-300	-7
Hoist and winch operators	53-7041	2,800	2,600	-200	-8
Industrial truck and tractor operators	53-7051	610,300	627,000	16,700	3
Laborers and material movers, hand	53-7060	3,565,700	3,485,400	-80,200	-2
Cleaners of vehicles and equipment	53-7061	348,900	352,500	3,600	1
Laborers and freight, stock, and material movers, hand	53-7062	2,317,300	2,298,600	-18,700	-1
Machine feeders and offbearers	53-7063	140,600	109,500	-31,200	-22
Packers and packagers, hand	53-7064	758,800	724,800	-34,000	-4
Pumping station operators	53-7070	32,500	24,500	-8,000	-25
Gas compressor and gas pumping station operators	53-7071	4,300	3,400	-900	-21
Pump operators, except wellhead pumpers	53-7072	9,700	7,800	-1,900	-20
Wellhead pumpers	53-7073	18,600	13,300	-5,300	-28
Refuse and recyclable material collectors	53-7081	149,000	176,700	27,800	19
Shuttle car operators	53-7111	3,100	3,000	-100	-4
Tank car, truck, and ship loaders	53-7121	12,000	11,200	-900	-7
Material moving workers, all other	53-7199	41,000	40,000	-1,000	-2

(NOTE) Data in this table are rounded. See the discussion of the employment projections table in the *Handbook* introductory chapter on *Occupational Information Included in the Handbook.*

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this because their employers do not want to disturb customers during normal business hours. Refuse and recyclable material collectors often work shifts starting at 5 or 6 a.m. Some material movers work only during certain seasons, such as when the weather permits construction activity.

Training, Other Qualifications, and Advancement

Many material moving occupations require little or no formal training. Most training for these occupations is done on the job. For those jobs requiring physical exertion, employers may require that applicants pass a physical exam.

Education and training. Material movers generally learn skills informally, on the job, from more experienced workers or their supervisors. Many employers prefer applicants with a high school diploma or GED, but most simply require workers to be at least 18 years old and physically able to perform the work.

Workers who handle toxic chemicals or use industrial trucks or other dangerous equipment must receive specialized training in safety awareness and procedures. Many of the training requirements are standardized through the Occupational Safety and Health Administration (OSHA), but training for workers in mining is regulated by the Mine Safety and Health Administration (MSHA). This training is usually provided by the employer. Employers also must certify that each operator has received the training and evaluate each operator at least once every 3 years.

For other operators, such as crane operators and those working with specialized loads, there are some training and apprenticeship programs available, such as that offered by the International Union of Operating Engineers. Apprenticeships combine paid on-the-job training with classroom instruction.

Licensure. Seventeen States and 6 cities have laws requiring crane operators to be licensed. Licensing requirements typically include a written test as well as a skills test to demonstrate that the licensee can operate a crane safely.

Certification and other qualifications. Some types of equipment operators can become certified by professional associations, such as the National Commission for the Certification of Crane Operators, and some employers may require operators to be certified.

Material moving equipment operators need a good sense of balance, the ability to judge distances, and eye-hand-foot coordination. For jobs that involve dealing with the public, such as baggers or grocery store courtesy clerks, workers should be pleasant and courteous. Most jobs require basic arithmetic skills, the ability to read procedural manuals, and the capacity to understand orders and other billing documents. Experience operating mobile equipment—such as tractors on farms or heavy equipment in the Armed Forces—is an asset. As material moving equipment becomes more advanced, workers will need to be increasingly comfortable with technology.

Advancement. In many of these occupations, experience may allow workers to qualify or become trainees for jobs such as construction trades workers; assemblers or other production workers; or motor vehicle operators. In many workplaces, new employees gain experience in a material moving position before being promoted to a better paying and more highly skilled job. Some may eventually advance to become supervisors.

Employment

Material movers held 4.6 million jobs in 2008. They were distributed among the detailed occupations as follows:

Laborers and freight, stock, and material movers, hand	2,317,300
Packers and packagers, hand	758,800
Industrial truck and tractor operators	610,300
Cleaners of vehicles and equipment	348,900
Refuse and recyclable material collectors	149,000
Machine feeders and offbearers	140,600
Excavating and loading machine and dragline operators	75,700
Crane and tower operators	43,900
Conveyor operators and tenders	41,000
Wellhead pumpers	18,600
Tank car, truck, and ship loaders	12,000
Pump operators, except wellhead pumpers	9,700
Loading machine operators, underground mining	4,400
Gas compressor and gas pumping station operators	4,300
Shuttle car operators	3,100
Hoist and winch operators	2,800
Dredge operators	2,200
Material moving workers, all other	41,000

About 29 percent of all material movers worked in the wholesale trade or retail trade industries. Another 20 percent worked in manufacturing; 17 percent were in transportation and warehousing; 4 percent were in construction and mining; and 12 percent worked in the employment services industry, on a temporary or contract basis. For example, companies that need workers for only a few days, to move materials or to clean up a site, may contract with temporary help agencies specializing in providing suitable workers on a short-term basis. A small proportion of material movers were self-employed.

Material movers work in every part of the country. Some work in remote locations on large construction projects such as highways and dams, while others work in factories, warehouses, or mining operations.

Job Outlook

Despite little or no change in employment, numerous job openings will be created by the need to replace workers who leave this very large occupation.

Employment change. Employment in material moving occupations is projected to decline by 1 percent between 2008 and 2018. Improvements in equipment, such as automated storage and retrieval systems and conveyors, and in supply management processes, such as automatic identification and data collection (AIDC), will continue to raise productivity and reduce the demand for material movers.

Job growth for material movers depends on the growth or decline of employing industries and the type of equipment the workers operate or the materials they handle. Employment should grow in the warehousing and storage industry as more firms contract out their warehousing functions to this industry. Opportunities for material movers should decline in manufacturing due to productivity improvements and outsourcing of warehousing and other activities that depend on material movers. Opportunities will vary by establishment size as well, as

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large establishments are more likely to have the resources to invest in automated systems for their material moving needs. Although increasing automation will eliminate some routine tasks, many jobs will remain to meet the need to operate and maintain new equipment.

Job prospects. Despite the projected employment decline, a relatively high number of job openings will be created by the need to replace workers who transfer to other occupations, retire, or leave this very large occupation for other reasons—characteristic of occupations requiring little prior or formal training. Many industries where material moving workers are employed are sensitive to changes in economic conditions, so the number of job openings fluctuates with the economy.

Earnings

Median hourly wages of material moving workers in May 2008 were relatively low, as indicated by the following tabulation:

Gas compressor and gas pumping station operators	$21.45
Loading machine operators, underground mining	20.54
Shuttle car operators	20.29
Crane and tower operators	20.13
Pump operators, except wellhead pumpers	18.81
Wellhead pumpers	18.20
Tank car truck and ship loaders	18.14
Hoist and winch operators	17.50
Excavating and loading machine and dragline operators	16.93
Dredge operators	16.70
Refuse and recyclable material collectors	14.93
Industrial truck and tractor operators	13.98
Conveyor operators and tenders	13.95
Machine feeders and offbearers	12.29
Laborers and freight stock and material movers, hand	10.89
Cleaners of vehicles and equipment	9.35
Packers and packagers, hand	9.16
Material moving workers, all other	15.68

Wages vary according to experience and job responsibilities. Wages usually are higher in metropolitan areas. Seasonal peaks and lulls in workload can affect the number of hours scheduled, which affects earnings. Some crane operators, such as those unloading containers from ships at major ports, earn substantially more then their counterparts in other industries or establishments. Some material movers are union members, and these workers tend to earn higher wages.

Related Occupations

Other entry-level workers who perform physical work or operate machinery:

	Page
Agricultural workers, other	609
Building cleaning workers	495
Construction equipment operators	632
Construction laborers	635
Grounds maintenance workers	498
Logging workers	606

Sources of Additional Information

Information on training and apprenticeships for industrial truck operators is available from:

➤ International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036. Internet: **http://www.iuoe.org**

Information on crane and derrick operator certification and licensure is available from:

➤ National Commission for the Certification of Crane Operators, 2750 Prosperity Ave., Suite 505, Fairfax, VA 22031. Internet: **http://www.nccco.org**

Information on safety and training requirements is available from:

➤ U.S. Department of Labor, Occupational Safety and Health Administration (OSHA), 200 Constitution Ave. NW., Washington, DC 20210. Internet: **http://www.osha.gov**

➤ Mine Safety and Health Administration, 1100 Wilson Blvd., Arlington, VA 22209-3939. Internet: **http://www.msha.gov**

For information about job opportunities and training programs, contact local State employment service offices, building or construction contractors, manufacturers, and wholesale and retail establishments.

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos243.htm**

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Job Opportunities in the Armed Forces

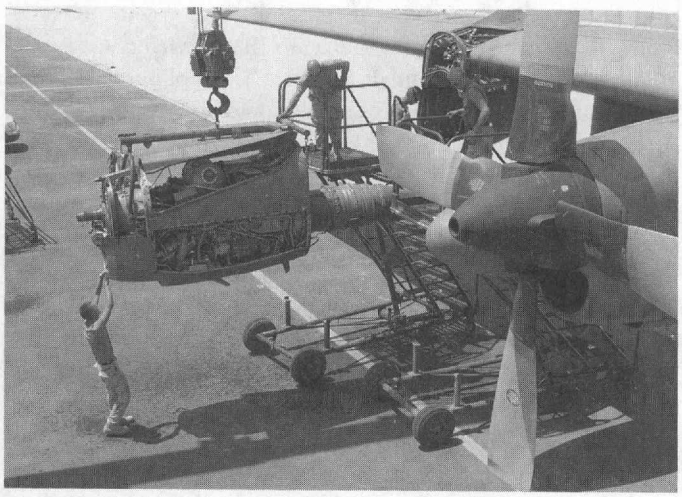
Significant Points

- Some training and duty assignments are hazardous, even in peacetime; hours and working conditions can be arduous and vary substantially, and personnel must strictly conform to military rules at all times.
- Requirements vary by branch of service, but enlisted personnel need at least a high school diploma or its equivalent while officers need a bachelor's or graduate degree.
- Opportunities should be excellent in all branches of the Armed Forces for applicants who meet designated standards.
- Military personnel are eligible for retirement after 20 years of service.

Nature of the Work

Maintaining a strong national defense requires workers who can do such diverse tasks as run a hospital, command a tank, program a computer system, operate a nuclear reactor, or repair and maintain a helicopter. The military provides training and work experience in these and many other fields for more than 2.4 million people. More than 1.4 million people serve in the active Army, Navy, Marine Corps, and Air Force, and more than 1.0 million serve in their Reserve components and the Air and Army National Guard. (The Coast Guard, which also is discussed in this *Handbook* statement, is part of the Department of Homeland Security.)

The military distinguishes between enlisted and officer careers. Enlisted personnel, who make up about 82 percent of the Armed Forces, carry out the fundamental operations of the military in combat, administration, construction, engineering, healthcare, human services, and other areas. Officers, who make up the remaining 18 percent of the Armed Forces, are the leaders of the military, supervising and managing activities in every occupational specialty.



The military provides training and work experience in many fields for more than 2.4 million people.

The sections that follow discuss the major occupational groups for enlisted personnel and officers.

Enlisted occupational groups. Administrative careers include a wide variety of positions. The military must keep accurate information for planning and managing its operations. Both paper and electronic records are kept on personnel and on equipment, funds, supplies, and all other aspects of the military. Administrative personnel record information, prepare reports, maintain files, and review information to assist military officers. Personnel may work in a specialized area, such as finance, accounting, legal affairs, maintenance, supply, or transportation.

Combat specialty occupations include enlisted specialties, such as infantry, artillery, and Special Forces, whose members operate weapons or execute special missions during combat. People in these occupations normally specialize by type of weapon system or combat operation. They maneuver against enemy forces and positions, and fire artillery, guns, mortars, and missiles to destroy enemy positions. They also may operate tanks and amphibious assault vehicles in combat or on scouting missions. When the military has especially difficult or specialized missions to perform, it calls upon Special Forces teams. These elite combat forces maintain a constant state of readiness to strike anywhere in the world on a moment's notice. Team members from the Special Forces conduct offensive raids, demolitions, intelligence, search-and-rescue missions, and other operations from aboard aircraft, helicopters, ships, or submarines.

Construction occupations in the military include personnel who build or repair buildings, airfields, bridges, foundations, dams, bunkers, and the electrical and plumbing components of these structures. Personnel in construction occupations operate bulldozers, cranes, graders, and other heavy equipment. Construction specialists also may work with engineers and other building specialists as part of military construction teams. Some personnel specialize in areas such as plumbing or electrical wiring. Plumbers and pipefitters install and repair the plumbing and pipe systems needed in buildings and on aircraft and ships. Building electricians install and repair electrical-wiring systems in offices, airplane hangars, and other buildings on military bases.

Electronic and electrical equipment repair personnel repair and maintain electronic and electrical equipment used in the military. Repairers normally specialize by type of equipment, such as avionics, computers, optical equipment, communications, or weapons systems. For example, electronic instrument repairers install, test, maintain, and repair a wide variety of elec-

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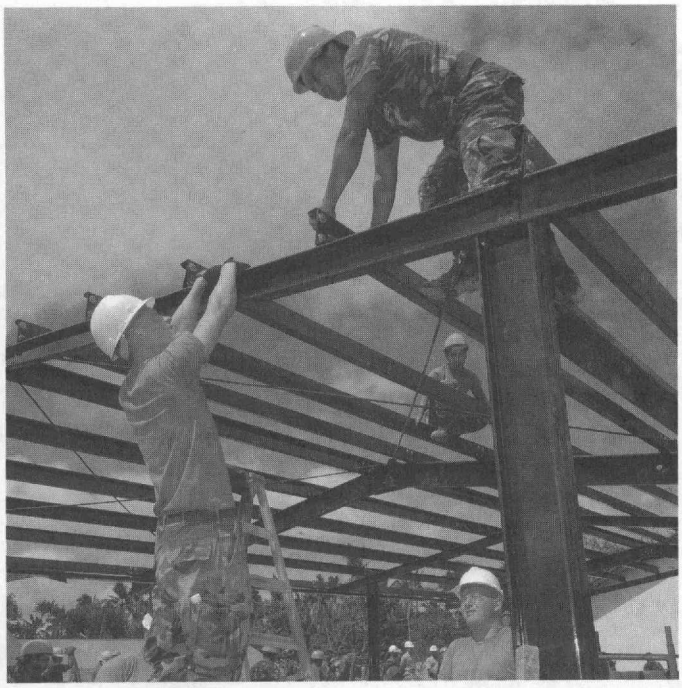

Construction specialists may work with engineers and other building specialists as part of military construction teams.

tronic systems, including navigational controls and biomedical instruments. Weapons maintenance technicians maintain and repair weapons used by combat forces; most of these weapons have electronic components and systems that assist in locating targets and in aiming and firing the weapon.

Engineering, science, and technical personnel in the military require specific knowledge to operate technical equipment, solve complex problems, or provide and interpret information. Personnel normally specialize in one area, such as space operations, information technology, environmental health and safety, or intelligence. Space operations specialists use and repair ground-control command equipment related to spacecraft, including electronic systems that track the location and operation of a craft. Information technology specialists develop software programs and operate computer systems. Environmental health and safety specialists inspect military facilities and food supplies for the presence of disease, germs, or other conditions hazardous to health and the environment. Intelligence specialists gather and study aerial photographs and use various types of radar and surveillance systems to discover information needed by the military.

Healthcare personnel assist medical professionals in treating and providing services for men and women in the military. They may work as part of a patient-service team in close contact with doctors, dentists, nurses, and physical therapists. Some specialize in providing emergency medical treatment, operating diagnostic tools such as x-ray and ultrasound equipment, laboratory testing of tissue and blood samples, maintaining pharmacy supplies or patients' records, constructing and repairing dental equipment or eyeglasses, or some other healthcare task.

Human resources development specialists recruit qualified personnel, place them in suitable occupations, and provide training programs. Personnel in this career area normally specialize by activity. For example, recruiting specialists provide information about military careers to young people, parents, schools, and local communities, and explain the Armed Service's employment and training opportunities, pay and benefits, and service life. Personnel specialists collect and store information about the people in the military, including information on their previous and current training, job assignments, promotions, and health. Training specialists and instructors teach classes, give demonstrations, and instruct military personnel on how to perform their jobs.

Machine operator and production personnel operate industrial equipment, machinery, and tools to fabricate and repair parts for a variety of items and structures. They may operate engines, turbines, nuclear reactors, and water pumps. Often, they specialize by type of work performed. Welders and metalworkers, for instance, work with various types of metals to repair or form the structural parts of ships, submarines, buildings, or other equipment. Survival equipment specialists inspect, maintain, and repair survival equipment such as parachutes and aircraft life support equipment.

Media and public affairs personnel assist with the public presentation and interpretation of military information and events. They take photographs; film, record, and edit audio and video programs; present news and music programs; and produce artwork, drawings, and other visual displays. Other public affairs specialists act as interpreters and translators to convert written or spoken foreign languages into English or other languages.

Protective service personnel include those who enforce military laws and regulations and provide emergency responses to natural and human-made disasters. For example, military police control traffic, prevent crime, and respond to emergencies. Other law enforcement and security specialists investigate crimes committed on military property and guard inmates in military correctional facilities. Firefighters put out, control, and help prevent fires in buildings, on aircraft, and aboard ships.

Support service personnel provide subsistence services and support the morale and well-being of military personnel and their families. Food service specialists prepare all types of food in dining halls, hospitals, and ships. Counselors help military personnel and their families deal with personal issues. They work as part of a team that may include social workers, psychologists, medical officers, chaplains, personnel specialists, and commanders. Religious program specialists assist chaplains with religious services, religious education programs, and related administrative duties.

Transportation and material-handling specialists ensure the safe transport of people and cargo. Most personnel within this occupational group are classified according to mode of transportation, such as aircraft, motor vehicle, or ship. Aircrew members operate equipment on aircraft. Vehicle drivers operate all types of heavy military vehicles, including fuel or water tank trucks, semitrailers, heavy troop transports, and passenger buses. Quartermasters and boat operators navigate and pilot many types of small watercraft, including tugboats, gunboats, and barges. Cargo specialists load and unload military supplies, using equipment such as forklifts and cranes.

Vehicle and machinery mechanics conduct preventive and corrective maintenance on aircraft, automotive and heavy equip-

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ment, heating and cooling systems, marine engines, and powerhouse station equipment. These workers typically specialize by the type of equipment that they maintain. For example, aircraft mechanics inspect, service, and repair helicopters, airplanes, and drones. Automotive and heavy equipment mechanics maintain and repair vehicles, such as humvees, trucks, tanks, self-propelled missile launchers, and other combat vehicles. They also repair bulldozers, power shovels, and other construction equipment. Heating and cooling mechanics install and repair air-conditioning, refrigeration, and heating equipment. Marine engine mechanics repair and maintain gasoline and diesel engines on ships, boats, and other watercraft. They also repair shipboard mechanical and electrical equipment. Powerhouse mechanics install, maintain, and repair electrical and mechanical equipment in power-generating stations.

Officer occupational groups. Combat specialty officers plan and direct military operations, oversee combat activities, and serve as combat leaders. This category includes officers in charge of tanks and other armored assault vehicles, artillery systems, Special Forces, and infantry. Combat specialty officers normally specialize by the type of unit they lead. Within the unit, they may further specialize by type of weapon system. Artillery and missile system officers, for example, direct personnel as they target, launch, test, and maintain various types of missiles and artillery. Special operations officers lead their units in offensive raids, demolitions, intelligence gathering, and search-and-rescue missions.

Engineering, science, and technical officers have a wide range of responsibilities based on their area of expertise. They lead or perform activities in areas such as space operations, environmental health and safety, and engineering. These officers may direct the operations of communications centers or the development of complex computer systems. Environmental health and safety officers study the air, ground, and water to identify and analyze sources of pollution and its effects. They also direct programs to control safety and health hazards in the workplace. Other personnel work as aerospace engineers, designing and directing the development of military aircraft, missiles, and spacecraft.

Executive, administrative, and managerial officers oversee and direct military activities in key functional areas, such as finance, accounting, health administration, international relations, and supply. Health services administrators, for instance, are responsible for the overall quality of care provided at the hospitals and clinics they operate. They must ensure that all of the departments work together. As another example, purchasing and contracting managers negotiate and monitor contracts for the purchase of the billions of dollars worth of equipment, supplies, and services that the military buys from private industry each year.

Healthcare officers provide health services at military facilities on the basis of their area of specialization. Officers who examine, diagnose, and treat patients with illness, injury, or disease include physicians, registered nurses, and dentists. Other officers provide therapy, rehabilitative treatment, and additional healthcare services for patients. Physical and occupational therapists plan and administer therapy to help patients adjust to disabilities, regain independence, and return to work. Speech therapists evaluate and treat patients with hearing and speech problems. Dietitians manage food service facilities and plan meals for hospital patients and for outpatients who need special diets. Pharmacists manage the purchase, storage, and dispensing of drugs and medicines. Physicians and surgeons in this occupational group provide the majority of medical services to the military and their families. Dentists treat diseases, disorders, and injuries of the mouth. Optometrists treat vision problems by prescribing eyeglasses or contact lenses. Psychologists provide mental healthcare and also conduct research on behavior and emotions.

Human resource development officers manage recruitment, placement, and training strategies and programs in the military. Recruiting managers direct recruiting efforts and provide information about military careers to young people, parents, schools, and local communities. Personnel managers direct military personnel functions, such as job assignment, staff promotion, and career counseling. Training and education directors identify training needs and develop and manage educational programs designed to keep military personnel current in the skills they need.

Media and public affairs officers oversee the development, production, and presentation of information or events for the public. These officers may produce and direct motion pictures, videos, and television and radio broadcasts that are used for training, news, and entertainment. Some plan, develop, and direct the activities of military bands. Public information officers respond to inquiries about military activities and prepare news releases and reports to keep the public informed.

Protective service officers are responsible for the safety and protection of individuals and property on military bases and vessels. Emergency management officers plan and prepare for all types of natural and human-made disasters by developing warning, control, and evacuation procedures to be used in the event of a disaster. Law enforcement and security officers enforce all applicable laws on military bases and investigate crimes when the law has been broken.

Support services officers manage food service activities and perform services in support of the morale and well-being of military personnel and their families. Food services managers oversee the preparation and delivery of food services within dining facilities located on military installations and vessels. Social workers focus on improving conditions that cause social problems, such as drug and alcohol abuse, racism, and sexism. Chaplains conduct worship services for military personnel and perform other spiritual duties according to the beliefs and practices of various religious faiths.

Transportation officers manage and perform activities related to the safe transport of military personnel and material by air and water. These officers normally specialize by mode of transportation or area of expertise, because, in many cases, they must meet licensing and certification requirements. Pilots in the military fly various types of specialized airplanes and helicopters to execute combat missions and to carry troops and equipment. Navigators use radar, radio, and other navigation equipment to determine their position and plan their route of travel. Officers on ships and submarines work as a team to manage the various departments aboard their vessels. Ships' engineers direct

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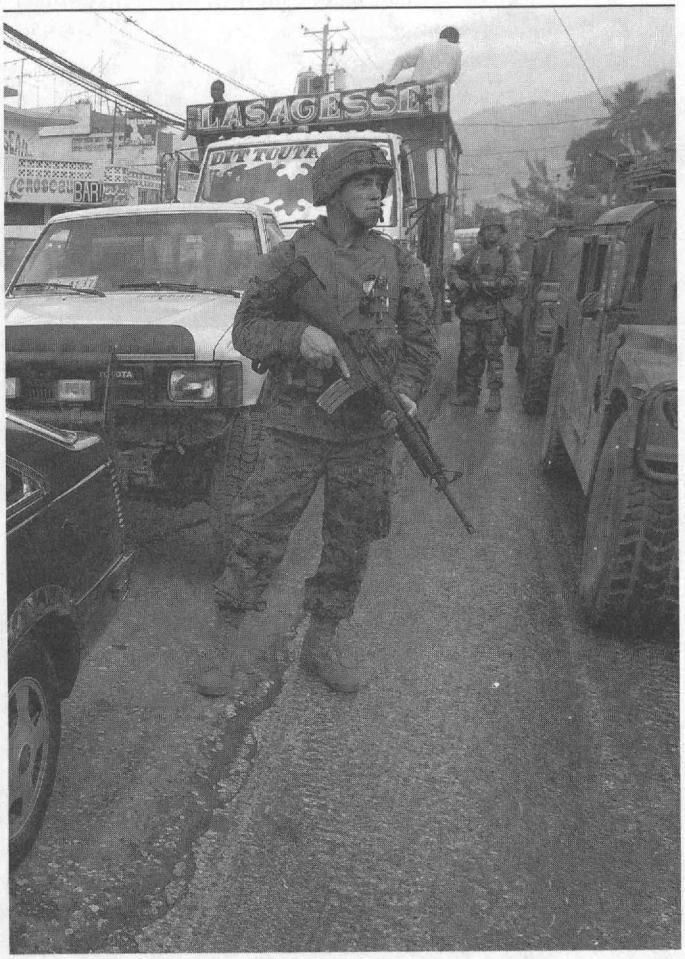
engineering departments aboard ships and submarines, including engine operations, maintenance, repair, heating, and power generation.

Work environment. Specific work environments and conditions depend on the branch of service, the occupational specialty, and other factors. Most military personnel live and work on or near military bases and facilities throughout the United States and the world. These bases and facilities usually offer comfortable housing and amenities, such as stores and recreation centers. Service members move regularly to complete their training or to meet the needs of their branch of service. Some are deployed to defend national interests. Military personnel must be physically fit, mentally stable, and ready to participate in or support combat missions that may be difficult and dangerous and involve time away from family. Some personnel are never deployed near combat areas.

In many circumstances, military personnel work standard hours, but personnel must be prepared to work long hours to fulfill missions, and they must conform to strict military rules at all times. Work hours depend on the occupational specialty and mission.

Training, Other Qualifications, and Advancement

To join the military, applicants must meet age, educational, aptitude, physical, and character requirements. These requirements vary by branch of service and vary between officers, who usually have a college degree, and enlisted personnel, who often do not. People are assigned an occupational specialty based on their aptitude, former training, and the needs of the military. All service members must sign a contract and commit to a minimum term of service. After joining the military, all enlistees receive general and occupation-specific training.



Some military personnel are deployed to defend national interests.

Those considering enlisting in the military should learn as much as they can about military life before making a decision. Doing so is especially important when one is thinking about making the military a career. Speaking to friends and relatives with military experience is a good idea, as is comparing the pros and cons. The next step is talking to a recruiter, who can determine whether the applicant qualifies for enlistment, explain the various enlistment options, and tell which military occupational specialties currently have openings. Applicants must bear in mind that the recruiter's job is to recruit promising applicants into his or her branch of military service, so the information that the recruiter gives is likely to stress the positive aspects of military life in the branch in which he or she serves.

Applicants should ask their recruiter for the branch they have chosen to assess their chances of being accepted for training in the occupation of their choice or, better still, take the aptitude exam to see how well they score. The military uses this exam as a placement exam, and test scores largely determine an individual's chances of being accepted into a particular training program. Selection for a particular type of training depends on the needs of the service and the applicant's general and technical aptitudes and personal preferences. Because all prospective recruits are required to take the exam, those who do so before committing themselves to enlisting have the advantage of knowing in advance whether they stand a good chance of being accepted for training in a particular specialty. The recruiter can schedule applicants to take the Armed Services Vocational Aptitude Battery without any obligation to join. Many high schools offer the exam as an easy way for students to explore the possibility of a military career, and the test also affords an insight into career areas in which the student has demonstrated aptitudes and interests. The exam is not part of the process of joining the military as an officer.

If an applicant decides to join the military, the next step is to pass the physical examination and sign an enlistment contract. Negotiating the contract involves choosing, qualifying for, and agreeing on a number of enlistment options, such as the length of active-duty time, which may vary according to the option. Most active-duty programs have first-term enlistments of 4 years, although there are some 2-year, 3-year, and 6-year programs. The contract also will state the date of enlistment and other options—for example, bonuses and the types of training to be received. If the service is unable to fulfill any of its obligations under the contract, such as providing a certain kind of training, the contract may become null and void.

All branches of the Armed Services offer a delayed entry program (DEP) by which an individual can delay entry into active duty for up to 1 year after enlisting. High school students can enlist during their senior year and enter a service after graduation. Others choose this program because the job training they desire is not currently available, but will be within the coming year, or because they need time to arrange their personal affairs.

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The process of joining the military as an officer is different: officers must meet educational, physical, and character requirements, but they do not take an aptitude test. The education and training section that follows includes more information.

Education and training. All branches of the Armed Forces usually require their members to be high school graduates or have equivalent credentials, such as a GED. In 2008, more than 98 percent of recruits were high school graduates. Officers usually need a bachelor's or graduate degree. Training varies for enlisted and officer personnel and varies by occupational specialty. Currently, the U.S. Military is working with several different certifying bodies to ensure that soldiers who separate from the Armed Forces receive formal recognition in the private sector for their military-based technical training.

Enlisted personnel training. Following enlistment, new members of the Armed Forces undergo initial-entry training, better known as "basic training" or "boot camp." Through courses in military skills and protocol, recruit training provides a 6- to 13-week introduction to military life. Days and nights are carefully structured and include rigorous physical exercise designed to improve strength and endurance and build each unit's cohesion.

Following basic training, most recruits take additional training at technical schools that prepare them for a particular military occupational specialty. The formal training period generally lasts from 10 to 20 weeks, although training for certain occupations—nuclear power plant operator, for example—may take as long as a year. Recruits not assigned to classroom instruction receive on-the-job training at their first duty assignment.

Many service people get college credit for the technical training they receive on duty. Combined with off-duty courses, such training can lead to an associate's degree through programs in community colleges such as the Community College of the Air Force. In addition to receiving on-duty training, military personnel may choose from a variety of educational programs. Most military installations have tuition assistance programs for people wishing to take courses during off-duty hours. The courses may be correspondence courses or courses in degree programs offered by local colleges or universities. Tuition assistance pays up to 100 percent of college costs, up to a credit-hour and annual limit. Each branch of the service provides opportunities for full-time study to a limited number of exceptional applicants. Military personnel accepted into these highly competitive programs receive full pay, allowances, tuition, and related fees. In return, they must agree to serve an additional amount of time in the service. Other highly selective programs enable enlisted personnel to qualify as commissioned officers through additional military training.

Warrant officer training. Warrant officers are technical and tactical leaders who specialize in a specific technical area; for example, Army aviators make up one group of warrant officers. The Army Warrant Officer Corps constitutes less than 5 percent of the total Army. Although the Corps is small in size, its level of responsibility is high. Its members receive extended career opportunities, worldwide leadership assignments, and increased pay and retirement benefits. Selection to attend Warrant Officer Candidate School is highly competitive and restricted to those who meet rank and length-of-service requirements. The only exception is for Army aviator warrant officer, which has no requirement of prior military service.

Officer training. Officer training in the Armed Forces is provided through the Federal service academies (Military, Naval, Air Force, and Coast Guard); the Reserve Officers Training Corps (ROTC) program offered at many colleges and universities; Officer Candidate School (OCS) or Officer Training School (OTS); the National Guard (State Officer Candidate School programs); the Uniformed Services University of Health Sciences; and other programs. All are highly selective and are good options for those wishing to make the military a career. Some personnel are directly appointed to attend one of these academies or programs. People interested in obtaining training through the Federal service academies must be unmarried and without dependents in order to enter and graduate, while those seeking training through OCS, OTS, or ROTC need not be single.

Federal service academies provide a 4-year college program leading to a bachelor-of-science (B.S.) degree. Midshipmen or cadets are provided free room and board, tuition, medical and dental care, and a monthly allowance. Graduates receive regular or reserve commissions and have a 5-year active-duty obligation, or more if they are entering flight training.

To become a candidate for appointment as a cadet or midshipman in one of the service academies, applicants are required to obtain a nomination from an authorized source, usually a member of Congress. Candidates do not need to personally know a member of Congress to request a nomination. Nominees must have an academic record of the requisite quality, college aptitude test scores above an established minimum, and recommendations from teachers or school officials; they also must pass a medical examination. Appointments are made from the list of eligible nominees. Appointments to the Coast Guard Academy, however, are based strictly on merit and do not require a nomination.

ROTC programs train students in approximately 270 Army, 130 Navy and Marine Corps, and 140 Air Force units at participating colleges and universities. In addition to taking regular college courses, trainees take 3 to 5 hours of military instruction a week. After graduation, they may serve as officers on active duty for a stipulated period. Some may serve their obligation in the Reserves or National Guard. In the last 2 years of an ROTC program, students typically receive a monthly allowance while attending school, as well as additional pay for summer training. ROTC scholarships for 2, 3, and 4 years are available on a competitive basis. All scholarships pay for tuition and have allowances for textbooks, supplies, and other costs.

College graduates can earn a commission in the Armed Forces through OCS or OTS programs in the Army, Navy, Air Force, Marine Corps, Coast Guard, and National Guard. These programs consist of several weeks of intensive academic, physical, and leadership training. Those who graduate as officers generally must serve their obligation on active duty.

Personnel with training in certain health professions may qualify for direct appointment as officers. In the case of peo-

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ple studying for the health professions, financial assistance and internship opportunities are available from the military in return for specified periods of military service. Prospective medical students can apply to the Uniformed Services University of Health Sciences, which offers a salary and free tuition in a program leading to a doctor-of-medicine (M.D.) degree. In return, graduates must serve for 7 years in either the military or the Public Health Service. Direct appointments also are available for those qualified to serve in other specialty areas, such as the judge advocate general (legal) or chaplain corps. Flight training is available to commissioned officers in each branch of the Armed Forces. In addition, the Army has a direct enlistment option to become a warrant officer aviator.

Other qualifications. In order to join the services, enlisted personnel must sign a legal agreement called an enlistment contract, which usually involves a commitment of up to 8 years of service. Depending on the terms of the contract, 2 to 6 years are spent on active duty and the balance is spent in the National Guard or Reserves. The enlistment contract obligates the service to provide the agreed-upon job, rating, pay, cash bonuses for enlistment in certain occupations, medical and other benefits, occupational training, and continuing education. In return, enlisted personnel must serve satisfactorily for the period specified.

Requirements for each service vary, but certain qualifications for enlistment are common to all branches. In order to enlist, usually one must be at least 17 years old, be a U.S. citizen or an alien holding permanent resident status, not have a felony record, and possess a birth certificate. Applicants who are 17 years old must have the consent of a parent or legal guardian before entering the service. For active service in the Army, the maximum age is 42; for the Navy, 34; for the Air Force and Coast Guard, 27; and for the Marine Corps, 29. All applicants must pass a written examination—the Armed Services Vocational Aptitude Battery—and meet certain minimum physical standards—for example, for height, weight, vision, and overall health. Officers must meet different age and physical standards, depending on their branch of service.

Women are eligible to enter most military specialties; for example, they may become mechanics, missile maintenance technicians, heavy equipment operators, and fighter pilots, or they may enter into medical care, administrative support, and intelligence specialties. Generally, only occupations involving direct exposure to combat are excluded.

Advancement. Each service has different criteria for promoting personnel. Generally, the first few promotions for both enlisted personnel and officers come easily; subsequent promotions are much more competitive. Criteria for promotion may include time in service and in grade, job performance, a fitness

Table 1. Military rank and employment for active duty personnel, January 2009

Grade	Rank and title				Total Employment
	Army	Navy	Air Force	Marine Corps	
Commissioned officers:					
O-10	General	Admiral	General	General	38
O-9	Lieutenant General	Vice Admiral	Lieutenant General	Lieutenant General	151
O-8	Major General	Rear Admiral (U)	Major General	Major General	304
O-7	Brigadier General	Rear Admiral (L)	Brigadier General	Brigadier General	476
O-6	Colonel	Captain	Colonel	Colonel	12,137
O-5	Lieutenant Colonel	Commander	Lieutenant Colonel	Lieutenant Colonel	29,131
O-4	Major	Lieutenant Commander	Major	Major	44,861
O-3	Captain	Lieutenant	Captain	Captain	72,397
O-2	1st Lieutenant	Lieutenant (JG)	1st Lieutenant	1st Lieutenant	27,492
O-1	2nd Lieutenant	Ensign	2nd Lieutenant	2nd Lieutenant	25,762
Warrant officers:					
W-5	Chief Warrant Officer	Chief Warrant Officer	—	Chief Warrant Officer	679
W-4	Chief Warrant Officer	Chief Warrant Officer	—	Chief Warrant Officer	3,401
W-3	Chief Warrant Officer	Chief Warrant Officer	—	Chief Warrant Officer	5,213
W-2	Chief Warrant Officer	Chief Warrant Officer	—	Chief Warrant Officer	7,255
W-1	Warrant Officer	Warrant Officer	—	Warrant Officer	3,312
Enlisted personnel:					
E-9	Sergeant Major	Master Chief Petty Officer	Chief Master Sergeant	Sergeant Major/ Master Gunnery Sergeant	10,891
E-8	1st Sergeant/Master Sergeant	Senior Chief Petty Officer	Senior Master Sergeant	1st Sergeant/Master Sergeant	28,134
E-7	Sergeant 1st Class	Chief Petty Officer	Master Sergeant	Gunnery Sergeant	101,351
E-6	Staff Sergeant	Petty Officer 1st Class	Technical Sergeant	Staff Sergeant	181,051
E-5	Sergeant	Petty Officer 2nd Class	Staff Sergeant	Sergeant	259,328
E-4	Corporal	Petty Officer 3rd Class	Senior Airman	Corporal	274,336
E-3	Private 1st Class	Seaman	Airman 1st Class	Lance Corporal	206,444
E-2	Private	Seaman Apprentice	Airman	Private 1st Class	93,184
E-1	Private	Seaman Recruit	Airman Basic	Private	71,618

SOURCE: U.S. Department of Defense, Defense Manpower Data Center

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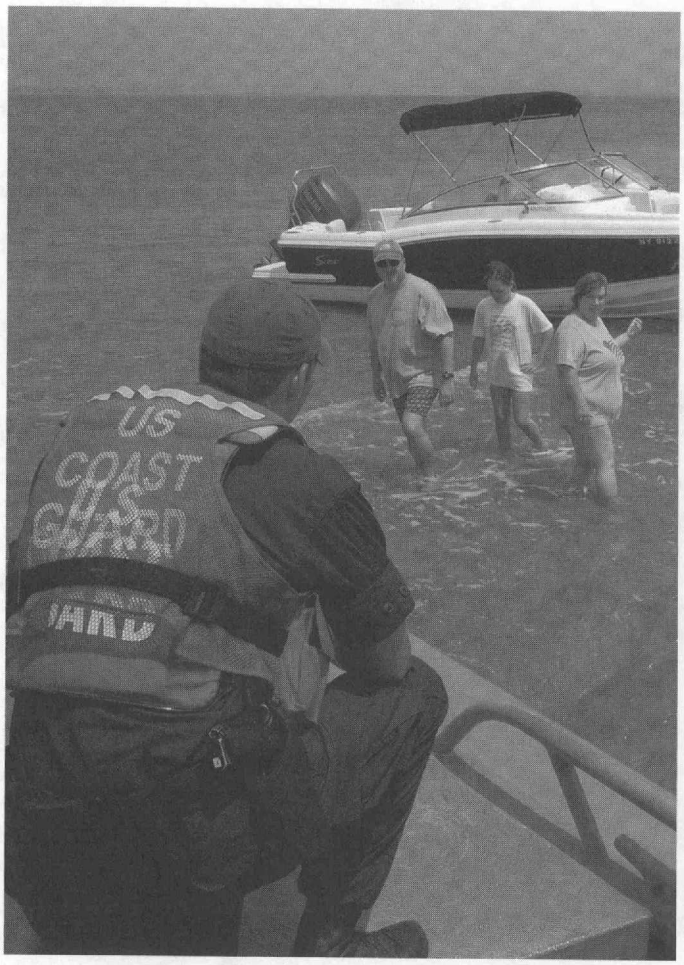
report (supervisor's recommendation), and passing scores on written examinations. Table 1 shows the officers, warrant officers, and enlisted ranks by service.

People planning to apply the skills they gained through military training to a civilian career should first determine how good the prospects are for civilian employment in jobs related to the military specialty that interests them. Second, they should know the prerequisites for the related civilian job. Because many civilian occupations require a license, certification, or minimum level of education, it is important to determine whether military training is sufficient for a person to enter the civilian equivalent occupation or, if not, what additional training will be required. Other *Handbook* statements discuss the job outlook, training requirements, and other aspects of civilian occupations for which military training and experience are helpful. Additional information often can be obtained from school counselors.

Employment

In 2009, more than 2.4 million people served in the Armed Forces. More than 1.4 million were on active duty—about 561,000 in the Army, 327,000 in the Navy, 325,000 in the Air Force, and 202,000 in the Marine Corps. In addition, more than 1.0 million people served in their Reserve components and in the Air and Army National Guard, and 41,000 individuals served in the Coast Guard, which is now part of the Department of Homeland Security. Table 2 shows the occupational composition of the active-duty and Coast Guard enlisted personnel in January 2009; table 3 presents similar information for active-duty and Coast Guard officers, including noncommissioned warrant officers.

Military personnel are stationed throughout the United States and in many countries around the world. About half of all military jobs in the U.S. are located in California, Texas, North Carolina, Virginia, Florida, and Georgia. Approximately 265,000 service members were deployed in support of Operations Enduring Freedom and Iraqi Freedom as of June 1, 2009. An additional 378,000 individuals were stationed outside the United States, including 160,000 assigned to ships at sea. About 95,000 were stationed in Europe, mainly in Germany, and another 71,000 were assigned to East Asia and the Pacific area, mostly in Japan and the Republic of Korea.



In 2009, 41,000 individuals served in the Coast Guard, which is now part of the Department of Homeland Security.

Job Outlook

Opportunities should be excellent for qualified individuals in all branches of the Armed Forces.

Employment change. The United States spends a significant portion of its overall budget on national defense. The num-

Table 2. Military enlisted personnel by broad occupational category and branch of military service, January 2009

Occupational Group - Enlisted	Army	Air Force	Coast Guard	Marine Corps	Navy	Total, all services
Administrative occupations	6,727	17,537	1,621	9,219	22,147	57,251
Combat specialty occupations	132,079	480	904	52,445	7,595	193,503
Construction occupations	20,872	4,689	—	6,759	5,521	37,841
Electronic and electrical repair occupations	37,466	34,751	4,663	16,199	47,985	141,064
Engineering, science, and technical occupations	42,770	41,328	1,212	26,940	38,778	151,028
Healthcare occupations	30,945	16,420	772	—	23,960	72,097
Human resource development occupations	20,251	11,321	1	7,134	5,300	44,007
Machine operator and production occupations	6,372	6,181	1,816	2,575	8,596	25,540
Media and public affairs occupations	8,233	6,910	152	2,518	3,659	21,472
Protective service occupations	29,076	34,099	2,816	7,156	12,555	85,702
Support services occupations	13,554	6,071	1,263	2,765	9,188	32,841
Transportation and material handling occupations	69,454	31,396	11,748	25,909	45,176	183,683
Vehicle and machinery mechanic occupations	54,771	43,409	6,119	22,068	45,209	171,576
Non-occupation coded personnel	1,081	6,681	326	12	755	8,855
Total, by service	473,651	261,273	33,413	181,699	276,424	1,226,460

SOURCE: U.S. Department of Defense, Defense Manpower Data Center

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Table 3. Military officer personnel by broad occupational category and branch of service, January 2009

Occupational Group - Officer	Army	Air Force	Coast Guard	Marine Corps	Navy	Total, all services
Combat specialty occupations	20,201	2,611	77	5,315	1,125	29,329
Engineering, science, and technical occupations	21,676	17,800	210	4,006	7,616	51,308
Executive, administrative, and managerial occupations	13,104	7,327	197	2,725	5,442	28,795
Healthcare occupations	10,626	8,661	1	—	7,468	26,756
Human resource development occupations	2,676	2,293	151	279	520	5,919
Media and public affairs occupations	310	305	15	175	290	1,095
Protective service occupations	2,867	1,131	60	353	284	4,695
Support services occupations	1,741	758	3	38	857	3,397
Transportation occupations	12,519	22,828	580	7,345	27,340	70,612
Non-occupation coded personnel	2,597	866	6,769	88	386	10,706
Total, by service	88,317	64,580	8,063	20,324	51,328	232,612

SOURCE: U.S. Department of Defense, Defense Manpower Data Center

ber of active-duty personnel is expected to remain roughly constant through 2018. However, recent conflicts and the resulting strain on the military may lead to an increase in the number of active-duty personnel. The current goal of the Armed Forces is to maintain a force sufficient to fight and win two major regional conflicts at the same time. Political events, however, could lead to a significant restructuring with or without an increase in size.

Job prospects. Opportunities should be excellent for qualified individuals in all branches of the Armed Forces through 2018. Many military personnel retire with a pension after 20 years of service, while they still are young enough to start a new career. About 184,000 personnel must be recruited each year to replace those who complete their commitment or retire. Since the end of the draft in 1973, the military has met its personnel requirements with volunteers. When the economy is good and civilian employment opportunities generally are more favorable, it is more difficult for all the services to meet their recruitment quotas. When there are economic downturns, recruits may face more competition for various occupational specialties. It is also more difficult to meet these goals during times of war, when recruitment goals typically rise.



Educational requirements will continue to rise as military jobs become more technical and complex.

Educational requirements will continue to rise as military jobs become more technical and complex. High school graduates and applicants with a college background will be sought to fill the ranks of enlisted personnel, while virtually all officers will need at least a bachelor's degree and, in some cases, a graduate degree as well.

Earnings

The earnings structure for military personnel is shown in table 4. Most enlisted personnel started as recruits at Grade E-1 in 2009; however, those with special skills or above-average education started as high as Grade E-4. Most warrant officers started at Grade W-1 or W-2, depending upon their occupational and academic qualifications and the branch of service of which they were a member, but warrant officer typically is not an entry-level occupation and, consequently, most of these individuals had previous military service. Most commissioned officers started at Grade O-1; some with advanced education started at Grade O-2, and some highly trained officers—for example, physicians and dentists—started as high as Grade O-3. Pay varies by total years of service as well as rank. Because it usually takes many years to reach the higher ranks, most personnel in higher ranks receive the higher pay rates awarded to those with many years of service.

In addition to receiving their basic pay, military personnel are provided with free room and board (or a tax-free housing and subsistence allowance), free medical and dental care, a military clothing allowance, military supermarket and department store shopping privileges, 30 days of paid vacation a year (referred to as leave), and travel opportunities. In many duty stations, military personnel may receive a housing allowance that can be used for off-base housing. This allowance can be substantial, but varies greatly by rank and duty station. For example, in fiscal year 2009, the basic allowance for housing for an E-4 with dependents was $681.90 per month; for a comparable individual without dependents, it was $511.50. The allowance for an O-4 with dependents was $1,297.80 per month; for a comparable individual without dependents, it was $1,128.60. Other allowances are paid for foreign duty, hazardous duty, submarine and flight duty, and employment as a medical officer. Athletic and other facilities—such as gymnasiums, tennis courts, golf courses, bowling centers, libraries, and movie theaters—are

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Table 4. Military basic monthly pay by grade for active duty personnel, April 2009

Grade	Years of service					
	Less than 2	Over 4	Over 8	Over 12	Over 16	Over 20
Commissioned officers:						
O-10	—	—	—	—	—	14,689
O-9	—	—	—	—	—	12,847
O-8	9,090	9,641	10,299	10,786	11,235	12,172
O-7	7,553	8,195	8,660	9,193	10,299	11,007
O-6	5,598	6,554	6,861	6,898	7,983	8,797
O-5	4,667	5,690	6,053	6,571	7,287	7,697
O-4	4,027	5,042	5,640	6,326	6,654	6,723
O-3	3,540	4,723	5,197	5,622	5,760	5,760
O-2	3,059	4,148	4,233	4,233	4,233	4,233
O-1	2,655	3,341	3,341	3,341	3,341	3,341
Warrant officers:						
W-5	—	—	—	—	—	6,506
W-4	3,659	4,160	4,541	5,021	5,515	5,903
W-3	3,341	3,670	4,114	4,565	4,904	5,422
W-2	2,957	3,382	3,871	4,164	4,481	4,757
W-1	2,595	3,108	3,573	3,882	4,199	4,484
Enlisted personnel:						
E-9	—	—	—	4,521	4,796	5,185
E-8	—	—	3,619	3,878	4,125	4,475
E-7	2,516	2,990	3,285	3,578	3,839	3,995
E-6	2,176	2,602	2,951	3,226	3,323	3,370
E-5	1,994	2,335	2,671	2,828	2,828	2,828
E-4	1,828	2,128	2,219	2,219	2,219	2,219
E-3	1,650	1,860	1,860	1,860	1,860	1,860
E-2	1,569	1,569	1,569	1,569	1,569	1,569
E-1 4 months+	1,400	—	—	—	—	—
E-1 Less than 4 months	1,295	—	—	—	—	—

SOURCE: U.S. Department of Defense—Defense Finance and Accounting Service

available on many military installations. Military personnel are eligible for retirement benefits after 20 years of service.

The Veterans Administration (VA) provides numerous benefits to those who have served at least 24 months of continuous active duty in the Armed Forces. Veterans are eligible for free care in VA hospitals for all service-related disabilities, regardless of time served; those with other medical problems are eligible for free VA care if they are unable to pay the cost of hospitalization elsewhere. Admission to a VA medical center depends on the availability of beds, however. Veterans also are eligible for certain loans, including loans to purchase a home. Regardless of their health, veterans can convert a military life insurance policy to an individual policy with any participating company upon separation from the military. In addition, job counseling, testing, and placement services are available.

Veterans who participate in the Montgomery GI Bill Program receive education benefits. Under this program, Armed Forces personnel may elect to deduct up to $100 a month from their pay during the first 12 months of active duty, putting the money toward their future education. In fiscal year 2009, veterans who served on active duty for 3 or more years or who spent 2 years in active duty plus 4 years in the Selected Reserve received $1,321 a month in basic benefits for 36 months of full-time institutional training. Those who enlisted and served less than 3 years received $1,073 a month for 36 months of the same. In addition, each service provides its own contributions to the enlistee's future education. The sum of the amounts from all these sources becomes the service member's educational fund. Upon separation from active duty, the fund can be used to finance educational costs at any VA-approved institution. Among those institutions which are approved by the VA are many vocational, correspondence, certification, business, technical, and flight training schools; community and junior colleges; and colleges and universities. The new Post-9/11 GI Bill is an alternative education benefit. There is no deductable for service personnel. The size of the benefit is scaled to the State and to the institution that the veteran is attending. Service personnel must carefully choose which program will be of the most benefit to them in their planned educational future.

Sources of Additional Information

Each of the military services publishes handbooks, fact sheets, and pamphlets describing its entrance requirements, its training and advancement opportunities, and other aspects of military careers. These publications are widely available at all recruiting stations, at most State employment service offices, and in high schools, colleges, and public libraries. Information on educational and other veterans' benefits is available from VA offices located throughout the country.

In addition, the Defense Manpower Data Center, an agency of the Department of Defense, publishes *Military Career Guide Online*, a compendium of military occupational, training, and career information designed for use by students and jobseekers. This information is available on the Internet at **http://www.todaysmilitary.com.**

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The Occupational Outlook Quarterly also provides information about military careers and training; see the spring 2007 article "Military training for civilian careers (Or: How to gain practical experience while serving your country)," available online at **http://www.bls.gov/opub/ooq/2007/spring/art02.pdf.**

The Occupational Information Network (O*NET) provides information on a wide range of occupational characteristics. Links to O*NET appear at the end of the Internet version of this occupational statement, accessible at **http://www.bls.gov/ooh/ocos249.htm**

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Data for Occupations Not Covered in Detail

Employment in the hundreds of occupations covered in detail in the main body of the *Handbook* accounts for more than 134 million, or 89 percent, of all jobs in the economy. Although occupations covering the full spectrum of work are included, those requiring lengthy education or training generally are given the most attention.

This chapter presents summary data on 127 additional occupations, for which employment projections are prepared, but for which detailed occupational information is not developed. These occupations account for about 7 percent of all jobs. For each occupation, the Occupational Information Network (O*NET) code, a brief description of the nature of the work, the number of jobs in 2008, a phrase describing the projected employment change from 2008 to 2018, and the most significant source of postsecondary education or training are presented. For a complete list of O*NET codes cited in the *Handbook*, refer to a later chapter, *Occupational Information Network* (O*NET) Coverage. For guidelines on interpreting the description of projected employment change, refer to a chapter in the front of the *Handbook*, Occupational Information Included in the *Handbook*.

The approximately 4 percent of all jobs not covered either in the detailed occupational descriptions in the main body of the *Handbook* or in the summary data presented in this chapter are mainly residual categories, such as "all other managers," for which little meaningful information could be developed.

Management, business, and financial occupations

Agents and business managers of artists, performers, and athletes

Represent and promote artists, performers, and athletes to prospective employers. May handle contract negotiations and other business matters for clients.

2008 Employment: 22, 700
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Bachelor's or higher degree, plus work experience

Compliance officers, except agriculture, construction, health and safety, and transportation

Examine, evaluate, and investigate eligibility for or conformity with laws and regulations governing contract compliance of licenses and permits, and other compliance and enforcement inspection activities not classified elsewhere. Exclude tax examiners, collectors, and revenue agents and financial examiners.

2008 Employment: 260,200
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Long-term on-the-job training

Credit analysts

Analyze current credit data and financial statements of individuals or firms to determine the degree of risk involved in extending credit or lending money. Prepare reports with this credit information for use in decision-making.

2008 Employment: 73,200
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Emergency management specialists

Coordinate disaster response or crisis management activities, provide disaster preparedness training and prepare emergency plans and procedures for natural (e.g. hurricanes, floods, earthquakes), wartime, or technological (e.g., nuclear power plant emergencies, hazardous materials spills) disasters or hostage situations.

2008 Employment: 12,800
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Work experience in a related occupation

Financial examiners

Enforce or ensure compliance with laws and regulations governing financial and securities institutions and financial and real estate transactions. May examine, verify correctness of, or establish authenticity of records.

2008 Employment: 27,000
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Legislators

Develop laws and statutes at the Federal, State, or local level. Includes only elected officials.

2008 Employment: 67,600
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Bachelor's or higher degree, plus work experience

Loan counselors

Provide guidance to prospective loan applicants who have problems qualifying for traditional loans. Guidance may include determining the best type of loan and explaining loan requirements or restrictions.

2008 Employment: 32,400
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Logisticians

Analyze and coordinate the logistical functions of a firm or organization. Responsible for the entire life cycle of a product, including acquisition, distribution, internal allocation, delivery, and final disposal of resources.

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2008 Employment: 100,400
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Postmasters and mail superintendents

Direct and coordinate operational, administrative, management, and supportive services of a U.S. post office; or coordinate activities of workers engaged in postal and related work in assigned post office.

2008 Employment: 25,600
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Work experience in a related occupation

Social and community service managers

Plan, organize, or coordinate the activities of a social service program or community outreach organization. Oversee the program or organization's budget and polices regarding participant involvement, program requirement, and benefits. Work may involve directing social workers, counselors, or probation officers.

2008 Employment: 130,600
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Tax preparers

Prepare tax returns for individuals or small businesses but do not have the background or responsibilities of an accredited or certified public accountant.

2008 Employment: 95,800
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Transportation, storage, and distribution managers

Plan, direct, or coordinate transportation, storage, or distribution activities in accordance with governmental policies and regulations. Includes logistics managers.

2008 Employment: 99,700
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Work experience in a related occupation

Professional and related occupations

Audio-visual collections specialists

Prepare, plan, and operate audio-visual teaching aids for use in education. May record, catalogue, and file audio-visual materials.

2008 Employment: 6,800
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Bachelor's degree

Clergy

Conduct religious worship and perform other spiritual functions associated with beliefs and practices of religious faith or denomination. Provide spiritual and moral guidance and assistance to members.

2008 Employment: 670,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Master's degree

Dietetic technicians

Assist dieticians in the provision of food service and nutritional programs. Under the supervision of dieticians, may plan and produce meals based on established guidelines, teach principles of food and nutrition, or counsel individuals.

2008 Employment: 25,200
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Postsecondary vocational award

Directors, religious activities and education

Direct and coordinate activities of a denominational group to meet religious needs of students. Plan, direct, or coordinate church school programs designed to promote religious education among church membership. May provide counseling and guidance relative to marital, health, financial, or religious problems.

2008 Employment: 80,400
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Bachelor's degree

Farm and home management advisors

Advise, instruct, and assist individuals and families engaged in agriculture, agricultural-related processes, or home economics activities. Demonstrate procedures and apply research findings to solve problems; instruct and train in product development, sales, and the utilization of machinery and equipment to promote general welfare. Include county agricultural agents, feed and farm management advisors, home economists, and extension service advisors.

2008 Employment: 13,100
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Bachelor's degree

Law clerks

Assist lawyers or judges by researching or preparing legal documents. May meet with clients or assist lawyers and judges in court. Excludes lawyers, and paralegal and legal assistants.

2008 Employment: 37,700
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Mathematical technicians

Apply standardized mathematical formulas, principles, and methodology to technological problems in engineering and physical sciences in relation to specific industrial and research objectives, processes, equipment, and products.

2008 Employment: 1,200
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Associate degree

Merchandise displayers and window trimmers

Plan and erect commercial displays, such as those in windows and interiors of retail stores and at trade exhibitions.

2008 Employment: 85,200
Projected 2008-18employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

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Orthotists and prosthetists

Assist patients with disabling conditions of limbs and spine or with partial or total absence of limb by fitting and preparing orthopedic braces and prostheses.

2008 Employment: 5,900
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Psychiatric technicians

Care for mentally impaired or emotionally disturbed individuals, following physician instructions and hospital procedures. Monitor patients' physical and emotional well-being and report to medical staff. May participate in rehabilitation and treatment programs, help with personal hygiene, and administer oral medications and hypodermic injections.

2008 Employment: 57,100
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Postsecondary vocational award

Set and exhibit designers

Design special exhibits and movie, television, and theater sets. May study scripts, confer with directors, and conduct research to determine appropriate architectural styles.

2008 Employment: 10,900
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Bachelor's degree

Social science research assistants

Assist social scientists in laboratory, survey, and other social research. May perform publication activities, laboratory analysis, quality control, or data management. Normally these individuals work under the direct supervision of a social scientist and assist in those activities which are more routine. Excludes graduate teaching assistants, who both teach and do research.

2008 Employment: 21,000
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Associate degree

Title examiners, abstractors, and searchers

Search real estate records, examine titles, or summarize pertinent legal or insurance details for a variety of purposes. May compile lists of mortgages, contracts, and other instruments pertaining to titles by searching public and private records for law firms, real estate agencies, or title insurance companies.

2008 Employment: 69,500
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Service occupations

Amusement and recreation attendants

Perform a variety of attending duties at amusement or recreation facilities. May schedule use of recreations facilities, maintain and provide equipment to participants of sporting events or recreational pursuits, or operate amusement concessions and rides.

2008 Employment: 263,000
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Animal control workers

Handle animals for the purpose of investigations of mistreatment, or control of abandoned, dangerous, or unattended animals.

2008 Employment: 16,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Baggage porters and bellhops

Handle baggage for travelers at transportation terminals or for guests at hotels or similar establishments.

2008 Employment: 50,500
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Concierges

Assist patrons at hotel, apartment or office building with personal services. May take messages, arrange or give advice on transportation, business services or entertainment, or monitor guest requests for housekeeping and maintenance.

2008 Employment: 20,800
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Costume attendants

Select, fit and take care of costumes for cast members, and aid entertainers.

2008 Employment: 5,100
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Crossing guards

Guide or control vehicular or pedestrian traffic at such places as streets, schools, railroad crossings, or construction sites.

2008 Employment: 69,900
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Embalmers

Prepare bodies for interment in conformity with legal requirements.

2008 Employment: 8,500
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Postsecondary vocational award

First-line supervisors/managers of personal service workers

Supervise and coordinate activities of personal service workers, such as supervisors of flight attendants, hairdressers, or caddies.

2008 Employment: 213,200
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Work experience in a related occupation

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Funeral attendants

Perform a variety of tasks during a funeral, such as placing casket in parlor or chapel prior to service; arranging floral offerings or lights around casket; directing or escorting mourners; closing casket; and issuing and storing funeral equipment.

2008 Employment: 34,500
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Lifeguards, ski patrol, and other recreational protective service workers

Monitor recreational areas, such as pools, beaches, or ski slopes to provide assistance and protection to participants.

2008 Employment: 115,200
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job-training

Locker room, coatroom, and dressing room attendants

Provide personal items to patrons or customers in locker rooms, dressing rooms, or coatrooms.

2008 Employment: 18,500
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Medical equipment preparers

Prepare, sterilize, install, or clean laboratory or healthcare equipment. May perform routine laboratory tasks and operate or inspect equipment.

2008 Employment: 46,800
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Motion picture projectionists

Set up and operate motion picture projection and related sound reproduction equipment.

2008 Employment: 10,800
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Parking enforcement workers

Patrol assigned area, such as public parking lot or section of city to issue tickets to overtime parking violators and illegally parked vehicles.

2008 Employment: 10,000
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Residential advisors

Coordinate activities for residents of boarding schools, college fraternities or sororities, college dormitories, or similar establishments. Order supplies and determine need to maintenance, repairs, and furnishings. May maintain household records and assign rooms. May refer residents to counseling resources if needed.

2008 Employment: 56,900
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Tour guides and escorts

Escort individuals or groups on sightseeing tours or through places of interest, such as industrial establishments, public buildings, and art galleries.

2008 Employment: 38,400
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Transportation attendants, except flight attendants and baggage porters

Provide services to ensure the safety and comfort of passengers aboard ships, buses, trains, or within the station or terminal. Perform duties, such as greeting passengers, explaining the use of safety equipment, serving meals or beverages, or answering questions related to travel.

2008 Employment: 21,700
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Travel guides

Plan, organize, and conduct long distance cruises, tours, and expeditions for individuals or groups.

2008 Employment: 5,600
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Ushers, lobby attendants, and ticket takers

Assist patrons at entertainment events by performing duties, such as collecting admission tickets and passes from patrons, assisting in finding seats, searching for lost articles, and locating such facilities as rest rooms and telephones.

2008 Employment: 106,100
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Veterinary assistants and laboratory animal caretakers

Feed, water, and examine pets and other nonfarm animals for signs of illness, disease, or injury in laboratories and animal hospitals and clinics. Clean and disinfect cages and work areas, and sterilize laboratory and surgical equipment. May provide routine postoperative care, administer medication orally or topically, or prepare samples for laboratory examination under the supervision of veterinary or laboratory animal technologists or technicians, veterinarians, or scientists. Excludes nonfarm animal caretakers.

2008 Employment: 75,200
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Sales and related occupations

Door-to-door sales workers, news and street vendors, and related workers

Sell goods or services door-to-door or on the street.

2008 Employment: 181,600
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term on-the-job training

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Parts salespersons

Sell spare and replacement parts and equipment in repair shop or parts store.

2008 Employment: 227,500
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Telemarketers

Solicit orders for goods and services over the telephone.

2008 Employment: 341,600
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term on-the-job training

Office and administrative support occupations

Correspondence clerks

Compose letters in reply to request for merchandise, damage claims, credit and other information, delinquent accounts, incorrect billings, or unsatisfactory services. Duties may include gathering data to formulate reply and typing correspondence.

2008 Employment: 14,200
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term-on-the-job training

Court, municipal, and license clerks

Perform clerical duties in courts of law, municipalities, and governmental licensing agencies and bureaus. May prepare docket of cases to be called; secure information for judges and court; prepare draft agendas or bylaws for town or city council; answer official correspondence; keep fiscal records and accounts; issue licenses or permits; record data, administer tests, or collect fees.

2008 Employment: 122,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term-on-the-job training

Insurance claims and policy processing clerks

Process new insurance policies, modifications to existing policies, and claims forms. Obtain information from policyholders to verify the accuracy and completeness of information on claims forms, applications and related documents, and company records. Update existing policies and company records to reflect changes requested by policyholders and insurance company representatives. Excludes claims adjusters, examiners, and investigators.

2008 Employment: 253,800
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Mail clerks and mail machine operators, except Postal Service

Prepare incoming and outgoing mail for distribution. Use hand or mail handling machines to time, stamp, open, read, sort, and route incoming mail; and address, seal, stamp, fold, stuff, and affix postage to outgoing mail or packages. Duties may also include keeping necessary records and completed forms.

2008 Employment: 141,400
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term on-the-job training

New accounts clerks

Interview persons desiring to open bank accounts. Explain banking services available to prospective customers and assist them in preparing application form.

2008 Employment: 87,300
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Work experience in a related occupation

Office machine operators, except computer

Operate one or more of a variety of office machines, such as photocopying, photographic, and duplicating machines, or other office machines. Excludes computer operators; mail clerks and mail machine operators; and billing and posting clerks and machine operators.

2008 Employment: 79,900
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Short-term on-the-job training

Proofreaders and copy markers

Read transcript or proof type setup to detect and mark for correction any grammatical, typographical, or compositional errors. Excludes workers whose primary duty is editing copy. Includes proofreaders of Braille.

2008 Employment: 18,200
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Short-term on-the-job training

Statistical assistants

Compile and compute data according to statistical formulas for use in statistical studies. May perform actuarial computations and compile charts and graphs for use by actuaries. Includes actuarial clerks.

2008 Employment: 17,900
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Farming, fishing, and forestry occupations

Supervisors, farming, fishing, and forestry workers

This broad occupation includes two detailed occupations—first-line supervisors/managers of farming, fishing, and forestry workers; and farm labor contractors. First-line supervisors/managers of farming, fishing, and forestry workers directly supervise and coordinate the activities of agricultural, forestry, aquacultural, and related workers. Farm labor contractors recruit, hire, furnish, and supervise seasonal or temporary agricultural laborers for a fee. May transport, house, and provide meals for workers. Excludes first-line supervisors/managers of landscaping, lawn service, and groundskeeping workers.

2008 Employment: 48,600
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Work experience in a related occupation

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Construction and extraction occupations

Continuous mining machine operators

Operate self-propelled mining machines that rip coal, metal and nonmetal ores, rock, stone, or sand form the face and load it onto conveyors or into shuttle cars in a continuous operation.

2008 Employment: 11,200
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Derrick operators, oil and gas

Rig derrick equipment and operate pumps to circulate mud through drill hole.

2008 Employment: 25,000
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Earth drillers, except oil and gas

Operate a variety of drills—such as rotary, churn, and pneumatic—to tap subsurface water and salt deposits, to remove core samples during mineral exploration or soil testing, and to facilitate the use of explosives in mining or construction. May use explosives. Includes horizontal and earth boring machine operators.

2008 Employment: 23,300
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Explosives workers, ordnance handling experts, and blasters

Place and detonate explosives to demolish structures or to loosen, remove, or displace earth, rock, or other materials. May perform specialized handling, storage, and accounting procedures. Includes seismograph shooters. Excludes earth drillers, except oil and gas who may also work with explosives.

2008 Employment: 6,300
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Fence erectors

Erect and repair metal and wooden fences and fence gates around highways, industrial establishments, residences, or farms, using hand and power tools.

2008 Employment: 33,600
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

First-line supervisors/managers of construction trades and extraction workers

Directly supervise and coordinate activities of construction or extraction workers.

2008 Employment: 698,100
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Work experience in a related occupation

Helpers—brickmasons, blockmasons, stonemasons, and tile and marble setters

Help brickmasons, blockmasons, stonemasons, or tile and marble setters by performing duties of lesser skill. Duties include using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist brickmasons, blockmasons, and stonemasons or tile and marble setters.

2008 Employment: 50,800
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Helpers—carpenters

Help carpenters by performing duties of lesser skill. Duties include using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist carpenters.

2008 Employment: 79,800
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Helpers—electricians

Help electricians by performing duties of lesser skill. Duties include using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist electricians.

2008 Employment: 105,600
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Helpers—extraction workers

Help extraction craft workers, such as earth drillers, blasters and explosives workers, derrick operators, and mining machine operators, by performing duties of lesser skill. Duties include supplying equipment or cleaning work area. Excludes apprentice workers.

2008 Employment: 26,200
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term on-the-job training

Helpers—painters, paperhangers, plasterers, and stucco masons

Help painters, paperhangers, plasterers, or stucco masons by performing duties of lesser skill. Duties including using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist painters, paperhangers, plasterers, or stucco masons.

2008 Employment: 19,400
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Short-term on-the-job training

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Helpers—pipelayers, plumbers, pipefitters, and steamfitters

Help pipelayers, plumbers, pipefitters, or steamfitters by performing duties of lesser skill. Duties including using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist pipelayers, plumbers, pipefitters or steamfitters.

2008 Employment: 80,300
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Helpers—roofers

Help roofers by performing duties of lesser skill. Duties include using, supplying, or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers and report them with the appropriate skilled construction trade occupation. Excludes construction laborers who do not primarily assist roofers.

2008 Employment: 18,700
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Short-term on-the-job training

Highway maintenance workers

Maintain highways, municipal and rural roads, airport runways, and rights-of-way. Duties include patching broken or eroded pavement, repairing guard rails, highway markers, and snow fences. May also mow or clear brush from along road or plow snow from roadway. Excludes tree trimmers and pruners.

2008 Employment: 145,900
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Mine cutting and channeling machine operators

Operate machinery—such as longwall shears, plows, and cutting machines—to cut or channel along the face or seams of coal mines, stone quarries, or other mining surfaces to facilitate blasting, separating, or removing minerals or materials from mines or from the earth's surface. Includes shale planers.

2008 Employment: 9,400
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Rail-track laying and maintenance equipment operators

Lay, repair, and maintain track for standard or narrow-gauge railroad equipment used in regular railroad service or in plant yards, quarries, sand and gravel pits, and mines. Includes ballast cleaning machine operators and railroad bed tamping machine operators.

2008 Employment: 15,500
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Rock splitters, quarry

Separate blocks of rough dimension stone from quarry mass using jackhammer and wedges.

2008 Employment: 4,400
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Roof bolters, mining

Operate machinery to install roof support bolts in underground mine.

2008 Employment: 5,100
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Rotary drill operators, oil and gas

Set up or operate a variety of drills to remove petroleum products from the earth and to find and remove core samples for testing during oil and gas exploration.

2008 Employment: 28,600
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Roustabouts, oil and gas

Assemble or repair oil field equipment using hand and power tools. Perform other tasks as needed.

2008 Employment: 65,700
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Septic tank servicers and sewer pipe cleaners

Clean and repair septic tanks, sewer lines, or drains. May patch walls and partitions of tank, replace damaged drain tile, or repair breaks in underground piping.

2008 Employment: 25,900
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Service unit operators, oil, gas, and mining

Operate equipment to increase oil flow from producing wells or to remove stick pipe, casing, tools, or other obstructions from drilling wells. May also perform similar services in mining exploration operations. Includes fishing-tool technicians.

2008 Employment: 39,100
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Installation, maintenance, and repair occupations

Bicycle repairers

Repair and service bicycles.

2008 Employment: 10,100
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Commercial divers

Work below surface of water, using scuba gear to inspect, repair, remove, or install equipment and structures. May use a variety of power and hand tools, such as drills, sledgehammers, torches, and welding equipment. May conduct tests or experiments, rig explosives, or photograph structures or marine life. Excludes fishers and related fishing workers, athletes and sports competitors, and police and sheriff's patrol officers.

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2008 Employment: 2,400
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Postsecondary vocational award

Control and valve installers and repairers, except mechanical door

Install, repair, and maintain mechanical regulating and controlling devices, such as electric meters, gas regulators, thermostats, safety and flow valves, and other mechanical governors.

2008 Employment: 44,500
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Fabric menders, except garment

Repair tears, holes, and other defects in fabrics, such as draperies, linens, parachutes, and tents.

2008 Employment: 1,100
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

First-line supervisors/managers of mechanics, installers, and repairers

Supervise and coordinate the activities of mechanics, installers, and repairers. Excludes team or work leaders.

2008 Employment: 448,500
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Work experience in a related occupation

Helpers—installation, maintenance, and repair workers

Help installation, maintenance, and repair workers in maintenance, parts replacement, and repair of vehicles, industrial machinery, and electrical and electronic equipment. Perform duties, such as furnishing tools, materials, and supplies to other workers; cleaning work area, machines, and tools; and holding materials or tools for other workers.

2008 Employment: 150,900
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Locksmiths and safe repairers

Repair and open locks; make keys; change locks and safe combinations; and install and repair safes.

2008 Employment: 22,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Manufactured building and mobile home installers

Move or install mobile homes or prefabricated buildings.

2008 Employment: 10,300
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Mechanical door repairers

Install, service, or repair opening and closing mechanisms of automatic doors and hydraulic door closers. Includes garage door mechanics.

2008 Employment: 17,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Recreational vehicle service technicians

Diagnose, inspect, adjust, repair, or overhaul recreational vehicles including travel trailers. May specialize in maintaining gas, electrical, hydraulic, plumbing, or chassis/towing systems as well as repairing generators, appliances, and interior components. Includes workers who perform customized van conversions. Excludes automotive service technicians and mechanics, and bus and truck mechanics and diesel engine specialists who also work on recreation vehicles.

2008 Employment: 13,700
Projected 2008-18 employment change: About as fast average
Most significant source of postsecondary education or training: Long-term on-the-job training

Refractory materials repairers, except brickmasons

Build or repair furnaces, kilns, cupolas, boilers, converters, ladles, soaking pits, ovens, etc., using refractory materials.

2008 Employment: 2,500
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Riggers

Set up or repair rigging for construction projects, manufacturing plants, logging yards, ships and shipyards, or for the entertainment industry.

2008 Employment: 13,500
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Security and fire alarm systems installers

Install, program, maintain, and repair security and fire alarm wiring and equipment. Ensure that work is in accordance with relevant codes. Excludes electricians who do a broad range of electrical wiring.

2008 Employment: 66,200
Projected 2008-18 employment change: Much faster than average
Most significant source of postsecondary education or training: Postsecondary vocational award

Signal and track switch repairers

Install, inspect, test, maintain, or repair electric gate crossings, signals, signal equipment, track switches, section lines, or intercommunications systems within a railroad system.

2008 Employment: 6,800
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Tire repairers and changers

Repair and replace tires.

2008 Employment: 103,200
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Production occupations

Cementing and gluing machine operators and tenders

Operate or tend cementing and gluing machines to join items for further processing or to form a completed product. Processes include joining veneer sheets into plywood; gluing paper; joining rubber and rubberized fabric parts, plastic, simulated leather, or other materials. Excludes shoe machine operators and tenders.

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2008 Employment: 19,800
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Chemical equipment operators and tenders

Operate or tend equipment to control chemical changes or reactions in the processing of industrial or consumer products. Equipment used includes devulcanizers, steam-jacketed kettles, and reactor vessels. Excludes chemical plant and system operators.

2008 Employment: 53,000
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Chemical plant and system operators

Control or operate an entire chemical process or system of machines.

2008 Employment: 45,100
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Long-term on-the-job training

Cleaning, washing, and metal pickling equipment operators and tenders

Operate or tend machines to wash or clean products, such as barrels or kegs, glass items, tin plate, food, pulp, coal, plastic, or rubber, to remove impurities.

2008 Employment: 18,000
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Cooling and freezing equipment operators and tenders

Operate or tend equipment, such as cooling and freezing units, refrigerators, batch freezers, and freezing tunnels, to cool or freeze products, food, blood plasma, and chemicals.

2008 Employment: 9,900
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Crushing, grinding, and polishing machine setters, operators, and tenders

Set up, operate, or tend machines to crush, grind, or polish materials, such as coal, glass, grain, stone, food, or rubber.

2008 Employment: 41,200
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Cutters and trimmers, hand

Use hand tools or hand-held power tools to cut and trim a variety of manufactured items, such as carpet, fabric, stone, glass, or rubber.

2008 Employment: 24,200
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Short-term on-the-job training

Cutting and slicing machine setters, operators, and tenders

Set up, operate, or tend machines that cut or slice materials, such as glass, stone, cork, rubber, tobacco, food, paper, or insulating material. Excludes woodworking machines setters, operators, and tenders; cutting, punching, and press machine setters, operators, and tenders, metal and plastic; and textile cutting machine setters, operators, and tenders.

2008 Employment: 75,200
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Etchers and engravers

Engrave or etch metal, wood, rubber, or other materials for identification or decorative purposes. Includes such workers as etcher-circuit processors, pantograph engravers, and silk screen etchers. Includes photoengravers with prepress technicians and workers.

2008 Employment: 12,000
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Long-term on-the-job training

Extruding, forming, pressing, and compacting machine setters, operators, and tenders

Set up, operate, or tend machines, such as glass forming machines, plodder machines, and tuber machines, to shape and form products, such as glassware, food, rubber, soap, brick, tile, clay, wax, tobacco, or cosmetics. Excludes paper goods machine setters, operators, and tenders; and shoe machine operators and tenders.

2008 Employment: 83,300
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

First-line supervisors/managers of production and operating workers

Supervise and coordinate the activities of production and operating workers, such as inspectors, precision workers, machine setters, and operators, assemblers, fabricators, and plant and system operators. Excludes team or work leaders.

2008 Employment: 681,200
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Work experience in a related occupation

Furnace, kiln, oven, drier, and kettle operators and tenders

Operate or tend heating equipment other than basic metal, plastic or food processing equipment. Includes activities, such as annealing glass, drying lumber, curing rubber, removing moisture from materials, or boiling soap.

2008 Employment: 24,500
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Gas plant operators

Distribute or process gas for utility companies and others by controlling compressors to maintain specified pressures on main pipelines.

2008 Employment: 14,900
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Long-term on-the-job training

Grinding and polishing workers, hand

Grind, sand, or polish, using hand tools or hand-held power tools, a variety of metal, wood, stone, clay, plastic, or glass objects. Includes chippers, buffers, and finishers.

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2008 Employment: 40,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Helpers—production workers

Help production workers by performing duties of lesser skill. Duties include supplying or holding materials or tools, and cleaning work area and equipment. Excludes apprentice workers.

2008 Employment: 484,000
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Mixing and blending machine setters, operators, and tenders

Set up, operate, or tend machines to mix or blend materials, such as chemicals, tobacco, liquids, color pigments, or explosive ingredients. Excludes food batchmakers.

2008 Employment: 141,500
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Molders, shapers, and casters, except metal and plastic

Mold, shape, form, cast, or carve products such as food products, figurines, tile, pipes, and candles consisting of clay, glass, plaster, concrete, stone, or combinations of materials.

2008 Employment: 48,200
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Packaging and filling machine operators and tenders

Operate or tend machines to prepare industrial or consumer products for storage or shipment. Includes cannery workers who pack food products.

2008 Employment: 349,000
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Paper goods machine setters, operators, and tenders

Set up, operate, or tend paper goods machines that perform a variety of functions, such as converting, sawing, corrugating, banding, wrapping, boxing, stitching, forming, or sealing paper or paperboard sheets into products.

2008 Employment: 103,300
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Petroleum pump system operators, refinery operators, and gaugers

Control the operation of petroleum refining or processing units. May specialize in controlling manifold and pumping systems, gauging or testing oil in storage tanks, or regulating the flow of oil into pipelines.

2008 Employment: 47,100
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Long-term on-the-job training

Separating, filtering, clarifying, precipitating, and still machine setters, operators, and tenders

Set up, operate, or tend continuous flow or vat-type equipment; filter presses; shaker screens; centrifuges; condenser tubes; precipitating, fermenting, or evaporating tanks; scrubbing towers; or batch stills. These machines extract, sort, or separate liquids, gases, or solids from other materials to recover a refined product. Includes dairy processing equipment operators. Excludes chemical equipment operators and tenders.

2008 Employment: 40,800
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Tire builders

Operate machines to build tires from rubber components.

2008 Employment: 21,400
Projected 2008-18 employment change: Decline rapidly
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Transportation and material moving occupations

Aircraft cargo handling supervisors

Direct ground crew in the loading, unloading, securing, and staging of aircraft cargo and baggage. Determine the quantity and orientation of cargo and compute aircraft center of gravity. May accompany aircraft as member of flight crew and monitor and handle cargo in flight, and assist and brief passengers on safety and emergency procedures. Includes loadmasters.

2008 Employment: 4,900
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Work experience in a related occupation

Airfield operations specialists

Ensure the safe takeoff and landing of commercial and military aircraft. Duties include coordination between air-traffic control and maintenance personnel; dispatching; using airfield landing and navigational aids; implementing airfield safety procedures; monitoring and maintaining flight records; and applying knowledge of weather information.

2008 Employment: 8,100
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Long-term on-the-job training

Ambulance drivers and attendants, except emergency medical technicians

Drive ambulance or assist ambulance drivers in transporting sick, injured, or convalescent persons. Assist in lifting patients.

2008 Employment: 22,200
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Moderate-term on-the-job training

Bridge and lock tenders

Operate and tend bridges, canal locks, and lighthouses to permit marine passage on inland waterways, near shores, and at danger points in waterway passages. May supervise such operations. Includes drawbridge operators, lock tenders and operators, and slip bridge operators.

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2008 Employment: 4,700
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

First-line supervisors/managers of helpers, laborers, and material movers, hand

Supervise and coordinate the activities of helpers, laborers, or material movers.

2008 Employment: 183,500
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Work experience in a related occupation

First-line supervisors/managers of transportation and material moving machine and vehicle operators

Directly supervise and coordinate activities of transportation and material-moving machine and vehicle operators and helpers.

2008 Employment: 217,600
Projected 2008-18 employment change: Decline slowly
Most significant source of postsecondary education or training: Work experience in a related occupation

Parking lot attendants

Park automobiles or issue tickets for customers in parking lot or garage. May collect fee.

2008 Employment: 136,200
Projected 2008-18 employment change: More slowly than average
Most significant source of postsecondary education or training: Short-term on-the-job training

Service station attendants

Service automobiles, buses, trucks, boats, and other automotive or marine vehicles with fuel, lubricants, and accessories. Collect payment for services and supplies. May lubricate vehicle, change motor oil, install antifreeze, or replace lights or other accessories, such as windshield wiper blades or fan belts. May repair or replace tires.

2008 Employment: 83,300
Projected 2008-18 employment change: Little or no change
Most significant source of postsecondary education or training: Short-term on-the-job training

Traffic technicians

Conduct field studies to determine traffic volume, speed, effectiveness of signals, adequacy of lighting, and other factors influencing traffic conditions, under direction of traffic engineer.

2008 Employment: 7,400
Projected 2008-18 employment change: About as fast as average
Most significant source of postsecondary education or training: Short-term on-the-job training

Transportation inspectors

Inspect equipment or goods in connection with the safe transport of cargo or people. Includes rail transport inspectors, such as freight inspectors, car inspectors, rail inspectors, and other nonprecision inspectors of other types of transportation vehicles.

2008 Employment: 26,900
Projected 2008-18 employment change: Faster than average
Most significant source of postsecondary education or training: Work experience in a related occupation

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Assumptions and Methods Used in Preparing Employment Projections

Occupational statements in the *Handbook* include numerical projections of the change in employment between 2008 and 2018. These projections are developed using the Bureau of Labor Statistics (BLS) employment projections model system. Projections of occupational employment are the final step in the system; these steps are listed in the discussion of methods below. A discussion of projections methods also is accessible on the Internet at **http://www.bls.gov/opub/hom/homch13_a.htm**. The November 2009 *Monthly Labor Review* presents a comprehensive discussion of the 2008-18 projections of the economy, labor force, and industry and occupation employment. The winter 2009-10 *Occupational Outlook Quarterly* presents the projections in a series of charts.

The projections reflect the knowledge and judgment of staff in the BLS Office of Occupational Statistics and Employment Projections and of knowledgeable people from other BLS offices, other government agencies, colleges and universities, industries, unions, professional societies, and trade associations, who furnished data and information, prepared reports, or reviewed the projections. BLS takes full responsibility, however, for the projections.

Assumptions. The information in the *Handbook* is based on an economic projection which, in turn, is based on assumptions about several key variables that affect the U.S. economy. The United States entered a severe recession in December 2007, leading to declining output and high unemployment. However, BLS expects the economy to return to its long-term trend rate of growth over the next decade. Consequently, the employment projections are based on an anticipated growth rate of 2.4 percent of Gross Domestic Product (GDP) per year from 2008 to 2018.

Other key assumptions include slower growth in the labor force (0.8 percent annually from 2008 to 2018 compared with 1.1 percent annually over the past 10-year period, 1998–2008) as a large number of workers retire, and a slowdown in labor productivity (1.8 percent average annual growth compared with 2.6 percent annually over the 1998–2008 period). The projections model also assumes an unemployment rate of 5.1 percent in 2018.

Growth in personal consumption expenditures, the largest single component of GDP, is expected to slow to 2.5 percent annually from 2008-18, down from the 3 percent annual average from 1998–2008. Underlying this assumption is an expected slowdown in the growth of spending on non-durable goods (defined as goods lasting less than three years) and durable goods (such as cars and large appliances). Growth in spending on consumer services is anticipated to be stronger than overall personal consumption growth, however, driven in part by continued increases in medical care spending.

Residential investment (the construction of new homes and dwellings) is expected to increase 5.1 percent annually over the projections period, reflecting the severe housing slump downturn that began in 2006 and the historically low starting point. Non-residential investment, which includes purchases by firms of equipment and software as well as construction of non-residential structures, should see 3.0 percent growth per year from 2008 to 2018, similar to the 3.1 percent annual growth from 1998-2008. Underlying this assumption is an anticipated slowdown (compared to the prior decade) in non-residential structure investment. Total investment, consisting of residential plus non-residential investment, is expected to increase by 3.9 percent annually from 2008-18, reaching 15.7 percent of GDP in 2018, higher than the 14.0 percent mark of 2008.

BLS expects the trade deficit to be 4.4 percent of GDP in 2018, below the 2004 peak of 5.6 percent, but still equivalent to about $650 billion. Inflation is expected to average 1.9 percent from 2008 to 2018, reflecting low levels of inflation during the initial years due to the recession, followed by a return to the long-term trend.

Although BLS considers these assumptions reasonable, the economy may follow a different course, resulting in a different pattern of occupational growth. Real growth also could be different because most occupations are sensitive to a much wider variety of factors than those considered in the various projections models. Unforeseen changes in consumer, business, or government spending patterns and in the ways in which goods and services are produced as well as advances in technology could greatly alter the growth of individual occupations.

Methods. This section summarizes the steps involved in BLS projections of employment by occupation. BLS uses U.S. Census Bureau projections of the population by age, gender, ethnicity, and race, combined with projections of labor force participation rates—the percent of the specified group of the population working or seeking work—to arrive at estimates of the civilian labor force for the projected year.

BLS projections are developed in a series of steps, each of which is based on separate projections procedures, models, and various related assumptions. These steps, or system components, deal with:

1. Size and demographic composition of the labor force
2. Growth of the aggregate economy (GDP)
3. Inter-industry relationships (input-output) used to allocate components of final demand to commodities
4. Industry output and employment
5. Occupational employment

These components provide the overall analytical framework needed to develop detailed employment projections. Each component is developed in order, with the results of each used as input for successive components and with some results feeding back into earlier steps. Each step is repeated a number of times to ensure internal consistency as assumptions and results are reviewed and revised.

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The projections of the labor force and assumptions about other demographic variables, fiscal and monetary policies, foreign economic activity, and energy prices form the input to the macroeconomic model. This model projects GDP (all final sales in the economy) and the distribution of GDP by its major demand components (consumer expenditures, investment, government consumption and gross investment, and exports and imports).

Estimating the intermediate flows of goods and services—for example, the steel incorporated into automobiles—is the next step in the projections process. The resulting estimates of demand for goods and services are used to project industry output of final products as well as total output by industry.

Industry output of goods and services is then used to estimate industry employment. Trends in productivity are used to evaluate the future output per worker hour, and additional analysis is used to calculate worker hours. These estimates, along with output projections, are used to develop the final industry employment projections.

An industry-occupation matrix, also known as the National Employment Matrix, is used to project employment for wage and salary workers. The matrix shows occupational staffing patterns—each occupation as a percent of employment in every industry. The matrix covering the 2008-18 period includes 276 detailed industries and 750 detailed occupations. Data for current staffing patterns in the matrix come from the BLS Occupational Employment Statistics (OES) survey, which collects data from employers on a 3-year cycle.

The occupational staffing patterns for each industry were projected based on anticipated changes in the ways in which goods and services are produced, and were then applied to projected industry employment. The resulting employment was summed across industries to derive total wage and salary employment by occupation. Using this method, rapid employment growth is projected for healthcare workers, such as pharmacists and physical therapists, while employment of newspaper publishing workers, such as reporters and correspondents, is expected to decline, reflecting the projected changes in the healthcare and newspaper publishing industries, respectively.

Employment in an occupation also may grow or decline as a result of many other factors. For example, relatively fast growth is expected among computer systems analysts and software engineers as organizations continue to adopt increasingly sophisticated technology. On the other hand, automation, the expanding use of computers, and developments in computer software will result in declining employment among procurement clerks, order clerks, and word processors and typists. The projected-year matrix incorporates these expected changes.

Data on self-employed workers in each occupation come from the Current Population Survey (CPS). Numbers of self-employed workers were projected separately.

Replacement needs. In most occupations, replacement needs provide more job openings than growth. Replacement openings occur as people leave occupations. Some individuals transfer to other occupations as a step up the career ladder or to change careers; some stop working temporarily, perhaps to return to school or care for a family; other workers—retirees for example—leave the labor force permanently. A discussion of replacements and the methods used to prepare estimates is presented on the Bureau's Employment Projections homepage at **http://www.bls.gov/emp**.

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Occupational Information Network Coverage

The *Occupational Information Network* (O*NET), which replaced the *Dictionary of Occupational Titles,* is used by public employment service offices to classify and place jobseekers. O*NET was developed by job analysts. The information on job duties, knowledge and skills, education and training, and other occupational characteristics comes directly from workers and employers. Information on O*NET is available from O*NET Project, U.S. Department of Labor/ETA, 200 Constitution Ave. NW., Room S-4231, Washington, DC 20210-0001. Telephone (202) 693-3660. Internet: **http://www.doleta.gov/programs/onet**.

The structure of O*NET reflects the *Standard Occupational Classification* (SOC) system, and represents the Federal Government's effort to analyze the occupational structure in the United States and to provide a national occupational classification system. The 2000 SOC includes about 820 detailed occupations. The Government is developing the 2010 SOC. Information on the SOC, including its occupational structure, is available on the Internet: **http://www.bls.gov/soc**.

Occupational statements in this 2010-11 edition of the *Handbook* are based on the 2000 SOC, which relates to or matches the definitions used in the Bureau's Occupational Employment Statistics (OES) survey—the principal source of occupational employment data in the *Handbook*. The table below lists O*NET codes and titles that are related to occupations in the *Handbook*.

O*NET-SOC Code	O*NET-SOC Title	Page
11-1011.00	Chief Executives	83
11-1011.03	Chief Sustainability Officers	83
11-1021.00	General and Operations Managers	83
11-1031.00	Legislators	823
11-2011.00	Advertising and Promotions Managers	32
11-2011.01	Green Marketers	32
11-2021.00	Marketing Managers	32
11-2022.00	Sales Managers	32
11-2031.00	Public Relations Managers	32
11-3011.00	Administrative Services Managers	29
11-3021.00	Computer and Information Systems Managers	35
11-3031.00	Financial Managers	52
11-3031.01	Treasurers and Controllers	52
11-3031.02	Financial Managers, Branch or Department	52
11-3041.00	Compensation and Benefits Managers	61
11-3042.00	Training and Development Managers	61
11-3049.00	Human Resources Managers, All Other	61
11-3051.00	Industrial Production Managers	67
11-3051.01	Quality Control Systems Managers	67
11-3051.02	Geothermal Production Managers	67
11-3051.03	Biofuels Production Managers	67
11-3051.04	Biomass Production Managers	67
11-3051.05	Methane/Landfill Gas Collection System Operators	67
11-3051.06	Hydroelectric Production Managers	67
11-3061.00	Purchasing Managers	79
11-3071.00	Transportation, Storage, and Distribution Managers	824
11-3071.01	Transportation Managers	824
11-3071.02	Storage and Distribution Managers	824
11-9011.00	Farm, Ranch, and Other Agricultural Managers	48
11-9011.01	Nursery and Greenhouse Managers	48
11-9011.02	Crop and Livestock Managers	48
11-9011.03	Aquacultural Managers	48
11-9012.00	Farmers and Ranchers	48
11-9021.00	Construction Managers	38
11-9031.00	Education Administrators, Preschool and Child Care Center/Program	41
11-9032.00	Education Administrators, Elementary and Secondary School	41
11-9033.00	Education Administrators, Postsecondary	41
11-9039.00	Education Administrators, All Other	41
11-9039.01	Distance Learning Coordinators	41
11-9039.02	Fitness and Wellness Coordinators	41
11-9041.00	Engineering Managers	46
11-9041.01	Biofuels/Biodiesel Technology and Product Development Managers	46
11-9051.00	Food Service Managers	55
11-9061.00	Funeral Directors	58
11-9071.00	Gaming Managers	520
11-9081.00	Lodging Managers	70
11-9111.00	Medical and Health Services Managers	73
11-9111.01	Clinical Nurse Specialists	73
11-9121.00	Natural Sciences Managers	46
11-9121.01	Clinical Research Coordinators	46
11-9121.02	Water Resource Specialists	46
11-9131.00	Postmasters and Mail Superintendents	824
11-9141.00	Property, Real Estate, and Community Association Managers	76
11-9151.00	Social and Community Service Managers	824
13-1011.00	Agents and Business Managers of Artists, Performers, and Athletes	823
13-1021.00	Purchasing Agents and Buyers, Farm Products	79
13-1022.00	Wholesale and Retail Buyers, Except Farm Products	79
13-1023.00	Purchasing Agents, Except Wholesale, Retail, and Farm Products	79
13-1031.00	Claims Adjusters, Examiners, and Investigators	96
13-1031.01	Claims Examiners, Property and Casualty Insurance	96
13-1031.02	Insurance Adjusters, Examiners, and Investigators	96
13-1032.00	Insurance Appraisers, Auto Damage	96
13-1041.00	Compliance Officers, Except Agriculture, Construction, Health and Safety, and Transportation	823
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13-1041.03 Equal Opportunity Representatives and Officers....823
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13-1041.06 Coroners....823
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13-1073.00 Training and Development Specialists....61
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13-1081.02 Logistics Analysts....823
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13-2011.02 Auditors....86
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13-2021.01 Assessors....90
13-2021.02 Appraisers, Real Estate....90
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13-2072.00 Loan Officers....109
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15-1021.00 Computer Programmers....134
15-1031.00 Computer Software Engineers, Applications....134
15-1032.00 Computer Software Engineers, Systems Software....134
15-1041.00 Computer Support Specialists....138
15-1051.00 Computer Systems Analysts....140
15-1051.01 Informatics Nurse Specialists....140
15-1061.00 Database Administrators....128
15-1071.00 Network and Computer Systems Administrators....128
15-1071.01 Computer Security Specialists....128
15-1081.00 Network Systems and Data Communications Analysts....128
15-1081.01 Telecommunications Specialists....128
15-1099.00 Computer Specialists, All Other....128
15-1099.01 Software Quality Assurance Engineers and Testers....128
15-1099.02 Computer Systems Engineers/Architects....128
15-1099.03 Network Designers....128
15-1099.04 Web Developers....128
15-1099.05 Web Administrators....128
15-1099.06 Geospatial Information Scientists and Technologists....128
15-1099.07 Geographic Information Systems Technicians....128
15-1099.08 Database Architects....128
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15-1099.11 Information Technology Project Managers....128
15-1099.12 Electronic Commerce Specialists....128
15-1099.13 Video Game Designers....128
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GPO U.S. GOVERNMENT PRINTING OFFICE: 2010—358-433

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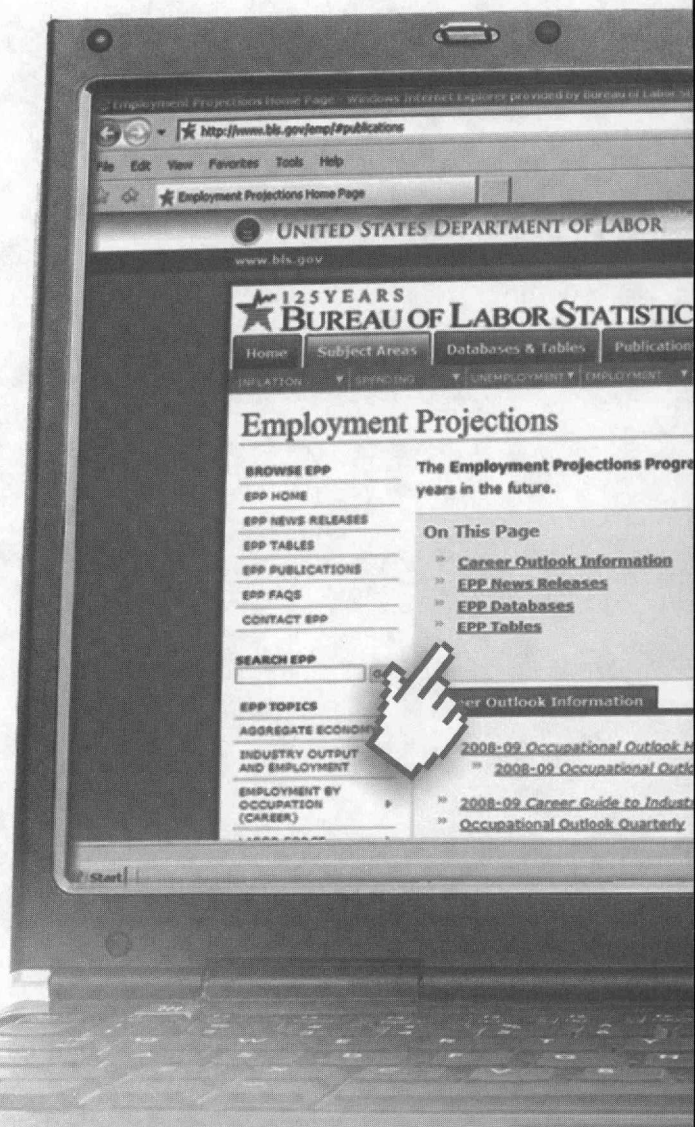

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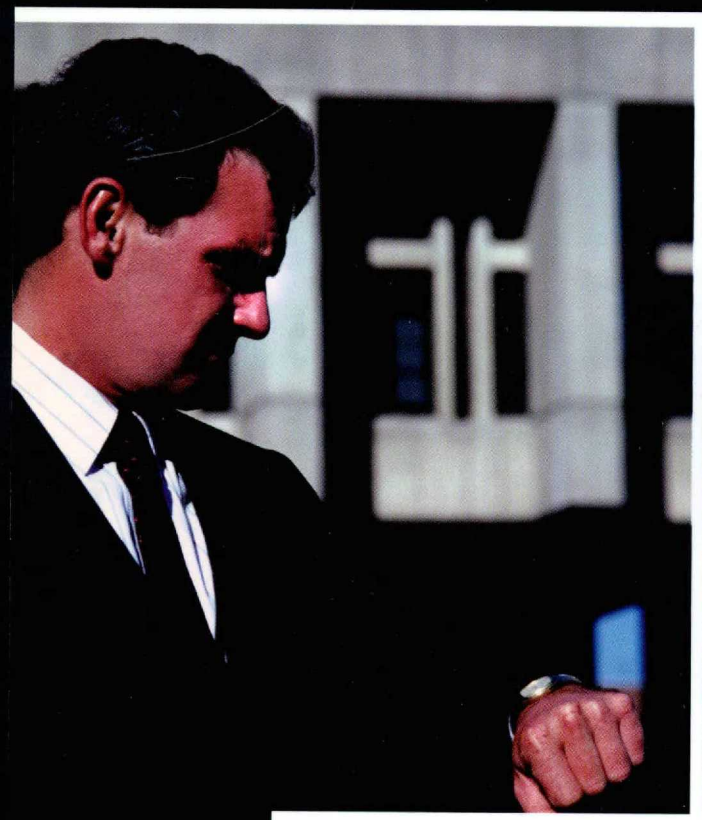

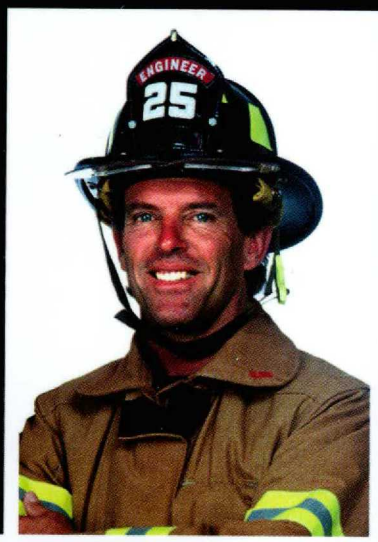

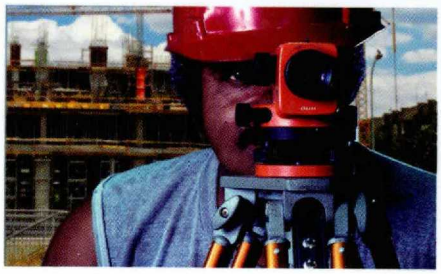

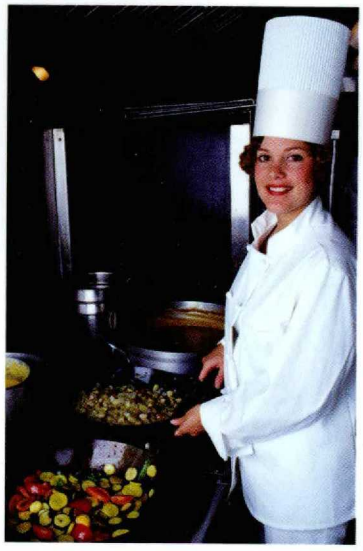





ISBN 978-0-16-084317-4



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