

or a ceiling tile installer employed full time, carpenters and painters usually do the work.

Training, Other Qualifications, and Advancement

Most drywall installers, ceiling tile installers, and tapers start as helpers and learn their skills on the job. Installer helpers start by carrying materials, lifting and holding panels, and cleaning up debris. Within a few weeks, they learn to measure, cut, and install materials. Eventually, they become fully experienced workers. Taper apprentices begin by taping joints and touching up nail holes, scrapes, and other imperfections. They soon learn to install corner guards and to conceal openings around pipes. At the end of their training, drywall installers, ceiling tile installers, and tapers learn to estimate the cost of installing and finishing drywall.

Some drywall installers, ceiling tile installers, and tapers learn their trade in an apprenticeship program. The United Brotherhood of Carpenters and Joiners of America, in cooperation with local contractors, administers an apprenticeship program in both drywall installation and finishing and acoustical carpentry. Apprenticeship programs consist of at least 3 years, or 6,000 hours, of on-the-job training and 144 hours a year of related classroom instruction. In addition, local affiliates of the Associated Builders and Contractors and the National Association of Home Builders conduct training programs for nonunion workers. The International Brotherhood of Painters and Allied Trades conducts an apprenticeship program in drywall finishing that lasts 2 to 3 years.

Employers prefer high school graduates who are in good physical condition, but they frequently hire applicants with less education. High school or vocational school courses in carpentry provide a helpful background for drywall work. Regardless of educational background, installers must be good at simple arithmetic. Other useful high school courses include English, wood shop, metal shop, blueprint reading, and mechanical drawing.

Drywall installers, ceiling tile installers, and tapers with a few years' experience and with leadership ability may become supervisors. Some workers start their own contracting businesses.

Job Outlook

Job opportunities for drywall installers, ceiling tile installers, and tapers are expected to be excellent through 2010, partly due to a shortage of adequate training programs. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment is expected to grow more slowly than the average for all occupations over the 2000-10 period, reflecting increases in new construction and remodeling. In addition to traditional interior work, the growing acceptance of insulated exterior wall systems will provide additional jobs for drywall workers.

In addition to those resulting from job growth, many jobs will open up each year because of the need to replace workers who transfer to other occupations or leave the labor force. Because of their relatively weak attachment to the occupation, many drywall installers, ceiling tile installers, and tapers with limited skills leave the occupation when they find that they dislike the work or fail to find steady employment.

Despite the growing use of exterior panels, most drywall installation and finishing is done indoors. Therefore, drywall workers lose less worktime because of inclement weather than do some other construction workers. Nevertheless, they may be unemployed between construction projects and during downturns in construction activity.

Earnings

In 2000, the median hourly earnings of drywall and ceiling tile installers were \$15.80. The middle 50 percent earned between \$12.27 and \$20.81. The lowest 10 percent earned less than \$9.68, and the highest 10 percent earned more than \$26.86. The median hourly earnings in the largest industries employing drywall and ceiling tile installers in 2000 were:

Nonresidential building construction	\$16.18
Residential building construction	15.96
Masonry, stonework, and plastering	15.93

In 2000, the median hourly earnings of tapers were \$17.81. The middle 50 percent earned between \$13.99 and \$23.34. The lowest 10 percent earned less than \$11.06, and the highest 10 percent earned more than \$27.62. The median hourly earnings of tapers in 2000 in masonry, stonework, and plastering were \$17.67.

Trainees usually started at about half the rate paid to experienced workers, and received wage increases as they became more highly skilled.

Some contractors pay these workers according to the number of panels they install or finish per day; others pay an hourly rate. A 40-hour week is standard, but the workweek may sometimes be longer. Workers who are paid hourly rates receive premium pay for overtime.

Related Occupations

Drywall installers, ceiling tile installers, and tapers combine strength and dexterity with precision and accuracy to make materials fit according to a plan. Other occupations that require similar abilities include carpenters; carpet, floor, and tile installers and finishers; insulation workers; and plasterers and stucco masons.

Sources of Additional Information

For information about work opportunities in drywall application and finishing and ceiling tile installation, contact local drywall installation and ceiling tile installation contractors, a local of the unions previously mentioned, 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.

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

- ▶ Associated Builders and Contractors, Inc., 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>
- ▶ National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.com>
- ▶ International Brotherhood of Painters and Allied Trades, 1750 New York Ave. NW., Washington, DC 20006. Internet: <http://www.ibpat.org>
- ▶ United Brotherhood of Carpenters and Joiners of America, 101 Constitution Ave. NW., Washington, DC 20001.

Electricians

(O*NET 47-2111.00)

Significant Points

- Job opportunities are expected to be excellent for qualified electricians.
- Most electricians acquire their skills by completing a formal 4- or 5-year apprenticeship program.
- About one-third of all electricians work in industries other than construction.

Nature of the Work

Electricity is essential for light, power, air conditioning, and refrigeration. Electricians install, connect, test, and maintain electrical systems for a variety of purposes, including climate control, security, and communications. They also may install and maintain the electronic controls for machines in business and industry. Although most electricians specialize in either construction or maintenance, a growing number do both.

Electricians work with blueprints when they install electrical systems in factories, office buildings, homes, and other structures. Blueprints indicate the locations of circuits, outlets, load centers, panel boards, and other equipment. Electricians must follow the National Electric Code and comply with State and local building codes when they install these systems. In factories and offices, they first place conduit (pipe or tubing) inside designated partitions, walls, or other concealed areas. They also fasten to the wall small metal or plastic boxes that will house electrical switches and outlets. They then pull insulated wires or cables through the conduit to complete circuits between these boxes. In lighter construction, such as residential, plastic-covered wire usually is used instead of conduit.

Regardless of the type of wire used, electricians connect it to circuit breakers, transformers, or other components. They join the wires in boxes with various specially designed connectors. After they finish the wiring, they use testing equipment, such as ohmmeters, voltmeters, and oscilloscopes, to check the circuits for proper connections, ensuring electrical compatibility and safety of components.

In addition to wiring a building's electrical system, electricians may install coaxial or fiber optic cable for computers and other telecommunications equipment. A growing number of electricians install telephone systems, computer wiring and equipment, street lights, intercom systems, and fire alarm and security systems. They also may connect motors to electrical power and install electronic controls for industrial equipment.

Maintenance work varies greatly, depending on where the electrician is employed. Electricians who specialize in residential work may rewire a home and replace an old fuse box with a new circuit breaker to accommodate additional appliances. Those who work in large factories may repair motors, transformers, generators, and electronic controllers on machine tools and industrial robots. Those in office buildings and small plants may repair all types of electrical equipment.

Maintenance electricians spend much of their time in preventive maintenance. They periodically inspect equipment, and locate and correct problems before breakdowns occur. Electricians may also

advise management on whether continued operation of equipment could be hazardous. When needed, they install new electrical equipment. When breakdowns occur, they must make the necessary repairs as quickly as possible in order to minimize inconvenience. Electricians may replace items such as circuit breakers, fuses, switches, electrical and electronic components, or wire. When working with complex electronic devices, they may work with engineers, engineering technicians, or industrial machinery installation, repair, and maintenance workers. (For information about each of these occupations, see the statements located elsewhere in the *Handbook*.)

Electricians use handtools such as screwdrivers, pliers, knives, and hacksaws. They also use power tools and testing equipment such as oscilloscopes, ammeters, and test lamps.

Working Conditions

Electricians' work is sometimes strenuous. They may stand for long periods and frequently work on ladders and scaffolds. Their working environment varies, depending on the type of job. Some may work in dusty, dirty, hot, or wet conditions, or in confined areas, ditches, or other uncomfortable places. Electricians risk injury from electrical shock, falls, and cuts; to avoid injuries, they must follow strict safety procedures. Some electricians may have to travel to jobsites, which may be up to 100 miles away.

Most electricians work a standard 40-hour week, although overtime may be required. Those in maintenance work may work nights or weekends, and be on call. Companies that operate 24 hours a day may employ three shifts of electricians.

Employment

Electricians held about 698,000 jobs in 2000. About two-thirds were employed in the construction industry. About one-third worked as maintenance electricians and were employed outside the construction industry. In addition, about 8 percent of electricians were self-employed.

Because of the widespread need for electrical services, jobs for electricians are found in all parts of the country.

Training, Other Qualifications, and Advancement

Most people learn the electrical trade by completing a 4- or 5-year apprenticeship program. Apprenticeship gives trainees a thorough knowledge of all aspects of the trade and generally improves their ability to find a job. Although more electricians are trained through apprenticeship than are workers in other construction trades, some still learn their skills informally, on the job.

Apprenticeship programs may be sponsored by joint training committees made up of local unions of the International Brotherhood of Electrical Workers and local chapters of the National Electrical Contractors Association; company management committees of individual electrical contracting companies; or by local chapters of the Associated Builders and Contractors and the Independent Electrical Contractors Association. Training also may be provided by company management committees of individual electrical contracting companies and by local chapters of the Associated Builders and Contractors and the Independent Electrical Contractors. Because of the comprehensive training received, those who complete apprenticeship programs qualify to do both maintenance and construction work.

The typical large apprenticeship program provides at least 144 hours of classroom instruction each year, and 8,000 hours of on-the-job training over the course of the apprenticeship. In the classroom, apprentices learn blueprint reading, electrical theory, electronics, mathematics, electrical code requirements, and safety and first aid practices. They also may receive specialized training



Electricians lay out conduit for electric wires.

in welding, communications, fire alarm systems, and cranes and elevators. On the job, under the supervision of experienced electricians, apprentices must demonstrate mastery of the electrician's work. At first, they drill holes, set anchors, and set up conduit. Later, they measure, fabricate, and install conduit, as well as install, connect, and test wiring, outlets, and switches. They also learn to set up and draw diagrams for entire electrical systems.

Those who do not enter a formal apprenticeship program can begin to learn the trade informally by working as helpers for experienced electricians. While learning to install conduit, connect wires, and test circuits, helpers also learn safety practices. Many helpers supplement this training with trade school or correspondence courses.

Regardless of how one learns the trade, previous training is very helpful. High school courses in mathematics, electricity, electronics, mechanical drawing, science, and shop provide a good background. Special training offered in the Armed Forces and by postsecondary technical schools also is beneficial. All applicants should be in good health and have at least average physical strength. Agility and dexterity also are important. Good color vision is needed because workers must frequently identify electrical wires by color.

Most apprenticeship sponsors require applicants for apprentice positions to be at least 18 years old and have a high school diploma or its equivalent. For those interested in becoming maintenance electricians, a background in electronics is increasingly important because of the growing use of complex electronic controls on manufacturing equipment.

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

Electricians periodically take courses offered by their employer or union to keep abreast of changes in the National Electrical Code, materials, or methods of installation.

Experienced electricians can become supervisors and then superintendents. Those with sufficient capital and management skills may start their own contracting business, although this may require an electrical contractor's license.

Job Outlook

Job opportunities for skilled electricians are expected to be excellent, largely due to the numerous openings arising each year from experienced electricians who leave the occupation. In addition, many potential workers may prefer work that is less strenuous and has more comfortable working conditions. Well-trained workers will have especially favorable opportunities.

Employment of electricians is expected to increase about as fast as the average for all occupations through the year 2010. As the population and economy grow, more electricians will be needed to install and maintain electrical devices and wiring in homes, factories, offices, and other structures. New technologies also are expected to continue to stimulate the demand for these workers. Increasingly, buildings will be prewired during construction to accommodate use of computers and telecommunications equipment. More factories will be using robots and automated manufacturing systems. Installation of this equipment, which is expected to increase, should also stimulate demand for electricians. Additional jobs will be created by rehabilitation and retrofitting of existing structures.

In addition to jobs created by increased demand for electrical work, many openings will occur each year as electricians transfer to other occupations, retire, or leave the labor force for other reasons. Because of their lengthy training and relatively high earnings, a smaller proportion of electricians than of other craftworkers leave

their occupation each year. The number of retirements is expected to rise, however, as more electricians reach retirement age.

Employment of construction electricians, like that of many other construction workers, is sensitive to changes in the economy. This results from the limited duration of construction projects and the cyclical nature of the construction industry. During economic downturns, job openings for electricians are reduced as the level of construction activity declines. Apprenticeship opportunities also are less plentiful during these periods.

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 be laid off during recessions. Also, efforts to reduce operating costs and increase productivity, through the increased use of contracting out for electrical services, may limit opportunities for maintenance electricians in many industries. However, this should be partially offset by increased demand by electrical contracting firms.

Job opportunities for electricians also vary by area. Employment opportunities follow the movement of people and businesses among States and local areas, and reflect differences in local economic conditions. The number of job opportunities in a given year may fluctuate widely from area to area.

Earnings

In 2000, median hourly earnings of electricians were \$19.29. The middle 50 percent earned between \$14.49 and \$25.41. The lowest 10 percent earned less than \$11.31, and the highest 10 percent earned more than \$31.71. Median hourly earnings in the industries employing the largest numbers of electricians in 2000 are shown below:

Motor vehicles and equipment	\$26.71
Local government	19.88
Electrical work	19.22
Heavy construction, except highway	17.92
Plumbing, heating, and air-conditioning	17.26

Depending on experience, apprentices usually start at between 30 and 50 percent of the rate paid to experienced electricians. As they become more skilled, they receive periodic increases throughout the course of the apprenticeship program. Many employers also provide training opportunities for experienced electricians to improve their skills.

Many construction electricians are members of the International Brotherhood of Electrical Workers. Among unions organizing 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

To install and maintain electrical systems, electricians combine manual skill and knowledge of electrical materials and concepts. Workers in other occupations involving similar skills include heating, air-conditioning, and refrigeration mechanics and installers; line installers and repairers; electrical and electronics installers and repairers; electronic home entertainment equipment installers and repairers; and elevator installers and repairers.

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. This information may also be available from local chapters of the Independent Electrical Contractors, Inc.; the National Electrical Contractors Association; the Home Builders Institute; the Associated Builders and Contractors; and the International Brotherhood of Electrical Workers.

For general information about the work of electricians, contact:

- ▶ Independent Electrical Contractors, Inc., 2010-A Eisenhower Ave., Alexandria, VA 22314. Internet: <http://www.ieci.org>
- ▶ National Electrical Contractors Association (NECA), 3 Metro Center, Suite 1100, Bethesda, MD 20814. Internet: <http://www.necanet.org>
- ▶ International Brotherhood of Electrical Workers (IBEW), 1125 15th St. NW., Washington, DC 20005. Internet: <http://www.ibew.org>
- ▶ Associated Builders and Contractors, 1300 N. 17th St., Arlington, VA 22209. Internet: <http://www.abc.org>
- ▶ National Association of Home Builders, 1201 15th St. NW., Washington, DC 20005. Internet: <http://www.nahb.org>

Elevator Installers and Repairers

(O*NET 47-4021.00)

Significant Points

- Workers learn the trade through 4 to 5 years of on-the-job training and classroom instruction.
- Elevator installers and repairers have one of the highest rates of union membership.
- Job opportunities are expected to be limited in this small occupation; prospects should be best for those with postsecondary education in electronics.

Nature of the Work

Elevator installers and repairers—also called *elevator constructors* or *elevator mechanics*—assemble, install, and replace elevators, escalators, 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, electricity, and hydraulics. Many elevators are controlled with microprocessors, which are programmed to analyze traffic conditions in order to dispatch elevators in the most efficient manner. With these computer controls, it is possible to get the greatest amount of service with the least number of cars.

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. Once this has been done, 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 it is in place, mechanics pull plastic-covered electrical wires through the conduit. 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, these 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 lift in an auto service station.

Installers and repairers also install escalators. They put in place the steel framework, the electrically powered stairs, and the tracks and install associated motors and electrical wiring. In addition to elevators and escalators, they 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.

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 is working according to specifications, such as stopping correctly at each floor within a specified time. Once an elevator is operating properly, 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 also troubleshoot and may be called in to do emergency repairs.

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

Elevator installers and repairers usually specialize in installation, maintenance, or repair work. Maintenance and repair workers generally need more knowledge of electricity and electronics than installers do, because a large part of maintenance and repair work is troubleshooting. Similarly, adjusters need a thorough knowledge of electricity, electronics, and computers to ensure that newly installed elevators operate properly.



Elevator installers need a working knowledge of electricity, electronics, and hydraulics.