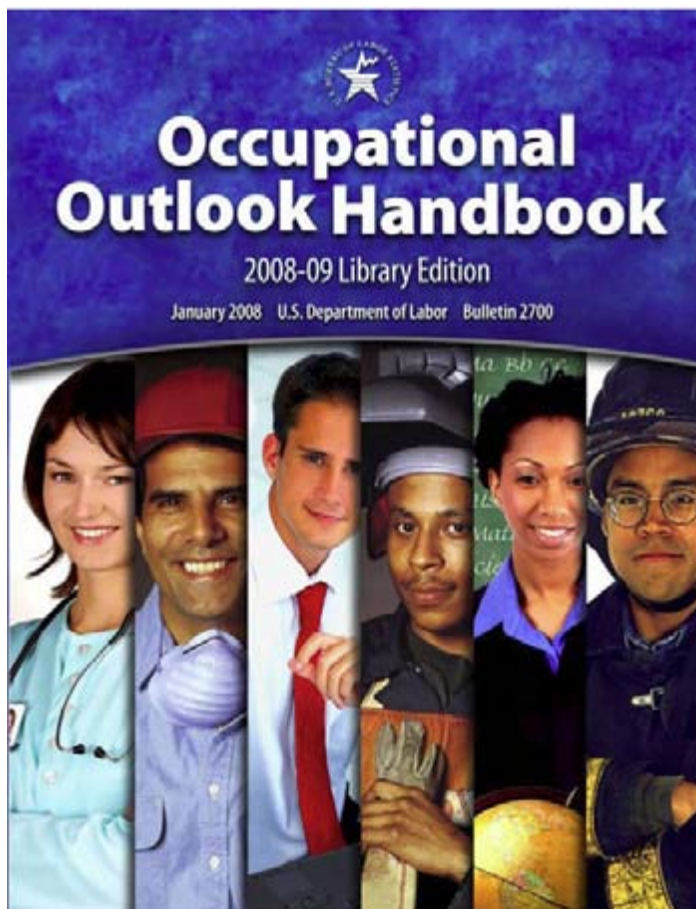


Construction Trades and Related Occupations



Reprinted from the
Occupational Outlook Handbook, 2008-09 Edition

U.S. Department of Labor
Bureau of Labor Statistics



Occupations Included in this Reprint

- Boilermakers
- Brickmasons, blockmasons, and stonemasons
- Carpenters
- Carpet, floor, and tile installers and finishers
- Cement masons, concrete finishers, segmental pavers, and terrazzo workers
- Construction and building inspectors
- Construction equipment operators
- Construction laborers
- Construction managers
- Drywall installers, ceiling tile installers, and tapers
- Electricians
- Elevator installers and repairers
- Glaziers
- Hazardous materials removal workers
- Insulation workers
- Painters and paperhangers
- Pipelayers, plumbers, pipefitters, and steamfitters
- Plasterers and stucco masons
- Roofers
- Sheet metal workers
- Structural and reinforcing iron and metal workers
- Welding, soldering, and brazing workers
- Woodworkers

Boilermakers

(O*NET 47-2011.00)

Significant Points

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

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. Chemicals, oil, beer, and hundreds of other products are processed and stored in the tanks and vats made by the Nation's boilermakers.

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.

Electric power plants harness highly pressurized steam in a boiler to spin the blades of a turbine, which is attached to an electric generator. In most plants, coal burned in a firebox is the dominant fuel used to generate steam in the boiler.

Because boilers last a long time—sometimes 50 years or more—boilermakers regularly maintain them and upgrade components, such as boiler tubes, heating elements, and ductwork, to increase efficiency. They regularly 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 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.

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 are increasingly automating this process to improve the quality of these vessels. Boiler sections are then welded together, often using robotic welding systems or automated orbital welding machines, which make more consistent welds than are possible by hand and eliminates some of the monotony of the task.

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 on the permanent site.

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 hammers, files, grinders, and cutting torches 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.

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.



Many boilermakers learn their trade through a formal apprenticeship.

Training, Other Qualifications, and Advancement

Most boilermakers learn this trade through a formal apprenticeship. A few become boilermakers through a combination of trade or technical school training and employer-provided training.

Education and training. Most boilermakers train in 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-workers.

Most apprentices must be high school graduates or have a GED or its equivalent. Those with welding training or a welding certification will have priority in applying for apprenticeship programs. Experienced boilermakers often attend apprenticeship classes or seminars to learn about new equipment, procedures, and technology. When an apprenticeship becomes available, the local union publicizes the opportunity by notifying local vocational schools and high school vocational programs.

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. Most apprentices must be at least 18 years old.

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

Employment

Boilermakers held about 18,000 jobs in 2006. About 63 percent worked in the construction industry, assembling and erecting boilers and other vessels. Around 18 percent worked in manufacturing, primarily in boiler manufacturing shops, iron and steel plants, petroleum refineries, chemical plants, and shipyards. Some also worked for boiler repair firms or railroads.

Job Outlook

Employment of boilermakers is expected to grow faster than average. Excellent employment opportunities are expected.

Employment change. Overall employment of boilermakers is expected to grow by 14 percent between 2006 and 2016, faster than the average for all occupations. 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 upgrade many of their boiler systems in the next few years.

The Energy Policy Act of 2005 is expected to lead to the construction of many new clean-burning coal power plants, spurring demand for boilermakers. The law, designed to promote conservation and use of cleaner technologies in energy production through tax credits and higher efficiency standards, is expected to positively affect the occupation and the energy industry throughout the 2006-16 projection period.

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

Job prospects. Job prospects should be excellent because of job growth and because the work of a boilermaker remains hazardous and physically demanding, leading some new apprentices to seek other types of work. An even greater number of openings will arise from the numerous boilermakers expected to retire over the projection decade.

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

Most industries that purchase boilers are sensitive to economic conditions. Therefore, during economic downturns, boilermakers in the construction industry may be laid off. However, maintenance and repairs of boilers must continue even during economic downturns so boilermaker mechanics in manufacturing and other industries generally have more stable employment.

Earnings

In May 2006, the median annual earnings of wage and salary boilermakers were about \$46,960. The middle 50 percent earned between \$37,300 and \$59,710. The lowest 10 percent earned less than \$30,410, and the highest 10 percent earned more than \$71,170. 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 a number of other occupations assemble, install, or repair metal equipment or machines. These occupations include assemblers and fabricators; machinists; industrial machinery

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Boilermakers..... | 47-2011 | 18,000 | 20,000 | 2,500 | 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*.

mechanics and maintenance workers; millwrights; pipelayers, plumbers, pipefitters, and steamfitters; sheet metal workers; tool and die makers; and welding, soldering, and brazing workers.

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.

Brickmasons, Blockmasons, and Stonemasons

(O*NET 47-2021.00, 47-2022.00)

Significant Points

- Job prospects are expected to be very good, especially for workers with restoration skills.
- Most 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 24 percent 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. These workers use their own perceptions and a variety of tools to en-

sure that the structure meets the desired standards. After finishing laying the bricks, blocks, or stone, these 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 use one of two methods, either the corner lead or the corner pole. Using the corner lead method, they begin by constructing a pyramid of bricks at each corner—called a lead. After the corner leads are complete, less experienced brickmasons fill in the wall between the corners using a line from corner to corner to guide each course, or layer, of brick. Due to the precision needed, corner leads are time-consuming to erect and require the skills of experienced bricklayers.

Because of the expense associated with building corner leads, some brickmasons use corner poles, also called masonry guides, which enable them to build an entire wall at the same time. They fasten the corner poles (posts) in a plumb position to define the wall line and stretch a line between them. This line serves as a guide for each course of brick. Brickmasons then spread a bed of mortar (a cement, lime, sand, and water mixture) 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, glass furnaces, incinerators, and other locations requiring high temperatures during the manufacturing process.

After a structure is completed there is still work that often 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 use chemicals to clean the laid materials to give the structure a finished appearance. Older structures also need to be refurbished as the mortar or binding agents break down. In many cases a grinder or blade is used to carefully remove the old mortar. Special care is taken to not damage the main structural integrity or the bricks, blocks, or stone. New mortar is then inserted. Depending on how much mortar is being replaced and how, it may take several applications to allow the new mortar to cure properly. These same masons replace and repair damaged masonry materials as part of the building's restoration process.

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. Stonemasons usually work on nonresidential structures, such as houses of worship, hotels, and office buildings, but they also work on residences.

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.

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 stone and weld or bolt these brackets to anchors in the wall. Finally, masons wash the stone with a cleansing solution to remove stains and dry 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. Using crowbars and hard rubber mallets for aligning and leveling, they then set the stone in the mortar bed. To finish, workers fill the joints and clean the stone slabs.

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 often are cut with a saw that has a diamond blade. 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 now are built with walls made of concrete block, brick veneer, stone, granite, marble, tile, or 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, but 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 is used and safety practices are followed.

Most workers work a standard 40-hour week. Earnings for workers in these trades can be reduced on occasion because



Brickmasons, blockmasons, and stonemasons usually work outdoors.

poor weather and slowdowns in construction activity limit the time they can work.

Training, Other Qualifications, and Advancement

Most 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 generally 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 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 on the job may last longer than if trained in an apprenticeship program. Industry-based training programs offered through construction companies usually last between 2 and 4 years.

Apprenticeships for brickmasons, blockmasons, and stonemasons usually are sponsored by local contractors, trade asso-

ciations, or local union-management committees. Apprenticeship programs usually require 3 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. Applicants for apprenticeships must be at least 17 years old and in good physical condition. A high school education is preferable 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 on the job to work with stone and concrete, which enables them to work with more than one masonry material.

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

Some workers learn 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 the on-the-job training.

Other qualifications. The most desired quality in workers is 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 employing many workers 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 continual “life long 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 182,000 jobs in 2006. The vast majority were brickmasons. Workers in these crafts are employed primarily by building, specialty trade, or general contractors.

About 24 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

Average employment growth is expected. Job prospects should be very good, especially for workers with restoration skills.

Employment change. Jobs for brickmasons, blockmasons, and stonemasons are expected to increase 10 percent over the 2006-16 decade, about as fast as the average for all occupations, as population and business growth create a need for new houses, industrial facilities, schools, hospitals, offices, and other structures. Also stimulating demand for workers will be the need to restore a growing number of old brick buildings. Moreover, the use of brick and stone for decorative work on building fronts, sidewalks, and in lobbies and foyers is increasing. Brick exteriors should remain very popular, reflecting a growing preference for durable exterior materials requiring little maintenance. Increased construction on hillsides also will spur the demand for new masons as designers create attractive areas that need retaining walls to hold soil in place. 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 very good through 2016. A large number of masons are expected to retire over the next decade. The large number of aging masonry buildings will increase opportunities for workers with restoration skills. Also, workers able to install new synthetic materials will have improved opportunities. Applicants who take masonry-related courses at technical schools will have better opportunities than those without these courses.

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 these workers may occur in some areas during peak periods of building activity.

Earnings

Median hourly earnings of wage and salary brickmasons and blockmasons in May 2006 were \$20.66. The middle 50 percent earned between \$15.96 and \$26.26. The lowest 10 percent earned less than \$12.24, and the highest 10 percent earned more than \$32.43. Median hourly earnings in the two industries employing the largest number of brickmasons in May 2006 were \$20.57 in the foundation, structure, and building exterior contractors industry and \$20.67 in the masonry contractors industry.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Brickmasons, blockmasons, and stonemasons..... | 47-2020 | 182,000 | 200,000 | 18,000 | 10 |
| Brickmasons and blockmasons | 47-2021 | 158,000 | 174,000 | 15,000 | 10 |
| Stonemasons | 47-2022 | 24,000 | 26,000 | 2,400 | 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*.

Median hourly earnings of wage and salary stonemasons in May 2006 were \$17.29. The middle 50 percent earned between \$13.12 and \$22.04. The lowest 10 percent earned less than \$10.36, and the highest 10 percent earned more than \$28.46.

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 based on specific advancement criteria.

Some brickmasons, blockmasons, and stonemasons are members of the International Union of Bricklayers and Allied Craftworkers.

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 carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; and plasterers and stucco masons.

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 Craftworkers; a local joint union-management apprenticeship committee; or the nearest office of the 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/atels_bat

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:

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

➤ International Union of Bricklayers and Allied Craftworkers, International Masonry Institute National Training Center, 17101 Science Dr., Bowie, MD 20715.

Internet: <http://www.imiweb.org>

➤ 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>

➤ 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:

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201.

Internet: <http://www.agc.org>

➤ Brick Industry Association, 11490 Commerce Park Dr., Reston, VA 22091-1525. Internet: <http://www.brickinfo.org>

➤ National Concrete Masonry Association, 13750 Sunrise Valley Dr., Herndon, VA 20171-3499.

Internet: <http://www.ncma.org>

Carpenters

(O*NET 47-2031.00, 47-2031.01, 47-2031.02)

Significant Points

- About 32 percent of all carpenters—the largest construction trade—were self-employed.
- Job opportunities should be best for those with the most training and skills.
- Between 3 and 4 years of both on-the-job training and classroom instruction usually is needed to become a skilled carpenter.

Nature of the Work

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

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.

When working with prefabricated components, such as stairs or wall panels, the carpenter's task is somewhat simpler because it does not require as much layout work or the cutting and assembly of as many pieces. Prefabricated components are designed for easy and fast installation and generally can be installed in a single operation.

Some carpenters do many different carpentry tasks, while others 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, for example, they might frame walls and partitions, put in doors and windows, build stairs, install cabinets and molding, and complete many other tasks. Because these carpenters are so well-trained, they often can switch from residential building to commercial construction or remodeling work, depending on which offers the best work opportunities.



Carpenters cut and shape wood, plastic, fiberglass, or drywall using hand and power tools.

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. (For more information on workers who install machinery, see the discussion of millwrights as well as industrial machinery installation, repair, and maintenance workers 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. Although many carpenters work indoors, those that work outdoors are subject to variable weather conditions.

Most carpenters work a standard 40 hour week. Hours may be longer during busy periods.

Training, Other Qualifications, and Advancement

Carpenters learn their trade through formal and informal training programs. Between 3 and 4 years of both on-the-job training and classroom instruction usually is needed to become a skilled carpenter. There are a number of ways to train, but a more formal training program often improves job opportunities.

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 length varies with the apprentice's skill.

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 with union membership.

Some people who are interested in carpentry careers choose to get their 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 the training.

Other qualifications. Carpenters need manual dexterity, eye-hand coordination, physical fitness, and a good sense of balance. The ability to solve arithmetic 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 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 largest building trades occupation. They held about 1.5 million jobs in 2006.

About 32 percent worked in construction of buildings and about 23 percent worked for specialty trade contractors. Most of the rest of the wage and salary workers 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

Average job growth, coupled with replacement needs, 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 10 percent during the 2006-16 decade, about as fast as the average for all occupations. The need for carpenters should grow as construction activity increases in response to demand for new housing and office and retail space, and for modernizing and expanding schools and industrial plants. A strong home remodeling market also will create demand for carpenters. Moreover, construction of roads and bridges as well as restaurants, hotels, and other businesses will increase the demand for carpenters in the coming decade.

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. In addition, improved adhesives are reducing the time needed to join materials, and lightweight, cordless, and pneumatic tools—such as nailers and drills—will all continue to make carpenters more productive. New and improved tools, equipment, techniques, and materials also have made carpenters more versatile, allowing them to perform more carpentry tasks.

Job prospects. Job opportunities should be best for those with the most training and skills. Job growth and replacement needs for those who leave the occupation create a large number

of openings each year. Many people with limited skills take jobs as carpenters but eventually leave the occupation because they dislike the work or cannot find steady employment.

Carpenters with all-around skills will have better opportunities for steady work than carpenters who can perform only a few relatively simple, routine tasks. Carpenters can experience periods of unemployment because of the short-term nature of many construction projects, winter slowdowns in construction activity in northern areas, and the cyclical nature of the construction industry.

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 2006, median hourly earnings of wage and salary carpenters were \$17.57. The middle 50 percent earned between \$13.55 and \$23.85. The lowest 10 percent earned less than \$10.87, and the highest 10 percent earned more than \$30.45. Median hourly earnings in the industries employing the largest numbers of carpenters were as follows:

| | |
|--|---------|
| Residential building construction..... | \$17.39 |
| Foundation, structure, and building exterior contractors | 17.03 |
| Nonresidential building construction | 15.12 |
| Building finishing contractors..... | 13.76 |
| Employment services | 10.88 |

Earnings can be reduced on occasion, because carpenters lose work time 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.

Related Occupations

Carpenters are skilled construction workers. Other skilled construction occupations include brickmasons, blockmasons, and stonemasons; cement masons, concrete finishers, segmental pavers, and terrazzo workers; drywall installers, ceiling tile installers, and tapers; electricians; pipelayers, plumbers, pipefitters, and steamfitters; and plasterers and stucco masons.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Carpenters | 47-2031 | 1,462,000 | 1,612,000 | 150,000 | 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*.

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'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 training opportunities and carpentry in general, contact:

➤ Associated Builders and Contractors, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203.

Internet: <http://www.trytools.org>

➤ Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201.

Internet: <http://www.agc.org>

➤ National Center for Construction Education and Research, 3600 NW, 43rd St., Bldg. G, Gainesville, FL, 32606.

Internet: <http://www.nccer.org>

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St.NW., Washington, DC 20005.

Internet: <http://www.hbi.org>

➤ United Brotherhood of Carpenters and Joiners of America, Carpenters Training Fund, 6801 Placid St., Las Vegas, NV 89119. 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.

Carpent, Floor, and Tile Installers and Finishers

(O*NET 47-2041.00, 47-2042.00, 47-2043.00, 47-2044.00)

Significant Points

- About 42 percent of carpet, floor, and tile installers and finishers are self-employed.
- Most workers learn on the job.
- Projected job growth varies by specialty; for example, tile and marble setters will have faster than average job growth, while little change is expected in the employment of carpet installers.
- Employment is less sensitive to fluctuations in construction activity than other construction trades workers.

Nature of the Work

Carpet, tile, and other types of floor coverings not only serve an important basic function in buildings, but their decorative quali-

ties also contribute to the appeal of the buildings. 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.

Before installing carpet, *carpet installers* first inspect the surface to be covered to determine its condition and, if 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 expected 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.

On special upholstery work, such as stairs, carpet may be held in place with staples. Also, in commercial installations, carpet often is glued directly to the floor or to padding that has been glued to the floor.

Carpet installers use hand tools such as hammers, drills, staple guns, carpet knives, and rubber mallets. They also may use carpetlaying 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 deaden sounds, absorb shocks, or create air-tight environments. Although they 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 deficiencies, such as a rotted or unlevelled sub-floor, in order to start with a sturdy, smooth, clean foundation. They measure and cut floor covering materials. When installing linoleum or vinyl, they may use an adhesive to cement the material directly to the floor. For laminate floor installation, workers may unroll and install a polyethylene film which acts as a moisture barrier, along with a thicker, padded underlayer which helps reduce noise. Cork and rubber floors often can be installed directly on top of the sub-floor without any 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 finish coats of varnish or polyurethane. To remove imperfections and smooth the surface, they will scrape and sand wooden floors using floor sanding machines. They then inspect 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.

Prior to installation, tilesetters use measuring devices and levels to ensure that the tile is placed in a consistent manner. Tile varies in color, shape, and size, ranging in size from 1 inch to 24 or more inches on a side, so tilesetters sometimes prearrange tiles on a dry floor according to the intended 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. To cover all exposed areas, including corners and around pipes, tubs, and wash basins, tilesetters cut tiles to fit with a machine saw or a special cutting tool. 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,” or thin layer of cement adhesive or “mastic,” a very sticky paste. They then properly position the tile and gently tap the surface with their trowel handle, 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 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 and includes sand for joints 1/8th of an inch and larger. They then apply the grout to the surface with a rubber-edged device called a grout float or a grouting trowel to fill the joints and remove excess grout. Before the grout sets, they wipe the tiles and finish the joints with a damp sponge for a uniform appearance.

Marble setters cut and set marble slabs in floors and walls of buildings. They trim and cut marble to specified sizes using a power wet saw, other cutting equipment, or handtools. After setting the marble in place, they polish the marble to 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, most 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,



Prior to installing tile, tilesetters use measuring devices and levels to ensure that the tile is placed in a consistent manner.

and reaching—activities that require endurance. The work can be very hard on workers’ knees and back. Carpet installers frequently lift heavy rolls of carpet and may move heavy furniture, which requires strength and can be physically exhausting. Safety regulations may require that they wear kneepads or safety goggles when using certain tools. Carpet and floor layers may be exposed to fumes from various kinds of glue and to fibers of certain types of carpet.

Although workers are subject to cuts from tools or materials, falls from ladders, and strained muscles, the occupation is not as hazardous as some other construction occupations.

Training, Other Qualifications, and Advancement

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

Education and training. Informal training for carpet installers often is sponsored by individual contractors. 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 measuring, cutting, and fitting.

Tile and marble setters also learn their craft mostly through on-the-job training. They start by helping carry materials and learning about the tools of the trade. They then learn to prepare the subsurface for tile or marble. As they progress, they learn to cut the tile and marble to fit the job. They also learn to apply grout and sealants used in finishing the materials to give it its final appearance. Apprenticeship programs and some contractor-sponsored programs provide comprehensive training in all phases of the tiling and floor layer trades.

Other floor layers also learn on the job and begin by learning how to use the tools of the trade. They next learn to prepare

surfaces to receive flooring. As they progress, they learn to cut and install the various floor coverings.

Other qualifications. Some skills needed to become carpet, floor, and tile installers and finishers include manual dexterity, eye-hand coordination, physical fitness, and a good sense of balance and color. 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. Many carpet, floor, and tile installers and finishers who begin working for someone else eventually go into business for themselves as independent subcontractors.

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; 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 contractors also need good English skills to deal with clients and subcontractors.

Employment

Carpet, floor, and tile installers and finishers held about 196,000 jobs in 2006. About 42 percent of all carpet, floor, and tile installers and finishers were self-employed, compared with 20 percent of all construction trades and related workers. The following tabulation shows 2006 wage-and-salary employment by specialty:

| | |
|--|--------|
| Tile and marble setters | 79,000 |
| Carpet installers | 73,000 |
| Floor layers, except carpet, wood, and hard tiles..... | 29,000 |
| Floor sanders and finishers..... | 14,000 |

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 more slowly than the average for all occupations. Job growth and opportunities, however, will differ among the individual occupations.

Employment change. Overall employment is expected to grow by 4 percent between 2006 and 2016, more slowly than the average for all occupations. Tile and marble setters, the largest specialty, will experience faster than average job 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.

Carpet installers, the second largest specialty, will have little or no job growth as residential investors and homeowners increasingly choose hardwood floors because of their durability, neutral colors, and low maintenance, and because owners feel these floors will add to the value of their 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, rubber, and vinyl, should experience rapidly declining employment because these materials are used less often and are often laid by other types of construction workers. Employment of floor sanders and finishers—a small specialty—is projected to have little or no job growth due to 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 be some employment growth, however, resulting from restoration of damaged hardwood floors, which is typically more cost effective than installing new floors.

Job prospects. In addition to employment growth, 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 because many of these workers do not stay in the occupation long.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Carpet, floor, and tile installers and finishers..... | 47-2040 | 196,000 | 203,000 | 7,500 | 4 |
| Carpet installers | 47-2041 | 73,000 | 72,000 | -900 | -1 |
| Floor layers, except carpet, wood, and hard tiles..... | 47-2042 | 29,000 | 25,000 | -3,500 | -12 |
| Floor sanders and finishers..... | 47-2043 | 14,000 | 14,000 | -300 | -2 |
| Tile and marble setters | 47-2044 | 79,000 | 91,000 | 12,000 | 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*.

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 slightly 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 2006, the median hourly earnings of wage and salary carpet installers were \$16.62. The middle 50 percent earned between \$12.06 and \$23.26. The lowest 10 percent earned less than \$9.46, and the top 10 percent earned more than \$31.11. The median hourly earnings of carpet installers working for building finishing contractors were \$17.17, and \$15.69 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 earnings of wage and salary floor layers except carpet, wood, and hard tiles were \$16.44 in May 2006. The middle 50 percent earned between \$12.71 and \$23.78. The lowest 10 percent earned less than \$9.77, and the top 10 percent earned more than \$32.32.

Median hourly earnings of wage and salary floor sanders and finishers were \$13.89 in May 2006. The middle 50 percent earned between \$10.84 and \$18.47. The lowest 10 percent earned less than \$9.08, and the top 10 percent earned more than \$24.21.

Median hourly earnings of wage and salary tile and marble setters were \$17.59 in May 2006. The middle 50 percent earned between \$13.16 and \$23.50. The lowest 10 percent earned less than \$10.26, and the top 10 percent earned more than \$29.95.

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 earn; 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 brickmasons, blockmasons, and stonemasons; carpenters; cement masons, concrete finishers, segmental pavers, and terrazzo workers; drywall installers, ceiling tile installers, and tapers; painters and paperhangers; roofers; and sheet metal workers.

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 tollfree helpline: (877) 872-5627.

For general information about the work of carpet installers and floor layers, contact:

► Floor Covering Installation Contractors Association, 7439 Milwood Dr., West Bloomfield, MI 48322.

Internet: <http://www.fcica.com/index2.html>

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

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

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

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

► 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 information concerning training of carpet, floor, and tile installers and finishers, contact:

► United Brotherhood of Carpenters and Joiners of America, 50 F St. NW., Washington, DC 20001. 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," in print at many libraries and career centers and online at: <http://www.bls.gov/opub/ooq/2002/summer/art01.pdf>

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

(O*NET 47-2051.00, 47-2053.00, 47-4091.00)

Significant Points

- Job opportunities are expected to be good, especially for those with the most experience and skills.
- Most 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 work overtime, with premium pay, because once concrete has been placed, the job must be completed.

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—smooth the concrete surface with a “bull float,” a long-handled tool 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, a small, smooth, rectangular metal tool.

Sometimes, cement masons perform all the steps of laying concrete, including the finishing. As the final step, they trowel 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 pre-mixed concrete. On concrete surfaces that will remain exposed after the forms are stripped, such as columns, ceilings, and wall panels, cement masons cut away high spots and loose concrete with hammer and chisel, fill any large indentations with a Portland cement paste, and smooth the surface with a carborundum stone. Finally, they coat the exposed area with a rich Portland cement mixture, using either a special tool or a coarse cloth to rub the concrete to a uniform finish.

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 on a previously prepared base that has been graded to the proper depth, although some projects may include the base preparation. A typical segmental paver installation be-

gins with leveling a layer of sand, followed by placement of the pavers, normally by hand but sometimes by machine. Usually the work includes constructing edges to prevent horizontal movement of the pavers. Sand is then added to fill the joints between the pavers.

Terrazzo workers 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. There are six different types of terrazzo, but the focus of this description is on the most common standard terrazzo: Marble-chip terrazzo, which requires three layers of materials. First, cement masons or terrazzo workers 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 light-weight 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, or terrazzo work is fast-paced and strenuous, and requires continuous physical effort. Because most finishing is done at floor level, workers must bend and kneel often. Many jobs are outdoors, and work is 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 in wet concrete.

Most workers work 40 hours a week, although the number of hours can be increased or decreased by outside factors. Earn-



Cement masons first set the forms for holding the concrete and properly align them.

ings for workers in these trades can be reduced on occasion because poor weather and slowdowns in construction activity limit the time they can work.

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.

Other workers train in formal apprenticeship programs usually sponsored by local contractors, trade associations, or local union-management committees. These earn while you learn programs provide on-the-job training and the 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. 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 quality employers look for is 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 ter-

razzo 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. Some 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 them prepare.

Employment

Cement masons, concrete finishers, segmental pavers, and terrazzo workers held about 229,000 jobs in 2006; 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 residential and nonresidential 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 2 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 specialized 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 expected to grow 11 percent over the 2006-16 decade, about as fast as the average for all occupations. More workers will 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.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Cement masons, concrete finishers, segmental pavers, and terrazzo workers..... | — | 229,000 | 255,000 | 26,000 | 11 |
| Cement masons, concrete finishers, and terrazzo workers..... | 47-2050 | 228,000 | 254,000 | 26,000 | 11 |
| Cement masons and concrete finishers | 47-2051 | 222,000 | 247,000 | 25,000 | 11 |
| Terrazzo workers and finishers | 47-2053 | 6,800 | 7,500 | 700 | 11 |
| Segmental pavers | 47-4091 | 1,000 | 1,100 | 100 | 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*.

The use of concrete for buildings is increasing. 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 are 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 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 2006, the median hourly earnings of wage and salary cement masons and concrete finishers were \$15.70. The middle 50 percent earned between \$12.38 and \$20.70. The bottom 10 percent earned less than \$10.02, and the top 10 percent earned more than \$27.07. Median hourly earnings in the industries employing the largest numbers of cement masons and concrete finishers were as follows:

| | |
|---|---------|
| Masonry contractors..... | \$17.05 |
| Nonresidential building construction | 16.34 |
| Highway, street, and bridge construction..... | 16.20 |
| Other specialty trade contractors | 16.15 |
| Poured concrete foundation and structure contractors..... | 15.38 |

In May 2006, the median hourly earnings of wage and salary terrazzo workers and finishers were \$15.21. The middle 50 percent earned between \$12.01 and \$20.50. The bottom 10 percent earned less than \$9.31, and the top 10 percent earned more than \$27.22.

In May 2006, the median hourly earnings of wage and salary segmental pavers were \$13.80. The middle 50 percent earned between \$10.47 and \$17.05. The bottom 10 percent earned less than \$8.41, and the top 10 percent earned more than \$19.11.

Like other construction trades workers, 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.

Some cement masons, concrete finishers, segmental pavers, and terrazzo workers belong to unions, mainly 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

Cement masons, concrete finishers, segmental pavers, and terrazzo workers combine skill with knowledge of building materials to construct buildings, highways, and other structures. Other occupations involving similar skills and knowledge include brickmasons, blockmasons, and stonemasons; carpet, floor, and tile installers and finishers; drywall installers, ceiling tile installers, and tapers; and plasterers and stucco masons.

Sources of Additional Information

For information about apprenticeships and work opportunities, contact local concrete or terrazzo contractors, locals of unions previously mentioned, a local joint union-management apprenticeship committee, or the nearest office of the 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/atels_bat

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. Internet: <http://www.trytools.org>
- Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400, Arlington, VA 22201. 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. Internet: <http://www.imiweb.org>
- National Center for Construction Education and Research, 3600 NW., 43rd St., Bldg. G, Gainesville, FL 32606. Internet: <http://www.nccer.org>
- National Concrete Masonry Association, 13750 Sunrise Valley Dr., Herndon, VA 20171-3499. Internet: <http://www.ncma.org>
- National Terrazzo and Mosaic Association, 201 North Maple, Suite 208, Purcellville, VA 20132.
- 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>
- Portland Cement Association, 5420 Old Orchard Rd., Skokie, IL 60077. Internet: <http://www.cement.org>
- United Brotherhood of Carpenters and Joiners, 50 F St.NW., Washington, DC 20001. Internet: <http://www.carpenters.org>

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

► Mason Contractors Association of America, 33 South Roselle Rd., Schaumburg, IL 60193.

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.

Construction and Building Inspectors

(O*NET 47-4011.00)

Significant Points

- About 41 percent of inspectors worked for local governments, primarily municipal or county building departments.
- Many home inspectors are self-employed.
- Opportunities should be best for experienced construction supervisors and craftworkers who have some college education, engineering or architectural training, or certification as construction inspectors or plan examiners.

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, contents of the building, adequacy of fire protection equipment, and risks posed by adjoining buildings.

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 work-sites 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.

For information on *Fire inspectors*, see the *Handbook* statement on *Fire fighting occupations*.

Home inspectors conduct inspections of newly built or previously owned homes, condominiums, town homes, manufactured homes, apartments, and at times 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 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 inspect the installation of the mechanical components of commercial kitchen appliances, heating and air-conditioning equipment, gasoline and butane tanks, gas and oil piping, and gas-fired and oil-fired appliances. Some specialize in boilers or ventilating equipment as well.

Plumbing inspectors examine plumbing systems, including private disposal systems, water supply and distribution systems, plumbing fixtures and traps, and drain, waste, and vent lines.

Public works inspectors ensure that Federal, State, and local government construction of water and sewer systems, highways, streets, bridges, and dams 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.

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 jobsite, 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 onsite 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—



Construction and building inspectors must check building measurements against construction codes.

especially those who are self-employed—may have a varied work schedule, at times working evenings and weekends.

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 distribution of all construction and building inspectors by their highest level of educational attainment in 2006 was:

| | Percent |
|------------------------------------|---------|
| High school graduate or less | 31 |
| Some college, no degree | 28 |
| Associate's degree..... | 12 |
| Bachelor's degree..... | 26 |
| Graduate degree | 2 |

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 possibly the passing of 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, 33 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, stan-

dards 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 small 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 110,000 jobs in 2006. Local governments—primarily municipal or county building departments—employed 41 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 who specialize in multiple areas may be on staff.

Another 26 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. About 1 in 10 construction and building inspectors was self-employed. Since many home inspectors are self-employed, it is likely that most self-employed construction and building inspectors were home inspectors.

Job Outlook

Job opportunities in construction and building inspection should be best for highly experienced supervisors and construction craft workers who have some college education, engineering or architectural training, or certification as inspectors or plan examiners. Inspectors should experience faster than average employment growth.

Employment change. Employment of construction and building inspectors is expected to grow by 18 percent over the 2006-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Construction and building inspectors..... | 47-4011 | 110,000 | 130,000 | 20,000 | 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*.

2016 decade, which is 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 are certified.

Job prospects. Inspectors are involved in all phases of construction, including maintenance and repair work, and are therefore less likely 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. Inspectors with previous related experience in construction, a postsecondary degree, and engineering or architectural training will have the best prospects. 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 earnings of wage and salary construction and building inspectors were \$46,570 in May 2006. The middle 50 percent earned between \$36,610 and \$58,780. The lowest 10 percent earned less than \$29,210, and the highest 10 percent earned more than \$72,590. Median annual earnings in the industries employing the largest numbers of construction and building inspectors were:

| | |
|--|----------|
| Architectural, engineering, and related services | \$46,850 |
| Local government | 46,040 |
| State government..... | 43,680 |

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.

More than a quarter of all construction and building inspectors belonged to a union in 2006.

Related Occupations

Because construction and building inspectors are familiar with construction principles, the most closely related occupations are construction occupations, especially carpenters, plumbers, and electricians. 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; appraisers and assessors of real estate; construction managers; civil engineers; cost estimators; engineering technicians; and surveyors, cartographers, photogrammetrists, and surveying technicians.

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 Avenue, NW., 6th Floor, Washington, DC 20001-2070.

Internet: <http://www.iccsafe.org>

➤ National Fire Protection Association, 1 Batterymarch Park, Quincy, Massachusetts, 02169-7471.

Internet: <http://www.nfpa.org>

For more information about construction inspectors, contact:

➤ Association of Construction Inspectors, 1224 North Nokomis NE., Alexandria, MN 56308.

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/iapmo>

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.

Construction Equipment Operators

(O*NET 47-2071.00, 47-2072.00, 47-2073.00)

Significant Points

- Many construction equipment operators acquire their skills on the job, but formal apprenticeship programs provide more comprehensive training.
- Job opportunities are expected to be very 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. They use machines to dig trenches to lay or repair sewer and other pipelines and hoist heavy construction materials. They may even work offshore constructing oil rigs. Construction equipment operators also operate machinery that spreads asphalt and concrete on roads and other structures.

These workers also set up and inspect the equipment, make adjustments, and perform some maintenance and minor repairs. Construction equipment operators control equipment by moving levers, foot pedals, operating switches, or joysticks. Construction equipment is more complicated to use than it was in the past. For example, Global Positioning System (GPS) technology is now being used to help with grading and leveling activities.

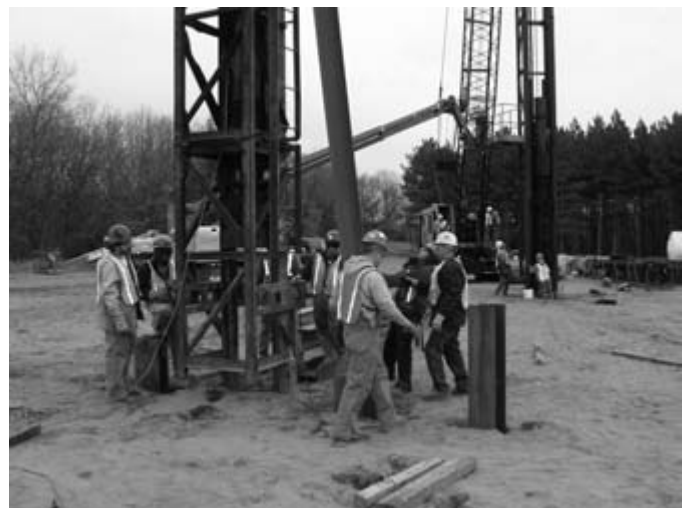
Included in the construction equipment operator occupation are paving, surfacing, and tamping equipment operators; pile-driver operators; and operating engineers. *Paving and surfacing equipment operators* use levers and other controls to operate machines that spread and level asphalt or spread and smooth concrete for roadways or other structures. *Asphalt paving machine 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 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 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.

Operating engineers and other construction equipment operators use 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 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. Construction equipment operators who are classified as operating engineers are capable of operating several different types of construction 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 construction operations must be suspended in winter. Bulldozers, scrapers, and especially tampers and piledrivers are noisy and shake or jolt the operator. Operating heavy construction equipment can be dangerous. As with most machinery, accidents generally can be avoided by observing proper operating procedures and safety practices. Construction equipment operators are cold in the winter and hot in the summer and often get dirty, greasy, muddy, or dusty. Some operators work in remote locations on



Piledriver operators use large machines to hammer piles into the ground.

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 usually learn their skills on the job, but formal apprenticeship programs provide more comprehensive training.

Education and training. Employers of construction equipment operators generally prefer to hire high school graduates, although some employers may train non-graduates 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.

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 and cranes. 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 and the Associated General Contractors of America. 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 and 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 such 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. The best training facilities have equipment on-site so that students can do the tasks that they are learning about.

Licensure. Construction equipment operators often obtain a commercial driver's license so that they can haul their equipment to the various job sites. Commercial driver's licenses are issued by States according to each State's rules and regulations. (See the statement on truck drivers and driver/sales workers elsewhere in the *Handbook* for more information on commercial driver's licenses.)

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. Operators need to be in good physi-

cal 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 in the right school will allow a worker to have opportunities across the country. While attending some vocational schools, operators are able to qualify for or attain various certifications. These certifications prove to potential employers that an operator is able to handle specific types of equipment. Certifications last from 3 to 5 years and must be renewed.

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

Employment

Construction equipment operators held about 494,000 jobs in 2006. 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 | 424,000 |
| Paving, surfacing, and tamping equipment operators | 64,000 |
| Pile-driver operators | 5,600 |

About 63 percent of construction equipment operators worked in the construction industry. Many equipment operators worked in heavy construction, building highways, bridges, or railroads. About 17 percent of construction equipment operators worked in State and local government. Others—mostly grader, bulldozer, and scraper operators—worked in mining. Some also worked for manufacturing or utility companies. About 5 percent of construction equipment operators were self-employed.

Job Outlook

Average job growth, reflecting increased demand for their services, and the need to replace workers who leave the occupation should result in very good job opportunities for construction equipment operators.

Employment change. Employment of construction equipment operators is expected to increase 8 percent between 2006 and 2016, about as fast as the average for all occupations. Even though improvements in equipment are expected to continue to raise worker productivity and to moderate the demand for new workers somewhat, employment is expected to increase because population and business growth will create a need for new houses, industrial facilities, schools, hospitals, offices, and other structures.

Specifically, more paving, surfacing, and tamping equipment operators will be needed as a result of expected growth in highway, bridge, and street construction. There has been consistent Congressional support for road projects. Bridge construction is expected to increase most because bridges will need to be repaired or replaced before they become unsafe. In some areas, deteriorating highway conditions also will spur demand for highway maintenance and repair.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Construction equipment operators | 47-2070 | 494,000 | 536,000 | 42,000 | 8 |
| Paving, surfacing, and tamping equipment operators | 47-2071 | 64,000 | 70,000 | 5,800 | 9 |
| Pile-driver operators..... | 47-2072 | 5,600 | 6,000 | 500 | 8 |
| Operating engineers and other construction equipment operators | 47-2073 | 424,000 | 460,000 | 35,000 | 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*.

More piledriver operators will be needed as construction continues to move into areas that are challenging to build in and require the use of piles as supports. Increases in bridge construction will also create demand for piledriver operators.

Demand for operating engineers and other construction equipment operators will be driven by the demand for new construction. Increases in pipeline construction will also create demand. These operators work in all sectors of construction.

Job prospects. Job opportunities for construction equipment operators are expected to be very good. Some potential workers may choose not to enter training programs because they prefer work that has more comfortable working conditions and is less seasonal in nature. This reluctance 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 large variety of equipment will have the best prospects. Operators with pipeline experience will have especially good opportunities.

Employment of construction equipment operators, like that of many other construction workers, is sensitive to the fluctuations in 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

Earnings for construction equipment operators vary. In May 2006, median hourly earnings of wage and salary operating engineers and other construction equipment operators were \$17.74. The middle 50 percent earned between \$13.89 and \$23.98. The lowest 10 percent earned less than \$11.54, and the highest 10 percent earned more than \$30.83. Median hourly earnings in the industries employing the largest numbers of operating engineers were:

| | |
|---|---------|
| Highway, street, and bridge construction..... | \$19.88 |
| Utility system construction | 18.62 |
| Other specialty trade contractors | 18.00 |
| Other heavy and civil engineering construction..... | 17.63 |
| Local government | 15.95 |

Median hourly earnings of wage and salary paving, surfacing, and tamping equipment operators were \$15.05 in May 2006. The middle 50 percent earned between \$11.98 and \$19.71. The

lowest 10 percent earned less than \$9.97, and the highest 10 percent earned more than \$25.30. Median hourly earnings in the industries employing the largest numbers of paving, surfacing, and tamping equipment operators in were as follows:

| | |
|---|---------|
| Other specialty trade contractors | \$15.26 |
| Highway, street, and bridge construction..... | 15.11 |
| Local government | 14.86 |

In May 2006, median hourly earnings of wage and salary piledriver operators were \$22.20. The middle 50 percent earned between \$16.31 and \$31.65. The lowest 10 percent earned less than \$12.83, and the highest 10 percent earned more than \$37.28. Median hourly earnings in the industries employing the largest numbers of pile driver operators were as follows:

| | |
|---|---------|
| Other heavy and civil engineering construction..... | \$28.60 |
| Highway, street, and bridge construction..... | 22.50 |
| Other specialty trade contractors | 20.60 |
| Utility system construction | 18.62 |

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 work time may be limited by bad weather. About 28 percent of construction equipment operators belong to a union.

Related Occupations

Other workers who operate mechanical equipment include agricultural equipment operators; truck drivers, heavy and tractor trailer; logging equipment operators; and a variety of material moving occupations.

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

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

➤ International Union of Operating Engineers, 1125 17th St. NW., Washington, DC 20036. Internet: <http://www.iuoe.org>

➤ National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32614-1104. Internet: <http://www.nccer.org>

➤ Pile Driving Contractors Association, P.O. Box 66208, Orange Park, FL 32065. 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.

Construction Laborers

(O*NET 47-2061.00)

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 potentially 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 in a short amount of time. While 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 build forms for pouring concrete. They 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 mix concrete using a portable mixer 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 oversight of 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. They also dig trenches, install sewer, water, and storm drain pipes, 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 tunnel, shaft, and road construction.

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.

Construction laborers often work as part of a team with other skilled craftworkers, jointly carrying out assigned construction tasks. At other times, construction laborers may work alone, reading and interpreting instructions, plans, and specifications with little or no supervision.

Work environment. Most laborers do physically demanding work. They may lift and carry heavy objects, and stoop, kneel, crouch, or crawl in awkward positions. Some work at great heights, or outdoors in all weather conditions. Some



Construction laborers remove excess materials after a job is completed.

jobs expose workers to harmful materials or chemicals, fumes, odors, loud noise, or dangerous machinery. Some laborers may be exposed to lead-based paint, asbestos, or other hazardous substances during their work especially when working in confined spaces. 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 in underground construction, construction laborers must be especially alert to safely follow procedures and must deal with a variety of hazards.

Construction laborers generally work 8-hour shifts, although longer shifts are common. Overnight work may be required when working on highways. In some parts of the country, construction laborers may work only during certain seasons. They may also 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. While some construction laborer jobs have no specific educational qualifications or entry-level training, apprenticeships for laborers require a high school diploma or 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 find work through temporary help agencies that send laborers to construction sites for short-term work. Entry-level workers generally help more experienced workers. They perform routine tasks, such as cleaning and preparing the work-site 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 may also choose or be required to attend a trade or vocational school or community college to receive further trade-related training.

Some laborers receive more formal training. A number of employers, particularly large nonresidential construction contractors with union membership, offer employees formal apprenticeships, which provide the best preparation. 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 construc-

tion, and environmental remediation, such as lead or asbestos abatement, and mold or hazardous waste remediation.

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 2006. They worked throughout the country but, like the general population, were concentrated in metropolitan areas. About 67 percent of construction laborers work in the construction industry, including 30 percent who work for specialty trade contractors. About 17 percent were self-employed in 2006.

Job Outlook

Employment is expected to grow about as fast as the average. In many areas, there will be competition for jobs, especially for those requiring limited skills. Laborers who have special-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | | Change, 2006-16 | |
|-----------------------------|----------|------------------|----------------------------|---------|-----------------|---------|
| | | | Number | Percent | Number | Percent |
| Construction laborers | 47-2061 | 1,232,000 | 1,366,000 | 134,000 | 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*.

ized 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 11 percent between 2006 and 2016, about as fast as the average for all occupations. The construction industry in general is expected to grow more slowly than it has in recent years. Due to the large variety of tasks that laborers perform, demand for laborers will mirror the level of overall construction activity.

Construction laborer jobs will be adversely affected by automation as some jobs are replaced by new machinery and equipment that improves productivity and quality. Also, laborers will be increasingly employed by staffing agencies that will contract out laborers to employers on a temporary basis, and in many areas employers will continue to rely on day laborers instead of full-time laborers on staff.

Job prospects. In many geographic areas there will be competition, especially for jobs requiring limited skills, due to a plentiful supply of workers who are willing to work as day laborers. In other areas, however, opportunities will be better. 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 will also 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. 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 earnings of wage and salary construction laborers in May 2006 were \$12.66. The middle 50 percent earned between \$9.95 and \$17.31. The lowest 10 percent earned less than \$8.16, and the highest 10 percent earned more than \$24.19. Median hourly earnings in the industries employing the largest number of construction laborers were as follows:

| | |
|--|---------|
| Nonresidential building construction..... | \$13.62 |
| Other specialty trade contractors | 12.93 |
| Residential building construction | 12.82 |
| Foundation, structure, and building exterior contractors | 12.41 |
| Employment services..... | 9.90 |

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 rate paid to experienced workers. Pay increases as apprentices gain experience and learn new skills. Some laborers belong to the Laborers' International Union of North America.

Related Occupations

The work of construction laborers is closely related to other construction occupations. Other workers who perform similar physical work include persons in material moving occupations; forest, conservation, and logging workers; and grounds maintenance workers.

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 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 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.

For information on education programs for laborers, contact:

► Laborers-AGC Education and Training Fund, 37 Deerfield Rd., P.O. Box 37, Pomfret Center, CT 06259.

Internet: <http://www.laborerslearn.org>

► National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32614-1104.

Internet: <http://www.nccer.org>

Construction Managers

(O*NET 11-9021.00)

Significant Points

- Construction managers must be available—often 24 hours a day—to deal with delays, bad weather, or emergencies at the jobsite.
- Employers prefer jobseekers who combine construction industry work experience with a bachelor's degree in construction science, construction management, or civil engineering.
- Although certification is not required, there is a growing movement toward certification of construction managers.
- Excellent job opportunities are expected.

Nature of the Work

Construction managers plan, direct, and coordinate a wide variety of construction projects, including the building of all types of residential, commercial, and industrial structures, roads, bridges, wastewater treatment plants, and schools and hospitals. Construction managers may oversee an entire project or just part of one. They schedule and coordinate all design and construction processes, including the selection, hiring, and oversight of specialty trade contractors, but they usually do not do any actual construction of the structure.

Construction managers are salaried or self-employed managers who oversee construction supervisors and workers. They are often called project managers, constructors, construction super-

intendents, project engineers, program managers, construction supervisors, or general contractors. Construction managers may be owners or salaried employees of a construction management or contracting firm, or may work under contract or as a salaried employee of the property owner, developer, or contracting firm overseeing the construction project.

These managers coordinate and supervise the construction process from the conceptual development stage through final construction, making sure that the project gets done on time and within budget. They often work with owners, engineers, architects, and others who are involved in the construction process. Given the designs for buildings, roads, bridges, or other projects, construction managers oversee the planning, scheduling, and implementation of those designs.

Large construction projects, such as an office building or industrial complex, are often too complicated for one person to manage. These projects are divided into many segments: site preparation, including land clearing and earth moving; sewage systems; landscaping and road construction; building construction, including excavation and laying of foundations and erection of the structural framework, floors, walls, and roofs; and building systems, including fire-protection, electrical, plumbing, air-conditioning, and heating. Construction managers may be in charge of one or more of these activities.

Construction managers determine the best way to get materials to the building site and the most cost-effective plan and schedule for completing the project. They divide all required construction site activities into logical steps, budgeting the time required to meet established deadlines. This may require sophisticated estimating and scheduling techniques and use of computers with specialized software. (See the section on cost estimators elsewhere in the *Handbook*.)

They also oversee the selection of general contractors and trade contractors to complete specific pieces of the project—which could include everything from structural metalworking and plumbing to painting and carpet installation. Construction managers determine the labor requirements and, in some cases, supervise or monitor the hiring and dismissal of workers. They oversee the performance of all trade contractors and are responsible for ensuring that all work is completed on schedule.

Construction managers direct and monitor the progress of construction activities, sometimes through construction supervisors or other construction managers. They oversee the delivery and use of materials, tools, and equipment; worker productivity and safety; and the quality of construction. They are responsible for obtaining all necessary permits and licenses and, depending upon the contractual arrangements, direct or monitor compliance with building and safety codes, other regulations, and requirements set by the project's insurers.

Work environment. Working out of a main office or out of a field office at the construction site, construction managers monitor the overall construction project. Decisions regarding daily construction activities generally are made at the jobsite. Managers may travel extensively when the construction site is not close to their main office or when they are responsible for activities at two or more sites. Management of overseas construction projects usually entails temporary residence in another country.



Construction managers must be available—often 24 hours a day—to deal with delays, bad weather, or emergencies at the job site.

Often “on call” 24 hours a day, construction managers deal with delays, the effects of bad weather, or emergencies at the site. Most work more than a standard 40-hour week because construction may proceed around-the-clock. They may need to work this type of schedule for days or weeks to meet special project deadlines, especially if there are delays.

Although the work usually is not considered inherently dangerous, construction managers must be careful while performing onsite services.

Training, Other Qualifications, and Advancement

Employers increasingly prefer to hire construction managers with a bachelor's degree in construction science, construction management, building science, or civil engineering, although it is also possible for experienced construction workers to move up to become construction managers. In addition to having education and experience, construction managers must understand contracts, plans, specifications, and regulations.

Education and training. For construction manager jobs, employers increasingly prefer to hire individuals who have a bachelor's degree in construction science, construction management, building science, or civil engineering, plus work experience. Practical construction experience is very important, whether gained through an internship, a cooperative education program, a job in the construction trades, or another job in the industry. Traditionally, people advanced to construction management positions after having substantial experience as construction craftworkers—carpenters, masons, plumbers, or electricians, for example—or after having worked as construction supervisors or as owners of independent specialty contracting firms. However, as construction processes become increasingly complex, employers are placing more importance on specialized education after high school.

About 105 colleges and universities offer bachelor's degree programs in construction science, building science, and construction engineering. These programs include courses in project control and development, site planning, design, construction methods, construction materials, value analysis, cost estimating, scheduling, contract administration, accounting, business and financial management, safety, building codes and standards, inspection procedures, engineering and architectural sciences, mathematics, statistics, and information technology. Graduates from 4-year

degree programs usually are hired as assistants to project managers, field engineers, schedulers, or cost estimators. An increasing number of graduates in related fields—engineering or architecture, for example—also enter construction management, often after acquiring substantial experience on construction projects.

About 60 colleges and universities offer a master’s degree program in construction management or construction science. Master’s degree recipients, especially those with work experience in construction, typically become construction managers in very large construction or construction management companies. Often, individuals who hold a bachelor’s degree in an unrelated field seek a master’s degree in construction management or construction science to work in the construction industry. Some construction managers obtain a master’s degree in business administration or finance to further their career prospects. Doctoral degree recipients usually become college professors or conduct research.

A number of 2-year colleges throughout the country offer construction management or construction technology programs. Many individuals also attend training and educational programs sponsored by industry associations, often in collaboration with postsecondary institutions.

Other qualifications. Construction managers should be flexible and work effectively in a fast-paced environment. They should be decisive and work well under pressure, particularly when faced with unexpected occurrences or delays. The ability to coordinate several major activities at once, while analyzing and resolving specific problems, is essential, as is an understanding of engineering, architectural, and other construction drawings. Familiarity with computers and software programs for job costing, online collaboration, scheduling, and estimating also is important.

Good oral and written communication skills also are important, as are leadership skills. Managers must be able to establish a good working relationship with many different people, including owners, other managers, designers, supervisors, and craftworkers. The ability to converse fluently in Spanish is increasingly an asset because Spanish is the first language of many workers in the construction industry.

Certification and advancement. There is a growing movement toward certification of construction managers. Although certification is not required to work in the construction industry, it can be valuable because it provides evidence of competence and experience. Both the American Institute of Constructors and the Construction Management Association of America have established voluntary certification programs for construction managers. Requirements combine written examinations with verification of education and professional experience. The American Institute of Constructors awards the Associate Constructor (AC) and Certified Professional Constructor (CPC) designations to candidates who meet its requirements and pass the appropriate

construction examinations. The Construction Management Association of America awards the Certified Construction Manager (CCM) designation to workers who have the required experience and who pass a technical examination. Applicants for this designation also must complete a self-study course that covers the professional role of a construction manager, legal issues, allocation of risk, and other topics related to construction management.

Advancement opportunities for construction managers vary depending upon an individual’s performance and the size and type of company for which they work. Within large firms, managers may eventually become top-level managers or executives. Highly experienced individuals may become independent consultants; some serve as expert witnesses in court or as arbitrators in disputes. Those with the required capital may establish their own construction management services, specialty contracting, or general contracting firm.

Employment

Construction managers held 487,000 jobs in 2006. About 57 percent were self-employed, many as owners of general or specialty trade construction firms. Most salaried construction managers were employed in the construction industry, 13 percent by specialty trade contractor businesses—for example, plumbing, heating, air-conditioning, and electrical contractors—9 percent in residential building construction; and 9 percent in nonresidential building construction. Others were employed by architectural, engineering, and related services firms and by local governments.

Job Outlook

Faster than average employment growth is expected. Additionally, excellent job opportunities will exist as the number of job openings exceeds the number of qualified applicants.

Employment change. Employment of construction managers is projected to increase by 16 percent during the 2006-16 decade, faster than the average for all occupations. More construction managers will be needed as the level of construction activity continues to grow. Population and business growth will result in more construction of residential homes, office buildings, shopping malls, hospitals, schools, restaurants, and other structures that require construction managers.

The increasing complexity of construction projects will also boost demand for specialized management-level personnel within the construction industry. Sophisticated technology and the proliferation of laws setting standards for buildings and construction materials, worker safety, energy efficiency, environmental protection, and the potential for adverse litigation have further complicated the construction process. Advances in building materials and construction methods; the need to replace portions of the Nation’s infrastructure; and the growing number of multipur-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | | Change, 2006-16 | |
|----------------------------|----------|------------------|----------------------------|---------|-----------------|---------|
| | | | Number | Percent | Number | Percent |
| Construction managers..... | 11-9021 | 487,000 | 564,000 | 77,000 | 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*.

pose buildings and energy-efficient structures will further add to the demand for more construction managers.

Job prospects. Excellent employment opportunities for construction managers are expected through 2016 because the number of job openings will exceed the number of qualified individuals seeking to enter the occupation. This situation is expected to continue even as college construction management programs expand to meet the current high demand for graduates. The construction industry often does not attract sufficient numbers of qualified job seekers because working conditions are considered poor.

In addition to job openings arising from employment growth, many additional openings should result annually from the need to replace workers who transfer to other occupations or leave the labor force for other reasons. A substantial number of seasoned managers are also expected to retire over the next decade, likely resulting in a large number of openings.

Prospects for individuals seeking construction manager jobs in construction management, architectural and engineering services, and construction contracting firms should be best for people who have a bachelor's or higher degree in construction science, construction management, or civil engineering plus practical experience working in construction. Employers will increasingly prefer applicants with college degrees, internships, and a strong background in building technology. Construction managers will also have many opportunities to start their own firms.

Employment of construction managers, 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

Earnings of salaried construction managers and self-employed independent construction contractors vary depending upon the size and nature of the construction project, its geographic location, and economic conditions. In addition to typical benefits, many salaried construction managers receive bonuses and use of company motor vehicles.

Median annual earnings of wage and salary construction managers in May 2006 were \$73,700. The middle 50 percent earned between \$56,090 and \$98,350. The lowest paid 10 percent earned less than \$43,210, and the highest paid 10 percent earned more than \$135,780. Median annual earnings in the industries employing the largest numbers of construction managers were as follows:

| | |
|--|----------|
| Building equipment contractors | \$75,200 |
| Electrical contractors | 74,380 |
| Nonresidential building construction | 74,080 |
| Foundation, structure, and building exterior contractors | 71,640 |
| Residential building construction..... | 69,400 |

The earnings of self-employed workers are not included in these numbers.

According to a July 2007 salary survey by the National Association of Colleges and Employers, people with a bachelor's

degree in construction science/management received job offers averaging \$46,930 a year.

Related Occupations

Construction managers participate in the conceptual development of a construction project and oversee its organization, scheduling, and implementation. Other workers who perform similar functions include architects, except landscape and naval; civil engineers; cost estimators; landscape architects; and engineering and natural sciences managers.

Sources of Additional Information

- For information about constructor certification, contact:
- American Institute of Constructors, 717 Princess St., Alexandria, VA 22314. Internet: <http://www.aicnet.org>
- For information about construction management and construction manager certification, contact:
- Construction Management Association of America, 7918 Jones Branch Dr., Suite 540, McLean, VA 22102. Internet: <http://www.cmaanet.org>
- Information on accredited construction science and management educational programs and accreditation requirements is available from:
- American Council for Construction Education, 1717 North Loop 1604 E, Suite 320, San Antonio, TX 78232. Internet: <http://www.acce-hq.org>
 - National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32614. Internet: <http://www.nccer.org>

Drywall Installers, Ceiling Tile Installers, and Tapers

(O*NET 47-2081.00, 47-2082.00)

Significant Points

- Most workers learn this trade on the job by starting as helpers to more experienced workers; additional classroom instruction may also be needed.
- Job prospects are expected to be good.
- Inclement weather seldom interrupts work, but workers may be idled when downturns in the economy slow construction activity.

Nature of the Work

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 and lathers also help to build walls and ceilings.

Because drywall panels are manufactured in standard sizes—usually 4 feet by 8 or 12 feet—drywall installers must measure, cut, fit, and fasten them to the inside framework of buildings. Workers cut smaller pieces to go around doors and windows. Installers saw, drill, or cut holes in panels for electrical outlets, air-conditioning units, and plumbing. After making these alterations, installers may glue, nail, or 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 with brush-like strokes. 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. On large projects, finishers may use automatic taping tools that apply the joint compound and tape in one step. Using increasingly wider trowels, tapers apply second and third coats of the compound, sanding the treated areas after each coat to make them as smooth as the rest of the wall surface. This results in a seamless and almost perfect surface. For hard to reach heights and ceilings, sanding poles are commonly used. Some tapers apply textured surfaces to walls and ceilings with trowels, brushes, or spray guns.

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 reflection 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, stapling, or wire-tying the lath directly to the structural framework.

Making walls out of plaster requires the work of lathers. *Lathers* apply the support base for plaster coatings, fireproofing, or acoustical materials. This support base, called lath, is put on walls, ceilings, ornamental frameworks, and partitions of buildings before plaster and other coatings are added. Lathers use handtools and portable power tools, to nail, screw, staple, or wire-tie the lath directly to the structural framework of a building. At one time, lath was made of wooden strips, but now, it is usually made of wire, metal mesh, or gypsum, also known as rockboard. Metal lath is used when the plaster on top of it will be exposed to weather or water or when a surface is curved or irregular and not suitable for drywall.

Work environment. As in many other construction trades, this work is sometimes physically strenuous. Drywall installers, ceiling tile installers, lathers, and tapers spend most of the day on their feet, either standing, bending, stretching, or kneeling.



Most beginners learn this trade on the job by helping experienced workers.

Some tapers use stilts to tape and finish ceiling and angle joints. Installers have to lift and maneuver heavy, cumbersome drywall panels. Hazards include falls from ladders and scaffolds and injuries from power tools and from working with sharp tools, such as utility knives. Because sanding a joint compound to a smooth finish creates a great deal of dust, most finishers wear masks and goggles for protection.

A 40-hour week is standard, but the workweeks often fluctuate depending on the workload. Workers who are paid hourly rates receive premium pay for overtime.

Training, Other Qualifications, and Advancement

Drywall installers, ceiling tile installers, and tapers learn their trade through formal and informal training programs. It can take 3 to 4 years of both classroom and 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. Training for this profession can begin in a high school, where classes in English, math, mechanical drawing, blueprint reading, and general shop are recommended. 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 union membership, offer employees formal apprenticeships. These programs combine on-the-job training with related classroom instruction—at least 144 hours of instruction each year. 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 drywall installers, ceiling tile installers, and tapers learn their trade this way.

Helpers and apprentices start by carrying materials, lifting and holding panels, 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, and install

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Drywall installers, ceiling tile installers, and tapers | 47-2080 | 240,000 | 258,000 | 17,000 | 7 |
| Drywall and ceiling tile installers | 47-2081 | 186,000 | 199,000 | 14,000 | 7 |
| Tapers | 47-2082 | 54,000 | 58,000 | 3,900 | 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*.

materials. Eventually, they become fully experienced workers. Tapers learn their job 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.

Other jobseekers may choose to obtain their classroom training before seeking a job. There are a number of vocational-technical schools and training academies affiliated with the 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. Some skills needed to become a drywall installer, ceiling tile installer, and taper include manual dexterity, eye-hand coordination, good physical fitness, and a good sense of balance. The ability to solve basic arithmetic problems quickly and accurately also is required. In addition, a good work history or military service is viewed favorably by contractors.

Supervisors and contractors need good English skills in order 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 at what cost.

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, recognized Nationwide.

Advancement. Drywall installers, ceiling tile installers, and tapers may advance to carpentry supervisor or general construction supervisor positions. Others may become independent 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 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.

Employment

Drywall installers, ceiling tile installers, and tapers held about 240,000 jobs in 2006. Most worked for contractors specializing in drywall and ceiling tile installation; others worked for contractors doing many kinds of construction. About 56,000 were self-employed independent contractors.

Most installers and tapers are employed in populous areas. In other areas, where there may not be enough work to keep a

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

Job Outlook

Employment is expected to increase about as fast as the average for all occupations, largely reflecting overall growth of the construction industry. Good job prospects are expected overall.

Employment change. Employment is expected to grow by 7 percent between 2006 and 2016, about as fast as the average for all occupations. Growth reflects the number of new construction and remodeling projects. New residential construction projects are expected to provide the majority of new 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.

Job prospects. Job opportunities for drywall installers, ceiling tile installers, and tapers are expected to be good. 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 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.

Despite the growing use of exterior panels, most drywall installation and finishing is done indoors. Therefore, drywall workers lose less work time because of inclement weather than do some other construction workers. Nevertheless, like many other construction workers, employment 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 2006, the median hourly earnings of wage and salary drywall and ceiling tile installers were \$17.38. The middle 50 percent earned between \$13.60 and \$22.58. The lowest 10 percent earned less than \$10.90, and the highest 10 percent earned more than \$28.85. The median hourly earnings in the industries employing the largest numbers of drywall and ceiling tile installers were as follows:

| | |
|--|---------|
| Foundation, structure, and building exterior contractors | \$18.10 |
| Drywall and insulation contractors | 17.42 |
| Nonresidential building construction | 17.26 |
| Residential building construction..... | 17.26 |

In May 2006, the median hourly earnings of wage and salary tapers were \$19.85. The middle 50 percent earned between \$14.65 and \$25.70. The lowest 10 percent earned less than \$11.59, and the highest 10 percent earned more than \$31.23.

Some contractors pay these workers according to the number of panels they install or finish per day; others pay an hourly rate.

Trainees usually start at about half the rate paid to experienced workers and receive wage increases as they became more skilled.

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 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: www.trytools.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., Washington, DC 20005.

Internet: <http://www.hbi.org>

➤ National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32614-1104.

Internet: <http://www.nccer.org>

➤ United Brotherhood of Carpenters and Joiners of America, Carpenters Training Fund, 6801 Placid St., Las Vegas, NV 89119. 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.

Electricians

(O*NET 47-2111.00)

Significant Points

- Job opportunities should be very good, especially for those with the broadest range of skills.
- Most electricians acquire their skills by completing an apprenticeship program lasting 4 to 5 years.
- About 4 out of 5 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 bring electricity into homes, businesses, and factories. They install and maintain the wiring, fuses, and other components through which electricity flows. Many electricians also install and maintain electrical machines in factories.

Electricians usually start their work by reading blueprints. Blueprints are technical diagrams that show the locations of circuits, outlets, load centers, panel boards, and other equipment. To ensure public safety, electricians follow the National Electrical Code, and State and local building codes.

Electricians connect all types of wires to circuit breakers, transformers, outlets, or other components. They join the wires in boxes with various specially designed connectors. When installing wiring, electricians use hand tools 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, oscilloscopes, and other equipment to test connections and ensure the compatibility and safety of components.

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 work fix and upgrade existing electrical systems and repair electrical equipment.

When electricians install wiring systems in factories and commercial settings, they first place conduit (pipe or tubing) inside partitions, walls, or other concealed areas as designated by the blueprints. They also fasten small metal or plastic boxes to the walls that will house electrical switches and outlets. They pull insulated wires or cables through the conduit to complete circuits between these boxes. The diameter and number of wires installed depends on how much power will need to run through it. The greater the diameter of the wire, the more electricity it can handle. In residential construction, electricians usually install insulated wire encased in plastic, which does not need to run through conduit.

Some electricians also install low-voltage wiring systems in addition to electrical systems, although line installers and repairers specialize in this work. Low-voltage wiring accommodates voice, data, and video equipment, such as telephones,

computers, intercoms, and fire alarm and security systems. Electricians also may install coaxial or fiber optic cable for telecommunications equipment and electronic controls for industrial uses.

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 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 might also do some construction and installation work.

Electricians in large factories usually do maintenance work that is more complex. They may repair motors, transformers, generators, and electronic controllers on machine tools and industrial robots. Electricians also advise management whether continued operation of 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. 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. They must follow strict safety procedures to avoid injuries. When working outdoors, they may be subject to inclement weather conditions. 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



Electricians may rewire a home and replace an old fuse box with a new circuit breaker box to accommodate additional appliances.

may work nights or weekends and be on call to go to the work-site 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. These programs combine on-the-job training with related classroom instruction.

Education and training. Most electricians learn their trade through apprenticeship programs. These 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 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 may also need classes in mathematics because they solve mathematical problems on the job.

Education can continue throughout an electrician's career. Electricians often complete regular safety programs, manufacturer-specific training, and management training courses. Classes on installing low-voltage voice, data, and video systems have recently become common 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 electric and building codes. Experienced electricians periodically take courses offered by their employer or union to learn about changes in the National Electrical Code.

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. Some States require 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. They 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 this 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 705,000 jobs in 2006. About 68 percent of wage-and-salary workers were employed in the construction industry and the remainder worked as maintenance electricians in other industries. In addition, about 11 percent of electricians were self-employed.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Electricians..... | 47-2111 | 705,000 | 757,000 | 52,000 | 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*.

Job Outlook

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

Employment change. Employment of electricians should increase 7 percent between 2006 and 2016, about as fast as the average for all occupations. 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. An increase in power plant construction over the next ten years will require many additional electricians. New technologies also are expected to continue to spur demand for these workers. For example, buildings increasingly need wiring to accommodate computers and telecommunications equipment. Robots and other automated manufacturing systems in factories also will require the installation and maintenance of more complex wiring systems. As the economy rehabilitates and retrofits older structures, which usually require electrical improvements to meet modern codes, it will create additional jobs.

Job prospects. In addition to jobs created by the increased demand for electrical work, many openings are expected over the next decade as a large number of electricians retire. This will create very 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, especially those areas where power plants are being constructed.

Employment of electricians, 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.

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 lay offs during recessions. In addition, opportunities for maintenance electricians may be limited in many industries by the 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 2006, median hourly earnings of wage and salary electricians were \$20.97. The middle 50 percent earned between \$16.07 and \$27.71. The lowest 10 percent earned less than \$12.76, and the highest 10 percent earned more than \$34.95.

Median hourly earnings in the industries employing the largest numbers of electricians were:

| | |
|--|---------|
| Motor vehicle parts manufacturing | \$31.90 |
| Electric power generation, transmission, and distribution | 26.32 |
| Local government | 23.80 |
| Nonresidential building construction | 20.58 |
| Electrical contractors | 20.47 |
| Plumbing, heating, and air-conditioning contractors | 19.56 |
| Employment services | 17.15 |

Apprentices usually start at between 40 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.

Some electricians are members of 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

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. Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

Information also may 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 information about union apprenticeship and training programs, contact:

➤ National Joint Apprenticeship Training Committee, 301 Prince George's Blvd., Upper Marlboro, MD 20774.

Internet: <http://www.njatc.org>

➤ National Electrical Contractors Association, 3 Metro Center, Suite 1100, Bethesda, MD 20814.

Internet: <http://www.necanet.org>

➤ International Brotherhood of Electrical Workers, 1125 15th St.NW., Washington, DC 20005.

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. Internet: <http://www.trytools.org>

➤ Independent Electrical Contractors, Inc., 4401 Ford Ave., Suite 1100, Alexandria, VA 22302.

Internet: <http://www.ieci.org>

➤ National Association of Home Builders, Home Builders Institute, 1201 15th St.NW., Washington, DC 20005.

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

Elevator Installers and Repairers

(O*NET 47-4021.00)

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 downturns in the economy and inclement weather than other construction trades workers.

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, 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 controls, it is possible to get the greatest amount of service with the fewest number of cars.

Elevator installers and repairers usually specialize in installation, maintenance, or repair work. Maintenance and repair workers generally need greater knowledge of electricity and electronics 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, 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 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 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 insure that the equipment and rooms are clean. They also troubleshoot and may be called to do emergency repairs. Unlike most elevator installers, those who specialize in elevator maintenance are on their own most of the day and typically service the same elevators periodically.

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 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 electricity, electronics, and computers to ensure that newly installed elevators operate properly.



Repairers make sure that an elevator operates according to specifications and stops at each floor within a specified time.

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. Most of their work is performed indoors in existing buildings or buildings under construction.

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 due to inclement weather than do other construction trades workers.

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, usually during a 4-year period. 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 in their particular company's equipment.

Licensure. Most cities and States require elevator installers and repairers to pass a licensing examination. Other requirements for licensure 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 a drug test and an aptitude test. Good physical condition and mechanical aptitude 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 or Certified Accessibility and Private Residence Lift Technician.

Advancement. Ongoing training is very important if a worker is 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 further 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 22,000 jobs in 2006. Most were employed by specialty trades contractors, particularly elevator maintenance and repair contractors. Others were employed by field offices of elevator manufacturers, machinery wholesalers, government agencies, or businesses that do their own elevator maintenance and repair.

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 2006-16 decade, about as fast as the average for all occupations. 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 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. The demand for elevator installers and repairers will also increase as a growing number of the elderly require easier access to their homes through stair lifts and residential elevators.

Job prospects. Workers should have excellent opportunities when seeking to enter this occupation. Elevator installer and repairer jobs have relatively high earnings and good benefits. However, the dangerous and physically challenging nature of this occupation and the significant training it requires reduces the number of applicants and creates 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, so employment of elevator repairers is less affected by economic downturns and seasonality than other construction trades.

Earnings

Earnings of elevator installers and repairers are among the highest of all construction trades. Median hourly earnings of wage and salary elevator installers and repairers were \$30.59 in May 2006. The middle 50 percent earned between \$23.90 and \$35.76. The lowest 10 percent earned less than \$17.79, and the top 10 percent earned more than \$42.14. Median hourly earnings in the building equipment contractors industry were \$30.74.

Earnings for members of the International Union of Elevator Constructors vary based on the local and specialty. Check with a local in your area for exact wages.

About three out of four elevator installers and repairers were members of unions or covered by a union contract, one of the highest proportions of all occupations. The largest numbers were members of the International Union of Elevator Constructors. In addition to free continuing education, elevator installers and repairers receive 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 boilermakers; electricians; electrical and electronics installers and repairers; industrial machinery mechanics and maintenance workers; millwrights;

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | | Change, 2006-16 | |
|--|----------|------------------|----------------------------|---------|-----------------|---------|
| | | | Number | Percent | Number | Percent |
| Elevator installers and repairers..... | 47-4021 | 22,000 | 24,000 | 1,900 | 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*.

sheet metal workers; and structural and reinforcing iron and metal workers.

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, Suite A, 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.

Glaziers

(O*NET 47-2121.00)

Significant Points

- Many glaziers learn the trade by helping experienced workers.
- Job opportunities are expected to be good.

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 com-

mercial 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 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.

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



Most glaziers learn their trade by helping experienced workers, sometimes with supplemental classroom training.

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. Their work can, at times, result in injuries as they work with sharp tools and may need to remove broken glass. They must be prepared to lift heavy glass panels and work on scaffolding, sometimes at great heights. Glaziers do a considerable amount of bending, kneeling, lifting, and standing during the installation process.

Training, Other Qualifications, and Advancement

Most glaziers 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 class-

room, 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.

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, eye-hand coordination, physical 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 journeymen. 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 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. 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 55,000 jobs in 2006. About 68 percent of glaziers worked for glazing contractors engaged in new construction, alteration, and repair. About 16 percent of glaziers worked in retail glass shops that install or replace glass, and for wholesale distributors of products containing glass.

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 12 percent from 2006 to 2016, about as fast as the average for all occupations. Employment of glaziers is expected to increase as a result of growth in residential and nonresidential construction. Demand for glaziers also will be spurred by the continuing need to modernize and repair existing structures, which often involves installing new windows. Also, more homeowners now prefer rooms with more sunlight and are adding sunrooms and skylights to houses. 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

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Glaziers | 47-2121 | 55,000 | 62,000 | 6,600 | 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*.

buildings. Homes and buildings that have been built recently are less likely to need replacement windows than older structures.

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

Job prospects. Job opportunities for glaziers are expected to be good. 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 2006, median hourly earnings of wage and salary glaziers were \$16.64. The middle 50 percent earned between \$12.85 and \$22.18. The lowest 10 percent earned less than \$10.19, and the highest 10 percent earned more than \$30.52. Median hourly wage-and-salary earnings in the foundation, structure, and building exterior contractors industry were \$17.03. Median hourly earnings for glaziers employed by building materials and supply dealers, where most glass shops are found, were \$15.51.

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 they gain experience. Because glaziers can lose work time due to weather conditions and fluctuations in construction activity, their overall earnings may be lower than their hourly wages suggest.

Some glaziers employed in construction are members of the International Union of Painters and Allied Trades.

Related Occupations

Glaziers use their knowledge of construction materials and techniques to install glass. Other construction workers whose jobs also involve skilled, custom work are brickmasons, blockmasons, and stonemasons; carpenters; carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; sheet metal workers; and painters and paperhangers. In addition, automotive body and related repairers install broken or damaged glass on the vehicles they repair.

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'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 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. Internet: www.trytools.org

► National Glass Association, Education and Training Department, 8200 Greensboro Dr., Suite 302, McLean, VA 22102. 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.

Hazardous Materials Removal Workers

(O*NET 47-4041.00)

Significant Points

- Working conditions can be hazardous.
- 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.

Nature of the Work

Increased public awareness and Federal and State regulations are resulting in the removal of more hazardous materials from buildings, facilities, and the environment to prevent further con-

tamination of natural resources and to promote public health and safety. Hazardous materials typically possess at least one of four characteristics—ignitability, corrosivity, reactivity, or toxicity. Hazardous materials removal workers identify, remove, package, transport, and dispose of various hazardous materials, including asbestos, radioactive and nuclear materials, arsenic, lead, and mercury. These workers are sometimes called abatement, remediation, or decontamination workers. Removal workers often respond to emergencies where harmful substances are present.

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.

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, resisted corrosion, and insulated well, making it ideal for such applications. Embedded in materials, asbestos is fairly harmless; airborne, however, it can cause several lung diseases, including lung cancer and asbestosis. Today, asbestos is rarely used in buildings, but there are still structures that contain the material that must be remediated. Similarly, lead was a common building component 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 large 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 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 used to produce electricity. *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 evaluate materials, operate high-pressure cleaning equipment for decontami-



Most hazardous materials removal workers are required to wear respirators to protect them from airborne particles.

nation, and package radioactive materials for transportation or disposal.

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 the materials, laws, typically regulated 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, formulate 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 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 also may 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 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, and workers are trained to deal with safety breaches and hazardous situations. Crews and supervisors take every precaution 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. As a result, workers employed by treatment, storage, or disposal facilities may 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 often are far from urban areas. Workers, who often 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 emergencies, the cleanup of 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. The 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 they are not licensed to work with 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. Workers in all fields are required to take refresher courses every year to maintain their license.

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. Because much of the work is done in buildings, a background in construction is helpful.

Employment

Hazardous materials removal workers held about 39,000 jobs in 2006. About 79 percent were employed in waste management and remediation services. Another 5 percent were employed in construction, primarily in asbestos abatement and lead abatement. A small number worked at nuclear and electric plants as decommissioning and decontamination workers and radiation safety and decontamination technicians.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Hazardous materials removal workers..... | 47-4041 | 39,000 | 44,000 | 4,400 | 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*.

Job Outlook

Employment of hazardous materials removal workers is expected to grow about as fast as 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 11 percent between 2006 and 2016, about as fast as the average for all occupations. Since the 1970s, asbestos and lead-based paints and plumbing fixtures and pipes have not been used and much of the remediation 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 growth, however, will result from the need to abate lead and asbestos from Federal and historic buildings. Mold remediation is a small and previously rapidly growing part of the occupation. However, builders have reduced the mold problem by improving the quality of construction to prevent moisture from entering buildings, limiting job growth for this specialty. Also, as more workers in other occupations, such as painters and heating, ventilation, and air-conditioning workers, are able to perform mold, lead, and asbestos removal on small-scale projects, employment growth of hazardous materials removal workers will continue to be negatively impacted.

Employment of decontamination technicians, radiation safety technicians, and decommissioning and decontamination workers, however, is expected to grow in response to increased pressure for safer and cleaner nuclear and electric generation facilities. Renewed interest in nuclear power production could lead to the construction of additional facilities, resulting in the need for many new workers.

Numerous Superfund projects will require cleanup of hazardous materials waste sites, spurring demand for hazardous materials removal workers. However, employment growth will largely be determined by Federal funding, which has been declining in recent years.

Job prospects. In addition to some 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. The often dangerous aspects of the job lead to high turnover because many workers do not stay in the occupation long. Opportunities for decontamination technicians, radiation safety technicians, and decontamination workers should be particularly good as a number of new workers will be needed to replace those who retire or leave the occupation for other reasons.

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. The best employment opportunities for mold remediation

workers will be in Southeast, and parts of the Northeast and Northwest, where mold tends to thrive.

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 earnings of wage and salary hazardous materials removal workers were \$17.04 in May 2006. The middle 50 percent earned between \$13.31 and \$22.75 per hour. The lowest 10 percent earned less than \$11.02 per hour, and the highest 10 percent earned more than \$28.45 per hour. The median hourly earnings in remediation and other waste management services, the largest industry employing hazardous materials removal workers, were \$16.75.

Related Occupations

Asbestos abatement workers and lead abatement workers share skills with other construction trades workers, including painters and paperhangers; insulation workers; and sheet metal workers. Treatment, storage, and disposal workers, decommissioning and decontamination workers, and decontamination and radiation safety technicians work closely with plant and system operators, such as power plant operators, distributors, and dispatchers and water and liquid waste treatment plant and system operators. Police officers and firefighters also respond to emergencies and often are the first ones to respond to incidents where hazardous materials may be present.

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., P.O. Box 37, Pomfret, CT 06259.
Internet: <http://www.laborerslearn.org>

Insulation Workers

(O*NET 47-2131.00, 47-2132.00)

Significant Points

- Workers must follow strict safety guidelines to protect themselves from insulating irritants.
- Most insulation workers learn their work informally on the job; others 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. In-

sulation workers install the materials used to insulate buildings and equipment.

Insulation workers cement, staple, wire, tape, or spray insulation. When covering a steam pipe, for example, 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 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. Insulation workers may screw on sheet metal around insulated pipes to protect the insulation from weather conditions or physical abuse.

When covering a wall or other flat surface, 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 attics or exterior walls, workers may blow 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.

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



Insulation workers must follow strict safety guidelines to protect themselves.

machines to join sheet metal or secure clamps, and compressors to blow or spray insulation.

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. Workers must follow strict safety guidelines to protect themselves. They 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 some complete formal apprenticeship programs.

Education and training. Employers prefer to hire high school graduates. High school courses in blueprint reading, shop mathematics, science, sheet metal 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 2 years, depending on the nature of the work, but most training is completed in 3 to 6 months. 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 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 Asbestos 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 trainees must pass practical and written tests to demonstrate their knowledge of the trade.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Insulation workers..... | 47-2130 | 61,000 | 66,000 | 5,200 | 8 |
| Insulation workers, floor, ceiling, and wall..... | 47-2131 | 32,000 | 35,000 | 2,700 | 8 |
| Insulation workers, mechanical..... | 47-2132 | 28,000 | 31,000 | 2,500 | 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*.

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 should 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.

Certification and advancement. A voluntary certification program has been developed by insulation contractor organizations to help workers prove their skills and knowledge of residential insulation. Certification in insulation of industrial settings is being developed. Workers need at least 6 months of experience before they can complete certification. The North American Insulation Manufacturer's Association also offers a certification for insulation energy appraisal.

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 61,000 jobs in 2006. The construction industry employed 91 percent of workers; 53 percent work for drywall and insulation contractors. Other insulation workers held jobs in the Federal Government, in wholesale trade, and in shipbuilding and other manufacturing industries that have extensive installations for power, heating, and cooling. In less populated areas, carpenters, heating and air-conditioning installers or drywall installers may do insulation work.

Job Outlook

Insulation workers should have excellent employment opportunities due to about 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 8 percent during the 2006-16 decade, about as fast as the average for all occupations. Demand for insulation workers will be spurred by the continuing need for energy efficient buildings and power plant construction, both of which will generate work in existing structures and new construction. Growth might be tempered as other workers—

such as carpenters, heating and air-conditioning installers, or drywall installers—do some insulation work.

Job prospects. Job opportunities for insulation workers are expected to be excellent. In addition to opportunities created by job growth, there will be a need to replace many workers. The irritating nature of many insulation materials, combined with the often difficult working conditions, causes many insulation workers to leave the occupation each year. Job openings will also arise from the need to replace workers who retire or leave the labor force for other reasons.

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. Workers employed to perform industrial plant maintenance generally have more stable employment because maintenance and repair must be done continually.

Earnings

In May 2006, median hourly earnings of wage and salary insulation workers, floor, ceiling, and wall were \$14.67. The middle 50 percent earned between \$11.26 and \$20.00. The lowest 10 percent earned less than \$9.25, and the highest 10 percent earned more than \$27.76. Median hourly earnings of insulation workers, mechanical were \$17.74. The middle 50 percent earned between \$13.55 and \$25.12. The lowest 10 percent earned less than \$10.51, and the highest 10 percent earned more than \$33.39. Median hourly earnings in the industries employing the largest numbers of insulation workers were:

| | |
|--|---------|
| Insulation workers, mechanical | |
| Building finishing contractors | \$18.69 |
| Building equipment contractors..... | 16.60 |
| Insulation workers, floor, ceiling, and wall | |
| Building finishing contractors | \$14.53 |

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 carpenters; carpet, floor, and tile installers and finishers; dry-wall installers, ceiling tile installers, and tapers; roofers; and sheet metal workers.

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 organization:

► National Insulation Association, 99 Canal Center Plaza, Suite 222, Alexandria, VA 22314.

Internet: <http://www.insulation.org>

For more information about residential insulation, contact:

► Insulation Contractors Association of America, 1321 Duke St., Suite 303, Alexandria, VA 22314.

Internet: <http://www.insulate.org>

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 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.

Painters and Paperhangers

(O*NET 47-2141.00, 47-2142.00)

Significant Points

- 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.
- Most workers learn informally on the job as helpers, but some experts recommend completion of an apprenticeship program.
- About 42 percent of painters and paperhangers are self-employed.

Nature of the Work

Paint and wall coverings make surfaces clean, attractive, and bright. In addition, paints and other sealers protect exterior surfaces from wear caused by exposure to the weather.

Painters apply paint, stain, varnish, and other finishes to buildings and other structures. They choose 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 covered, so that the paint will adhere properly. This may require removing the old coat of paint by stripping, sanding, wire brushing, burning, or water and abrasive blasting. Painters also wash walls and trim to remove dirt and grease, fill nail holes and cracks, sandpaper rough spots, and brush off dust. On new surfaces, they apply a primer or sealer to prepare the surface for the finish coat. Painters also mix paints and match colors, relying on knowledge of paint composition and color harmony. In large paint shops or hardware stores, mixing and matching are automated.

There are several ways to apply paint and similar coverings. Painters must be able to choose the right 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 also produce the most attractive surface.

Some painting artisans specialize in creating unique finishes by using one of many decorative techniques. These techniques often involve "broken color," a process created by applying one or more colors in broken layers over a different base coat to produce a mottled 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 and can add 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 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.



Self-employed, independent painting contractors account for 2 out of 5 painters and paperhangers.

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 conical structures, they use a bosun's chair, a swing-like device.

Paperhangers cover walls and ceilings with decorative wall coverings made of paper, vinyl, or fabric. They first prepare the surface to be covered by applying "sizing," 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 the surface has been prepared, paperhangers must prepare the paste or other 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. Much 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 wall or ceiling, 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 razor knife, and wipe off any excess adhesive.

Work environment. Most painters and paperhangers work 40 hours a week or less; about 24 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, and stretching. These workers must have 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 sometimes 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. Although workers are subject to falls from ladders, the occupation is not as hazardous as some other construction occupations.

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 to

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. There are limited informal training opportunities for paperhangers because there are fewer paperhangers and helpers are usually not required.

If available, apprenticeships generally provide a mixture of classroom instruction and paid on-the-job training. Apprenticeships for painters and paperhangers consist of 2 to 4 years of on-the-job training, supplemented by a minimum of 144 hours of related classroom instruction each year. A high school education or its equivalent, with courses in mathematics, usually is required to enter an apprenticeship program. 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 schools that offer training prior to employment. These schools can take about a year to complete. Others receive training through local vocational high schools.

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 and in good physical condition, in addition to the high school diploma or equivalent 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 Protective Coating Specialist. Courses range from 1 day to several weeks depending on the certification program and specialty.

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 part 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 473,000 jobs in 2006; about 98 percent were painters. Around 38 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.

Self-employed independent painting contractors accounted for 42 percent of all painters and paperhangers, significantly greater than the 20 percent of all construction trades workers combined.

Job Outlook

Employment of painters and paperhangers is expected to grow about as fast as the average for all occupations, reflecting increases in the stock of buildings and other structures that require maintenance and renovation. 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 11 percent between 2006 and 2016, about as fast as the average for all occupations. Driving employment growth will be retiring baby boomers who 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.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Painters and paperhangers..... | 47-2140 | 473,000 | 526,000 | 53,000 | 11 |
| Painters, construction and maintenance..... | 47-2141 | 463,000 | 517,000 | 54,000 | 12 |
| Paperhangers..... | 47-2142 | 9,900 | 8,700 | -1,200 | -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*.

Employment of paperhangers 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 petrochemical industry 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 sponging 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, shortages of these workers may occur in some areas during peak periods of building activity.

Earnings

In May 2006, median hourly earnings of wage and salary painters, construction and maintenance, were \$15.00, not including the earnings of the self-employed. The middle 50 percent earned between \$12.19 and \$19.51. The lowest 10 percent earned less than \$9.97, and the highest 10 percent earned more than \$25.62. Median hourly earnings in the industries employing the largest numbers of painters were as follows:

| | |
|---|---------|
| Local government..... | \$20.11 |
| Drywall and insulation contractors | 16.18 |
| Nonresidential building construction..... | 15.68 |
| Residential building construction..... | 15.04 |
| Painting and wall covering contractors..... | 14.62 |

In May 2006, median earnings for wage and salary paperhangers were \$16.21. The middle 50 percent earned between \$13.12 and \$20.62. The lowest 10 percent earned less than \$10.34, and the highest 10 percent earned more than \$26.77.

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 occupations in which workers do finishing work include carpenters; carpet, floor, and tile installers and finishers; drywall installers, ceiling tile installers, and tapers; painting and coating workers, except construction and maintenance; and plasterers and stucco masons.

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, P.O. Box 141104, Gainesville, FL 32614.

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>

**Pipelayers, Plumbers,
Pipefitters, and Steamfitters**

(O*NET 47-2151.00, 47-2152.00, 47-2152.01, 47-2152.02)

Significant Points

- Job opportunities should be very good, especially for workers with welding experience.
- Pipelayers, plumbers, pipefitters, and steamfitters comprise one of the largest and highest paid construction occupations.
- Most States and localities require plumbers to be licensed.
- Apprenticeship programs generally provide the most comprehensive training, but many workers train 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 install an appliance. In addition to these activities, however, pipelayers, plumbers, pipefitters, and steamfitters install, maintain, and repair many different types of pipe systems. For example, some systems move water to a municipal water treatment plant and then to residential, commercial, and public buildings. Other systems dispose of waste, provide 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 pipelaying, plumbing, pipefitting, and steamfitting sometimes are considered a single trade, workers generally specialize in one of five areas. *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, glue, cement, or otherwise join the pieces together. *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 and water heaters. *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. Some pipefitters specialize in only one type of system. *Steamfitters* install pipe systems that move liquids or gases under high pressure. *Sprinklerfitters* install automatic fire sprinkler systems in buildings.

Pipelayers, plumbers, 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, on the other hand, are made of large cast-iron pipes; installation normally requires crews of pipefitters. Despite these differences, all pipelayers, plumbers, 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. Computers and specialized software are used to create blueprints and plan layouts.

When construction plumbers install piping in a new house, for example, 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. They first 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.



Pipelayers lay clay, concrete, plastic, or cast-iron pipe for drains, sewers, water mains, and oil or gas lines.

Sometimes, plumbers have to cut holes in walls, ceilings, and floors of a house. For 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 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. Pipefitters and steamfitters most often work in industrial and power plants. Plumbers work in commercial and residential settings where water and septic systems need to be installed and maintained. Pipelayers work outdoors, sometime in remote areas, as they build the pipelines that connect sources of oil, gas, and chemicals with the users of these materials. Sprinklerfitters work in all buildings that require the use of fire sprinkler systems.

Because pipelayers, plumbers, 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.

Pipelayers, plumbers, pipefitters, and steamfitters engaged in construction generally work a standard 40-hour week; those involved in maintaining pipe systems, including those who provide maintenance services under contract, may have to work evening or weekend shifts and work on call. These maintenance workers may spend a lot of time traveling to and from worksites.

Training, Other Qualifications, and Advancement

Most pipelayers, plumbers, pipefitters, and steamfitters train in career or technical schools or community colleges, and on the job through apprenticeships.

Education and training. Pipelayers, plumbers, pipefitters, and steamfitters enter into the occupation in a variety of ways. Most residential and industrial plumbers get their training in career and technical schools and community colleges and from on-the-job training. Pipelayers, plumbers, pipefitters, and steamfitters who work for nonresidential enterprises are usually trained through formal apprenticeship programs.

Apprenticeship programs generally provide the most comprehensive training available for these jobs. They are administered either 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, or 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 safely unloading materials. 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 pipelayers, plumbers, pipefitters, and steamfitters are trained through apprenticeship, some still learn their skills informally on the job.

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 working independently. Several States require a special license to work on gas lines. A few States require pipe fitters to be licensed. These 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. Armed Forces training in pipelaying, plumbing,

and pipefitting is considered very good preparation. In fact, people with this background may be given credit for previous experience when entering a civilian apprenticeship program. High school or postsecondary courses in shop, plumbing, general mathematics, drafting, blueprint reading, computers, and physics also are good preparation.

Advancement. With additional training, some pipelayers, 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 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.

Employment

Pipelayers, plumbers, pipefitters, and steamfitters constitute one of the largest construction occupations, holding about 569,000 jobs in 2006. About 55 percent worked for plumbing, heating, and air-conditioning contractors engaged in new construction, repair, modernization, or maintenance work. Others did maintenance work for a variety of industrial, commercial, and government employers. For example, pipefitters were employed as maintenance personnel in the petroleum and chemical industries, both of which move liquids and gases through pipes. About 12 percent of pipelayers, plumbers, pipefitters, and steamfitters were self-employed.

Job Outlook

Average employment growth is projected. Job opportunities are expected to be very good, especially for workers with welding experience.

Employment change. Employment of pipelayers, plumbers, pipefitters, and steamfitters is expected to grow 10 percent between 2006 and 2016, about as fast as the average for all occupations. Demand for plumbers will stem from new construction and building renovation. Bath remodeling, in particular, is expected to continue to grow and create more jobs for plumbers. In addition, repair and maintenance of existing residential systems will keep plumbers employed. Demand for pipefitters and steamfitters will be driven by maintenance and construction

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Pipelayers, plumbers, pipefitters, and steamfitters..... | 47-2150 | 569,000 | 628,000 | 59,000 | 10 |
| Pipelayers..... | 47-2151 | 67,000 | 72,000 | 5,800 | 9 |
| Plumbers, pipefitters, and steamfitters..... | 47-2152 | 502,000 | 555,000 | 53,000 | 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*.

of places such as powerplants, water and wastewater treatment plants, office buildings, and factories, with extensive pipe systems. Growth of pipelayer jobs will stem from the building of new water and sewer lines and pipelines to new oil and gas fields. Demand for sprinklerfitters will increase because of changes to State and local rules for fire protection in homes and businesses.

Job prospects. Job opportunities are expected to be very good, as demand for skilled pipelayers, plumbers, pipefitters, and steamfitters is expected to outpace the supply of workers well trained in this craft in some areas. 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, many of these firms no longer employ full-time, in-house plumbers or pipefitters. Instead, when they need a plumber, they rely on workers provided under service contracts by plumbing and pipefitting contractors.

Construction projects generally provide only temporary employment. When a project ends, some pipelayers, plumbers, 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 to retain workers. In addition, the jobs of pipelayers, plumbers, pipefitters, and steamfitters are generally less sensitive to changes in economic conditions than jobs in other construction trades. Even when construction activity declines, maintenance, rehabilitation, and replacement of existing piping systems, as well as the increasing installation of fire sprinkler systems, provide many jobs for pipelayers, plumbers, pipefitters, and steamfitters.

Earnings

Pipelayers, plumbers, pipefitters, and steamfitters are among the highest paid construction occupations. Median hourly earnings of wage and salary plumbers, pipefitters, and steamfitters were \$20.56. The middle 50 percent earned between \$15.62 and \$27.54. The lowest 10 percent earned less than \$12.30, and the highest 10 percent earned more than \$34.79. Median hourly earnings in the industries employing the largest numbers of plumbers, pipefitters, and steamfitters were:

| | |
|--|---------|
| Natural gas distribution..... | \$24.91 |
| Nonresidential building construction..... | 21.30 |
| Plumbing, heating, and air-conditioning contractors..... | 20.44 |
| Utility system construction..... | 19.18 |
| Local government..... | 17.86 |

In May 2006, median hourly earnings of wage and salary pipelayers were \$14.58. The middle 50 percent earned between \$11.75 and \$19.76. The lowest 10 percent earned less than \$9.73, and the highest 10 percent earned more than \$25.73.

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 pipelayers, plumbers, pipefitters, and steamfitters.

About 30 percent of pipelayers, plumbers, 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 boilermakers; electricians; elevator installers and repairers; heating, air-conditioning, and refrigeration mechanics and installers; industrial machinery mechanics and maintenance workers; millwrights; sheet metal workers; and stationary engineers and boiler operators. Other related occupations include construction managers and construction and building inspectors.

Sources of Additional Information

For information about apprenticeships or work opportunities in pipelaying, plumbing, pipefitting, and steamfitting, contact local plumbing, heating, and air-conditioning contractors; a local or State chapter of the National Association of Plumbing, Heating, and 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 is also available from the U.S. Department of Labor’s toll free helpline: (877) 872-5627.

For information about apprenticeship opportunities for pipelayers, plumbers, pipefitters, and steamfitters, contact:

- United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry, 901 Massachusetts Ave. NW., Washington, DC 20001. Internet: <http://www.ua.org>

For more information about training programs for pipelayers, plumbers, pipefitters, and steamfitters, contact:

- Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: <http://www.trytools.org>
- Home Builders Institute, National Association of Home Builders, 1201 15th St.NW., Washington, DC 20005. Internet: <http://www.hbi.org>

For general information about the work of pipelayers, plumbers, and pipefitters, contact:

- Mechanical Contractors Association of America, 1385 Piccard Dr., Rockville, MD 20850. Internet: <http://www.mcaa.org>
- National Center for Construction Education and Research, 3600 NW 43rd St., Bldg. G, Gainesville, FL 32606. Internet: <http://www.nccer.org>
- Plumbing-Heating-Cooling Contractors—National Association, 180 S. Washington St, Falls Church, VA 22040. 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. Internet: <http://www.firesprinkler.org>

► National Fire Sprinkler Association, 40 Jon Barrett Rd., Patterson, NY 12563. 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,” in print at many libraries and career centers and online at: <http://www.bls.gov/opub/ooq/2002/summer/art01.pdf>

Plasterers and Stucco Masons

(O*NET 47-2161.00)

Significant Points

- Plastering is physically demanding work.
- Becoming a skilled plasterer or stucco mason generally requires 3 or 4 years of training, either informally on the job or through a formal apprenticeship.
- Good employment opportunities are expected.
- The best employment opportunities should continue to be in Florida, California, and the Southwest.

Nature of the Work

Plastering—one of the oldest crafts in the building trades—remains popular due to the durability and relatively low cost of the material. 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 and stucco masons should not be confused with drywall installers, ceiling tile installers, and tapers—discussed elsewhere in the *Handbook*—who use drywall instead of plaster to make interior walls and ceilings.

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,” made of a lime-based plaster. 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 finish, white coat.

Applying different types of plaster coating requires different techniques. When applying the brown coat, plasterers spray or trowel the mixture onto the surface, then finish by smoothing it to an even, level surface. Helpers usually prepare this mixture.

For the finish, or white coat, plasterers themselves usually prepare a mixture of lime, plaster of Paris, 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.

Plasterers also work with a plaster material that can be finished in a single coat. This “thin-coat” or gypsum veneer plaster is made of lime and plaster of Paris and is mixed with water at the jobsite. This plaster provides a smooth, durable, abrasion-resistant finish on interior masonry surfaces, special gypsum baseboard, or drywall prepared with a bonding agent.

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 may also 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 pebblelike, decorative finish.

When required, plasterers and 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 polymer-based or polymer-modified base coat. They may apply an additional coat of this material with a decorative finish.

Work environment. Most plasterers work indoors, except for the few who apply decorative exterior finishes. Stucco masons, however, work outside when applying stucco or exterior



Most plasterers and stucco masons are employed in Florida, Texas, California, and the Southwest, where exterior stucco with decorative finishes is very popular.

wall insulation. Plasterers and stucco masons may work on scaffolds high above the ground.

Plastering and stucco work is physically demanding, requiring considerable standing, bending, lifting, and reaching overhead, sometimes causing neck and upper back cramps. The work can also be dusty and dirty. It can irritate the skin, eyes, and lungs unless protective masks and gloves are used.

Training, Other Qualifications, and Advancement

Becoming a skilled plasterer or stucco mason generally requires 3 or 4 years of training, either informally on the job or through a formal apprenticeship.

Education and training. Preparation for a career as a plasterer or stucco mason can begin in high school, with classes in mathematics, mechanical drawing, and shop. After high school, there are many different ways to train.

The most common way is to get a job with a contractor who will provide on-the-job training. Entry-level workers usually start as helpers, assisting more experienced workers. They may start by carrying materials, setting up scaffolds, and mixing plaster. Later, they learn to apply the scratch, brown, and finish coats and may also learn to replicate plaster decorations for restoration work. Some employers enroll helpers in an employer-provided training program or send the employee to a trade or vocational school, or community college to receive further classroom training.

Depending on the region, some employers say a formal apprenticeship is the best way to learn plastering. Apprenticeship programs, sponsored by local joint committees of contractors and unions, usually include 3 or 4 years of paid on-the-job training and 160 hours of classroom instruction each of those years. In class, apprentices learn drafting, blueprint reading, and basic mathematics for layout work. They also learn how to estimate materials and costs and how to cast ornamental plaster designs.

On the job, apprentices learn about lath bases, plaster mixes, methods of plastering and safety practices. They learn how to use various tools, such as hand and powered trowels, floats, brushes, straightedges, power tools, plaster-mixing machines, and piston-type pumps. Some apprenticeship programs also allow individuals to train in related occupations, such as cement masonry and bricklaying.

Applicants for apprentice or helper jobs who have a high school education are preferred. Courses in general mathematics, mechanical drawing, and shop provide a useful background.

Other qualifications. Workers need to be in good physical condition and have good manual dexterity. Artistic creativity is helpful for those who apply decorative finishes. Applicants for apprenticeships usually must be at least 18 years old.

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 of Journeyworkers and Apprentices in the Trowel Trades.”

With additional training and experience, plasterers and stucco masons may advance to jobs as supervisors, superintendents, or estimators for plastering contractors. Many become self-employed contractors. Others become building inspectors.

Employment

Plasterers and stucco masons held about 61,000 jobs in 2006. Many plasterers and stucco masons are employed in Florida, Texas, California, and the Southwest, where exterior stucco with decorative finishes is very popular. Use of exterior stucco on homes in other parts of the country is gaining popularity as well.

Most plasterers and stucco masons work for independent contractors. About 16 percent of plasterers and stucco masons are self-employed.

Job Outlook

Employment of plasterers and stucco masons is expected to grow about as fast as the average for all occupations as a result of increased appreciation for the durability and attractiveness of troweled finishes. Good job prospects are expected.

Employment change. Employment is expected to grow by 8 percent between 2006 and 2016, about as fast as the average for all occupations. In recent years, there has been an increased appreciation for the attractive finishes and durability that plaster provides. Thin-coat plastering—or veneering—in particular, is gaining wide acceptance as more builders recognize its ease of application, durability, quality of finish, and sound-proofing and fire-retarding qualities, although the increased use of fire sprinklers will reduce the demand for fire-resistant plaster work. Prefabricated wall systems and new polymer-based or polymer-modified acrylic exterior insulating finishes also are gaining popularity, particularly in the South and Southwest regions of the country, because of their relatively low cost. In addition, plasterers will be needed to renovate plasterwork in old structures and to create special architectural effects, such as curved surfaces, which are not practical with drywall materials.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|------------------------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Plasterers and stucco masons | 47-2161 | 61,000 | 66,000 | 5,000 | 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*.

Job prospects. Job opportunities for plasterers and stucco masons are expected to be good because many potential candidates prefer work that is less strenuous and more comfortable. Additionally, some prospects may be deterred by the lengthy apprenticeship. This creates more opportunity for people who want these jobs.

Job openings will come from employment growth and from the need to replace plasterers and stucco masons who transfer to other occupations or leave the labor force. Skilled, experienced plasterers with artistic ability should have excellent opportunities, especially with restoration projects. The best employment opportunities should continue to be in Florida, California, and the Southwest, where the use of stucco is expected to remain popular. But decorative custom finishes, expensive homes, and large-scale restoration projects will continue to drive demand for plastering in the Northeast, particularly in urban areas.

Employment of plasterers and stucco masons, 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 activity falls. On the other hand, shortages of these workers may occur in some areas during peak periods of building activity.

Bad weather affects plastering less than other construction trades because most work is indoors. On exterior surfacing jobs, however, plasterers and stucco masons may lose time because plastering materials cannot be applied under wet or freezing conditions.

Earnings

In May 2006, median hourly earnings of wage and salary plasterers and stucco masons were \$16.68. The middle 50 percent earned between \$13.53 and \$21.25. The lowest 10 percent earned less than \$10.84, and the top 10 percent earned more than \$27.31.

The median hourly earnings in the largest industries employing plasterers and stucco masons were \$16.92 in drywall and insulation contractors and \$15.55 in masonry contractors.

Apprentices begin by earning about half the rate paid to experienced workers. Annual earnings for plasterers and stucco masons can be less than the hourly rate suggests because poor weather and periodic declines in construction activity can limit work hours.

Related Occupations

Other construction workers who use a trowel as their primary tool include brickmasons, blockmasons, and stonemasons; cement masons, concrete finishers, segmental pavers, and terrazzo workers; and drywall installers, ceiling tile installers, and tapers.

Sources of Additional Information

For information about apprenticeships or other work opportunities, you may contact local plastering contractors, locals of the unions mentioned below, local joint union-management apprenticeship committees, or the nearest office of your State apprenticeship agency or employment service. 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 general information about the work of plasterers and stucco masons, contact:

➤ Association of Wall and Ceiling Industries International, 803 West Broad St., Falls Church, VA 22046. Internet: <http://www.awci.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 information on certification and the training of plasterers and stucco masons, contact:

➤ International Union of Bricklayers and Allied Craftworkers, International Masonry Institute, The James Brice House, 42 East St., Annapolis, MD 21401. Internet: <http://www.imiweb.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," in print at many libraries and career centers and online at: <http://www.bls.gov/opub/ooq/2002/summer/art01.pdf>.

Roofers

(O*NET 47-2181.00)

Significant Points

- Most roofers learn their skills informally on the job; some roofers train through 3-year apprenticeships.
- Most job openings will arise from the need to replace those who leave the occupation because the work is hot, strenuous, and dirty, causing many people to switch to jobs in other construction trades.
- Demand for roofers is less susceptible to downturns in the economy than demand for other construction trades because most roofing work consists of repair and reroofing.

Nature of the Work

A leaky roof can damage ceilings, walls, and furnishings. Roofers repair and install roofs made of tar or asphalt and gravel; rubber or thermoplastic; metal; or shingles to protect buildings and their contents from water damage. Repair and reroofing—replacing old roofs on existing buildings—makes up the majority of work for roofers.

There are two types of roofs—low-slope and steep-slope. Low-slope roofs rise 4 inches per horizontal foot or less 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 have low-slope

roofs. Most 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 first put a layer of insulation on the roof deck. Over the insulation, they often spread a coat of molten bitumen, a tarlike substance. Next, they install partially overlapping layers of roofing felt—a fabric saturated 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 watertight. Roofers repeat these steps to build up the desired number of layers, called “plies.” The top layer is 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 a single-ply membrane 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 growing number of buildings now have “green” roofs that incorporate plants. A “green” roof begins with a single or multi-ply 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 usually responsible for making sure the roof is watertight and can withstand 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, the roofer then staples or nails 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 roof surfaces intersect, or 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 nailheads with roofing cement or caulking to prevent water leakage. Roofers who use tile, metal shingles, or shakes (rough wooden shingles) follow a similar process.

Roofers also install equipment that requires cutting through roofs, such as ventilation ducts and attic fans. Some roofers are expert in waterproofing; some waterproof and dampproof 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 as 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 or burns from hot bitumen, but safety precautions, can prevent



Most residential steep-slope roofs are covered with shingles.

most accidents. In addition, roofs can become extremely hot during the summer, causing heat-related illnesses. In 2005, the rate of injuries for roofing contractors in construction was almost twice that of workers overall.

Training, Other Qualifications, and Advancement

Most roofers learn their skills informally 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 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, 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, it can take several years to get experience working on all types of roofing.

Other qualifications. Good physical condition and 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 contractors themselves.

Employment

Roofers held about 156,000 jobs in 2006. Almost all salaried roofers worked for roofing contractors. About 20 percent of

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Roofers..... | 47-2181 | 156,000 | 179,000 | 22,000 | 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*.

roofers were self-employed. Many self-employed roofers specialized in residential work.

Job Outlook

Most job openings will arise from turnover, because the work is hot, strenuous, and dirty, causing many people to switch to jobs in other construction trades. Faster-than-average employment growth is expected.

Employment change. Employment of roofers is expected to grow 14 percent between 2006 and 2016, which is faster than the average for all occupations. Roofs deteriorate faster than most other parts of buildings, and they need to be repaired or replaced more often. So as the number of buildings continues to increase, demand for roofers is expected to grow. In addition to repair work, the need to install roofs on new buildings is also expected to add to the demand for roofers.

Job prospects. Job opportunities for roofers will arise 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 significant 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 easiest to find during spring and summer.

Employment of roofers who install new roofs, 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. Nevertheless, roofing is more heavily concentrated on repair and replacement rather than new installation, making demand for roofers less susceptible to the business cycle than it is for some other construction trades.

Earnings

In May 2006, median hourly earnings of wage and salary roofers were \$15.51. The middle 50 percent earned between \$12.12 and \$20.79. The lowest 10 percent earned less than \$9.81, and the highest 10 percent earned more than \$26.79. The median hourly earnings of roofers in the foundation, structure, and building exterior contractors industry were \$15.54. Earnings may be reduced on occasion when poor weather limits the time roofers can work.

Apprentices usually start 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 the United Union of Roofers, Waterproofers, and Allied Workers. Hourly wages and fringe benefits are generally higher for union workers.

Related Occupations

Roofers use shingles, bitumen and gravel, single-ply plastic or rubber sheets, or other materials to waterproof building surfaces. Workers in other occupations who cover surfaces with special materials for protection and decoration include carpenters; carpet, floor, and tile installers and finishers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; dry-wall installers, ceiling tile installers, and tapers; plasterers and stucco masons; and sheet metal workers.

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: 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 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.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/opus/ooq/2002/summer/art01.pdf> and in print at many libraries and career centers.

Sheet Metal Workers

(O*NET 47-2211.00)

Significant Points

- About 66 percent of sheet metal workers are found in the construction industry; around 21 percent are in manufacturing.
- 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 may 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 then measure, cut, bend, shape, and fasten pieces of sheet metal to make ductwork, countertops, and other custom products. In an increasing number of shops, sheet metal workers use computerized metalworking equipment. This enables them to perform their tasks more quickly and to experiment with different layouts to find the one that wastes the least material. They cut, drill, and form parts with computer-controlled saws, lasers, shears, and presses.

In shops without computerized equipment, and for products that cannot be made on 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 on machine tools.

Before assembling pieces, sheet metal workers check each part for accuracy using measuring instruments such as calipers and micrometers and, if necessary, finish pieces using hand, rotary, or squaring shears and hacksaws. After inspecting the pieces, workers fasten seams and joints together with welds, bolts, cement, rivets, solder, specially formed sheet metal drive clips, or other connecting devices. They then take the parts to the construction site, where they further assemble the pieces 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 on site. They secure the first panel 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 to heating, ventilation, and air-conditioning (HVAC) systems; sometimes duct installers are called *HVAC technicians*. A growing activity for sheet metal workers is building commissioning, which is a complete mechanical inspection of a building's HVAC, water, and lighting systems.



Sheet metal workers often take additional training, provided by the union or by their employer, to improve their skills.

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 shops that are well-lighted and well-ventilated. However, they stand for long periods and lift heavy materials and finished pieces. Sheet metal workers must follow safety practices because working around high-speed machines can be dangerous. They also are subject to cuts from sharp metal, burns from soldering and welding, and falls from ladders and scaffolds. They are often required to wear safety glasses and must not wear jewelry or loose-fitting clothing that could easily be caught in a machine. They may work at a variety of different production stations to reduce the repetitiveness of the work.

Those performing installation work do considerable bending, lifting, standing, climbing, and squatting, sometimes in close quarters or awkward positions. Although duct systems and kitchen equipment are installed indoors, the installation of siding, roofs, and gutters involves much outdoor work, exposing sheet metal workers to various kinds of weather.

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. While 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 they become, and the more likely they are 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 while they learn about materials and tools and their uses. Later, they learn to operate machines that bend or cut metal. In time, helpers go out on the jobsite to learn installation. Employers may send the employee to courses at a trade or vocational school or community college to receive further formal training. Helpers may be promoted to the journey level if they show the requisite knowledge and skills. Most sheet metal workers in large-scale manufacturing receive on-the-job training, with additional class work or in-house training as necessary. The training needed to become proficient in manufacturing takes less time than the training in construction.

Some employers, particularly large nonresidential construction contractors with union membership, offer formal apprenticeships. These 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, usually 4 to 5 years, varies with the apprentice's skill. Apprenticeship programs provide comprehensive instruction in both sheet metal fabrication and 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, and testing and balancing of building systems.

On the job, apprentices first receive safety training and then training in tasks that allow them to immediately begin work. They learn the basics of pattern layout and how to cut, bend, fabricate, and install sheet metal. They begin by learning to install and maintain basic ductwork and gradually advance to more difficult jobs, such as making more complex ducts, commercial kitchens, and decorative pieces. They also use materials such as fiberglass, plastics, and other nonmetallic materials. Workers often focus on a sheet metal specialty. In the classroom, apprentices learn drafting, plan and specification reading, trigonometry and geometry applicable to layout work, welding, the use of computerized equipment, and 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,

spatial and form perception, 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.

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. Workers often take additional training, provided by the union or by their employer, to improve existing skills or to acquire new ones.

Certification and advancement. Certifications in one of the specialties can be beneficial to workers. Certifications related to sheet metal specialties are offered by a wide variety of associations, some of which are listed in the sources of more information at the end of this statement. Those that complete registered apprenticeships are certified as journey workers, which can help to prove their skills to employers.

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 189,000 jobs in 2006. About 66 percent of all sheet metal workers were in the construction industry, including 45 percent who worked for plumbing, heating, and air-conditioning contractors; most of the rest in construction worked for roofing and sheet metal contractors. Some worked for other special trade contractors and for general contractors engaged in residential and commercial building.

About 21 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

Average employment growth is projected. Job opportunities in construction should be good, particularly for individuals who have apprenticeship training or who are certified welders; applicants for jobs in manufacturing may experience competition.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, | | Change, 2006-16 | |
|---------------------------|----------|------------------|-----------------------|--------|-----------------|--|
| | | | 2016 | Number | Percent | |
| Sheet metal workers | 47-2211 | 189,000 | 201,000 | 13,000 | 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 change. Employment of sheet metal workers is expected to increase 7 percent between 2006 and 2016, about as fast as the average for all occupations. This reflects growth in the number of industrial, commercial, and residential structures being built. 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 also should boost employment. In addition, the popularity of decorative sheet metal products and increased architectural restoration are expected to add to the demand for sheet metal workers.

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 may experience competition because a number of manufacturing plants that employ sheet metal workers are moving to other countries and the plants that remain are becoming more productive.

Sheet metal workers in construction may experience periods of unemployment, particularly when construction projects end and economic conditions dampen construction activity. Nevertheless, employment of sheet metal workers is less sensitive to declines in new construction than is the employment of some other construction workers, such as carpenters. Maintenance of existing equipment—which is less affected by economic fluctuations than is new construction—makes up a large part of the work done by sheet metal workers. Installation of new air-conditioning and heating systems in existing buildings continues during construction slumps, 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 due to bad weather than other construction workers.

Earnings

In May 2006, median hourly earnings of wage and salary sheet metal workers were \$17.96. The middle 50 percent earned between \$13.30 and \$24.89. The lowest 10 percent of all sheet metal workers earned less than \$10.36, and the highest 10 percent earned more than \$32.30. The median hourly earnings of the largest industries employing sheet metal workers were:

| | |
|---|---------|
| Building finishing contractors | \$18.84 |
| Plumbing, heating, and air-conditioning contractors | 18.60 |
| Roofing contractors..... | 17.27 |
| Architectural and structural metals manufacturing | 16.60 |

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. In addition, union workers in some areas receive supplemental wages from the union when they are on layoff or shortened workweeks.

Related Occupations

To fabricate and install sheet metal products, sheet metal workers combine metalworking skills and knowledge of construction ma-

terials and techniques. Other occupations in which workers lay out and fabricate metal products include assemblers and fabricators; machinists; machine setters, operators, and tenders—metal and plastic; and tool and die makers. Construction occupations requiring similar skills and knowledge include glaziers and heating, air-conditioning, and refrigeration mechanics and installers.

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 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: 1 (877) 872-5627.

For general and training information about sheet metal workers, contact:

➤ International Training Institute for the Sheet Metal and Air-Conditioning Industry, 601 N. Fairfax St., Suite 240, Alexandria, VA 22314. Internet: <http://www.sheetmetal-iti.org>

➤ National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32614. Internet: <http://www.nccer.org>

➤ Sheet Metal and Air-Conditioning Contractors’ National Association, 4201 Lafayette Center Dr., Chantilly, VA 20151. Internet: <http://www.smacna.org>

➤ Sheet Metal Workers International Association, 1750 New York Ave. NW., Washington, DC 20006. 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.

Structural and Reinforcing Iron and Metal Workers

(O*NET 47-2171.00, 47-2221.00)

Significant Points

- Workers must be in good physical condition and must not fear heights.
- Most employers recommend completion of a formal 3-year or 4-year apprenticeship, but some workers learn on the job.
- Earnings of structural iron and steel workers are among the highest of all construction trades.
- In most areas, job opportunities should be excellent.

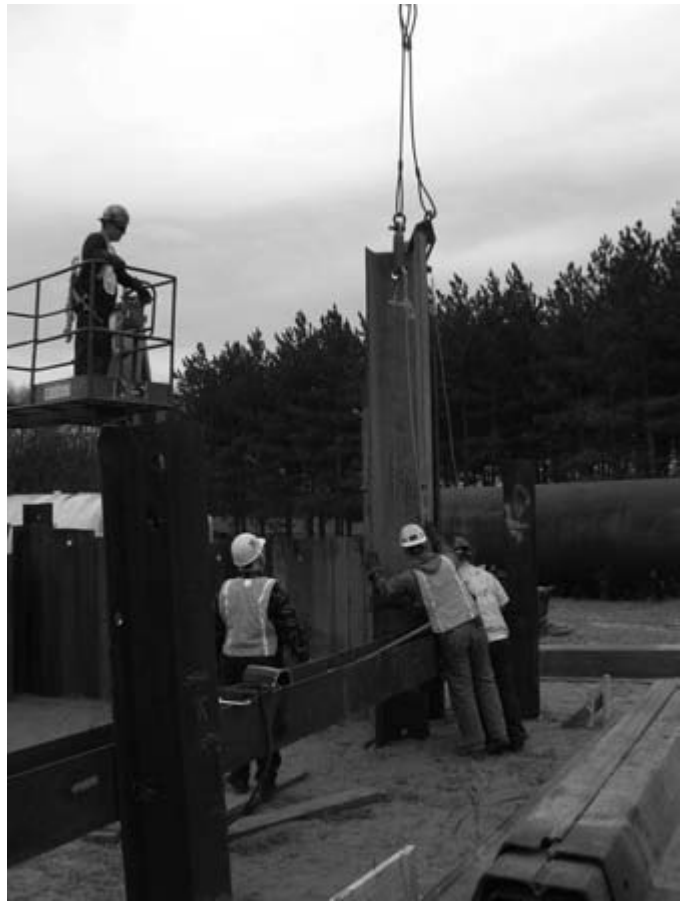
Nature of the Work

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 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.



Earnings of structural iron and steel workers are among the highest of all construction trades.

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.

Training, Other Qualifications, and Advancement

Many workers learn to be ironworkers through formal apprenticeships, but others learn on the job less formally. Certifications in welding and rigging can increase a worker's usefulness on the job site.

Education and training. Most employers recommend a 3- or 4-year apprenticeship consisting of paid on-the-job training and evening 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.

In the classroom, apprentices study 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. These workers generally do not receive classroom training, although some large contractors have extensive training programs. 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; however, learning through work experience alone may not provide training as complete as an apprenticeship program, and it usually takes longer.

Other qualifications. Ironworkers must be at least 18 years old. A high school diploma is preferred by employers and local apprenticeship committees. High school courses in general mathematics, mechanical drawing, English, and welding are considered helpful. 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 as journey workers, which often make them more competitive 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 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 102,000 jobs in 2006; structural iron and steel workers held about 72,000 jobs; and reinforcing iron and rebar workers held about 30,000 jobs. About 88 percent worked in construction, with 50 percent working for foundation, structure, and building exterior contractors. Most of the remaining ironworkers worked for contractors specializing in the construction of homes; factories; commercial buildings; religious structures; schools; bridges and tunnels; and water, sewer, communications, and power lines.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Structural and reinforcing iron and metal workers | — | 102,000 | 110,000 | 7,800 | 8 |
| Reinforcing iron and rebar workers | 47-2171 | 30,000 | 34,000 | 3,500 | 12 |
| Structural iron and steel workers | 47-2221 | 72,000 | 76,000 | 4,300 | 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*.

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.

Job Outlook

Average job growth is projected, but in most areas of the country job opportunities should be excellent.

Employment change. Employment of structural and reinforcing iron and metal workers is expected to grow 8 percent between 2006 and 2016, about as fast as the average for all occupations. Nonresidential and heavy construction is expected to increase, creating jobs. 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 continue to support and fund the building of roads, which will secure jobs for the near future. However, a lack of qualified applicants may restrain employment growth in some areas.

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 excellent, although the number of job openings can fluctuate from year to year with economic conditions and the level of construction activity. Many workers prefer to enter other occupations with better working conditions, leading to opportunities for those who wish to become structural and reinforcing iron and metal workers.

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

Earnings of structural iron and steel workers are among the highest of all construction trades. In May 2006, median earnings of wage and salary structural iron and steel workers in all industries were \$19.46 an hour. The middle 50 percent earned between \$14.11 and \$27.08. The lowest 10 percent earned

less than \$10.94, and the highest 10 percent earned more than \$34.78.

Median hourly earnings of wage and salary reinforcing iron and rebar workers in all industries were \$18.38. The middle 50 percent earned between \$13.15 and \$27.03. The lowest 10 percent earned less than \$10.25, and the highest 10 percent earned more than \$34.15.

Median hourly earnings of wage and salary structural iron and steel workers in foundation, structure, and building exterior contractors were \$20.54 and in nonresidential building construction, \$16.76. Reinforcing iron and rebar workers earned median hourly earnings of \$18.67 in foundation, structure, and building exterior contractors.

About 31 percent of the workers in this trade are union members. According to International Association of Bridge, Structural, Ornamental, and Reinforcing Iron Workers, average hourly earnings, including benefits, for structural and reinforcing metal workers who belonged to a union and worked full time were slightly 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 50 to 60 percent of the rate paid to experienced journey 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, the short-term nature of construction jobs, 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 assemblers and fabricators; boilermakers; civil engineers; cement masons, concrete finishers, segmental pavers, and terrazzo workers; construction managers; and welding, soldering, and brazing workers.

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 Web site: 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 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. Internet: <http://www.ironworkers.org>

For general information about ironworkers, contact either of the following sources:

► Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: <http://www.trytools.org>

► Associated General Contractors of America, Inc., 2300 Wilson Blvd., Suite 400., Arlington, VA 22201.

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," in print at many libraries and career centers and online at: <http://www.bls.gov/opub/ooq/2002/summer/art01.pdf>

Welding, Soldering, and Brazing Workers

(O*NET 51-4121.00, 51-4121.06, 51-4121.07, 51-4122.00)

Significant Points

- About 2 out of 3 jobs are in manufacturing industries.
- Training ranges from a few weeks of school or on-the-job training to several years of combined school and on-the-job training.
- Employment is projected to grow more slowly than average.
- Job prospects should be excellent as employers report 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 when constructing buildings, bridges, and other structures and to join pipes in pipelines, power plants, and refineries.

There are over 80 different welding processes that a welder can employ. Some are performed manually, and the work is entirely controlled by the welder. Others are semiautomatic, and the welder uses machinery, such as a wire feeder, to perform welding tasks.

One of the most common types of welding is arc welding. Standard arc welding involves two large metal alligator clips that carry a strong electrical current. One clip is attached to any part of the piece being welded. The second clip is connected to a thin welding rod. When the rod touches the piece, a powerful electrical circuit is created. The massive heat created by the electrical current causes both the piece and the steel core of the rod to melt together, cooling quickly to form a solid bond. The speed with which the welder works can affect the strength of the weld.

Two common and advanced types of arc welding are Tungsten Inert Gas (TIG) and Metal Inert Gas (MIG) welding. TIG welding often is used with stainless steel or aluminum. The welder holds the welding rod in one hand and an electric torch in the other hand. The torch is used to simultaneously melt the rod and the piece. MIG uses a spool of continuously fed wire instead of a rod, which allows the welder to join longer stretches of metal without stopping to replace a rod. The welder holds the wire feeder, which functions like the alligator clip in arc welding.

Like arc 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 800 degrees Fahrenheit; brazing uses metals with a higher melting point. Because soldering and brazing do not melt the piece, these processes normally do not create the distortions or weaknesses in the piece that can occur with welding. Soldering commonly is used to join electrical, electronic, and other small metal parts. Brazing produces a stronger joint than does soldering and often is used to join metals other than steel, such as brass. Brazing can also 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 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, such 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 welds to ensure that they meet standards or specifications.

By observing problems during the welding process, welders can compensate by adjusting the speed, voltage, amperage, or feed of the rod. Some welders have more limited duties, however. They perform routine jobs that already have been planned and laid out and do not require extensive knowledge of welding techniques.

Automated welding is 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 constantly monitor the machine to ensure that it produces the desired bond.

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. Plasma cutting has been increasing in popularity because, unlike other methods, it can

cut a wide variety of metals, including stainless steel, aluminum, and titanium.

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, hoods with protective lenses, and other devices designed to prevent burns and eye injuries and to protect them from falling objects. They normally work in well-ventilated areas to limit their exposure to fumes. 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 nearly 1 out of 5 welders work 50 hours per week or more. Welders also may work in shifts as long as 12 hours. Some welders, solderers, brazers, and machine operators work in factories that operate around the clock, necessitating shift work.

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 schools. The U.S. Armed Forces operate welding schools as well. Although some employers provide training, they prefer to hire workers who already have experience or formal training. 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 the programming of robots and other computer-controlled machines. Since 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.

Welding, soldering, and brazing workers need good eyesight, hand-eye coordination, and manual dexterity. They should be able to concentrate on detailed work for long periods and be able to bend, stoop, and work in awkward positions. In addi-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Welding, soldering, and brazing workers..... | 51-4120 | 462,000 | 484,000 | 22,000 | 5 |
| Welders, cutters, solderers, and brazers | 51-4121 | 409,000 | 430,000 | 21,000 | 5 |
| Welding, soldering, and brazing machine setters, operators, and tenders | 51-4122 | 53,000 | 54,000 | 1,600 | 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*.

tion, welders increasingly must be willing to receive training and perform tasks 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, become welding engineers.

Employment

Welding, soldering, and brazing workers held about 462,000 jobs in 2006. About 2 of every 3 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 of welding, soldering, and brazing workers is expected to grow more slowly than average. They will have excellent job opportunities as some welding employers report difficulty finding trained welders.

Employment change. Employment of welding, soldering, and brazing workers is expected to grow about 5 percent over the 2006-16 decade, slower than the average for all occupations. Welding has grown significantly over the long term because of advances that have allowed it to replace other joining technologies in many applications. Thus, demand for welders is increasing in the construction, manufacturing, and utilities industries. Despite overall employment declines in the manufacturing industry, the outlook for welders in manufacturing is far stronger than for other occupations. 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 auto industry have been able to find work in the booming oil and gas industry, although the shift may require relocating.

Automation is less of a threat to welders and welding machine operators than to other manufacturing occupations. Welding machines must still be operated by someone who is knowledgeable about welding and can inspect the weld and make adjustments. In custom applications, much of the work is difficult or impossible to automate. This includes manufacturing small batches of items, construction work, and making repairs in factories.

Job prospects. Retirements and job growth in the oil and gas and other industries are expected to create excellent opportunities for welders. Welding schools report that graduates have

little difficulty finding work, and some welding employers report difficulty finding trained welders.

Earnings

Median wage-and-salary earnings of welders, cutters, solderers, and brazers were \$15.10 an hour in May 2006. The middle 50 percent earned between \$12.30 and \$18.47. The lowest 10 percent had earnings of less than \$10.08, and the top 10 percent earned over \$22.50. The range of earnings of welders reflects the wide range of skill levels. Median hourly wage-and-salary earnings of welders, cutters, solderers, and brazers in the industries employing the largest numbers of them were:

| | |
|--|---------|
| Other general purpose machinery manufacturing | \$15.43 |
| Agriculture, construction, and mining machinery manufacturing | 14.90 |
| Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance..... | 14.59 |
| Architectural and structural metals manufacturing..... | 14.39 |
| Motor vehicle body and trailer manufacturing | 13.68 |

Median wage-and-salary earnings of welding, soldering, and brazing machine setters, operators, and tenders were \$14.90 an hour in May 2006. The middle 50 percent earned between \$12.02 and \$18.90. The lowest 10 percent had earnings of less than \$9.95, and the top 10 percent earned over \$25.44. Their median wage-and-salary earnings in motor vehicle parts manufacturing, the industry employing them in the largest numbers, were \$17.75 an hour in May 2006.

Many welders belong to unions. Among these are the International Association of Machinists and Aerospace Workers; the International Brotherhood of Boilermakers, Iron Ship Builders, Blacksmiths, Forgers and Helpers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the United Association of Journeymen and Apprentices of the Plumbing, Pipefitting, Sprinkler Fitting Industry of the United States and Canada; and the United Electrical, Radio, and Machine Workers of America.

Related Occupations

Welding, soldering, and brazing workers are skilled metal workers. Other skilled metal workers include machinists; machine setters, operators, and tenders—metal and plastic; computer control programmers and operators; tool and die makers; sheet metal workers; and boilermakers. Assemblers and fabricators of electrical and electronic equipment often assemble parts using soldering. Pipelayers, plumbers, pipefitters, and steamfitters also need welding skills.

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>

Woodworkers

(O*NET 51-7011.00, 51-7021.00, 51-7031.00, 51-7032.00, 51-7041.00, 51-7042.00, 51-7099.99)

Significant Points

- Most woodworkers are trained on the job; basic machine operations may be learned in a few months, but becoming a skilled woodworker often requires several years of experience.
- Job prospects will be best for highly skilled woodworkers who produce customized work, which is less susceptible to automation and import competition, and for those who can operate 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 and other materials, wood products continue to be useful and popular. Woodworkers help to meet the demand for wood products by creating finished products from lumber. Many of these products are mass produced, such as many types of furniture, kitchen cabinets, and musical instruments. Other products are crafted in small shops that make architectural woodwork, handmade furniture, and other specialty items.

Although the term woodworker often evokes images of a craftsman who builds ornate furniture using hand tools, the modern wood industry is highly technical. Some woodworkers still build by hand, but more often, handtools have been replaced by power tools, and much of the work has been automated. Work is usually done on an assembly line, meaning that most individuals learn to perform a single part of a complex process. Different types of woodworkers are employed in every stage of the building process, from sawmill to finished product. Their activities vary greatly.

Many woodworkers use computerized numerical control (CNC) machines to operate factory tools. Using these machines, woodworkers can create complex designs with fewer human steps. This technology has raised worker productivity by allowing one operator to simultaneously tend a greater number of machines. The integration of computers with equipment has improved production speed and capability, simplified setup

and maintenance requirements, and increased the demand for workers with computer skills.

Production woodworkers set up, operate, and tend all types of woodworking machines. In sawmills, *sawing machine operators and tenders* set up, operate, or tend wood-sawing machines that cut logs into planks, timbers, or boards. In manufacturing plants, woodworkers first determine the best method of shaping and assembling parts, working from blueprints, supervisors' instructions, or shop drawings that woodworkers themselves produce. Before cutting, they often must measure and mark the materials. They verify dimensions and may trim parts using handtools such as planes, chisels, wood files, or sanders to ensure a tight fit.

Woodworking machine operators and tenders set up, operate, or tend specific woodworking machines, such as drill presses, lathes, shapers, routers, sanders, planers, and wood-nailing machines. New operators may simply press a switch on a woodworking machine and monitor the automatic operation, but more highly skilled 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. The product is then finish-sanded; stained, and, if necessary, coated with a sealer, such as lacquer or varnish. Woodworkers may perform this work in teams or be assisted by helpers.

Precision or custom woodworkers, such as *cabinetmakers and bench carpenters, modelmakers and patternmakers, and furniture finishers*, often build one-of-a-kind items. These highly skilled precision woodworkers usually perform a complete cycle of tasks—cutting, shaping, and preparing surfaces and assembling complex wood components into a finished wood product. Precision workers normally need substantial training and an ability to work from detailed instructions and specifications. In addition, they often are required to exercise independent judgment when undertaking an assignment. They may still use heavy machinery and power tools in their everyday work. As CNC machines have become less expensive, many smaller firms have started using them.

Work environment. Working conditions vary by industry and specific job duties. In logging and sawmills, for example,



Woodworkers use sophisticated equipment to make wood into furniture.

workers handle heavy, bulky material and often encounter excessive noise, dust, and other air pollutants. However, the use of earplugs and respirators may alleviate these problems. Safety precautions and computer-controlled equipment minimize risk of injury from rough wood stock, sharp tools, and power equipment.

In furniture and kitchen cabinet manufacturing, employees who operate machinery also must wear ear and eye protection. They follow operating safety instructions and use safety shields or guards to prevent accidents. Those who work in areas where wood is cut or finishings applied often must wear an appropriate dust or vapor mask or a complete protective safety suit. Prolonged standing, lifting, and fitting of heavy objects are common characteristics of the job.

Training, Other Qualifications, and Advancement

Many woodworkers are highly skilled and require significant on-the-job training. Mathematics skills, especially geometry, are essential and computer skills are increasingly important.

Education and training. Employers seek applicants with a high school diploma or the equivalent because of the growing sophistication of machinery and the constant need for re-training. People seeking woodworking jobs can enhance their employment and advancement prospects by completing high school and receiving training in mathematics, science, and computer applications.

Woodworkers increasingly acquire skills through higher education. For many workers, this means earning a degree from a vocational or trade school. Others may attend colleges or 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.

Most woodworkers are trained on the job, however, picking up skills informally from experienced workers. They can learn basic machine operations and job tasks in a few months, but becoming a skilled woodworker often requires 2 or more years.

Beginners usually observe and help experienced machine operators. They may supply material to, or remove fabricated products from, machines. Trainees also do simple machine operating jobs while closely supervised by experienced workers.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Woodworkers | 51-7000 | 370,000 | 380,000 | 11,000 | 3 |
| Cabinetmakers and bench carpenters..... | 51-7011 | 149,000 | 153,000 | 4,100 | 3 |
| Furniture finishers | 51-7021 | 31,000 | 30,000 | -1,000 | -3 |
| Model makers and patternmakers, wood | 51-7030 | 4,200 | 2,500 | -1,700 | -40 |
| Model makers, wood..... | 51-7031 | 1,900 | 1,100 | -800 | -41 |
| Patternmakers, wood..... | 51-7032 | 2,300 | 1,400 | -900 | -40 |
| Woodworking machine setters, operators, and tenders..... | 51-7040 | 165,000 | 173,000 | 8,800 | 5 |
| Sawing machine setters, operators, and tenders, wood..... | 51-7041 | 65,000 | 68,000 | 2,500 | 4 |
| Woodworking machine setters, operators, and tenders, except sawing | 51-7042 | 100,000 | 106,000 | 6,400 | 6 |
| Woodworkers, all other | 51-7099 | 20,000 | 21,000 | 300 | 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*.

As beginners gain experience, they perform more complex jobs with less supervision. Some may learn to read blueprints, set up machines, and plan the sequence of the work.

Other qualifications. In addition to training, woodworkers need mechanical ability, manual dexterity, and the ability to pay attention to detail and safety. As the industry becomes more sophisticated, skill with computers and computer-controlled machinery is becoming more important.

Advancement. Advancement opportunities are often limited and depend on education and training, seniority, and a worker's skills and initiative. Sometimes experienced woodworkers become inspectors or supervisors responsible for the work of a group of woodworkers. 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 370,000 jobs in 2006. Self-employed woodworkers, mostly cabinetmakers and furniture finishers, accounted for 12 percent of these jobs.

Three out of 4 woodworkers were employed in manufacturing. About 2 out of 5 worked in establishments manufacturing household and office furniture and fixtures, and 1 in 3 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

Overall employment of woodworkers is expected to grow slower than average. Opportunities should be good for skilled applicants.

Employment change. Overall employment of woodworkers is expected to grow by 3 percent during the 2006-16 decade, which is slower than the average of all occupations. This slow

growth will be a result of increased automation in the wood products manufacturing industry. Technology is becoming increasingly important to this industry, and automation has greatly reduced the number of people required to produce a finished product. Furthermore, international competition—especially from China—has led to a significant decline in domestic employment of these workers.

Employment of sawing and woodworking machine setters, operators, and tenders is expected to grow more slowly than the average through 2016. Import growth will lead to job losses in the U.S. industry. To remain competitive, some domestic firms are expected to move their production processes to foreign countries, further reducing employment. Firms that stay are increasingly using advanced technology, such as robots and CNC machinery. These developments will prevent employment from rising with the demand for wood products, particularly in the mills and manufacturing plants where many processes can be automated.

Employment of furniture finishers is expected to decline slowly. Since furniture is largely mass-produced, it is highly susceptible to import competition; the percentage of imported furniture sold in the United States has steadily increased over the years, a trend that is expected to continue. Labor is significantly less expensive in developing countries, so these forces will likely affect the industry for quite some time.

Employment of bench carpenters and cabinetmakers is expected to grow more slowly than average, while modelmakers and patternmakers are expected to decline rapidly. Other specialized woodworking occupations will experience little or now change in growth. 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.

Job prospects. Despite slower than average employment growth, prospects should be good for qualified workers. Many experienced woodworkers will soon reach retirement age, and this will create a need for new 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. Custom workers and modelmakers and patternmakers who know how to create and execute designs on a computer may have

the best opportunities. 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. Competition for jobs is expected to be mild, and opportunities should be best for woodworkers who, through vocational education or experience, develop highly specialized woodworking skills or knowledge of CNC machine tool operation.

Employment in all woodworking specialties is highly sensitive to economic cycles. During economic downturns, workers are subject to layoffs or reductions in hours.

Earnings

Median annual wage-and-salary earnings of cabinetmakers and bench carpenters were \$27,010 in May 2006. The middle 50 percent earned between \$21,350 and \$34,290. The lowest 10 percent earned less than \$17,660, and the highest 10 percent earned more than \$43,060.

Median annual wage-and-salary earnings of sawing machine setters, operators, and tenders, wood were \$24,280. The middle 50 percent earned between \$19,620 and \$29,930. The lowest 10 percent earned less than \$16,290, and the highest 10 percent earned more than \$36,220.

Median annual wage-and-salary earnings of woodworking machine setters, operators, and tenders, except sawing were \$23,940. The middle 50 percent earned between \$19,460 and \$29,480. The lowest 10 percent earned less than \$16,410, and the highest 10 percent earned more than \$35,950.

Median annual wage-and-salary earnings were \$25,010 for furniture finishers and \$22,580 for all other woodworkers.

Related Occupations

Like woodworkers, carpenters also work with wood. In addition, many woodworkers follow blueprints and drawings and use machines to shape and form raw wood into a final product. Workers who perform similar functions working with other materials include sheet metal workers; structural and reinforcing iron and metal workers; computer control programmers and operators; machinists; textile, apparel, and furnishings occupations; and tool and die makers.

Sources of Additional Information

For information about careers and education and training programs in woodworking, contact:

► WoodLINKS USA, P.O. Box 1153, Point Roberts, WA 98281.
Internet: <http://www.woodlinks.com/USA/home.html>