

work is hot, strenuous, and dirty, and a significant number of workers treat roofing as a temporary job until something better comes along. Some roofers leave the occupation to go into other construction trades.

Employment of roofers is expected to grow about as fast as the average for all occupations through the year 2010. Roofs deteriorate faster than most other parts of buildings and periodically need to be repaired or replaced. About three-fourths of roofing work is repair and replacement, a higher proportion than in most other construction work. As a result, demand for roofers is less susceptible to downturns in the economy than that for other construction trades. In addition to repair and reroofing work on the growing stock of buildings, new construction of industrial, commercial, and residential buildings will add to the demand for roofers. Jobs should be easiest to find during spring and summer, when most roofing is done.

Earnings

In 2000, median hourly earnings of roofers were \$13.95. The middle 50 percent earned between \$10.72 and \$18.86. The lowest 10 percent earned less than \$8.68, and the highest 10 percent earned more than \$24.47. The median hourly earnings in 2000 of roofers in the roofing, siding, and sheet metal work industry were \$14.00.

Some roofers are members of the United Union of Roofers, Waterproofers, and Allied Workers.

Apprentices usually start at about 40 percent of the rate paid to experienced roofers and receive periodic raises as they acquire the skills of the trade. Earnings for roofers are reduced on occasion because poor weather often limits the time they can work.

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; drywall installers, ceiling tile installers, and tapers; and plasterers and stucco masons.

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.

For information about the work of roofers, contact:

- National Roofing Contractors Association, 10255 W. Higgins Rd., 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.

Sheet Metal Workers

(O*NET 47-2211.00)

Significant Points

- Two out of 3 jobs are found in the construction industry; about 1 out of 3 is in manufacturing.
- Apprenticeship programs lasting 4 or 5 years are considered the best training.
- Job opportunities should be excellent in construction.

Nature of the Work

Sheet metal workers make, install, and maintain air-conditioning, heating, ventilation, and pollution control duct systems; roofs; siding; rain gutters; downspouts; skylights; restaurant equipment; outdoor signs; 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. In addition to construction-related sheet metal work, some sheet metal workers are employed in the 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, counter tops, and other custom products. In an increasing number of shops, sheet metal workers use computerized metalworking equipment. This enables them to experiment with different layouts and to select the one that results in the least waste of material. They cut or 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 use hand calculators to 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 it by using hand, rotary, or squaring shears and hacksaws. After the parts have been inspected, 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 measure and cut the roofing panels that are needed to complete the job. 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



Sheet metal workers usually fabricate their products at a shop away from the construction site.

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.

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.

Working Conditions

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 usually wear safety glasses but must not wear jewelry or loose-fitting clothing that could easily be caught in a machine.

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

Employment

Sheet metal workers held about 224,000 jobs in 2000. Two-thirds of all sheet metal workers were found in the construction industry. Of those employed in construction, three-fourths worked for plumbing, heating, and air-conditioning contractors; most of the rest worked for roofing and sheet metal contractors. Some worked for other special trade contractors and for general contractors engaged in residential and commercial building. Most of the sheet metal workers outside of construction are found in manufacturing industries, such as the fabricated structural metal products, industrial machinery equipment, and aircraft and parts industries. Some work for the Federal government.

Compared with workers in most construction craft occupations, relatively few sheet metal workers are self-employed.

Training, Other Qualifications, and Advancement

Apprenticeship generally is considered to be the best way to learn this trade. The apprenticeship program consists of 4 or 5 years of on-the-job training and a minimum of 144 hours per year of classroom instruction. Apprenticeship programs provide comprehensive instruction in both sheet metal fabrication and installation. They are 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.

On the job, apprentices learn the basics of pattern layout and how to cut, bend, fabricate, and install sheet metal. They begin with basic ductwork and gradually advance to more difficult jobs, such as making more complex ducts, fittings, and decorative pieces. They also use materials such as fiberglass, plastics, and other non-metallic materials.

In the classroom, apprentices learn drafting, plan and specification reading, trigonometry and geometry applicable to layout

work, the use of computerized equipment, welding, and the principles of heating, air-conditioning, and ventilating systems. Safety is stressed throughout the program. In addition, apprentices learn the relationship between sheet metal work and other construction work.

Some persons pick up the trade informally, usually by working as helpers to experienced sheet metal 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. Those who acquire their skills this way often take vocational school courses in mathematics or sheet metal fabrication to supplement their work experience. To be promoted to the journey level, helpers usually must pass the same written examination as apprentices. Most sheet metal workers in large-scale manufacturing receive on-the-job training.

Applicants for jobs as apprentices or helpers should be in good physical condition and have mechanical and mathematical aptitude. Good eye-hand coordination, spatial and form perception, and manual dexterity also are important. Local apprenticeship committees require a high school education or its equivalent. 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 Armed Services.

It is important for experienced sheet metal workers to keep abreast of new technological developments, such as the growing 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.

Sheet metal workers may advance to supervisory jobs. Some of these workers take additional training in welding and do work that is more specialized. 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.

Job Outlook

Job opportunities are expected to be excellent for sheet metal workers in the construction industry and in construction-related sheet metal fabrication, reflecting both rapid employment growth and openings arising each year as experienced sheet metal workers leave the occupation. In addition, many potential workers may prefer work that is less strenuous and that has more comfortable working conditions, thus limiting the number of applicants for sheet metal jobs. Opportunities should be particularly good for individuals who acquire apprenticeship training. Prospects are expected to be better for sheet metal workers in the construction industry than for those in manufacturing because construction is expected to grow faster than the manufacturing industries that employ sheet metal workers.

Employment of sheet metal workers in construction is expected to increase faster than the average for all occupations through 2010, reflecting growth in the demand for sheet metal installations as more industrial, commercial, and residential structures are built. The need to install energy-efficient air-conditioning, heating, and ventilation systems in the increasing stock of old 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. On the other hand, average job growth is projected for sheet metal workers in manufacturing.

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 do.

Earnings

In 2000, median hourly earnings of sheet metal workers employed in all industries were \$15.31. The lowest 10 percent of all sheet metal workers earned less than \$8.90, and the highest 10 percent earned more than \$27.54.

The median hourly earnings of the largest industries employing sheet metal workers in 2000 are shown below.

Federal Government	\$18.85
Plumbing, heating, and air-conditioning	16.06
Roofing, siding, and sheet metal work	15.37
Fabricated structural metal products	14.11
Aircraft and parts	13.47

Apprentices normally start at about 40 percent of the rate paid to experienced workers. As apprentices acquire more skills throughout the course of their training, they receive periodic 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. Many sheet metal workers are members of the Sheet Metal Workers' International Association.

Related Occupations

To fabricate and install sheet metal products, sheet metal workers combine metalworking skills and knowledge of construction materials and techniques. Other occupations in which workers lay out and fabricate metal products include 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; 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.

For general 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.

► Sheet Metal and Air-Conditioning Contractors National Association, 4201 Lafayette Center Dr., Chantilly, VA 20151-1209. Internet:

<http://www.smacna.org>

► Sheet Metal Workers International Association, 1750 New York Ave. NW., Washington, DC 20006. Internet: <http://www.smwia.org>

Structural and Reinforcing Iron and Metal Workers

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

Significant Points

- Most employers recommend a 3- or 4-year apprenticeship.
- During economic downturns, workers can experience high rates of unemployment.
- The danger of injuries due to falls is great; therefore, those who work at great heights do not work during wet, icy, or extremely windy conditions.

Nature of the Work

Builders use materials made from iron, steel, aluminum, fiberglass, or precast concrete to construct highways, bridges, office and other large buildings, and power transmission towers. These structures have frames made of steel columns, beams, and girders. In addition, reinforced concrete—concrete containing steel bars or wire fabric—is an important material in buildings, bridges, and other structures, as the steel gives the concrete additional strength. Moreover, metal stairways, catwalks, floor gratings, ladders, window frames, lampposts, railings, fences, and decorative ironwork increase the functionality and attractiveness of these structures. Structural and reinforcing iron and metal workers fabricate, assemble, and install these products. They also repair, renovate, and maintain older buildings and structures, such as manufacturing plants, highways, and bridges.

Even though the primary metal involved in this work is steel, workers often are known as *ironworkers*. 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. The structural metal arrives at the construction site in sections. There, it is lifted into position by a crane. Ironworkers then connect the sections and set the cables to do the hoisting.

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, metal workers attach cables from a crane or derrick. One worker directs the hoist operator with hand signals. 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, where several workers, using spud wrenches, position the steel with connecting bars and jacks. Workers using drift pins or the handle of a spud wrench—a long wrench with a pointed handle—align the holes in the steel with the holes in the framework. Then, they temporarily bolt the piece in place; check vertical and horizontal alignment with plumb bobs, laser equipment, transits, or levels; and bolt or weld the piece permanently in place.

Reinforcing iron and rebar workers set the bars in the forms that hold concrete, following blueprints showing the location, size, and number of reinforcing bars (rebar). They then fasten the bars together by tying wire around them with pliers. When reinforcing floors, workers place blocks under the rebar to hold the bars off the