

- Air-Conditioning Contractors of America (ACCA), Suite 300, 2800 Shirlington Rd., Arlington, VA 22206. Internet: <http://www.acca.org>
 - Refrigeration Service Engineers Society (RSES), 1666 Rand Rd., Des Plaines, IL 60016-3552.
 - National Association of Plumbing-Heating-Cooling Contractors (PHCC), 180 S. Washington St., P.O. Box 6808, Falls Church, VA 22046. Internet: <http://www.naphcc.org>
 - Northamerican Heating, Refrigeration, and Air-conditioning Wholesalers Association (NHRAW), 1389 Dublin Road, PO Box 16790, Columbus, OH 43216-6790. Internet: <http://www.nhraw.org>
- For information on technician testing and certification, contact:
- North American Technician Excellence (NATE), Suite 300, 8201 Greensboro Dr., McLean, VA 22102. Internet: <http://www.natex.org>
- For information on career opportunities and training, write to:
- Associated Builders and Contractors, Suite 800, 1300 North 17th St., Rosslyn, VA 22209. Internet: <http://www.abc.org>
 - Home Builders Institute, National Association of Home Builders, 1201 15th St. NW., 6th Floor, Washington, DC 20005. Internet: <http://www.hbi.org>
 - Mechanical Contractors Association of America, 1385 Piccard Dr., Rockville, MD 20850-4329. Internet: <http://www.mcca.org>
 - Air-Conditioning and Refrigeration Institute, 4301 North Fairfax Dr., Suite 425, Arlington, VA 22203. Internet: <http://www.coolcareers.org>

Home Appliance Repairers

(O*NET 49-9031.01, 49-9032.02)

Significant Points

- Although employment of home appliance repairers is expected to grow slowly, opportunities should be good for skilled repairers.
- Many repairers are high school graduates who are trained on the job.
- Knowledge of basic electronics is becoming increasingly important.

Nature of the Work

Anyone whose washer, dryer, or refrigerator has ever broken knows the importance of a dependable repair person. Home appliance repairers, often called service technicians, keep home appliances working and help prevent unwanted breakdowns. Some repairers work specifically on small appliances such as microwaves and vacuum cleaners; others specialize in major appliances such as refrigerators, dishwashers, washers, and dryers.

Home appliance repairers visually inspect appliances and check for unusual noises, excessive vibration, fluid leaks, or loose parts to determine why they fail to operate properly. They use service manuals, troubleshooting guides, and experience to diagnose particularly difficult problems. They disassemble the appliance to examine its internal parts for signs of wear or corrosion. Repairers follow wiring diagrams and use testing devices such as ammeters, voltmeters, and wattmeters to check electrical systems for shorts and faulty connections.

After identifying problems, they replace or repair defective belts, motors, heating elements, switches, gears, or other items. They tighten, align, clean, and lubricate parts as necessary. Repairers use common hand tools, including screwdrivers, wrenches, files, and pliers, as well as soldering guns and special tools designed for particular appliances. When repairing appliances with electronic parts, they may replace circuit boards or other electronic components.

Many manufacturers incorporate “fuzzy logic” technology into their newer and more expensive appliances. Fuzzy logic technology involves sensors, or inputs, strategically placed inside an appliance to transmit information to an on-board computer. The computer



Gas appliance repairers check the heating units of stoves and may replace defective parts.

processes this information and adjusts variables such as water and electricity, to optimize appliance performance and reduce wasted resources. Fuzzy logic uses 1 input; “neurofuzzy logic” uses up to 5 inputs; and “chaos logic” uses up to 10 inputs. Dishwashers, washers, and dryers commonly use neurofuzzy logic in their components.

When repairing refrigerators and window air-conditioners, repairers must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in their cooling systems as required by law. Repairers conserve the refrigerant by making sure there are no leaks in the system; they recover the refrigerant by venting it into proper cylinders; and they recycle the refrigerant for reuse with special filter-dryers. Federal regulations also require that home appliance repairers document the capture and disposal of refrigerants.

Home appliance installers generally install “white goods” such as refrigerators, washing machines and stoves. They may have to install pipes in a customer’s home to connect the appliances to the gas line. They measure, lay out, cut, and thread pipe and connect it to a feeder line and to the appliance. They may have to saw holes in walls or floors and hang steel supports from beams or joists to hold gas pipes in place. Once the gas line is in place, they turn on the gas and check for leaks. *Gas appliance repairers* check the heating unit and replace tubing, thermocouples, thermostats, valves, and indicator spindles. They also answer emergency calls for gas leaks.

Repairers also answer customers’ questions about the care and use of appliances. For example, they demonstrate how to load automatic washing machines, arrange dishes in dishwashers, or sharpen chain saws to maximize performance.

Repairers write up estimates of the cost of repairs for customers, keep records of parts used and hours worked, prepare bills, and collect payments. Self-employed repairers also deal with the original appliance manufacturers to recoup monetary claims for work performed on appliances still under warranty.

Working Conditions

Home appliance repairers who handle portable appliances usually work in repair shops that are generally quiet, well lighted, and adequately ventilated. Those who repair major appliances usually make service calls to customers’ homes. They carry their tools and a number of commonly used parts with them in a truck or van for use on their service calls. A repairer may spend several hours a day driving to and from appointments and emergency calls. They may work in clean comfortable rooms such as kitchens, or in damp, dirty, or dusty areas of a home. Repairers sometimes work in cramped

and uncomfortable positions when they're replacing parts in hard-to-reach areas of appliances.

Repairer jobs generally are not hazardous, but they must exercise care and follow safety precautions to avoid electrical shocks and injuries when lifting and moving large appliances. When repairing gas appliances and microwave ovens, they must be aware of the dangers of gas and radiation leaks.

Many home appliance repairers work a standard 40-hour week. Some repairers work early morning, evening, and weekend shifts. Many repairers remain on-call in case of emergency. Many repairers work overtime and weekend hours in the summer months, when they are in high demand to fix air-conditioners and refrigerators.

Home appliance repairers usually work with little or no direct supervision, a feature of the job that appeals to many people.

Employment

Home appliance repairers held nearly 43,000 jobs in 2000. More than 20 percent of repairers are self-employed. About 40 percent of salaried repairers worked in retail establishments such as department stores, household appliance stores, and fuel dealers. Others worked for gas and electric utility companies, electrical repair shops, and wholesalers.

Almost every community in the country employs appliance repairers; a high concentration of jobs are found in more populated areas.

Training, Other Qualifications, and Advancement

Employers generally require a high school diploma for home appliance repairer jobs. Repairers of small appliances commonly learn the trade on the job; repairers of large household appliances often receive their training in a formal trade school, community college, or directly from the appliance manufacturer. Mechanical aptitude is desirable, and those who work in customers' homes must be courteous and tactful.

Employers prefer to hire people with formal training in appliance repair and electronics. Many repairers complete 1- or 2-year formal training programs in appliance repair and related subjects in high schools, private vocational schools, and community colleges. Courses in basic electricity and electronics are becoming increasingly necessary as more manufacturers install circuit boards and other electronic control systems in home appliances.

Whether their basic skills are developed through formal training or on the job, trainees usually receive additional training from their employer and manufacturers. In shops that fix portable appliances, they work on a single type of appliance, such as a vacuum cleaner, until they master its repair. Then they move on to others, until they can repair all those handled by the shop. In companies that repair major appliances, beginners assist experienced repairers on service visits. They may also study on their own. They learn to read schematic drawings, analyze problems, determine whether to repair or replace parts, and follow proper safety procedures. Up to 3 years of on-the-job training may be needed for a technician to become skilled in all aspects of repair.

Some appliance manufacturers and department store chains have formal training programs that include home study and shop classes, in which trainees work with demonstration appliances and other training equipment. Many repairers receive supplemental instruction through 2- or 3-week seminars conducted by appliance manufacturers. Experienced repairers also often attend training classes and study service manuals. Repairers authorized for warranty work by manufacturers are required to attend periodic training sessions.

The U.S. Environmental Protection Agency (EPA) has mandated that all repairers who buy or work with refrigerants must be certified in their proper handling; a technician must pass a written examination

to become certified to buy and handle refrigerants. Exams are administered by organizations approved by the EPA, such as trade schools, unions, and employer associations. There are even EPA-approved take-home certification exams. Though no formal training is required for certification, many of these organizations offer training programs designed to prepare workers for the certification examination.

To protect consumers and recognize highly skilled home appliance repairers, the Association of Home Appliance Manufacturers has instituted the National Appliance Service Technician Certification Program (NASTeC). Together, manufacturers, schools, and field experts write questions that measure the skills of their trade. To become certified, technicians must pass a comprehensive examination testing their competence in the diagnosis, repair, and maintenance of major home appliances. The examination is given on demand at locations throughout the country. While there has not previously been standardized certification, growing numbers of employers now encourage repairers to become certified.

The Professional Service Association (PSA) has a certification program with similar goals to the NASTeC program—to recognize skilled repairers. To become certified, technicians must pass an examination. The PSA certification is valid for 4 years. If certified technicians complete at least 15 credit hours of instruction every year during the 4 years, then the technicians need not sit for the examination for recertification. Otherwise, they must retake the examination.

Repairers in large shops or service centers may be promoted to supervisor, assistant service manager, or service manager. A few repairers advance to managerial positions such as regional service manager or parts manager for appliance or tool manufacturers. Preference is given to those who demonstrate technical competence and show an ability to get along with coworkers and customers. Experienced repairers who have sufficient funds and knowledge of small business management may open their own repair shop.

Job Outlook

Employment of home appliance repairers is expected to increase more slowly than the average for all occupations through the year 2010. Prospects should continue to be good for well-trained repairers, particularly those with a strong background in electronics. The number of home appliances in use is expected to increase with growth in the number of households and businesses. In the past, employment growth of home appliance repairers has been limited because of the need for less frequent repairs due to solid-state circuitry, microprocessors, and sensing devices in appliances. Also, many consumers tended to purchase new appliances when existing warranties expired rather than invest in repairs on old appliances, further reducing the need for home appliance repairers. These employment limitations could be somewhat offset over the next decade as more consumers purchase higher priced appliances designed to have much longer lives, making consumers more likely to use repair service than to purchase new appliances. Moreover, as home appliance repairers retire or transfer to other occupations, additional job openings will arise.

The availability of manufacturer-sponsored training programs could limit employment growth. Manufacturers often make these programs available only to large equipment dealers, thereby discouraging repairers from becoming self-employed or working for small shops. Many self-employed repairers are forced to join larger shops so that they can stay abreast of developments in the industry. Jobs are expected to be increasingly concentrated in larger companies as the number of smaller shops and family-owned businesses declines. However, those repairers that maintain strong industry relationships may still go into business for themselves.

Employment is relatively steady because the demand for appliance repair services continues even during economic downturns.

However, during economic slowdowns some repair shops may lay off repairers.

Earnings

Median annual earnings, including commission, of home appliance repairers were \$28,860 in 2000. The middle 50 percent earned between \$21,840 and \$38,040 a year. The lowest 10 percent earned less than \$17,300, and the highest 10 percent earned more than \$45,750 a year. Median annual earnings in the two industries employing the largest numbers of home appliance repairers in 2000 were \$27,560 in electrical repair shops and \$24,860 in household appliance stores.

Earnings of home appliance repairers vary according to the skill level required to fix equipment, geographic location, and the type of equipment repaired. Because many repairers receive commission along with their salary, earnings increase along with the number of jobs a repairer can complete in a day.

Many larger dealers, manufacturers and service stores offer benefits such as health insurance coverage, sick leave, and retirement and pension programs. Some home appliance repairers belong to the International Brotherhood of Electrical Workers.

Related Occupations

Other workers who repair electrical and electronic equipment include heating, air-conditioning, and refrigeration mechanics and installers; small-engine mechanics; office machine and cash register servicers; electronic home entertainment equipment installers and repairers; and coin, vending, and amusement machine servicers and repairers.

Sources of Additional Information

For information about jobs in the home appliance repair field, contact local appliance repair shops, manufacturers, vocational trade schools, appliance dealers, and utility companies, or the local office of the State employment service.

For general information about the work of home appliance repairers, contact:

- ▶ Appliance Service News, P.O. Box 809, St. Charles, IL 60174.
- ▶ North American Retail Dealers Association, 10 E. 22nd St., Suite 310, Lombard, IL 60148-4915. Internet: <http://www.narda.com>
- ▶ National Appliance Service Association, 9247 N. Meridian, Suite 105, Indianapolis, IN 46260.

For information on technician certification, as well as general information about the work of home appliance repairers, contact:

- ▶ National Appliance Service Technician Certification Program (NASTeC), 10 E. 22nd St., Suite 310, Lombard, IL 60148. Internet: <http://www.nastecnet.org>
- ▶ Professional Service Association, 71 Columbia St., Cohoes, NY 12047.

Industrial Machinery Installation, Repair, and Maintenance Workers

(O*NET 49-9041.00, 49-9042.00, 49-9043.00, 49-9044.00)

Significant Points

- Workers learn their trade through a 4-year apprenticeship program, or through informal on-the-job training supplemented by classroom instruction.
- Despite slower-than-average employment growth resulting from technological advancements in machinery, applicants with broad skills in machine repair should have favorable job prospects.

Nature of the Work

When production workers encounter problems with the machines they operate, they call industrial machinery installation, repair, and maintenance workers. These workers include industrial machinery mechanics, millwrights, and general maintenance and repair and machinery maintenance workers. Their work is important not only because an idle machine will delay production, but also because a machine that is not properly repaired and maintained may damage the final product or injure the operator.

Industrial machinery mechanics repair, install, adjust, or maintain industrial production and processing machinery or refinery and pipeline distribution systems. *Millwrights* install, dismantle, or move machinery and heavy equipment according to layout plans, blueprints, or other drawings. *General maintenance and repair workers* perform work involving the skills of two or more maintenance or craft occupations to keep machines, mechanical equipment, or the structure of an establishment in repair. *Machinery maintenance workers* lubricate machinery, change parts, or perform other routine machinery maintenance.

Much of the work begins when machinery arrives at the job site. New equipment must be unloaded, inspected, and moved into position. To lift and move light machinery, industrial machinery installation, repair, and maintenance workers use rigging and hoisting devices, such as pulleys and cables. In other cases, they require the assistance of hydraulic lift-truck or crane operators to position the machinery. Because industrial machinery installation, repair, and maintenance workers often decide which device to use for moving machinery, they must know the load-bearing properties of ropes, cables, hoists, and cranes.

Industrial machinery installation, repair, and maintenance workers consult with production managers and others to determine the optimal placement of machines in a plant. In some instances, this placement requires building a new foundation. Industrial machinery installation, repair, and maintenance workers either prepare the foundation themselves or supervise its construction, so they must know how to read blueprints and work with building materials, such as concrete, wood, and steel.

When assembling machinery, industrial machinery installation, repair, and maintenance workers fit bearings, align gears and wheels, attach motors, and connect belts, according to the manufacturer's blueprints and drawings. Precision leveling and alignment are important in the assembly process; industrial machinery installation, repair, and maintenance workers must have good mathematical skills, so that they can measure angles, material thickness, and small distances with tools such as squares, calipers, and micrometers. When a high level of precision is required, devices such as lasers and ultrasonic measuring tools may be used. Industrial machinery installation, repair, and maintenance workers also work with hand and power tools, such as cutting torches, welding machines, and soldering guns. Some of these workers use metalworking equipment, such as lathes or grinders, to modify parts to specifications.

Maintenance mechanics must be able to detect and diagnose minor problems and correct them before they become major ones. For example, after hearing a vibration from a machine, the mechanic must decide whether it is due to worn belts, weak motor bearings, or some other problem. Computerized maintenance, vibration analysis techniques, and self-diagnostic systems are making this task easier. Self-diagnostic features on new industrial machinery can determine the cause of a malfunction and, in some cases, alert the mechanic to potential trouble spots before symptoms develop.

After diagnosing the problem, the mechanic disassembles the equipment and repairs or replaces the necessary parts. Once the