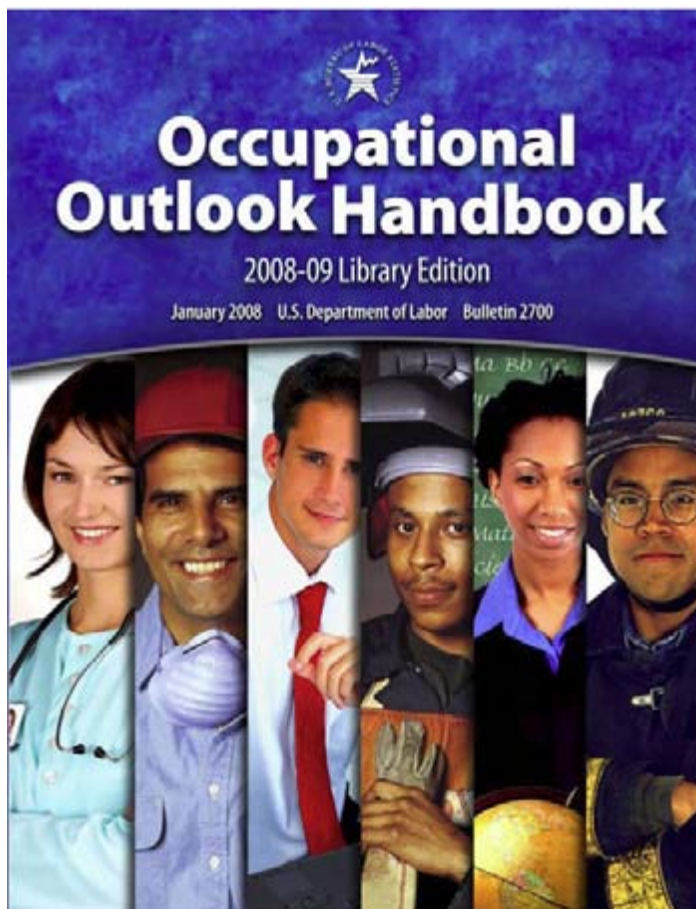


Installation, Maintenance, and Repair Occupations



Reprinted from the
Occupational Outlook Handbook, 2008-09 Edition

U.S. Department of Labor
Bureau of Labor Statistics



Occupations Included in this Reprint

- Aircraft and avionics equipment mechanics and service technicians
- Automotive body and related repairers
- Automotive service technicians and mechanics
- Coin, vending, and amusement machine servicers and repairers
- Computer, automated teller, and office machine repairers
- Diesel service technicians and mechanics
- Electrical and electronics installers and repairers
- Electronic home entertainment equipment installers and repairers
- Heating, air-conditioning, and refrigeration mechanics and installers
- Heavy vehicle and mobile equipment service technicians and mechanics
- Home appliance repairers
- Industrial machinery mechanics and maintenance workers
- Line installers and repairers
- Maintenance and repair workers, general
- Millwrights
- Precision instrument and equipment repairers
- Radio and telecommunications equipment installers and repairers
- Small engine mechanics

Aircraft and Avionics Equipment Mechanics and Service Technicians

(O*NET 49-2091.00, 49-3011.00)

Significant Points

- Most workers learn their jobs in 1 of about 170 schools certified by the Federal Aviation Administration (FAA).
- Job opportunities should be favorable for persons who have completed an aircraft mechanic training program, but keen competition is likely for jobs at major airlines, which offer the best pay and benefits.
- Job opportunities are likely to continue to be best at small commuter and regional airlines, at FAA repair stations, and in general aviation.

Nature of the Work

To keep aircraft in peak operating condition, aircraft and avionics equipment mechanics and service technicians perform scheduled maintenance, make repairs, and complete inspections required by the Federal Aviation Administration (FAA).

Many aircraft mechanics, also called airframe mechanics, power plant mechanics, and avionics technicians, specialize in preventive maintenance. They inspect aircraft engines, landing gear, instruments, pressurized sections, accessories—brakes, valves, pumps, and air-conditioning systems, for example—and other parts of the aircraft, and do the necessary maintenance and replacement of parts. They also keep records related to the maintenance performed on the aircraft. Mechanics and technicians conduct inspections following a schedule based on the number of hours the aircraft has flown, calendar days since the last inspection, cycles of operation, or a combination of these factors. In large, sophisticated planes equipped with aircraft monitoring systems, mechanics can gather valuable diagnostic information from electronic boxes and consoles that monitor the aircraft's basic operations. In planes of all sorts, aircraft mechanics examine engines by working through specially designed openings while standing on ladders or scaffolds or by using hoists or lifts to remove the entire engine from the craft. After taking an engine apart, mechanics use precision instruments to measure parts for wear and use x-ray and magnetic inspection equipment to check for invisible cracks. They repair or replace worn or defective parts. Mechanics also may repair sheet metal or composite surfaces; measure the tension of control cables; and check for corrosion, distortion, and cracks in the fuselage, wings, and tail. After completing all repairs, they must test the equipment to ensure that it works properly.

Other mechanics specialize in repair work rather than inspection. They find and fix problems that pilot's describe. For example, during a preflight check, a pilot may discover that the aircraft's fuel gauge does not work. To solve the problem, mechanics may troubleshoot the electrical system, using electrical test equipment to make sure that no wires are broken or shorted out, and replace any defective electrical or electronic compo-

nents. Mechanics work as fast as safety permits so that the aircraft can be put back into service quickly.

Some mechanics work on one or many different types of aircraft, such as jets, propeller-driven airplanes, and helicopters. Others specialize in one section of a particular type of aircraft, such as the engine, hydraulics, or electrical system. *Airframe mechanics* are authorized to work on any part of the aircraft except the instruments, power plants, and propellers. Powerplant mechanics are authorized to work on engines and do limited work on propellers. *Combination airframe-and-powerplant mechanics*—called A&P mechanics—work on all parts of the plane except the instruments. Most mechanics working on civilian aircraft today are A&P mechanics. In small, independent repair shops, mechanics usually inspect and repair many different types of aircraft.

Avionics systems—components used for aircraft navigation and radio communications, weather radar systems, and other instruments and computers that control flight, engine, and other primary functions—are now an integral part of aircraft design and have vastly increased aircraft capability. *Avionics technicians* repair and maintain these systems. Their duties may require additional licenses, such as a radiotelephone license issued by the U.S. Federal Communications Commission (FCC). Because of the increasing use of technology, more time is spent repairing electronic systems, such as computerized controls. Technicians also may be required to analyze and develop solutions to complex electronic problems.

Work environment. Mechanics usually work in hangars or in other indoor areas. When hangars are full or when repairs must be made quickly, they may work outdoors, sometimes in unpleasant weather. Mechanics often work under time pressure to maintain flight schedules or, in general aviation, to keep from inconveniencing customers. At the same time, mechanics have a tremendous responsibility to maintain safety standards, and this can cause the job to be stressful.

Frequently, mechanics must lift or pull objects weighing more than 70 pounds. They often stand, lie, or kneel in awkward positions and occasionally must work in precarious positions, such as on scaffolds or ladders. Noise and vibration are common when engines are being tested, so ear protection is necessary.

Aircraft mechanics usually work 40 hours a week on 8-hour shifts around the clock. Overtime and weekend work is frequent.

Training, Other Qualifications, and Advancement

Most workers learn their jobs in 1 of about 170 trade schools certified by the FAA. Most mechanics who work on civilian aircraft are certified by the FAA as an “airframe mechanic” or a “powerplant mechanic.”

Education and training. Although a few people become mechanics through on-the-job training, most learn their jobs in 1 of about the 170 schools certified by the FAA. About one-third of these schools award 2-year and 4-year degrees in avionics, aviation technology, or aviation maintenance management.

FAA standards established by law require that certified mechanic schools offer students a minimum of 1,900 class hours. Coursework in schools normally lasts from 18 to 24 months



Avionics technicians repair and maintain components used for aircraft navigation, radio communications, and weather radar systems, as well as instruments and computers that control flight, engine, and other functions.

and provides training with the tools and equipment used on the job. Aircraft trade schools are placing more emphasis on technologies such as turbine engines, composite materials—including graphite, fiberglass, and boron—and aviation electronics, which are increasingly being used in the construction of new aircraft.

Courses in mathematics, physics, chemistry, electronics, computer science, and mechanical drawing are helpful because they demonstrate many of the principles involved in the operation of aircraft, and knowledge of these principles is often necessary to make repairs. Recent technological advances in aircraft maintenance require mechanics to have an especially strong background in electronics to get or keep jobs in this field.

Courses that develop writing skills also are important because mechanics are often required to submit reports. Mechanics must be able to read, write, and understand English.

A few mechanics are trained on the job by experienced mechanics. They must be supervised by certified mechanics until they have FAA certificates.

Licensure. The FAA requires at least 18 months of work experience for an airframe or powerplant certificate, although completion of a program at an FAA-certified mechanic school can be substituted for the work experience requirement. Mechanics and technicians also must pass an exam for certification and take at least 16 hours of training every 24 months to keep their certificate current. Many mechanics take training courses offered by manufacturers or employers, usually through outside contractors.

The FAA also offers a combined certificate that allows for certification as both an airframe and a powerplant mechanic, the A&P certificate. For a combined A&P certificate, mechanics must acquire at least 30 months of experience working with both engines and airframes, or experience combined with the completion of an FAA-certified mechanic school program. FAA regulations also require current work experience to keep the A&P certificate valid. Applicants must have at least 1,000 hours of work experience in the previous 24 months or take a refresher course. Most airlines require that mechanics have a high school diploma and an A&P certificate. Applicants for

all certificates must pass written and oral tests and demonstrate that they can do the work authorized by the certificate.

Avionics technicians need an FAA mechanics' certificate. They also must be trained and qualified and have the proper tools to work on avionics equipment. Many have avionics repair experience from the military or from working for avionics manufacturers.

Other qualifications. Applicants must be at least 18 years of age. Some aircraft mechanics in the Armed Forces acquire enough general experience to satisfy the work experience requirements for the FAA certificate. With additional study, they may pass the certifying exam. In general, however, jobs in the military services are too specialized to provide the broad experience required by the FAA. Most Armed Forces mechanics have to complete the entire FAA training program, although a few receive some credit for the material they learned in the service. In any case, military experience is a great advantage when seeking employment; employers consider applicants with formal training to be the most desirable applicants.

Aircraft mechanics must do careful and thorough work that requires a high degree of mechanical aptitude. Employers seek applicants who are self-motivated, hard working, enthusiastic, and able to diagnose and solve complex mechanical problems. Additionally, employers prefer mechanics who can perform a variety of tasks. Agility is important for the reaching and climbing necessary to do the job. Because they may work on the tops of wings and fuselages on large jet planes, aircraft mechanics must not be afraid of heights.

Advances in computer technology, aircraft systems, and the materials used to manufacture airplanes have made mechanics' jobs more highly technical. Aircraft mechanics must possess the skills necessary to troubleshoot and diagnose complex aircraft systems. They also must continually update their skills with and knowledge of new technology and advances in aircraft technology.

Advancement. As aircraft mechanics gain experience, they may advance to lead mechanic (or crew chief), inspector, lead inspector, or shop supervisor positions. Opportunities are best for those who have an aircraft inspector's authorization. To obtain an inspector's authorization, a mechanic must have held an A&P certificate for at least 3 years, with 24 months of hands-on experience.

In the airlines, where promotion often is determined by examination, supervisors sometimes advance to executive positions. Those with broad experience in maintenance and overhaul might become inspectors with the FAA. With additional business and management training, some open their own aircraft maintenance facilities. Mechanics with the necessary pilot licenses and flying experience may take the FAA examination for the position of flight engineer, with opportunities to become pilots.

Mechanics and technicians learn many different skills in their training that can be applied to other jobs, and some transfer to other skilled repairer occupations or electronics technician jobs. For example, some avionics technicians continue their education and become aviation engineers, electrical engineers (specializing in circuit design and testing), or communication engineers. Others become repair consultants, in-house elec-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Aircraft and avionics equipment mechanics and service technicians..... | — | 138,000 | 152,000 | 14,000 | 10 |
| Avionics technicians | 49-2091 | 16,000 | 17,000 | 1,300 | 8 |
| Aircraft mechanics and service technicians..... | 49-3011 | 122,000 | 135,000 | 13,000 | 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*.

tronics designers, or join research groups that test and develop products.

Employment

Aircraft and avionics equipment mechanics and service technicians held about 138,000 jobs in 2006; about 5 in 6 of these workers was an aircraft mechanic and service technician.

Employment of aircraft and avionics equipment mechanics and service technicians primarily is concentrated in a small number of industries. More than half of aircraft and avionics equipment mechanics and service technicians worked in air transportation and support activities for air transportation. Around 18 percent worked in aerospace product and parts manufacturing and about 16 percent worked for the Federal Government. Most of the rest worked for companies that operate their own planes to transport executives and cargo.

Most airline mechanics and service technicians work at major airports near large cities. Civilian mechanics employed by the U.S. Armed Forces work at military installations. Mechanics who work for aerospace manufacturing firms typically are located in California or in Washington State. Others work for the FAA, many at the facilities in Oklahoma City, Atlantic City, Wichita, or Washington, DC. Mechanics for independent repair shops work at airports in every part of the country.

Job Outlook

Job growth for these mechanics and technicians is expected to be about as fast as the average for all occupations. Job opportunities should be favorable for people who have completed an aircraft mechanic training program, but keen competition is likely for jobs at major airlines.

Employment change. Employment is expected to increase by 10 percent during the 2006-16 period, about as fast as the average for all occupations. Passenger traffic is expected to increase as the result of an expanding economy and a growing population, and the need for aircraft mechanics and service technicians will grow accordingly.

Job prospects. Most job openings for aircraft mechanics through the year 2016 will stem from the need to replace the many mechanics expected to retire over the next decade. In addition, some mechanics will leave to work in related fields, such as automobile repair, as their skills are largely transferable to other maintenance and repair occupations.

Also contributing to favorable future job opportunities for mechanics is the long-term trend toward fewer students entering technical schools to learn skilled maintenance and repair trades. Many of the students who have the ability and aptitude to work on planes are choosing to go to college, work in

computer-related fields, or go into other repair and maintenance occupations with better working conditions. If this trend continues, the supply of trained aviation mechanics may not keep up with the needs of the air transportation industry.

Job opportunities will continue to be the best at small commuter and regional airlines, at FAA repair stations, and in general aviation. Commuter and regional airlines is the fastest growing segment of the air transportation industry, but wages in these airlines tend to be lower than those in the major airlines, so they attract fewer job applicants. Also, some jobs will become available as experienced mechanics leave for higher paying jobs with the major airlines or transfer to other occupations. At the same time, general aviation aircraft are becoming increasingly sophisticated, boosting the demand for qualified mechanics. Mechanics will face more competition for jobs with large airlines because the high wages and travel benefits that these jobs offer generally attract more qualified applicants than there are openings. Also, there is an increasing trend for large airlines to outsource aircraft and avionics equipment mechanic jobs overseas; however, most airline companies prefer that aircraft maintenance be performed in the U.S. because overseas contractors may not comply with more stringent U.S. safety regulations.

In spite of these factors, job opportunities with the airlines are expected to be better than they have been in the past. But, in general, prospects will be best for applicants with experience. Mechanics who keep abreast of technological advances in electronics, composite materials, and other areas will be in greatest demand. Also, mechanics who are mobile and willing to relocate to smaller rural areas will have better job opportunities. The number of job openings for aircraft mechanics in the Federal Government should decline as the Government increasingly contracts out service and repair functions to private repair companies.

Avionics technicians who do not have FAA certification, but who are prepared to master the intricacies of the aircraft while working with certified A&P mechanics, should have good opportunities. However, certified technicians who are trained to work with complex aircraft systems, performing some duties normally performed by certified A&P mechanics, should have the best job prospects. Additionally, technicians with licensing that enables them to work on the airplane, either removing or reinstalling equipment, are expected to be in especially high demand.

Earnings

Median hourly earnings of aircraft mechanics and service technicians were about \$22.95 in May 2006. The middle 50 per-

cent earned between \$18.96 and \$28.12. The lowest 10 percent earned less than \$14.94, and the highest 10 percent earned more than \$34.51. Median hourly earnings in the industries employing the largest numbers of aircraft mechanics and service technicians in May 2006 were:

| | |
|---|---------|
| Scheduled air transportation | \$27.46 |
| Nonscheduled air transportation | 23.33 |
| Federal Government..... | 23.19 |
| Aerospace product and parts manufacturing..... | 21.58 |
| Support activities for air transportation | 19.57 |

Median hourly earnings of avionics technicians were about \$22.57 in May 2006. The middle 50 percent earned between \$19.02 and \$26.65. The lowest 10 percent earned less than \$15.65, and the highest 10 percent earned more than \$30.33.

Mechanics who work on jets for the major airlines generally earn more than those working on other aircraft. Those who graduate from an aviation maintenance technician school often earn higher starting salaries than individuals who receive training in the Armed Forces or on the job. Airline mechanics and their immediate families receive reduced-fare transportation on their own and most other airlines.

About 3 in 10 aircraft and avionics equipment mechanics and service technicians are members of unions or covered by union agreements. The principal unions are the International Association of Machinists and Aerospace Workers, and the Transport Workers Union of America. Some mechanics are represented by the International Brotherhood of Teamsters.

Related Occupations

Workers in some other occupations that involve similar mechanical and electrical work are electricians, electrical and electronics installers and repairers, and elevator installers and repairers.

Sources of Additional Information

Information about jobs with a particular airline can be obtained by writing to the personnel manager of the company.

For general information about aircraft and avionics equipment mechanics and service technicians, contact:

► Professional Aviation Maintenance Association, 400 Commonwealth Dr., Warrendale, PA 15096.

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

For information on jobs in a particular area, contact employers at local airports or local offices of the State employment service.

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

Automotive Body and Related Repairers

(O*NET 49-3021.00, 49-3022.00)

Significant Points

- To become a fully skilled automotive body repairer, formal training followed by on-the-job instruction is recommended because fixing newer automobiles requires advanced skills.
- Excellent job opportunities are projected because of the large number of older workers who are expected to retire in the next 10 to 15 years.
- Repairers need good reading ability and basic mathematics and computer skills to use print and digital technical manuals.

Nature of the Work

Most of the damage resulting from everyday vehicle collisions can be repaired, and vehicles can be refinished to look and drive like new. *Automotive body repairers*, often called collision repair technicians, straighten bent bodies, remove dents, and replace crumpled parts that cannot be fixed. They repair all types of vehicles, and although some work on large trucks, buses, or tractor-trailers, most work on cars and small trucks. They can work alone, with only general direction from supervisors, or as specialists on a repair team. In some shops, helpers or apprentices assist experienced repairers.

Each damaged vehicle presents different challenges for repairers. Using their broad knowledge of automotive construction and repair techniques, automotive body repairers must decide how to handle each job based on what the vehicle is made of and what needs to be fixed. They must first determine the extent of the damage and order any needed parts.

If the car is heavily damaged, an automotive body repairer might start by realigning the frame of the vehicle. Repairers chain or clamp frames and sections to alignment machines that use hydraulic pressure to align damaged components. "Uni-body" vehicles—designs built without frames—must be restored to precise factory specifications for the vehicle to operate correctly. For these vehicles, repairers use benchmark systems to accurately measure how much each section is out of alignment, and hydraulic machinery to return the vehicle to its original shape.

Once the frame is aligned, repairers can begin to fix or replace damaged body parts. If the vehicle or part is made of metal, body repairers will use a pneumatic metal-cutting gun or other tools to remove badly damaged sections of body panels and then weld in replacement sections. Less serious dents are pulled out with a hydraulic jack or hand prying bar or knocked out with handtools or pneumatic hammers. Small dents and creases in the metal are smoothed by holding a small anvil against one side of the damaged area while hammering the opposite side. Repairers also remove very small pits and dimples with pick hammers and punches in a process called metal finishing. Body

repairers use plastic or solder to fill small dents that cannot be worked out of plastic or metal panels. On metal panels, they file or grind the hardened filler to the original shape and clean the surface with a media blaster—similar to a sand blaster—before repainting the damaged portion of the vehicle.

Body repairers also repair or replace the plastic body parts that are increasingly used on new vehicles. They remove damaged panels and identify the type and properties of the plastic used. With most types of plastic, repairers can apply heat from a hot-air welding gun or immerse the panel in hot water and press the softened section back into shape by hand. Repairers replace plastic parts that are badly damaged or very difficult to fix. A few body repairers specialize in fixing fiberglass car bodies.

Some body repairers specialize in installing and repairing glass in automobiles and other vehicles. *Automotive glass installers and repairers* remove broken, cracked, or pitted windshields and window glass. Glass installers apply a moisture-proofing compound along the edges of the glass, place the glass in the vehicle, and install rubber strips around the sides of the windshield or window to make it secure and weatherproof.

Many large shops make repairs using an assembly-line approach where vehicles are fixed by a team of repairers who each specialize in one type of repair. One worker might straighten frames while another repairs doors and fenders, for example. In most shops, automotive painters do the painting and refinishing, but in small shops, workers often do both body repairing and painting. (Automotive painters are discussed in the section on painting and coating workers, except construction and maintenance elsewhere in the *Handbook*.)

Work environment. Repairers work indoors in body shops that are noisy with the clatter of hammers against metal and the whine of power tools. Most shops are well ventilated to disperse dust and paint fumes. Body repairers often work in awkward or cramped positions, and much of their work is strenuous and dirty. Hazards include cuts from sharp metal edges, burns from torches and heated metal, injuries from power tools, and fumes from paint. However, serious accidents usually are avoided when the shop is kept clean and orderly and safety practices are observed. Automotive repair and maintenance shops averaged 4 cases of work-related injuries and illnesses per 100 full-time



Automotive body repairers remove, repair, and replace car and truck parts that have been damaged.

workers in 2005, compared to 4.6 per 100 workers in all private industry.

Most automotive body repairers work a standard 40-hour week. More than 40 hours a week may be required when there is a backlog of repair work to be completed. This may include working on weekends.

Training, Other Qualifications, and Advancement

Automotive technology is rapidly becoming more sophisticated, and most employers prefer applicants who have completed a formal training program in automotive body repair or refinishing. Most new repairers complete at least part of this training on the job. Many repairers, particularly in urban areas, need a national certification to advance past entry-level work.

Education and training. A high school diploma or GED is often all that is required to enter this occupation, but more specific education and training is needed to learn how to repair newer automobiles. Collision repair programs may be offered in high school or in postsecondary vocational schools and community colleges. Courses in electronics, physics, chemistry, English, computers, and mathematics provide a good background for a career as an automotive body repairer. Most training programs combine classroom instruction and hands-on practice.

Trade and technical school programs typically award certificates to graduates after 6 months to a year of collision repair study. Some community colleges offer 2-year programs in collision repair. Many of these schools also offer certificates for individual courses, so that students are able to take classes incrementally or as needed.

New repairers begin by assisting experienced body repairers in tasks such as removing damaged parts, sanding body panels, and installing repaired parts. Novices learn to remove small dents and make other minor repairs. They then progress to more difficult tasks, such as straightening body parts and returning them to their correct alignment. Generally, it takes 3 to 4 years of hands-on training to become skilled in all aspects of body repair, some of which may be completed as part of a formal education program. Basic automotive glass installation and repair can be learned in as little as 6 months, but becoming fully qualified can take several years.

Continuing education and training are needed throughout a career in automotive body repair. Automotive parts, body materials, and electronics continue to change and to become more complex. To keep up with these technological advances, repairers must continue to gain new skills by reading technical manuals and furthering their education with classes and seminars. Many companies within the automotive body repair industry send employees to advanced training programs to brush up on skills or to learn new techniques.

Other qualifications. Fully skilled automotive body repairers must have good reading ability and basic mathematics and computer skills. Restoring unibody automobiles to their original form requires repairers to follow instructions and diagrams in technical manuals and to make precise three-dimensional measurements of the position of one body section relative to another. In addition, repairers should enjoy working with their hands and be able to pay attention to detail while they work.

Certification and advancement. Certification by the National Institute for Automotive Service Excellence (ASE), although voluntary, is the pervasive industry credential for non entry-level automotive body repairers. This is especially true in large, urban areas. Repairers may take up to four ASE Master Collision Repair and Refinish Exams. Repairers who pass at least one exam and have 2 years of hands-on work experience earn ASE certification. The completion of a postsecondary program in automotive body repair may be substituted for 1 year of work experience. Those who pass all four exams become ASE Master Collision Repair and Refinish Technicians. Automotive body repairers must retake the examination at least every 5 years to retain their certification. Many vehicle manufacturers and paint manufacturers also have product certification programs that can advance a repairer's career.

As beginners increase their skills, learn new techniques, earn certifications, and complete work more rapidly, their pay increases. An experienced automotive body repairer with managerial ability may advance to shop supervisor, and some workers open their own body repair shops. Other repairers become automobile damage appraisers for insurance companies.

Employment

Automotive body and related repairers held about 206,000 jobs in 2006; about 13 percent specialized in automotive glass installation and repair. Fifty-eight percent of repairers worked for automotive repair and maintenance shops in 2006, while 20 percent worked for automobile dealers. Others worked for organizations, such as trucking companies, that maintain their own motor vehicles. A small number of repairers worked for wholesalers of motor vehicles, parts, and supplies. More than 15 percent of automotive body repairers were self-employed, roughly double the number for all installation, maintenance, and repair occupations.

Job Outlook

Employment of automotive body and related repairers is expected to grow about as fast as average through the year 2016, and job opportunities are projected to be excellent due to a growing number of retirements in this occupation.

Employment change. Employment of automotive body repairers is expected to grow 12 percent over the 2006-16 decade, as compared to 10 percent for all occupations. Demand for qualified body repairers will increase as the number of vehicles on the road continues to grow. With more motor vehicles in use, more vehicles will be damaged in accidents. In addition, new automotive designs of lighter weight are prone to greater collision damage than are older, heavier designs, so more repairs are needed. Employment growth will continue to be concentrated

in automotive body, paint, interior, and glass repair shops, with little or no change in automotive dealerships.

Despite the anticipated increase in the number of auto accidents, the increasing demand for automotive body repairers will be tempered by improvements in the quality of vehicles. Also, technological innovations that enhance safety will reduce the likelihood of accidents.

Demand for automotive body repair services will similarly be constrained as more vehicles are declared a total loss after accidents. In many such cases, the vehicles are not repaired because of the high cost of replacing the increasingly complex parts and electronic components and because of the extensive damage that results when airbags deploy. Also, higher insurance premiums and deductibles mean that minor damage is more often going unrepaired. Larger shops are instituting productivity enhancements, such as employing a team approach to repairs, which may limit employment growth by reducing the time it takes to make repairs.

Job prospects. Employment growth will create some opportunities, but the need to replace experienced repairers who transfer to other occupations or who retire or stop working for other reasons will account for the majority of job openings over the next 10 years. Opportunities will be excellent for people with formal training in automotive body repair and refinishing. Those without any training or experience in automotive body refinishing or collision repair—before or after high school—will face competition for these jobs.

Experienced body repairers are rarely laid off during a general slowdown in the economy as the automotive repair business is not very sensitive to changes in economic conditions. Although repair of minor dents and crumpled fenders is often put off when drivers have less money, major body damage must be repaired before a vehicle can be driven safely.

Earnings

Median hourly wage-and-salary earnings of automotive body and related repairers, including incentive pay, were \$16.92 in May 2006. The middle 50 percent earned between \$13.00 and \$22.33 an hour. The lowest 10 percent earned less than \$10.10, and the highest 10 percent earned more than \$28.71 an hour. Median hourly earnings of automotive body and related repairers were \$17.85 in automobile dealers and \$16.66 in automotive repair and maintenance.

Median hourly wage-and-salary earnings of automotive glass installers and repairers, including incentive pay, were \$14.77. The middle 50 percent earned between \$11.44 and \$18.42 an hour. The lowest 10 percent earned less than \$9.19, and the highest 10 percent earned more than \$22.22 an hour. Median hourly earnings in automotive repair and maintenance shops,

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Automotive body and related repairers | — | 206,000 | 232,000 | 26,000 | 12 |
| Automotive body and related repairers | 49-3021 | 183,000 | 204,000 | 21,000 | 12 |
| Automotive glass installers and repairers | 49-3022 | 24,000 | 28,000 | 4,400 | 19 |

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

the industry employing most automotive glass installers and repairers, were \$14.80.

The majority of body repairers employed by independent repair shops and automotive dealers are paid on an incentive basis. Under this system, body repairers are paid a set amount for various tasks, and earnings depend on both the amount of work assigned and how fast it is completed. Employers frequently guarantee workers a minimum weekly salary. Body repairers who work for trucking companies, buslines, and other organizations that maintain their own vehicles usually receive an hourly wage.

Helpers and trainees typically earn between 30 percent and 60 percent of the earnings of skilled workers. They are paid by the hour until they are skilled enough to be paid on an incentive basis.

Employee benefits vary widely from business to business. However, industry sources report that benefits such as paid leave, health insurance, and retirement assistance are increasingly common in the collision repair industry. Automotive dealerships are the most likely to offer such incentives.

Related Occupations

Repairing damaged motor vehicles often involves working on mechanical components, as well as vehicle bodies. Automotive body repairers often work closely with individuals in several related occupations, including automotive service technicians and mechanics, diesel service technicians and mechanics, auto damage appraisers, and painting and coating workers, except construction and maintenance. Automotive glass installers and repairers complete tasks very similar to those of glaziers.

Sources of Additional Information

Additional details about work opportunities may be obtained from automotive body repair shops, automobile dealers, or local offices of your State employment service. State employment service offices also are a source of information about training programs.

For general information about automotive body repairer careers, contact any of the following sources:

- AutomotiveCareersToday, 8400 Westpark Dr., MS#2, McLean, VA 22102. Internet: <http://www.autocareerstoday.org>
- Automotive Service Association, P.O. Box 929, Bedford, Texas 76095. Internet: <http://www.asashop.org>
- Inter-Industry Conference On Auto Collision Repair Education Foundation (I-CAR), 5125 Trillium Blvd., Hoffman Estates, IL 60192. Internet: <http://www.collisicareers.org>
- National Automobile Dealers Association, 8400 Westpark Dr., McLean, VA 22102. Internet: <http://www.nada.org>

For general information about careers in automotive glass installation and repair, contact:

- National Glass Association. 8200 Greensboro Dr., Suite 302, McLean, VA 22102. Internet: <http://www.glass.org>

For information on how to become a certified automotive body repairer, write to:

- National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175.

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

For a directory of certified automotive body repairer programs, contact:

- National Automotive Technician Education Foundation, 101 Blue Seal Dr., SE., Suite 101, Leesburg, VA 20175.

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

For a directory of accredited private trade and technical schools that offer training programs in automotive body repair, contact:

- Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: <http://www.accsct.org>

Automotive Service Technicians and Mechanics

(O*NET 49-3023.00, 49-3023.01, 49-3023.02)

Significant Points

- Automotive service technicians and mechanics must continually adapt to changing technology and repair techniques as vehicle components and systems become increasingly sophisticated.
- Formal automotive technician training is the best preparation for these challenging technology-based jobs.
- Opportunities should be very good for automotive service technicians and mechanics with diagnostic and problem-solving skills, knowledge of electronics and mathematics, and mechanical aptitude.

Nature of the Work

Automotive service technicians inspect, maintain, and repair automobiles and light trucks that run on gasoline, electricity, or alternative fuels such as ethanol. Automotive service technicians' and mechanics' responsibilities have evolved from simple mechanical repairs to high-level technology-related work. The increasing sophistication of automobiles requires workers who can use computerized shop equipment and work with electronic components while maintaining their skills with traditional handtools. As a result, automotive service workers are now usually called technicians rather than mechanics. (Service technicians who work on diesel-powered trucks, buses, and equipment are discussed in the *Handbook* section on diesel service technicians and mechanics. Motorcycle technicians—who repair and service motorcycles, motor scooters, mopeds, and small all-terrain vehicles—are discussed in the *Handbook* section on small engine mechanics.)

Today, integrated electronic systems and complex computers regulate vehicles and their performance while on the road. Technicians must have an increasingly broad knowledge of how vehicles' complex components work and interact. They also must be able to work with electronic diagnostic equipment and digital manuals and reference materials.

When mechanical or electrical troubles occur, technicians first get a description of the problem from the owner or, in a large shop, from the repair service estimator or service advisor who wrote the repair order. To locate the problem, technicians

use a diagnostic approach. First, they test to see whether components and systems are secure and working properly. Then, they isolate the components or systems that might be the cause of the problem. For example, if an air-conditioner malfunctions, the technician might check for a simple problem, such as a low coolant level, or a more complex issue, such as a bad drive-train connection that has shorted out the air conditioner. As part of their investigation, technicians may test drive the vehicle or use a variety of testing equipment, including onboard and hand-held diagnostic computers or compression gauges. These tests may indicate whether a component is salvageable or whether a new one is required.

During routine service inspections, technicians test and lubricate engines and other major components. Sometimes technicians repair or replace worn parts before they cause breakdowns or damage the vehicle. Technicians usually follow a checklist to ensure that they examine every critical part. Belts, hoses, plugs, brake and fuel systems, and other potentially troublesome items are watched closely.

Service technicians use a variety of tools in their work. They use power tools, such as pneumatic wrenches to remove bolts quickly; machine tools like lathes and grinding machines to rebuild brakes; welding and flame-cutting equipment to remove and repair exhaust systems, and jacks and hoists to lift cars and engines. They also use common handtools, such as screwdrivers, pliers, and wrenches, to work on small parts and in hard-to-reach places. Technicians usually provide their own handtools, and many experienced workers have thousands of dollars invested in them. Employers furnish expensive power tools, engine analyzers, and other diagnostic equipment.

Computers are also commonplace in modern repair shops. Service technicians compare the readouts from computerized diagnostic testing devices with benchmarked standards given by the manufacturer. Deviations outside of acceptable levels tell the technician to investigate that part of the vehicle more closely. Through the Internet or from software packages, most shops receive automatic updates to technical manuals and access to manufacturers' service information, technical service bulletins, and other databases that allow technicians to keep up with common problems and learn new procedures.

High technology tools are needed to fix the computer equipment that operates everything from the engine to the radio in many cars. In fact, today most automotive systems, such as braking, transmission, and steering systems, are controlled primarily by computers and electronic components. Additionally, luxury vehicles often have integrated global positioning systems, Internet access, and other new features with which technicians will need to become familiar. Also, as more alternate-fuel vehicles are purchased, more automotive service technicians will need to learn the science behind these automobiles and how to repair them.

Automotive service technicians in large shops often specialize in certain types of repairs. For example, *transmission technicians and rebuilders* work on gear trains, couplings, hydraulic pumps, and other parts of transmissions. Extensive knowledge of computer controls, the ability to diagnose electrical and hydraulic problems, and other specialized skills are needed to work on these complex components, which employ some of the

most sophisticated technology used in vehicles. *Tuneup technicians* adjust ignition timing and valves and adjust or replace spark plugs and other parts to ensure efficient engine performance. They often use electronic testing equipment to isolate and adjust malfunctions in fuel, ignition, and emissions control systems.

Automotive air-conditioning repairers install and repair air-conditioners and service their components, such as compressors, condensers, and controls. These workers require special training in Federal and State regulations governing the handling and disposal of refrigerants. *Front-end mechanics* align and balance wheels and repair steering mechanisms and suspension systems. They frequently use special alignment equipment and wheel-balancing machines. *Brake repairers* adjust brakes, replace brake linings and pads, and make other repairs on brake systems. Some technicians specialize in both brake and front-end work.

Work environment. While most automotive service technicians worked a standard 40 hour week in 2006, 30 percent worked longer hours. Some may work evenings and weekends to satisfy customer service needs. Generally, service technicians work indoors in well-ventilated and -lighted repair shops. However, some shops are drafty and noisy. Although many problems can be fixed with simple computerized adjustments,



Automotive service technicians use several types of diagnostic tools, including pressure gauges and electronic meters.

technicians frequently work with dirty and greasy parts, and in awkward positions. They often lift heavy parts and tools. Minor cuts, burns, and bruises are common, but technicians can usually avoid serious accidents if safe practices are observed.

Training, Other Qualifications, and Advancement

Automotive technology is rapidly increasing in sophistication, and most training authorities strongly recommend that people seeking work in automotive service complete a formal training program in high school or in a postsecondary vocational school or community college. However, some service technicians still learn the trade solely by assisting and learning from experienced workers. Acquiring National Institute for Automotive Service Excellence (ASE) certification is important for those seeking work in large, urban areas.

Education and training. Most employers regard the successful completion of a vocational training program in automotive service technology as the best preparation for trainee positions. High school programs, while an asset, vary greatly in scope. Graduates of these programs may need further training to become qualified. Some of the more extensive high school programs participate in Automotive Youth Education Service (AYES), a partnership between high school automotive repair programs, automotive manufacturers, and franchised automotive dealers. All AYES high school programs are certified by the National Institute for Automotive Service Excellence. Students who complete these programs are well prepared to enter entry-level technician positions or to advance their technical education. Courses in automotive repair, electronics, physics, chemistry, English, computers, and mathematics provide a good educational background for a career as a service technician.

Postsecondary automotive technician training programs usually provide intensive career preparation through a combination of classroom instruction and hands-on practice. Schools update their curriculums frequently to reflect changing technology and equipment. Some trade and technical school programs provide concentrated training for 6 months to a year, depending on how many hours the student attends each week, and award a certificate. Community college programs usually award a certificate or an associate degree. Some students earn repair certificates in a particular skill and leave to begin their careers. Associate degree programs, however, usually take 2 years to complete and include classes in English, basic mathematics, computers, and other subjects, as well as automotive repair. Recently, some programs have added classes on customer service, stress management, and other employability skills. Some formal training programs have alliances with tool manufacturers that help entry-level technicians accumulate tools during their training period.

Various automobile manufacturers and participating franchised dealers also sponsor 2-year associate degree programs at postsecondary schools across the Nation. Students in these programs typically spend alternate 6- to 12-week periods attending classes full time and working full time in the service departments of sponsoring dealers. At these dealerships, students work with an experienced worker who provides hands-on instruction and timesaving tips.

Those new to automotive service usually start as trainee technicians, technicians' helpers, or lubrication workers, and gradually acquire and practice their skills by working with experienced mechanics and technicians. In many cases, on-the-job training may be a part of a formal education program. With a few months' experience, beginners perform many routine service tasks and make simple repairs. While some graduates of postsecondary automotive training programs are often able to earn promotion to the journey level after only a few months on the job, it typically takes 2 to 5 years of experience to become a fully qualified service technician, who is expected to quickly perform the more difficult types of routine service and repairs. An additional 1 to 2 years of experience familiarizes technicians with all types of repairs. Complex specialties, such as transmission repair, require another year or two of training and experience. In contrast, brake specialists may learn their jobs in considerably less time because they do not need complete knowledge of automotive repair.

Employers increasingly send experienced automotive service technicians to manufacturer training centers to learn to repair new models or to receive special training in the repair of components, such as electronic fuel injection or air-conditioners. Motor vehicle dealers and other automotive service providers may send promising beginners or experienced technicians to manufacturer-sponsored technician training programs to upgrade or maintain employees' skills. Factory representatives also visit many shops to conduct short training sessions.

Other qualifications. The ability to diagnose the source of a problem quickly and accurately requires good reasoning ability and a thorough knowledge of automobiles. Many technicians consider diagnosing hard-to-find troubles one of their most challenging and satisfying duties. For trainee automotive service technician jobs, employers look for people with strong communication and analytical skills. Technicians need good reading, mathematics, and computer skills to study technical manuals. They must also read to keep up with new technology and learn new service and repair procedures and specifications.

Training in electronics is vital because electrical components, or a series of related components, account for nearly all malfunctions in modern vehicles. Trainees must possess mechanical aptitude and knowledge of how automobiles work. Experience working on motor vehicles in the Armed Forces or as a hobby can be very valuable.

Certification and advancement. ASE certification has become a standard credential for automotive service technicians. While not mandatory for work in automotive service, certification is common for all non entry-level technicians in large, urban areas. Certification is available in 1 or more of 8 different areas of automotive service, such as electrical systems, engine repair, brake systems, suspension and steering, and heating and air-conditioning. For certification in each area, technicians must have at least 2 years of experience and pass the examination. Completion of an automotive training program in high school, vocational or trade school, or community or junior college may be substituted for 1 year of experience. For ASE certification as a Master Automobile Technician, technicians must be certified in all eight areas.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Automotive service technicians and mechanics..... | 49-3023 | 773,000 | 883,000 | 110,000 | 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*.

By becoming skilled in multiple auto repair services, technicians can increase their value to their employer and their pay. Experienced technicians who have administrative ability sometimes advance to shop supervisor or service manager. Those with sufficient funds many times open independent automotive repair shops. Technicians who work well with customers may become automotive repair service estimators.

Employment

Automotive service technicians and mechanics held about 773,000 jobs in 2006. Automotive repair and maintenance shops and automotive dealers employed the majority of these workers—29 percent each. In addition, automotive parts, accessories, and tire stores employed 7 percent of automotive service technicians. Others worked in gasoline stations; general merchandise stores; automotive equipment rental and leasing companies; Federal, State, and local governments; and other organizations. Almost 17 percent of service technicians were self-employed, more than twice the proportion for all installation, maintenance, and repair occupations.

Job Outlook

The number of jobs for automotive service technicians and mechanics is projected to grow faster than average for all occupations over the next decade. Employment growth will create many new jobs, but total job openings will be significantly larger because many skilled technicians are expected to retire and will need to be replaced.

Employment change. Employment of automotive service technicians and mechanics is expected to increase 14 percent between 2006 and 2016, compared to 10 percent for all occupations. It will add a large number of new jobs, about 110,000, over the decade. Demand for technicians will grow as the number of vehicles in operation increases, reflecting continued growth in the driving age population and in the number of multi-car families. Growth in demand will be offset somewhat by continuing improvements in the quality and durability of automobiles, which will require less frequent service.

Employment growth will continue to be concentrated in automobile dealerships and independent automotive repair shops. Many new jobs also will be created in small retail operations that offer after-warranty repairs, such as oil changes, brake repair, air-conditioner service, and other minor repairs generally taking less than 4 hours to complete. Employment of automotive service technicians and mechanics in gasoline service stations will continue to decline, as fewer stations offer repair services.

Job prospects. In addition to openings from growth, many job openings will be created by the need to replace a growing number of retiring technicians. Job opportunities in this occupation are expected to be very good for those who complete

high school or postsecondary automotive training programs and who earn ASE certification. Some employers report difficulty in finding workers with the right skills. People with good diagnostic and problem-solving abilities, and training in basic electronics and computer courses are expected to have the best opportunities. Those without formal automotive training are likely to face competition for entry-level jobs.

Most people who enter the occupation can expect steady work, even during downturns in the economy. Although car owners tend to postpone maintenance and repair on their vehicles when their budgets are strained, employers usually cut back on hiring new workers during economic downturns instead of letting experienced workers go.

Earnings

Median hourly wage-and-salary earnings of automotive service technicians and mechanics, including commission, were \$16.24 in May 2006. The middle 50 percent earned between \$11.96 and \$21.56 per hour. The lowest 10 percent earned less than \$9.17, and the highest 10 percent earned more than \$27.22 per hour. Median annual earnings in the industries employing the largest numbers of service technicians were as follows:

| | |
|--|---------|
| Local government, excluding schools..... | \$19.07 |
| Automobile dealers | 18.85 |
| Automotive repair and maintenance | 14.55 |
| Gasoline stations | 14.51 |
| Automotive parts, accessories, and tire stores | 14.38 |

Many experienced technicians employed by automobile dealers and independent repair shops receive a commission related to the labor cost charged to the customer. Under this system, weekly earnings depend on the amount of work completed. Employers frequently guarantee commissioned technicians a minimum weekly salary.

Automotive service technicians who are members of labor unions, such as the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace, and Agricultural Implement Workers of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters, may enjoy more benefits than non-union workers do.

Related Occupations

Other workers who repair and service motor vehicles include automotive body and related repairers, diesel service technicians and mechanics, and small engine mechanics.

Sources of Additional Information

For more details about work opportunities, contact local automobile dealers and repair shops or local offices of the State em-

ployment service. The State employment service also may have information about training programs.

For general information about a career as an automotive service technician, contact:

➤ AutomotiveCareersToday, 8400 Westpark Dr., MS#2, McLean, VA 22102. Internet: <http://www.autocareerstoday.org>

➤ Career Voyages, U.S. Department of Labor, 200 Constitution Ave., NW., Washington, DC 20210.

Internet:

<http://www.careervoyages.gov/automotive-main.cfm>

➤ National Automobile Dealers Association, 8400 Westpark Dr., McLean, VA 22102. Internet: <http://www.nada.org>

A list of certified automotive service technician training programs can be obtained from:

➤ National Automotive Technicians Education Foundation, 101 Blue Seal Dr., SE., Suite 101, Leesburg, VA 20175.

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

For a directory of accredited private trade and technical schools that offer programs in automotive service technician training, contact:

➤ Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: <http://www.accsct.org>

Information on automobile manufacturer-sponsored programs in automotive service technology can be obtained from:

➤ Automotive Youth Educational Systems (AYES), 100 W. Big Beaver, Suite 300, Troy, MI 48084.

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

Information on how to become a certified automotive service technician is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175.

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

Coin, Vending, and Amusement Machine Servicers and Repairers

(O*NET 49-9091.00)

Significant Points

- Most workers in this occupation learn their skills on the job.
- Opportunities should be especially good for people with some knowledge of electronics.

Nature of the Work

Coin, vending, and amusement machines give out change, test our gaming skills, and dispense refreshments nearly everywhere we turn. Coin, vending, and amusement machine servicers and repairers install, service, and stock such machines and keep them in good working order.

Occupations in this industry are classified by the type of machine they work on and whether they specialize in servicing or repairing the machines. *Vending machine servicers*, often called route drivers, visit machines that dispense soft drinks,

candy and snacks, and other items. They collect money from the coin and cash-operated machines, restock merchandise, and change labels to indicate new selections. They also keep the machines clean and appealing.

Vending machine repairers, often called mechanics or technicians, make sure that the machines operate correctly. On the relatively simple gravity-operated machines, repairers check the keypads, motors, and merchandise chutes. When checking complicated electrical and electronic machines, such as beverage dispensers, they check to see that the machines mix drinks properly and that the refrigeration and heating units work correctly. If the machines are not in good working order, the mechanics repair them. When installing machines, vending machine repairers make the necessary water and electrical connections and check them for proper operation.

Amusement machine servicers and repairers work on jukeboxes, video games, pinball machines, and slot machines. They update selections, repair or replace malfunctioning parts, and rebuild existing equipment.

Vending machine servicers and repairers employed by small companies may both fill and fix machines on a regular basis. These combination servicers-repairers stock machines, collect money, fill coin and currency changers, and repair machines when necessary.

If a machine breaks down, vending and amusement machine repairers inspect it for obvious problems, such as loose electrical wires, malfunctions of the coin mechanism or bill validator, and leaks. When servicing electronic machines, repairers test them with hand-held diagnostic computers that determine the extent and location of any problem. Repairers may only have to replace a circuit board or other component to fix the problem. However, if the problem cannot be readily located, these workers refer to technical manuals and wiring diagrams and use testing devices, such as electrical circuit testers, to find defective parts. Repairers decide whether they must replace a part and whether they can fix the malfunction onsite or whether they have to send the machine to the repair shop.

In the repair shop, vending and amusement machine repairers use power tools, such as grinding wheels, saws, and drills, as well as voltmeters, ohmmeters, oscilloscopes, and other testing equipment. They also use ordinary repair tools, such as screwdrivers, pliers, and wrenches.

Preventive maintenance—avoiding trouble before it starts—is a major job of repairers. For example, they periodically clean refrigeration condensers, lubricate mechanical parts, and adjust machines so that they perform properly. Servicers and repairers also do some paperwork, such as filing reports, preparing repair cost estimates, ordering parts, and keeping daily records of merchandise distributed and money collected. However, new machines with computerized inventory controls reduce the paperwork that a servicer must complete.

Work environment. Repairers generally work a total of 40 hours a week. However, vending and amusement machines operate around the clock, so repairers may be on call to work at night and on weekends and holidays.

Some vending and amusement machine repairers work primarily in company repair shops that generally are quiet, well lighted, and have adequate workspace. Others many spend sub-

stantial time on the road, visiting machines wherever they have been placed. Repair work is relatively safe, although servicers and repairers must take care to avoid hazards such as electrical shocks and cuts from sharp tools and other metal objects.

Training, Other Qualifications, and Advancement

Most workers learn their skills on the job. Employers normally hire high school graduates, and give preference to those with high school or vocational school courses in electronics, refrigeration, and machine repair.

Education and training. Electronics have become more prevalent in vending and amusement machines. While employers only require workers to have graduated high school, they give preference to those who have completed programs in basic electronics at vocational high schools and junior colleges. Post-secondary programs in electronics can last 1 to 2 years.

Once hired, new workers are trained informally on the job to fill and fix machines by observing, working with, and receiving instruction from experienced repairers. Beginners start training with simple jobs, such as cleaning or stocking machines. They then learn to rebuild machines by removing defective parts and repairing, adjusting, and testing the machines. Next, they accompany an experienced repairer on service calls and, finally, make visits on their own. This learning process takes from 6



Coin, vending, and amusement machine repairers may make repairs onsite or at their workshop.

months to 2 years, depending on the individual's abilities, previous education, types of machines serviced, and quality of instruction.

To learn about new machines, repairers and servicers sometimes attend training sessions sponsored by manufacturers and distributors. Both trainees and experienced workers sometimes take evening courses in basic electricity, electronics, microwave ovens, refrigeration, and other related subjects to learn about new techniques and equipment.

Other qualifications. Employers usually require applicants to demonstrate mechanical ability, either through related work experience or by scoring well on mechanical-aptitude tests. Because coin, vending, and amusement machine servicers and repairers sometimes handle thousands of dollars in merchandise and cash, employers try to hire persons who are trustworthy and have no criminal record. Also, the ability to deal tactfully with people is important because servicers and repairers play a significant role in relaying customers' requests and concerns. A driver's license and a good driving record are essential for most vending and amusement machine servicer and repairer jobs, and some employers require their servicers to be bonded.

Certification and advancement. The National Automatic Merchandising Association has two self-study technician training programs, one for vending machine repairers and another for machine servicers. Self-study manuals give instruction in subjects such as customer relations, safety, electronics, and reading schematics. Upon completion of the program, repairers must pass a written test to become certified as a technician or journeyman. Certified and other skilled servicers and repairers may be promoted to supervisory jobs or go into business for themselves.

Employment

Coin, vending, and amusement machine servicers and repairers held about 48,000 jobs in 2006. Of these workers, 18 percent were self-employed. Twenty-four percent of these workers were employed by vending machine operators that sell food and other items through machines. Others worked for beverage manufacturing or wholesale companies that have their own machines and for amusement, gambling, and recreation establishments that own video games, jukeboxes, slot machines, and similar types of amusement equipment.

Job Outlook

Employment of coin, vending, and amusement machine servicers and repairers is expected to decline moderately through the year 2016. Opportunities for these workers, however, should be good for those with the proper training or related experience.

Employment change. Employment of coin, vending, and amusement machine services and repairers is expected to decrease by 3 percent between 2006. However, the number of vending machines available to the public is expected to increase. Establishments that are likely to install additional vending machines include industrial plants, hospitals, stores, schools and prisons in order to meet the public demand for inexpensive snacks and other food items. Growth of casino slot machines and coin-operated lottery ticket machines will increase the total number of amusement machines as well.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Coin, vending, and amusement machine servicers and repairers | 49-9091 | 48,000 | 46,000 | -1,400 | -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*.

Despite the expected increase in the number of vending and amusement machines in use, improved technology in newer machines will cause a moderate decline in employment because these machines require less maintenance and need restocking less often. Many will contain computers that record sales and inventory data, reducing the amount of time-consuming paperwork that otherwise would have to be filled out. In addition, some new machines use wireless data transmitters to signal the vending machine company when the machine needs restocking or repairing. This allows servicers and repairers to be dispatched only when needed, instead of having to check each machine on a regular schedule.

Job prospects. Job opportunities should be good for those with training in a related electronic repair field, and who are willing to travel and work at times other than regular business hours. Opportunities will be limited for those with just a high school degree and no training in electronics repair. Job openings will also arise from the need to replace experienced repairers who transfer to other occupations or leave the labor force.

Earnings

Median hourly earnings of coin, vending, and amusement machine servicers and repairers were \$13.80 in May 2006. The middle 50 percent earned between \$10.84 and \$17.23 an hour. The lowest 10 percent earned less than \$8.77 an hour, and the highest 10 percent earned more than \$21.35 an hour. Median hourly earnings were \$12.94 in vending machine operators, the industry employing the largest number of coin, vending, and amusement machine servicers and repairers in May 2006.

Typically, workers who service and repair slot machines in States with some form of legalized gaming have the highest wages. Overtime work usually commands a premium on wages, and some union contracts stipulate higher pay for night work and for emergency repair jobs on weekends and holidays than for regular hours. Some of these workers are members of the International Brotherhood of Teamsters: 17 percent of vending machine repairers and servicers belonged to a union in 2006, as compared with 12 percent for all occupations.

Related Occupations

Other workers who repair equipment with electrical and electronic components include electrical and electronics installers and repairers; electronic home entertainment equipment installers and repairers; heating, air-conditioning, and refrigeration mechanics and installers; and home appliance repairers.

Sources of Additional Information

Information on job opportunities in this field can be obtained from local vending machine firms and local offices of your State employment service.

For general information on vending machine servicing and repair, contact:

➤ National Automatic Merchandising Association, 20 N. Wacker Dr., Suite 3500, Chicago, IL 60606.

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

➤ Vending Times, 1375 Broadway, New York, NY 10018.

Computer, Automated Teller, and Office Machine Repairers

(O*NET 49-2011.00, 49-9091.00)

Significant Points

- Workers qualify for these jobs by receiving training in electronics from associate degree programs, the military, vocational schools, equipment manufacturers, or employers.
- Employment is expected to grow more slowly than the average for all occupations.
- Job prospects will be best for applicants with knowledge of electronics, and who have formal training and repair experience.

Nature of the Work

Computer, automated teller, and office machine repairers install, fix, and maintain many of the machines that are common to businesses and households. Some repairers travel to customers' workplaces or other locations to make the necessary repairs. These workers—known as *field technicians*—often have assigned areas in which they perform preventive maintenance on a regular basis. *Bench technicians* work in repair shops located in stores, factories, or service centers. In small companies, repairers may work both in repair shops and at customer locations.

Computer repairers, also known as *computer service technicians* or *data processing equipment repairers*, service mainframe, server, and personal computers; printers; and auxiliary computer equipment. These workers primarily perform hands-on repair, maintenance, and installation of computers and related equipment. Workers who provide technical assistance, in person or by telephone, to computer system users are known as computer support specialists or computer support technicians. (See the section on computer support specialists and systems administrators elsewhere in the *Handbook*.)

Computer repairers usually replace subsystems instead of repairing them. Replacement is common because subsystems are inexpensive and businesses are reluctant to shut down their

computers for time-consuming repairs. Subsystems commonly replaced by computer repairers include video cards, which transmit signals from the computer to the monitor; hard drives, which store data; and network cards, which allow communication over the network. Defective modules may be given to bench technicians, who use software programs to diagnose the problem and who may repair the modules, if possible.

Office machine and cash register servicers work on photocopiers, cash registers, mail-processing equipment, and fax machines. Newer models of office machinery include computerized components that allow them to function more effectively than earlier models.

Office machine repairers usually work on machinery at the customer's workplace. However, if the machines are small enough, customers may bring them to a repair shop for maintenance. Common malfunctions include paper misfeeds caused by worn or dirty parts, and poor-quality copy resulting from problems with lamps, lenses, or mirrors. These malfunctions usually can be resolved simply by cleaning the relevant components. Breakdowns also may result from the failure of commonly used parts. For example, heavy use of a photocopier may wear down the printhead, which applies ink to the final copy. In such cases, the repairer usually replaces the part instead of repairing it.

Automated teller machine servicers install and repair automated teller machines (ATMs). These machines allow customers to carry out bank transactions without the assistance of a teller. ATMs also provide a growing variety of other services, including stamp, phone card, and ticket sales.

When ATMs malfunction, computer networks recognize the problem and alert repairers. Common problems include worn magnetic heads on card readers, which prevent the equipment from recognizing customers' bankcards, and "pick failures," which prevent the equipment from dispensing the correct amount of cash. Field technicians travel to the locations of ATMs and usually repair equipment by removing and replacing defective components. Broken components are taken to a repair shop, where bench technicians make the necessary repairs. Field technicians perform routine maintenance on a regular basis, replacing worn parts and running diagnostic tests to ensure that the equipment functions properly.

To install large equipment, such as mainframe computers and ATMs, repairers connect the equipment to power sources and communication lines that allow the transmission of information over computer networks. For example, when an ATM dispenses cash, it transmits the withdrawal information to the customer's bank. Workers also may install operating software and peripheral equipment, checking that all components are configured to function together correctly.

Computer, automated teller, and office machine repairers use a variety of tools for diagnostic tests and repair. To diagnose malfunctions, they use multimeters to measure voltage, current, resistance, and other electrical properties; signal generators to provide test signals; and oscilloscopes to monitor equipment signals. To diagnose computerized equipment, repairers use software programs. To repair or adjust equipment, workers use handtools, such as pliers, screwdrivers, soldering irons, and wrenches.



Computer repairers perform hands-on repair, maintenance, and installation of computers and related equipment.

Work environment. Repairers usually work in clean, well-lit surroundings. Because computers and office machines are sensitive to extreme temperatures and humidity, repair shops usually are air-conditioned and well ventilated. Field repairers must travel frequently to various locations to install, maintain, or repair customers' equipment. ATM repairers may have to perform their jobs in small, confined spaces that house the equipment.

Because computers and ATMs are critical for many organizations to function efficiently, data processing equipment repairers and ATM field technicians often work around the clock. Their schedules may include evening, weekend, and holiday shifts, sometimes assigned on the basis of seniority. Office machine and cash register servicers usually work regular business hours because the equipment they repair is not as critical. Most repairers work about 40 hours per week, but about 12 percent work more than 50 hours per week.

Although their jobs are not strenuous, repairers must lift equipment and work in a variety of postures. Repairers of computer monitors need to discharge voltage from the equipment to avoid electrocution. Workers may have to wear protective goggles.

Training, Other Qualifications, and Advancement

Knowledge of electronics is required, and employers prefer workers with formal training. Office machine and ATM repairers usually have an associate degree. Certification is available for entry-level workers, as well as experienced workers seeking advancement.

Education and training. Knowledge of electronics is necessary for employment as a computer, automated teller, or office machine repairer. Employers prefer workers who are certified or who have training in electronics from an associate degree program, the military, a vocational school, or an equipment manufacturer. Employers generally provide some training to

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Computer, automated teller, and office machine repairers..... | 49-2011 | 175,000 | 180,000 | 5,200 | 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*.

new repairers on specific equipment; however, workers are expected to arrive on the job with a basic understanding of equipment repair. Employers may send experienced workers to training sessions to keep up with changes in technology and service procedures.

Most office machine and ATM repairer positions require an associate degree in electronics. A basic understanding of mechanical equipment also is important because many of the parts that fail in office machines and ATMs, such as paper loaders, are mechanical. Entry-level employees at large companies normally receive on-the-job training lasting several months. Such training may include a week of classroom instruction, followed by a period of 2 weeks to several months assisting an experienced repairer.

Certification and other qualifications. Various organizations offer certification. Certification demonstrates a level of competency, and can make an applicant more attractive to employers.

Field technicians work closely with customers and must have good communications skills and a neat appearance. Employers may require that field technicians have a driver's license.

Certification and advancement. Newly hired computer repairers may work on personal computers or peripheral equipment. With experience, they can advance to positions maintaining more sophisticated systems, such as networking equipment and servers. Field repairers of ATMs may advance to bench technician positions responsible for more complex repairs. Experienced workers may become specialists who help other repairers diagnose difficult problems or who work with engineers in designing equipment and developing maintenance procedures. Experienced workers also may move into management positions responsible for supervising other repairers.

Because of their familiarity with equipment, experienced repairers may move into customer service or sales positions. Some experienced workers open their own repair shops or become wholesalers or retailers of electronic equipment.

Certification may also increase one's opportunities for advancement. Certification is available for workers with varying levels of skills and experience. To obtain certification, workers generally must pass an examination corresponding to their skill level.

Employment

Computer, automated teller, and office machine repairers held about 175,000 jobs in 2006. Wholesale trade establishments employed about 31 percent of the workers in this occupation; most of these establishments were wholesalers of professional and commercial equipment and supplies. Many workers also were employed in computer and software stores and office supply stores. Others worked in electronic and precision equipment repair shops and computer systems design firms. About 20 percent of computer, automated teller, and office machine

repairers were self-employed, compared to 7 percent for all installation, maintenance, and repair occupations.

Job Outlook

Employment is expected to grow more slowly than the average for all occupations. Opportunities will be best for applicants with knowledge of electronics, formal training, and previous experience.

Employment change. Employment of computer, automated teller, and office machine repairers is expected to grow by 3 percent from 2006 to 2016, which is slower than the average for all occupations. Limited job growth will be driven by the increasing dependence of business and individuals on computers and other sophisticated office machines. The need to maintain this equipment will create new jobs for repairers.

Although computer equipment continues to become less expensive and more reliable, malfunctions still occur and can cause severe problems for users, most of whom lack the knowledge to make repairs. Computers are critical to most businesses today and will become even more so as companies increasingly engage in electronic commerce, and as individuals continue to bank, shop, and pay bills online.

People also are becoming increasingly reliant on ATMs. Besides offering bank and retail transactions, ATMs provide an increasing number of other services, such as employee information processing and distribution of government payments. The relatively slow rate at which new ATMs are installed, however, and the fact that they are becoming easier to repair, will limit demand for ATM repairers.

Conventional office machines, such as calculators, are inexpensive, and often are replaced instead of repaired. However, digital copiers and other, newer office machines are more costly and complex. This equipment often is computerized, designed to work on a network, and capable of performing multiple functions. But because this equipment is becoming more reliable, job growth in office machine repairers will be limited as well.

Job prospects. In addition to new job growth, a number of openings will result from the need to replace workers who retire or leave the occupation. Job prospects will be best for applicants with knowledge of electronics, formal training, and repair experience.

Earnings

Median hourly earnings of wage-and-salary computer, automated teller, and office machine repairers were \$17.54 in May 2006. The middle 50 percent earned between \$13.56 and \$22.44. The lowest 10 percent earned less than \$10.65, and the highest 10 percent earned more than \$27.36. Median hourly earnings in the industries employing the largest numbers of computer, automated teller, and office machine repairers in May 2006 were:

| | |
|--|---------|
| Computer systems design and related services | \$19.41 |
| Professional and commercial equipment and supplies merchant wholesalers | 19.09 |
| Office supplies, stationery, and gift stores | 16.64 |
| Electronic and precision equipment repair and maintenance..... | 15.82 |
| Computer and software stores..... | 15.20 |
| Electronics and appliance stores | 14.71 |

Related Occupations

Workers in other occupations who repair and maintain electronic equipment include electronic home entertainment equipment installers and repairers; home appliance repairers; broadcast and sound engineering technicians and radio operators; precision instrument and equipment repairers; electrical and electronics installers and repairers; electricians; radio and telecommunications equipment installers and repairers; coin, vending, and amusement machine servicers and repairers; industrial machinery mechanics and maintenance workers; and maintenance and repair workers, general.

Sources of Additional Information

For information on careers and certification, contact:

► ACES International, 5241 Princess Anne Rd., Suite 110, Virginia Beach, VA 23462.

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

► Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: <http://eta-i.org>

► International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107-4527.

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

Diesel Service Technicians and Mechanics

(O*NET 49-3031.00)

Significant Points

- A career in diesel engine repair can offer relatively high wages and the challenge of skilled repair work.
- Opportunities are expected to be very good for people who complete formal training programs.
- National certification is the recognized standard of achievement for diesel service technicians and mechanics.

Nature of the Work

Diesel-powered engines are more efficient and durable than their gasoline-burning counterparts. These powerful engines are standard in our Nation's trucks, locomotives, and buses and are becoming more prevalent in light vehicles, including passenger vehicles, pickups, and other work trucks.

Diesel service technicians and mechanics, including *bus and truck mechanics and diesel engine specialists*, repair and

maintain the diesel engines that power transportation equipment. Some diesel technicians and mechanics also work on other heavy vehicles and mobile equipment, including bulldozers, cranes, road graders, farm tractors, and combines. Other technicians repair diesel-powered passenger automobiles, light trucks, or boats. (For information on technicians and mechanics working primarily on gasoline-powered automobiles, heavy vehicles and mobile equipment, or boat engines, see the *Handbook* sections on automotive service technicians, heavy vehicle and mobile equipment service technicians, and small engine mechanics.)

Increasingly, diesel technicians must be versatile to adapt to customers' needs and new technologies. It is common for technicians to handle all kinds of repairs, working on a vehicle's electrical system one day and doing major engine repairs the next. Diesel maintenance is becoming increasingly complex, as more electronic components are used to control the operation of an engine. For example, microprocessors now regulate and manage fuel timing, increasing the engine's efficiency. Also, new emissions standards require mechanics to retrofit engines with emissions control systems, such as emission filters and catalysts, to comply with pollution regulations. In modern shops, diesel service technicians use hand-held or laptop computers to diagnose problems and adjust engine functions.

Technicians who work for organizations that maintain their own vehicles spend most of their time doing preventive maintenance. During a routine maintenance check, technicians follow a checklist that includes inspecting brake systems, steering mechanisms, wheel bearings, and other important parts. Following inspection, technicians repair or adjust parts that do not work properly or remove and replace parts that cannot be fixed.

Diesel service technicians use a variety of tools in their work, including power tools, such as pneumatic wrenches that remove bolts quickly; machine tools, such as lathes and grinding machines to rebuild brakes; welding and flame-cutting equipment to remove and repair exhaust systems; and jacks and hoists to lift and move large parts. Common handtools—screwdrivers, pliers, and wrenches—are used to work on small parts and get at hard-to-reach places. Diesel service technicians and me-



Diesel service technicians repair and maintain diesel engines in tractor trailers, locomotives, and construction equipment.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Bus and truck mechanics and diesel engine specialists | 49-3031 | 275,000 | 306,000 | 32,000 | 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*.

chanics also use a variety of computerized testing equipment to pinpoint and analyze malfunctions in electrical systems and engines. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment, but workers usually accumulate their own hand tools over time.

Work environment. Technicians normally work in well-lighted and ventilated areas. However, some shops are drafty and noisy. Many employers provide lockers and shower facilities. Diesel technicians usually work indoors, although they occasionally repair vehicles on the road. Diesel technicians may lift heavy parts and tools, handle greasy and dirty parts, and stand or lie in awkward positions while making repairs. Minor cuts, burns, and bruises are common, although serious accidents can usually be avoided when safety procedures are followed. Technicians may work as a team or be assisted by an apprentice or helper when doing heavy work, such as removing engines and transmissions.

Most service technicians work a standard 40-hour week, although some work longer hours, particularly if they are self-employed. A growing number of shops have expanded their hours to speed repairs and offer more convenience to customers. Technicians employed by truck and bus firms providing service around the clock may work evenings, nights, and weekends.

Training, Other Qualifications, and Advancement

Employers prefer to hire graduates of formal training programs because those workers are able to advance quickly to the journey level of diesel service. Other workers who learn diesel engine repair through on-the-job training need 3 to 4 years of experience before becoming journey-level technicians.

Education and training. High school courses in automotive repair, electronics, English, mathematics, and physics provide a strong educational background for a career as a diesel service technician or mechanic. Many mechanics also have additional training after high school.

A large number of community colleges and trade and vocational schools offer programs in diesel engine repair. These programs usually last from 6 months to 2 years and may lead to a certificate of completion or an associate degree. Some offer about 30 hours per week of hands-on training with equipment; others offer more lab or classroom instruction. Formal training provides a foundation in the latest diesel technology and instruction in the service and repair of the equipment that technicians will encounter on the job. Training programs also teach technicians to interpret technical manuals and to communicate well with coworkers and customers. Increasingly, employers work closely with representatives of educational programs, providing instructors with the latest equipment, techniques, and tools and offering jobs to graduates.

Although formal training programs lead to the best prospects, some technicians and mechanics learn through on-the-job training. Unskilled beginners generally are assigned tasks such as cleaning parts, fueling and lubricating vehicles, and driving vehicles into and out of the shop. Beginners are usually promoted to trainee positions as they gain experience and as vacancies become available.

After a few months' experience, most trainees can perform routine service tasks and make minor repairs. These workers advance to increasingly difficult jobs as they prove their ability and competence. After technicians master the repair and service of diesel engines, they learn to work on related components, such as brakes, transmissions, and electrical systems. Generally, technicians with at least 3 to 4 years of on-the-job experience will qualify as journey-level diesel technicians.

Employers often send experienced technicians and mechanics to special training classes conducted by manufacturers and vendors, in which workers learn about the latest technology and repair techniques.

Other qualifications. Employers usually look for applicants who have mechanical aptitude and strong problem-solving skills and who are at least 18 years old and in good physical condition. Technicians need a State commercial driver's license to test-drive trucks or buses on public roads. Many companies also require applicants to pass a drug test. Practical experience in automobile repair at an automotive service station, in the Armed Forces, or as a hobby is valuable as well.

Certification and advancement. Experienced diesel service technicians and mechanics with leadership ability may advance to shop supervisor or service manager, and some open their own repair shops. Technicians and mechanics with sales ability sometimes become sales representatives.

Although national certification is not required for employment, many diesel engine technicians and mechanics find that it increases their ability to advance. Certification by the National Institute for Automotive Service Excellence (ASE) is the recognized industry credential for diesel and other automotive service technicians and mechanics. Diesel service technicians may be certified as master medium/heavy truck technicians, master school bus technicians, or master truck equipment technicians. They may also be certified in specific areas of truck repair, such as drivetrains, brakes, suspension and steering, electrical and electronic systems, or preventive maintenance and inspection. For certification in each area, a technician must pass one or more of the ASE-administered exams and present proof of 2 years of relevant work experience. To remain certified, technicians must be retested every 5 years.

Employment

Diesel service technicians and mechanics held about 275,000 jobs in 2006. These workers were employed in almost every in-

dustry, particularly those that use trucks, buses, and equipment to haul, deliver, and transport materials, goods, and people. The largest employer, the truck transportation industry, employed 1 out of 6 diesel service technicians and mechanics. Less than 1 out of 10 were employed by local governments, mainly to repair school buses, waste removal trucks, and road equipment. A similar number were employed by automotive repair and maintenance facilities. The rest were employed throughout the economy, including construction, manufacturing, retail and wholesale trade, and automotive leasing. About 16,000, a relatively small number, were self-employed. Nearly every area of the country employs diesel service technicians and mechanics, although most work is found in towns and cities where trucking companies, bus lines, and other fleet owners have large operations.

Job Outlook

The number of jobs for diesel service technicians and mechanics is projected to grow about as fast as average. Opportunities should be very good for people who complete formal training in diesel mechanics.

Employment change. Employment of diesel service technicians and mechanics is expected to grow 11 percent from 2006 to 2016, about as fast as the average for all occupations. Additional trucks—and truck repairers—will be needed to keep pace with the increasing volume of freight shipped nationwide. Moreover, the greater durability and economy of the diesel engine relative to the gasoline engine is expected to increase the number of buses, trucks, and other vehicles powered by diesel engines.

And because diesel engines are now cleaner burning and more efficient—to comply with emissions and environmental standards—they are expected to be used in more passenger vehicles, which will create jobs for diesel service technicians and mechanics over the long run. In fact, auto industry executives are projecting more sales of diesel passenger vehicles as gasoline prices increase. In the short-run, many older diesel engines in trucks must be retrofitted to comply with the new emissions regulations, creating more jobs for diesel engine mechanics.

Job prospects. People who enter diesel engine repair will find favorable opportunities, especially as the need to replace workers who retire increases over the next decade. Opportunities should be very good for people who complete formal training in diesel mechanics at community colleges or vocational and technical schools. Applicants without formal training will face stiffer competition for jobs.

Most people entering this occupation can expect relatively steady work because changes in economic conditions have less of an effect on the diesel repair business than on other sectors of the economy. During a downturn in the economy, however, employers may be reluctant to hire new workers.

Earnings

Median hourly earnings of bus and truck mechanics and diesel engine specialists, including incentive pay, were \$18.11 in May 2006, more than the \$17.65 median hourly earnings for all installation, maintenance, and repair occupations. The middle 50 percent earned between \$14.48 and \$22.07 an hour. The lowest 10 percent earned less than \$11.71, and the highest 10 percent

earned more than \$26.50 an hour. Median hourly earnings in the industries employing the largest numbers of bus and truck mechanics and diesel engine specialists in May 2006 were as follows:

| | |
|--|---------|
| Local government | \$21.22 |
| Motor vehicle and motor vehicle parts and supplies merchant wholesalers | 18.27 |
| Automotive repair and maintenance | 17.53 |
| General freight trucking | 17.14 |
| Specialized freight trucking | 16.15 |

Because many experienced technicians employed by truck fleet dealers and independent repair shops receive a commission related to the labor cost charged to the customer, weekly earnings depend on the amount of work completed. Beginners usually earn from 50 to 75 percent of the rate of skilled workers and receive increases as they become more skilled.

About 23 percent of diesel service technicians and mechanics are members of labor unions, including the International Association of Machinists and Aerospace Workers; the Amalgamated Transit Union; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the Transport Workers Union of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters. Labor unions may provide additional benefits for their members.

Related Occupations

Diesel service technicians and mechanics repair trucks, buses, and other diesel-powered equipment. Related technician and mechanic occupations include aircraft and avionics equipment mechanics and service technicians, automotive service technicians and mechanics, heavy vehicle and mobile equipment service technicians and mechanics, and small engine mechanics.

Sources of Additional Information

More details about work opportunities for diesel service technicians and mechanics may be obtained from local employers such as trucking companies, truck dealers, or buslines; locals of the unions previously mentioned; and local offices of your State employment service. Local State employment service offices also may have information about training programs. State boards of postsecondary career schools have information on licensed schools with training programs for diesel service technicians and mechanics.

For general information about a career as a diesel service technician or mechanic, write:

➤ Association of Diesel Specialists, 10 Laboratory Dr., PO Box 13966, Research Triangle Park, NC 27709.

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

Information on how to become a certified diesel technician of medium to heavy-duty vehicles or a certified bus technician is available from:

➤ National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175.

➤ Internet: <http://www.asecert.org>

Electrical and Electronics Installers and Repairers

(O*NET 49-2092.00, 49-2093.00, 49-2094.00, 49-2095.00, 49-2096.00, 49-9031.00)

Significant Points

- Knowledge of electrical equipment and electronics is necessary for employment; employers often prefer applicants with an associate degree in electronics.
- Employment is projected to grow more slowly than average for all occupations.
- Job opportunities will be best for applicants with an associate degree, certification, and related experience.

Nature of the Work

Businesses and other organizations depend on complex electronic equipment for a variety of functions. Industrial controls automatically monitor and direct production processes on the factory floor. Transmitters and antennae provide communication links for many organizations. Electric power companies use electronic equipment to operate and control generating plants, substations, and monitoring equipment. The Federal Government uses radar and missile control systems to provide for the national defense and to direct commercial air traffic. These complex pieces of electronic equipment are installed, maintained, and repaired by electrical and electronics installers and repairers.

Installers and repairers, known as *field technicians*, often travel to factories or other locations to repair equipment. These workers usually have assigned areas in which they perform preventive maintenance on a regular basis. When equipment breaks down, field technicians go to a customer's site to repair the equipment. Bench technicians work in repair shops located in factories and service centers, fixing components that cannot be repaired on the factory floor.

Electrical and electronic equipment are two distinct types of industrial equipment, although much equipment contains both electrical and electronic components. In general, electrical portions provide the power for the equipment, while electronic components control the device, although many types of equipment still are controlled with electrical devices.

Some industrial electronic equipment is self-monitoring and alerts repairers to malfunctions. When equipment breaks down, repairers will first check for common causes of trouble, such as loose connections or obviously defective components. If routine checks do not locate the trouble, repairers may refer to schematics and manufacturers' specifications that show connections and provide instructions on how to locate problems. Automated electronic control systems are becoming increasingly complex, making diagnosis more challenging. With these systems, repairers use software programs and testing equipment to diagnose malfunctions. Among their diagnostic tools are multimeters, which measure voltage, current, and resistance, and

advanced multimeters, which measure capacitance, inductance, and current gain of transistors. Repairers also use signal generators, which provide test signals, and oscilloscopes, which display signals graphically. Finally, repairers use handtools such as pliers, screwdrivers, soldering irons, and wrenches to replace faulty parts and adjust equipment.

Because repairing components is a complex activity and factories cannot allow production equipment to stand idle, repairers on the factory floor usually remove and replace defective units, such as circuit boards, instead of fixing them. Defective units are discarded or returned to the manufacturer or a specialized shop for repair. Bench technicians at these locations have the training, tools, and parts needed to thoroughly diagnose and repair circuit boards or other complex components. These workers also locate and repair circuit defects, such as poorly soldered joints, blown fuses, or malfunctioning transistors.

Electrical and electronics installers often fit older manufacturing equipment with new automated control devices. Older manufacturing machines are frequently in good working order but are limited by inefficient control systems for which replacement parts are no longer available. Installers replace old electronic control units with new programming logic controls (PLCs). Setting up and installing a new PLC involves connecting it to different sensors and electrically powered devices (electric motors, switches, and pumps) and writing a computer program to operate the PLC. Electronics installers coordinate their efforts with those of other workers who are installing and maintaining equipment. (See the section on industrial machinery mechanics and maintenance workers elsewhere in the *Handbook*.)

Electrical and electronics installers and repairers, transportation equipment install, adjust, or maintain mobile electronic communication equipment, including sound, sonar, security, navigation, and surveillance systems on trains, watercraft, or other vehicles. *Electrical and electronics repairers, powerhouse, substation, and relay* inspect, test, maintain, or repair electrical equipment used in generating stations, substations, and in-service relays. These workers may be known as powerhouse electricians, relay technicians, or power transformer repairers. *Electric motor, power tool, and related repairers*—such as armature winders, generator mechanics, and electric golf cart repairers—specialize in installing, maintaining, and repairing electric motors, wiring, or switches.

Electronic equipment installers and repairers, motor vehicles have a significantly different job. They install, diagnose, and repair communication, sound, security, and navigation equipment in motor vehicles. Most installation work involves either new alarm or sound systems. New sound systems vary significantly in cost and complexity of installation. Replacing a head unit (radio) with a new CD player is simple, requiring the removal of a few screws and the connection of a few wires. Installing a new sound system with a subwoofer, amplifier, and fuses is far more complicated. The installer builds a fiberglass or wood box designed to hold the subwoofer and to fit inside the unique dimensions of the automobile. Installing sound-deadening material, which often is necessary with more powerful speakers, requires an installer to remove many parts of a car (for example, seats, carpeting, or interiors of doors), add sound-absorbing



Some repairers install, diagnose, and repair equipment in cars and other motor vehicles.

material in empty spaces, and reinstall the interior parts. The installer also runs new speaker and electrical cables. The new system may require additional fuses, a new electrical line to be run from the battery through a newly drilled hole in the firewall into the interior of the vehicle, or an additional or more powerful alternator or battery. Motor vehicle installers and repairers work with an increasingly complex range of electronic equipment, including DVD players, satellite navigation equipment, passive security systems, and active security systems.

Work environment. Many electrical and electronics installers and repairers work on factory floors, where they are subject to noise, dirt, vibration, and heat. Bench technicians primarily work in repair shops, where the surroundings are relatively quiet, comfortable, and well lighted.

Installers and repairers may have to do heavy lifting and work in a variety of positions. They must follow safety guidelines and often wear protective goggles and hardhats. When working on ladders or on elevated equipment, repairers must wear harnesses to avoid falls. Before repairing a piece of machinery, these workers must follow procedures to ensure that others cannot start the equipment during the repair process. They also must take precautions against electric shock by locking off power to the unit under repair.

Motor vehicle electronic equipment installers and repairers normally work indoors in well-ventilated and well-lighted repair shops. Minor cuts and bruises are common, but serious accidents usually are avoided when safety practices are observed.

Training, Other Qualifications, and Advancement

Applicants with an associate degree in electronics are preferred, and professional certification often is required.

Education and training. Knowledge of electrical equipment and electronics is necessary for employment. Employers often prefer applicants with an associate degree from a community college or technical school, although a high school diploma may be sufficient for some jobs. Entry-level repairers may begin by working with experienced technicians who provide technical guidance, and work independently only after developing the necessary skills.

Certification and other qualifications. Many employers require applicants to be certified. Certification is available from various professional and education organizations, and usually requires applicants to pass an exam demonstrating their level of expertise.

Installers and repairers should have good eyesight and color perception to work with the intricate components used in electronic equipment. Field technicians work closely with customers and should have good communication skills and a neat appearance. Employers also may require that field technicians have a driver's license.

Certification and advancement. Certification can also serve as a form of advancement. Workers who become certified in a specialty area may gain additional responsibilities and be awarded higher pay.

Experienced repairers with advanced training may become specialists or troubleshooters who help other repairers diagnose difficult problems. Workers with leadership ability may become supervisors of other repairers. Some experienced workers open their own repair shops.

Employment

Electrical and electronics installers and repairers held about 169,000 jobs in 2006. The following tabulation breaks down their employment by occupational specialty:

| | |
|---|--------|
| Electrical and electronics repairers, commercial and industrial equipment..... | 80,000 |
| Electric motor, power tool, and related repairers | 25,000 |
| Electrical and electronics repairers, powerhouse, substation, and relay..... | 22,000 |
| Electrical and electronics installers and repairers, transportation equipment | 21,000 |
| Electronic equipment installers and repairers, motor vehicles | 20,000 |

Many repairers worked for utilities; building equipment contractors; machinery and equipment repair shops; electrical and electronics wholesalers; electronics and appliance retailers; motor vehicle and parts dealers; manufacturers of electrical, electronic, and transportation equipment; and Federal, State, and local government.

Job Outlook

Employment is expected to increase more slowly than the average through the year 2016. Job prospects should be best for applicants with an associate degree, certification, and related experience.

Employment change. Overall employment of electrical and electronics installers and repairers is expected to grow by 3 percent through the year 2016, which is slower than the average for all occupations. Growth rates will vary by occupational specialty.

Employment of electrical and electronics installers and repairers of commercial and industrial equipment is expected to grow by 7 percent, which is about as fast as the average for all occupations. This equipment will become more sophisticated and will be used more frequently as businesses strive to lower costs by increasing and improving automation. Companies will

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Electrical and electronics installers and repairers..... | — | 169,000 | 174,000 | 5,200 | 3 |
| Electric motor, power tool, and related repairers..... | 49-2092 | 25,000 | 24,000 | -1,100 | -4 |
| Electrical and electronics installers and repairers, transportation equipment..... | 49-2093 | 21,000 | 22,000 | 900 | 4 |
| Electrical and electronics repairers, commercial and industrial equipment..... | 49-2094 | 80,000 | 86,000 | 5,500 | 7 |
| Electrical and electronics repairers, powerhouse, substation, and relay..... | 49-2095 | 22,000 | 21,000 | -1,000 | -5 |
| Electronic equipment installers and repairers, motor vehicles | 49-2096 | 20,000 | 21,000 | 900 | 5 |

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

install electronic controls, robots, sensors, and other equipment to automate processes such as assembly and testing. In addition, as prices decline, this equipment will be used more frequently throughout a number of industries, including services, utilities, and construction, as well as manufacturing. Improved reliability of equipment should not constrain employment growth, however: companies increasingly will rely on repairers because malfunctions that idle commercial and industrial equipment will continue to be costly.

Employment of motor vehicle electronic equipment installers and repairers is expected to grow by 5 percent, which is slower than the average for all occupations. As motor vehicle manufacturers install more and better sound, security, entertainment, and navigation systems in new vehicles, and as newer electronic systems require progressively less maintenance, employment growth for aftermarket electronic equipment installers will be limited.

Employment of electric motor, power tool, and related repairers is expected to decline slowly, decreasing by 4 percent. Improvements in electrical and electronic equipment design, as well as the increased use of disposable tool parts should suppress job growth.

Employment of electrical and electronic installers and repairers of transportation equipment is expected to grow by 4 percent, which is slower than the average for all occupations. Declining employment in the rail transportation industry will dampen growth in this occupational specialty.

Employment of electrical and electronics installers and repairers, powerhouse, substation, and relay is expected to decline slowly, decreasing by 5 percent. Consolidation and privatization in utilities industries should improve productivity, reducing employment. Newer equipment will be more reliable and easier to repair, further limiting employment.

Job prospects. Job opportunities should be best for applicants with an associate degree in electronics, certification, and related experience. In addition to employment growth, the need to replace workers who transfer to other occupations or leave the labor force will result in some openings.

Earnings

Median hourly earnings of wage-and-salary electrical and electronics repairers, commercial and industrial equipment were \$21.72 in May 2006. The middle 50 percent earned between \$17.18 and \$26.59. The lowest 10 percent earned

less than \$13.43, and the highest 10 percent earned more than \$30.90. In May 2006, median hourly earnings were \$23.49 in the Federal Government and \$19.92 in building equipment contractors, the industries employing the largest numbers of electrical and electronics repairers, commercial and industrial equipment.

Median hourly earnings of wage-and-salary electric motor, power tool, and related repairers were \$15.80 in May 2006. The middle 50 percent earned between \$12.56 and \$20.24. The lowest 10 percent earned less than \$9.97, and the highest 10 percent earned more than \$25.37. In May 2006, median hourly earnings were \$15.32 in commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance, the industry employing the largest number of electronic motor, power tool, and related repairers.

Median hourly earnings of wage-and-salary electrical and electronics repairers, powerhouse, substation, and relay were \$27.60 in May 2006. The middle 50 percent earned between \$23.62 and \$32.07. The lowest 10 percent earned less than \$19.42, and the highest 10 percent earned more than \$35.49. In May 2006, median hourly earnings were \$28.30 in electric power generation, transmission, and distribution, the industry employing the largest number of these repairers.

Median hourly earnings of wage-and-salary electronics installers and repairers, motor vehicles were \$13.57 in May 2006. The middle 50 percent earned between \$10.78 and \$17.41. The lowest 10 percent earned less than \$9.13, and the highest 10 percent earned more than \$23.45.

Median hourly earnings of wage-and-salary electrical and electronics repairers, transportation equipment were \$20.72 in May 2006. The middle 50 percent earned between \$16.79 and \$25.10. The lowest 10 percent earned less than \$13.24, and the highest 10 percent earned more than \$28.78.

Related Occupations

Workers in other occupations who install and repair electronic equipment include broadcast and sound engineering technicians and radio operators; computer, automated teller, and office machine repairers; electronic home entertainment equipment installers and repairers; radio and telecommunications equipment installers and repairers; electricians; elevator installers and repairers; aircraft and avionics equipment mechanics and service technicians; coin, vending, and amuse-

ment machine servicers and repairers; and maintenance and repair workers, general. Industrial machinery mechanics and maintenance workers also install, maintain, and repair industrial machinery.

Sources of Additional Information

For information on careers and certification, contact any of the following organizations:

➤ ACES International, 5241 Princess Anne Rd., Suite 110, Virginia Beach, VA 23462.

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

➤ Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: <http://eta-i.org/>

➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107-4527.

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

For a directory of accredited private trade and technical schools with training programs for diesel service technicians and mechanics, contact:

➤ Accrediting Commission of Career Schools and Colleges of Technology, 2101 Wilson Blvd., Suite 302, Arlington, VA 22201. Internet: <http://www.accsct.org>

➤ National Automotive Technicians Education Foundation, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175.

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

Electronic Home Entertainment Equipment Installers and Repairers

(O*NET 49-2097.00)

Significant Points

- Employers prefer applicants who have basic knowledge and skills in electronics; many applicants gain these skills at vocational training programs and community colleges.
- Employment is expected to grow more slowly than the average for all occupations because it often is cheaper to replace equipment than to repair it.
- Job opportunities will be best for applicants with knowledge of electronics, related hands-on experience, and good customer service skills.

Nature of the Work

Electronic home entertainment equipment installers and repairers—also called *service technicians*—repair a variety of equipment. They may specialize in one type of product, or may be trained in many different ones. The most common products include televisions and radios, stereo components, video and audio disc players, and video cameras. They also install and repair home security systems, intercom equipment, satellite television dishes, and home theater systems, which consist of large-screen televisions and sophisticated surround-sound audio components.

Customers usually bring small, portable equipment to repair shops for servicing. Repairers at these locations, known as *bench technicians*, are equipped with a full array of electronic tools and parts. When larger, less mobile equipment breaks down, customers may pay repairers to come to their homes. These repairers, known as field technicians, travel with a limited set of tools and parts, and attempt to complete the repair at the customer's location. If the job is complex, technicians may bring defective components back to the shop for diagnosis and repair.

When equipment breaks down, repairers check for common causes of trouble, such as dirty or defective components. Many repairs consist simply of cleaning and lubricating equipment. If routine checks do not locate the trouble, repairers may refer to schematics and manufacturers' specifications that provide instructions on how to locate problems. Repairers use a variety of test equipment to diagnose and identify malfunctions. Multimeters detect short circuits, failed capacitors, and blown fuses by measuring voltage, current, and resistance. Color-bar and dot generators provide onscreen test patterns, signal generators test signals, and oscilloscopes and digital storage scopes measure complex waveforms produced by electronic equipment. Repairs may involve removing and replacing a failed capacitor, transistor, or fuse. Repairers use hand tools, such as pliers, screwdrivers, soldering irons, and wrenches, to replace faulty parts. They also make adjustments to equipment, such as focusing and converging the picture of a television set or balancing the audio on a surround-sound system.

Improvements in technology have miniaturized and digitized many audio and video recording devices. Miniaturization has made repair work significantly more difficult because both the components and the acceptable tolerances are smaller. Also, components now are mounted on the surface of circuit boards, instead of plugged into slots, requiring more precise soldering when a new part is installed. Improved technologies have lowered the price of electronic home entertainment equipment to the point where customers often replace broken equipment instead of repairing it.

Work environment. Most repairers work in well-lit electrical repair shops. Field technicians, however, spend



Most home entertainment equipment installers and repairers work in electronic stores.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Electronic home entertainment equipment installers and repairers .. | 49-2097 | 40,000 | 41,000 | 1,200 | 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*.

much time traveling in service vehicles and working in customers' residences.

Repairers may have to work in a variety of positions and carry heavy equipment. Although the work of repairers is comparatively safe, they must take precautions against minor burns and electric shock. Because television monitors carry high voltage even when they are turned off, repairers need to discharge the voltage before servicing such equipment.

Training, Other Qualifications, and Advancement

Employers prefer applicants who have basic electronics skills, good problem-solving skills, and previous repair experience. Good customer service skills are essential for field technicians, as they spend a majority of their time working in customers' homes.

Education and training. Employers prefer applicants who have basic knowledge and skills in electronics as well as previous repair experience. Many applicants gain these skills at vocational training programs and community colleges. Training programs should include both hands-on experience and theoretical education in digital consumer electronics. Entry-level repairers may work closely with more experienced technicians, who provide technical guidance.

Other qualifications. Field technicians work closely with customers and must have good communication skills and a neat appearance. Repairers also must have good problem solving skills, as their main duty is to diagnose and solve problems. Employers also may require that field technicians have a driver's license.

Certification and advancement. Various organizations offer certification for electronic home entertainment equipment installers and repairers. Repairers may specialize in a variety of skill areas, including consumer electronics. To receive certification, repairers must pass qualifying exams corresponding to their level of training and experience.

Experienced repairers with advanced training may become specialists or troubleshooters, helping other repairers to diagnose difficult problems. Workers with leadership ability may become supervisors of other repairers. Some experienced workers open their own repair shops.

Employment

Electronic home entertainment equipment installers and repairers held about 40,000 jobs in 2006. Many repairers worked in electronics and appliance stores that sell and service electronic home entertainment products or in electronic and precision equipment repair and maintenance shops. About 12 percent of electronic home entertainment equipment installers and repairers were self-employed, compared to 7 percent for all installation, maintenance, and repair occupations.

Job Outlook

Employment is expected to increase more slowly than the average for all occupations. Job prospects will be best for applicants with knowledge of electronics, related experience, and good customer service skills.

Employment change. Employment of electronic home entertainment equipment installers and repairers is expected to grow by 3 percent from 2006 to 2016, which is slower than average for all occupations. Demand will be driven by the rising sales of home entertainment equipment.

The need for repairers is expected to grow slowly, however, because home entertainment equipment is less expensive than in the past. As technological developments have lowered the price and improved the reliability of equipment, the demand for repair services has decreased. When a malfunction does occur, it often is cheaper for consumers to replace equipment than to pay for repairs.

Employment growth will be spurred somewhat by the introduction of sophisticated digital equipment, such as high-definition digital televisions and digital camcorders. So long as the price of such equipment remains high, purchasers will be willing to hire repairers when malfunctions occur. There also will be demand to install sophisticated home entertainment systems, such as home theaters.

Job prospects. Job openings will come about because of employment growth and from the need to replace workers who retire or who leave the occupation. Opportunities will be best for applicants with knowledge of electronics and who have related hands-on experience and good customer service skills.

Earnings

Median hourly earnings of wage-and-salary electronic home entertainment equipment installers and repairers were \$14.42 in May 2006. The middle 50 percent earned between \$11.52 and \$18.24. The lowest 10 percent earned less than \$8.96, and the highest 10 percent earned more than \$22.42. In May 2006, median hourly earnings of electronic home entertainment equipment installers and repairers were \$14.46 in electronics and appliance stores and \$13.18 in electronic and precision equipment repair and maintenance.

Related Occupations

Other workers who install, repair, and maintain electronic equipment include computer, automated teller, and office machine repairers; electrical and electronics installers and repairers; radio and telecommunications equipment installers and repairers; precision instrument and equipment repairers; home appliance repairers; coin, vending, and amusement machine servicers and repairers; maintenance and repair workers, general; and electricians.

Sources of Additional Information

For information on careers and certification, contact:

➤ ACES International, 5241 Princess Anne Rd., Suite 110, Virginia Beach, VA 23462.

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

➤ Electronics Technicians Association International, 5 Depot St., Greencastle, IN 46135. Internet: <http://www.eta-i.org>

➤ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107-4527.

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

Heating, Air-Conditioning, and Refrigeration Mechanics and Installers

(O*NET 49-9021.00, 49-9021.01, 49-9021.02)

Significant Points

- Employment is projected to grow as fast as the average.
- Job prospects are expected to be excellent.
- Employers prefer to hire those who have completed technical school training or a formal apprenticeship.

Nature of the Work

Heating and air-conditioning systems control the temperature, humidity, and the total air quality in residential, commercial, industrial, and other buildings. Refrigeration systems make it possible to store and transport food, medicine, and other perishable items. Heating, air-conditioning, and refrigeration mechanics and installers—also called technicians—install, maintain, and repair such systems. Because heating, ventilation, air-conditioning, and refrigeration systems often are referred to as HVACR systems, these workers also may be called HVACR technicians.

Heating, air-conditioning, and refrigeration systems consist of many mechanical, electrical, and electronic components, such as motors, compressors, pumps, fans, ducts, pipes, thermostats, and switches. In central forced air heating systems, for example, a furnace heats air, which is then distributed via a system of metal or fiberglass ducts. Technicians must be able to maintain, diagnose, and correct problems throughout the entire system. To do this, they adjust system controls to recommended settings and test the performance of the system using special tools and test equipment.

Technicians often specialize in either installation or maintenance and repair, although they are trained to do both. They also may specialize in doing heating work or air-conditioning or refrigeration work. Some specialize in one type of equipment—for example, hydronics (water-based heating systems), solar panels, or commercial refrigeration. Some technicians also sell service contracts to their clients. Service contracts provide for regular maintenance of the heating and cooling systems and they help to reduce the seasonal fluctuations of this type of work.

Technicians follow blueprints or other specifications to install oil, gas, electric, solid-fuel, and multiple-fuel heating systems and air-conditioning systems. After putting the equipment in place, they install fuel and water supply lines, air ducts and vents, pumps, and other components. They may connect electrical wiring and controls and check the unit for proper operation. To ensure the proper functioning of the system, furnace installers often use combustion test equipment, such as carbon dioxide testers, carbon monoxide testers, combustion analyzers, and oxygen testers. These tests ensure that the system will operate safely and at peak efficiency.

After a furnace or air-conditioning unit has been installed, technicians often perform routine maintenance and repair work to keep the systems operating efficiently. They may adjust burners and blowers and check for leaks. If the system is not operating properly, they check the thermostat, burner nozzles, controls or other parts to diagnose and correct the problem.

Technicians also install and maintain heat pumps, which are similar to air conditioners but can be reversed so that they both heat and cool a home. Because of the added complexity and the fact that they run both in summer and winter, these systems often require more maintenance and need to be replaced more frequently than traditional furnaces and air conditioners.



Excellent job prospects are expected for heating, air-conditioning, and refrigeration mechanics and installers.

During the summer, when heating systems are not being used, heating equipment technicians do maintenance work, such as replacing filters, ducts, and other parts of the system that may accumulate dust and impurities during the operating season. During the winter, air-conditioning mechanics inspect the systems and do required maintenance, such as overhauling compressors.

Refrigeration mechanics install, service, and repair industrial and commercial refrigerating systems and a variety of refrigeration equipment. They follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, piping, and other components. They connect this equipment to the ductwork, refrigerant lines, and electrical power source. After making the connections, they charge the system with refrigerant, check it for proper operation and leaks, and program control systems.

When air-conditioning and refrigeration technicians service equipment, they must use care to conserve, recover, and recycle the refrigerants used in air-conditioning and refrigeration systems. The release of these refrigerants can be harmful to the environment. Technicians conserve the refrigerant by making sure that there are no leaks in the system; they recover it by venting the refrigerant into proper cylinders; they recycle it for reuse with special filter-dryers; or they ensure that the refrigerant is properly disposed of.

Heating, air-conditioning, and refrigeration mechanics and installers are adept at using a variety of tools, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, measurement gauges, and acetylene torches, to work with refrigerant lines and air ducts. They use voltmeters, thermometers, pressure gauges, manometers, and other testing devices to check airflow, refrigerant pressure, electrical circuits, burners, and other components.

Other craft workers sometimes install or repair cooling and heating systems. For example, on a large air-conditioning installation job, especially where workers are covered by union contracts, ductwork might be done by sheet metal workers and duct installers; electrical work by electricians; and installation of piping, condensers, and other components by pipelayers, plumbers, pipefitters, and steamfitters. Home appliance repairers usually service room air-conditioners and household refrigerators. (Additional information about each of these occupations appears elsewhere in the *Handbook*.)

Work environment. Heating, air-conditioning, and refrigeration mechanics and installers work in homes, retail establishments, hospitals, office buildings, and factories—anywhere there is climate-control equipment that needs to be installed, repaired, or serviced. They may be assigned to specific job sites at the beginning of each day or may be dispatched to a variety of locations if they are making service calls.

Technicians may work outside in cold or hot weather or in buildings that are uncomfortable because the air-conditioning or heating equipment is broken. In addition, technicians might work in awkward or cramped positions and sometimes are required to work in high places. Hazards include electrical shock, burns, muscle strains, and other injuries from handling heavy equipment. Appropriate safety equipment is necessary when handling refrigerants because contact can cause skin damage,

frostbite, or blindness. Inhalation of refrigerants when working in confined spaces also is a possible hazard.

The majority of mechanics and installers work at least a 40-hour week. During peak seasons, they often work overtime or irregular hours. Maintenance workers, including those who provide maintenance services under contract, often work evening or weekend shifts and are on call. Most employers try to provide a full workweek year-round by scheduling both installation and maintenance work, and many manufacturers and contractors now provide or even require year-round service contracts. In most shops that service both heating and air-conditioning equipment, employment is stable throughout the year.

Training, Other Qualifications, and Advancement

Because of the increasing sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those who have completed technical school training or a formal apprenticeship. Some mechanics and installers, however, still learn the trade informally on the job.

Education and training. Many secondary and postsecondary technical and trade schools, junior and community colleges, and the U.S. Armed Forces offer 6-month to 2-year programs in heating, air-conditioning, and refrigeration. Students study theory of temperature control, equipment design and construction, and electronics. They also learn the basics of installation, maintenance, and repair. Three accrediting agencies have set academic standards for HVACR programs. These accrediting bodies are HVAC Excellence, the National Center for Construction Education and Research, and the Partnership for Air-Conditioning, Heating, and Refrigeration Accreditation. After completing these programs, new technicians generally need between an additional 6 months and 2 years of field experience before they are considered proficient.

Many technicians train through apprenticeships. Apprenticeship programs frequently are run by joint committees representing local chapters of the Air-Conditioning Contractors of America, the Mechanical Contractors Association of America, Plumbing-Heating-Cooling Contractors—National Association, and locals of the Sheet Metal Workers' International Association or the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada. Local chapters of the Associated Builders and Contractors and the National Association of Home Builders sponsor other apprenticeship programs. Formal apprenticeship programs normally last 3 to 5 years and combine paid on-the-job training with classroom instruction. Classes include subjects such as the use and care of tools, safety practices, blueprint reading, and the theory and design of heating, ventilation, air-conditioning, and refrigeration systems. In addition to understanding how systems work, technicians must learn about refrigerant products and the legislation and regulations that govern their use.

Applicants for apprenticeships must have a high school diploma or equivalent. Math and reading skills are essential. After completing an apprenticeship program, technicians are considered skilled trades workers and capable of working alone. These programs are also a pathway to certification and, in some cases, college credits.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Heating, air conditioning, and refrigeration mechanics and installers | 49-9021 | 292,000 | 317,000 | 25,000 | 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*.

Those who acquire their skills on the job usually begin by assisting experienced technicians. They may begin by performing simple tasks such as carrying materials, insulating refrigerant lines, or cleaning furnaces. In time, they move on to more difficult tasks, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuits.

Several organizations have begun to offer basic self-study, classroom, and Internet courses for individuals with limited experience.

Licensure. Heating, air-conditioning, and refrigeration mechanics and installers are required to be licensed by some States and localities. Requirements for licensure vary greatly, but all States or localities that require a license have a test that must be passed. The contents of these tests vary by State or locality, with some requiring extensive knowledge of electrical codes and others focusing more on HVACR-specific knowledge. Completion of an apprenticeship program or 2 to 5 years of experience are also common requirements.

In addition, all technicians who purchase or work with refrigerants must be certified in their proper handling. To become certified to purchase and handle refrigerants, technicians must pass a written examination specific to the type of work in which they specialize. The three possible areas of certification are: Type I—servicing small appliances; Type II—high-pressure refrigerants; and Type III—low-pressure refrigerants. Exams are administered by organizations approved by the U.S. Environmental Protection Agency, such as trade schools, unions, contractor associations, or building groups.

Other qualifications. High school courses in shop math, mechanical drawing, applied physics and chemistry, electronics, blueprint reading, and computer applications provide a good background for those interested in entering this occupation. Some knowledge of plumbing or electrical work also is helpful. A basic understanding of electronics is becoming more important because of the increasing use of electronics in equipment controls. Because technicians frequently deal directly with the public, they should be courteous and tactful, especially when dealing with an aggravated customer. They also should be in good physical condition because they sometimes have to lift and move heavy equipment.

Certification and advancement. Throughout the learning process, technicians may have to take a number of tests that measure their skills. For those with relevant coursework and less than 1 year of experience, the industry has developed a series of exams to test basic competency in residential heating and cooling, light commercial heating and cooling, and commercial refrigeration. These are referred to as “Entry-level” certification exams and are commonly conducted at both secondary and postsecondary technical and trade schools. HVACR technicians who have at least 1 year of experience performing installations

and 2 years of experience performing maintenance and repair can take a number of different tests to certify their competency in working with specific types of equipment, such as oil-burning furnaces. These tests are offered through the Refrigeration Service Engineers Society, HVAC Excellence, Carbon Monoxide Safety Association, Air-Conditioning and Refrigeration Safety Coalition, and North American Technician Excellence, Inc., among others. Employers increasingly recommend taking and passing these tests and obtaining certification; doing so may increase advancement opportunities.

Advancement usually takes the form of higher wages. Some technicians, however, may advance to positions as supervisor or service manager. Others may move into sales and marketing. Still others may become building superintendents, cost estimators, system test and balance specialists, or, with the necessary certification, teachers. Those with sufficient money and managerial skill can open their own contracting business.

Employment

Heating, air-conditioning, and refrigeration mechanics and installers held about 292,000 jobs in 2006; about 55 percent worked for plumbing, heating, and air-conditioning contractors. The rest were employed in a variety of industries throughout the country, reflecting a widespread dependence on climate-control systems. Some worked for fuel oil dealers, refrigeration and air-conditioning service and repair shops, schools, and stores that sell heating and air-conditioning systems. Local governments, the Federal Government, hospitals, office buildings, and other organizations that operate large air-conditioning, refrigeration, or heating systems also employed these workers. About 13 percent of these workers were self-employed.

Job Outlook

With average job growth and numerous expected retirements, heating, air-conditioning, and refrigeration mechanics and installers should have excellent employment opportunities.

Employment change. Employment of heating, air-conditioning, and refrigeration mechanics and installers is projected to increase 9 percent during the 2006-16 decade, as fast as the average for all occupations. As the population and stock of buildings grows, so does the demand for residential, commercial, and industrial climate-control systems. Residential HVACR systems generally need replacement after 10 to 15 years; the large number of homes built in recent years will enter this replacement timeframe by 2016. The increased complexity of HVACR systems, which increases the possibility that equipment may malfunction, also will create opportunities for service technicians. A growing focus on improving indoor air quality and the increasing use of refrigerated equipment by a growing number of stores and gasoline stations that sell food

should also create more jobs for heating, air-conditioning, and refrigeration technicians.

Concern for the environment has prompted the development of new energy-saving heating and air-conditioning systems. An emphasis on better energy management should lead to the replacement of older systems and the installation of newer, more efficient systems in existing homes and buildings. Also, demand for maintenance and service work should increase as businesses and homeowners strive to keep increasingly complex systems operating at peak efficiency. Regulations prohibiting the discharge and production of older types of refrigerants that pollute the atmosphere should continue to result in the need to replace many existing air conditioning systems or to modify them to use new environmentally safe refrigerants. The pace of replacement in the commercial and industrial sectors will quicken if Congress or individual States change tax rules designed to encourage companies to buy new HVACR equipment.

Job prospects. Job prospects for heating, air-conditioning, and refrigeration mechanics and installers are expected to be excellent, particularly for those who have completed training from an accredited technical school or a formal apprenticeship. Job opportunities should be best in the fastest growing areas of the country. A growing number of retirements of highly skilled technicians are expected to generate many job openings. Many contractors have reported problems finding enough workers to meet the demand for service and installation of HVACR systems.

Technicians who specialize in installation work may experience periods of unemployment when the level of new construction activity declines, but maintenance and repair work usually remains relatively stable. People and businesses depend on their climate-control or refrigeration systems and must keep them in good working order, regardless of economic conditions.

Earnings

Median hourly wage-and-salary earnings of heating, air-conditioning, and refrigeration mechanics and installers were \$18.11 in May 2006. The middle 50 percent earned between \$14.12 and \$23.32 an hour. The lowest 10 percent earned less than \$11.38, and the top 10 percent earned more than \$28.57. Median hourly earnings in the industries employing the largest numbers of heating, air-conditioning, and refrigeration mechanics and installers were:

| | |
|--|---------|
| Hardware, and plumbing and heating equipment and supplies merchant wholesalers..... | \$20.53 |
| Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance..... | 19.95 |
| Direct selling establishments | 19.12 |
| Plumbing, heating, and air-conditioning contractors | 17.46 |
| Electrical contractors | 16.74 |

Apprentices usually begin at about 50 percent of the wage rate paid to experienced workers. As they gain experience and improve their skills, they receive periodic increases until they reach the wage rate of experienced workers.

Heating, air-conditioning, and refrigeration mechanics and installers enjoy a variety of employer-sponsored benefits. In addition to typical benefits such as health insurance and pen-

sion plans, some employers pay for work-related training and provide uniforms, company vans, and tools.

About 14 percent of heating, air-conditioning, and refrigeration mechanics and installers are members of a union. The unions to which the greatest numbers of mechanics and installers belong are the Sheet Metal Workers International Association and the United Association of Journeymen and Apprentices of the Plumbing and Pipefitting Industry of the United States and Canada.

Related Occupations

Heating, air-conditioning, and refrigeration mechanics and installers work with sheet metal and piping, and repair machinery, such as electrical motors, compressors, and burners. Other workers who have similar skills include boilermakers; home appliance repairers; electricians; sheet metal workers; and pipe-layers, plumbers, pipefitters, and steamfitters.

Sources of Additional Information

For more information about opportunities for training, certification, and employment in this trade, contact local vocational and technical schools; local heating, air-conditioning, and refrigeration contractors; a local of the unions or organizations previously mentioned; a local joint union-management apprenticeship committee; or the nearest office of the State employment service or apprenticeship agency. You can also find information on the registered apprenticeship system with links to State apprenticeship programs on the U.S. Department of Labor's Web site: http://www.doleta.gov/atels_bat Apprenticeship information is also available from the U.S. Department of Labor's toll free helpline: (877) 872-5627.

For information on career opportunities, training, and technician certification, contact:

- Air-Conditioning Contractors of America, 2800 Shirlington Rd., Suite 300, Arlington, VA 22206. Internet: <http://www.acca.org>
- Air-Conditioning and Refrigeration Institute, 4100 North Fairfax Dr., Suite 200, Arlington, VA 22203. Internet: <http://www.coolcareers.org> and <http://www.ari.org>
- Associated Builders and Contractors, Workforce Development Department, 4250 North Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: <http://www.trytools.org>
- Carbon Monoxide Safety Association, P.O. Box 669, Eastlake, CO 80614. Internet: <http://www.cosafety.org>
- Home Builders Institute, National Association of Home Builders, 1201 15th St.NW., 6th Floor, Washington, DC 20005. Internet: <http://www.hbi.org>
- HVAC Excellence, P.O. Box 491, Mt. Prospect, IL 60056. Internet: <http://www.hvacexcellence.org>
- Mechanical Contractors Association of America, Mechanical Service Contractors of America, 1385 Piccard Dr., Rockville, MD 20850. Internet: <http://www.mcaa.org> and <http://www.mcaa.org/msca>
- National Center for Construction Education and Research, P.O. Box 141104, Gainesville, FL 32601. Internet: <http://www.nccer.org>
- National Occupational Competency Testing Institute. Internet: <http://www.nocti.org>

► North American Technician Excellence, 4100 North Fairfax Dr., Suite 210, Arlington, VA 22203.

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

► Plumbing-Heating-Cooling Contractors, 180 S. Washington, St., P.O. Box 6808, Falls Church, VA 22046.

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

► Refrigeration Service Engineers Society, 1666 Rand Rd., Des Plaines, IL 60016. Internet: <http://www.rses.org>

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

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

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

Heavy Vehicle and Mobile Equipment Service Technicians and Mechanics

(O*NET 49-3041.00, 49-3042.00, 49-3043.00)

Significant Points

- Opportunities should be excellent for people with formal postsecondary training in diesel or heavy equipment mechanics; those without formal training will face keen competition.
- This occupation offers relatively high wages and the challenge of skilled repair work.
- Skill in using computerized diagnostic equipment is important in this occupation.

Nature of the Work

Heavy vehicles and mobile equipment are indispensable to many industrial activities from construction to railroads. Various types of equipment move materials, till land, lift beams, and dig earth to pave the way for development and production. Heavy vehicle and mobile equipment service technicians and mechanics repair and maintain engines and hydraulic, transmission, and electrical systems for this equipment. Farm machinery, cranes, bulldozers, and railcars are all examples of heavy vehicles that require such service. (For information on service technicians specializing in diesel engines, see the section on diesel service technicians and mechanics elsewhere in the *Handbook*.)

Service technicians perform routine maintenance checks on agricultural, industrial, construction, and rail equipment. They service fuel, brake, and transmission systems to ensure peak performance, safety, and longevity of the equipment. Maintenance checks and comments from equipment operators usually alert technicians to problems. After locating the problem, these technicians rely on their training and experience to use the best possible technique to solve the problem.

With many types of modern heavy and mobile equipment, technicians can plug diagnostic computers into onboard computers to diagnose a component needing adjustment or repair. If necessary, they may partially dismantle affected components

to examine parts for damage or excessive wear. Then, using hand-held tools, they repair, replace, clean, and lubricate parts as necessary. In some cases, technicians re-calibrate systems by typing codes into the onboard computer. After reassembling the component and testing it for safety, they put it back into the equipment and return the equipment to the field.

Many types of heavy and mobile equipment use hydraulics to raise and lower movable parts. When hydraulic components malfunction, technicians examine them for fluid leaks, ruptured hoses, or worn gaskets on fluid reservoirs. Occasionally, the equipment requires extensive repairs, as when a defective hydraulic pump needs replacing.

Service technicians diagnose electrical problems and adjust or replace defective components. They also disassemble and repair undercarriages and track assemblies. Occasionally, technicians weld broken equipment frames and structural parts, using electric or gas welders.

Technicians use a variety of tools in their work: power tools, such as pneumatic wrenches to remove bolts quickly; machine tools, like lathes and grinding machines, to rebuild brakes; welding and flame-cutting equipment to remove and repair exhaust systems; and jacks and hoists to lift and move large parts. Service technicians also use common hand tools—screwdrivers, pliers, and wrenches—to work on small parts and to get at hard-to-reach places. They may use a variety of computerized testing equipment to pinpoint and analyze malfunctions in electrical systems and other essential systems. Tachometers and dynamometers, for example, serve to locate engine malfunctions. Service technicians also use ohmmeters, ammeters, and voltmeters when working on electrical systems. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment, but hand tools are normally accumulated with experience, and many experienced technicians have thousands of dollars invested in them.

It is common for technicians in large shops to specialize in one or two types of repair. For example, a shop may have individual specialists in major engine repair, transmission work, electrical systems, and suspension or brake systems. Technicians in smaller shops, on the other hand, generally perform multiple functions.



Heavy vehicle service technicians often make repairs at work sites rather than in repair shops.

Technicians also specialize in types of equipment. *Mobile heavy equipment mechanics and service technicians*, for example, keep construction and surface mining equipment, such as bulldozers, cranes, graders, and excavators in working order. Typically, these workers are employed by equipment wholesale distribution and leasing firms, large construction and mining companies, local and Federal governments, and other organizations operating and maintaining heavy machinery and equipment fleets. Service technicians employed by the Federal Government may work on tanks and other armored equipment.

Farm equipment mechanics service, maintain, and repair farm equipment, as well as smaller lawn and garden tractors sold to suburban homeowners. What once was a general repairer's job around the farm has evolved into a specialized technical career. Farmers have increasingly turned to farm equipment dealers to service and repair their equipment because the machinery has grown in complexity. Modern equipment uses more computers, electronics, and hydraulics, making it difficult to perform repairs without specialized training and tools.

Railcar repairers specialize in servicing railroad locomotives and other rolling stock, streetcars and subway cars, or mine cars. Most railcar repairers work for railroads, public and private transit companies, and railcar manufacturers.

Work environment. Heavy vehicle and mobile equipment service technicians usually work indoors. To repair vehicles and equipment, technicians often lift heavy parts and tools, handle greasy and dirty parts, and stand or lie in awkward positions. Minor cuts, burns, and bruises are common, but serious accidents normally are avoided when safety practices are observed. Although some shops are drafty and noisy, technicians usually work in well-lighted and ventilated areas. Many employers provide uniforms, locker rooms, and shower facilities. Mobile heavy equipment mechanics and railcar repairers generally work a standard 40 hour week.

When heavy or mobile equipment breaks down at a construction site, it may be too difficult or expensive to bring into a repair shop, so the shop will send a field service technician to the site to make repairs. Field service technicians work outdoors and spend much of their time away from the shop. Generally, the more experienced service technicians specialize in field service. They drive trucks specially equipped with replacement parts and tools. On occasion, they must travel many miles to reach disabled machinery.

The hours of work for farm equipment mechanics vary according to the season of the year. During the busy planting and harvesting seasons, farm equipment mechanics often work 6 or 7 days a week, 10 to 12 hours daily. In slow winter months, however, mechanics may work fewer than 40 hours a week.

Training, Other Qualifications, and Advancement

Although industry experts recommend that applicants complete a formal diesel or heavy equipment mechanic training program after graduating from high school, many people qualify for service technician jobs by training on the job. Employers seek people with mechanical aptitude who are

knowledgeable about diesel engines, transmissions, electrical systems, computers, and hydraulics.

Education and training. High school courses in automobile repair, physics, chemistry, and mathematics provide a strong foundation for a career as a service technician or mechanic. After high school, those interested in heavy vehicle repair can choose to attend many community colleges and vocational schools that offer programs in diesel technology. Some of these schools tailor programs to heavy equipment mechanics. These programs teach the basics of analytical and diagnostic techniques, electronics, and hydraulics. The increased use of electronics and computers makes training in electronics essential for new heavy and mobile equipment mechanics. Some 1- to 2-year programs lead to a certificate of completion, whereas others lead to an associate degree in diesel or heavy equipment mechanics. Formal training programs enable trainee technicians to advance to the journey, or experienced worker, level sooner than with informal ones.

Entry-level workers with no formal background in heavy vehicle repair begin to perform routine service tasks and make minor repairs after a few months of on-the-job training. As they prove their ability and competence, workers advance to harder jobs. After trainees master the repair and service of diesel engines, they learn to work on related components, such as brakes, transmissions, and electrical systems. Generally, a service technician with at least 3 to 4 years of on-the-job experience is accepted as fully qualified.

Many employers send trainee technicians to training sessions conducted by heavy equipment manufacturers. The sessions, which typically last up to 1 week, provide intensive instruction in the repair of the manufacturer's equipment. Some sessions focus on particular components found in the equipment, such as diesel engines, transmissions, axles, or electrical systems. Other sessions focus on particular types of equipment, such as crawler-loaders and crawler-dozers. When appropriate, experienced technicians attend training sessions to gain familiarity with new technology or equipment.

Other qualifications. Technicians must read and interpret service manuals, so reading ability and communication skills are both important skills to have. The technology used in heavy equipment is becoming more sophisticated, and technicians should feel comfortable with computers and electronics because hand-held diagnostic computers are often used to make engine adjustments and diagnose problems. Experience in the Armed Forces working on diesel engines and heavy equipment provides valuable background for these positions.

Certification and advancement. Industry certification often allows workers to advance faster. Voluntary certification by the National Institute for Automotive Service Excellence is the recognized industry credential for heavy vehicle and mobile equipment service technicians, who may be certified as master medium/heavy truck technicians or in a specific area of heavy-duty equipment repair, such as brakes, electrical systems, or suspension and steering. For certification in each area, technicians must pass a written examination and have at least 2 years of experience. High school, vocational or trade school, or community or junior college training in

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Heavy vehicle and mobile equipment service technicians and mechanics..... | 49-3040 | 188,000 | 206,000 | 18,000 | 10 |
| Farm equipment mechanics | 49-3041 | 31,000 | 31,000 | 400 | 1 |
| Mobile heavy equipment mechanics, except engines | 49-3042 | 131,000 | 147,000 | 16,000 | 12 |
| Rail car repairers..... | 49-3043 | 27,000 | 28,000 | 1,300 | 5 |

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

gasoline or diesel engine repair may substitute for up to 1 year of experience. To remain certified, technicians must be retested every 5 years.

Experienced technicians may advance to field service jobs, where they have a greater opportunity to tackle problems independently and earn additional pay. Field positions may require a commercial driver's license and a clean driving record. Technicians with administrative ability may become shop supervisors or service managers. Some technicians open their own repair shops or invest in a franchise.

Employment

Heavy vehicle and mobile equipment service technicians and mechanics held about 188,000 jobs in 2006. Approximately 131,000 were mobile heavy equipment mechanics, 31,000 were farm equipment mechanics, and 27,000 were railcar repairers.

About 29 percent were employed by machinery, equipment, and supplies merchant wholesalers. About 14 percent worked in construction, primarily for specialty trade contractors and highway, street, and bridge construction companies; another 13 percent were employed by Federal, State, and local governments. Other service technicians worked in agriculture; mining; rail transportation and support activities; and commercial and industrial machinery and equipment rental, leasing, and repair. A small number repaired equipment for machinery and railroad rolling stock manufacturers or lawn and garden equipment and supplies stores. About 5 percent of service technicians were self-employed.

Nearly every area of the country employs heavy and mobile equipment service technicians and mechanics, although most work in towns and cities where equipment dealers, equipment rental and leasing companies, and construction companies have repair facilities.

Job Outlook

The number of heavy vehicle and mobile equipment service technicians and mechanics is expected to grow about as fast as average. Those who have completed postsecondary training programs should find excellent opportunities, but those without a formal background in diesel engine or heavy vehicle repair will face keen competition.

Employment change. Employment of heavy vehicle and mobile equipment service technicians and mechanics is expected to grow by 10 percent through the year 2016, about as fast as the average for all occupations. Increasing numbers of heavy duty and mobile equipment service technicians

will be required to support growth in the construction and mining industries. Additionally, the agriculture and railroad industries are projected to see more demand over the decade, potentially generating new jobs for farm equipment and railcar repairers, although job opportunities for these repairers will not be as numerous. Finally, as this equipment becomes more complex, repairs increasingly must be made by specially trained technicians. In large part, these service jobs will be with wholesale equipment dealers and rental and leasing companies who do much of the repair work associated with heavy vehicles and mobile equipment.

Job prospects. Opportunities for heavy vehicle and mobile equipment service technicians and mechanics should be excellent for those who have completed formal training programs in diesel or heavy equipment mechanics. People without formal training are expected to encounter growing difficulty entering these jobs.

Most job openings for mobile, rail, and farm equipment technicians will arise from the need to replace experienced repairers who retire. Employers report difficulty finding candidates with formal postsecondary training to fill available service technician positions. This is often because young people with mechanic training and experience opt to take jobs as automotive service technicians or diesel service technicians—jobs that offer more openings and a wider variety of locations in which to work.

Construction and mining operations, which use large numbers of heavy vehicles and mobile equipment, are particularly sensitive to changes in the level of economic activity. While the increased use of such equipment increases the need for periodic service and repair, heavy and mobile equipment may be idle during downturns. Thus, opportunities for service technicians that work on construction and mining equipment may fluctuate with the Nation's economic cycle. In addition, opportunities for farm equipment mechanics are seasonal and are best in warmer months.

Earnings

Median hourly earnings of mobile heavy equipment mechanics were \$19.44 in May 2006, as compared to \$17.65 per hour for all installation, maintenance, and repair occupations. The middle 50 percent earned between \$15.65 and \$23.45. The lowest 10 percent earned less than \$12.64, and the highest 10 percent earned more than \$28.18. Median hourly earnings in the industries employing the largest numbers of mobile heavy equipment mechanics were as follows:

| | |
|---|---------|
| Federal Government..... | \$21.96 |
| Local government | 20.33 |
| Machinery, equipment, and supplies merchant wholesalers..... | 19.15 |
| Commercial and industrial machinery and equipment rental and leasing | 18.73 |
| Other specialty trade contractors | 18.63 |

Median hourly earnings of farm equipment mechanics were \$14.16 in May 2006. The middle 50 percent earned between \$11.34 and \$17.35. The lowest 10 percent earned less than \$9.30, and the highest 10 percent earned more than \$20.77. In machinery, equipment, and supplies merchant wholesalers, the industry employing the largest number of farm equipment mechanics, median earnings were \$14.37.

Median hourly earnings of railcar repairers were \$20.82 in May 2006. The middle 50 percent earned between \$16.75 and \$24.71. The lowest 10 percent earned less than \$12.48, and the highest 10 percent earned more than \$28.02. Median hourly earnings were \$21.63 in rail transportation, the industry employing the largest number of railcar repairers.

Field technicians normally earn a higher wage than their counterparts because they are required to make on-the-spot decisions to serve their customers.

About 23 percent of heavy vehicle and mobile equipment service technicians and mechanics are members of unions, including the International Association of Machinists and Aerospace Workers, the International Union of Operating Engineers, and the International Brotherhood of Teamsters. Members may enjoy job benefits in addition to what employers provide.

Related Occupations

Workers in related repair occupations include aircraft and avionics equipment mechanics and service technicians; automotive service technicians and mechanics; diesel service technicians and mechanics; industrial machinery mechanics and maintenance workers; and small engine mechanics.

Sources of Additional Information

More details about job openings for heavy vehicle and mobile equipment service technicians and mechanics may be obtained from local heavy and mobile equipment dealers and distributors, construction contractors, and government agencies. Local offices of the State employment service also may have information on job openings and training programs.

For general information about a career as a heavy vehicle and mobile equipment service technician or mechanic, contact:

► The AED Foundation (Associated Equipment Dealers affiliate), 615 W. 22nd St., Oak Brook, IL 60523.

Internet: <http://www.aedcareers.com>

A list of certified diesel service technician training programs can be obtained from:

► National Automotive Technician Education Foundation (NATEF), 101 Blue Seal Dr., Suite 101, Leesburg, VA 20175.

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

Information on certification as a heavy-duty diesel service technician is available from:

► National Institute for Automotive Service Excellence (ASE), 101 Blue Seal Dr. SE, Suite 101, Leesburg, VA 20175.

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

Home Appliance Repairers

(O*NET 49-9031.00)

Significant Points

- Little or no change in employment is projected; however, very good job opportunities are expected, particularly for those with formal training in appliance repair and electronics.
- Workers learn on the job; good customer service skills and a driver's license are essential.

Nature of the Work

Home appliance repairers, also known as in-home service professionals, install and repair home appliances. Some repairers work on small appliances such as microwave ovens and vacuum cleaners. Others specialize in major appliances such as refrigerators, dishwashers, washers and dryers, and window air conditioning units. (Workers whose primary responsibility is the installation and repair of heating and central air conditioning units are covered in a separate *Handbook* statement on heating, air conditioning and refrigeration mechanics and installers—although some worker responsibilities may overlap.) Home appliance repairers install household durable goods such as refrigerators, washing machines, and cooking products. They may have to install pipes in a customer's home to connect the appliances to a gas or water line. In these cases, once the lines are in place, they turn on the gas or water and check for leaks. Home appliance repairers also answer customers' questions about the care and use of appliances.

When problems with home appliances occur, home appliance repairers visually inspect the appliance and check for unusual noises, excessive vibration, leakage of fluid, or loose parts to determine the cause of the failure. Repairers disassemble the appliance to examine its internal parts for signs of wear or corrosion. They follow service manuals and use testing devices such as ammeters, voltmeters, and wattmeters to check electrical systems for shorts and faulty connections.

After identifying problems, home appliance repairers 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 handtools, including screwdrivers, wrenches, files, and pliers, as well as soldering guns and tools designed for specific appliances. When repairing appliances with electronic parts, they may replace circuit boards or other electronic components.

When repairing refrigerators and window air-conditioners, repairers must take care to conserve, recover, and recycle chlorofluorocarbon (CFC) and hydrochlorofluorocarbon (HCFC) refrigerants used in the cooling systems, as is required by law. Federal regulations also require that home appliance repairers document the capture and disposal of refrigerants.

Repairers write up estimates of the cost of repairs for customers, keep records of parts used and hours worked, prepare bills, and collect payments. If an appliance is still under warranty, self-employed repairers will talk with the original

appliance manufacturer to recoup monetary claims for work performed.

Work environment. Home appliance repairers who handle portable appliances usually work in quiet and adequately lighted and ventilated repair shops. Those who repair major appliances may spend several hours a day driving to and from appointments and emergency calls. Repairers sometimes work in cramped and uncomfortable positions when they are replacing parts in hard-to-reach areas of appliances. Repairer jobs generally are not hazardous, but workers must exercise care and follow safety precautions to avoid electrical shocks and gas leaks, and prevent injuries when lifting and moving large appliances.

Home appliance repairers usually work with little or no direct supervision. Many home appliance repairers work a standard 40-hour week, but may work overtime and weekend hours in the summer months, when they are in high demand to fix refrigerators and window mounted air-conditioners. Some repairers work early morning, evening, and weekend shifts and may remain on call in case of an emergency.

Training, Other Qualifications, and Advancement

Most entry-level workers in this profession enter without any specific training or experience and learn on the job, although



Home appliance repairers often make house calls to diagnose and fix stoves, refrigerators, dishwashers, or other appliances.

employers prefer to hire those who have completed programs in electronics or appliance repair. A driver's license and good customer service skills are essential to work on appliances in customer's homes.

Education and training. Most home appliance repairers enter the occupation with a high school diploma or its equivalent and very little training in repairing appliances. Most learn their jobs while working with more experienced workers, which can last from several months to a few years. In businesses that fix portable appliances in a repair shop, trainees work on a single type of appliance, such as a vacuum cleaner, until they master its repair. Then they move on to others, until they can work on all appliances repaired by the shop. In companies that repair major appliances, beginners assist experienced repairers on service visits. Up to 3 years of on-the-job training may be needed for a technician to become skilled in all aspects of repair.

While on-the-job training is the most common method of training, employers prefer to hire students of appliance repair or electronics programs offered in high school vocational programs, postsecondary technical schools or community colleges. These programs can last 1 to 2 years and include courses in basic electricity and electronics as most home appliances contain electronic components. These programs can help reduce the amount of on-the-job training required for entry-level workers.

Whether their basic skills are developed through formal training or on the job, trainees usually receive additional training from their employer and from manufacturers. 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. Repairers authorized for warranty work by manufacturers are required to attend periodic training sessions.

Licensure. The U.S. Environmental Protection Agency (EPA) has mandated that all repairers who buy or work with refrigerants pass a written examination to become certified in their proper handling. Exams are administered by EPA-approved organizations, such as trade schools, unions, and employer associations. There also are EPA-approved take-home certification exams. Although no formal training is required for certification, many of these organizations offer training programs designed to prepare workers for the certification examination.

A driver's license is necessary in order to drive to customer's homes.

Certification and other qualifications. Mechanical and electrical aptitudes are desirable, and those who work in customers' homes must be courteous and tactful. Those who are self-employed need good business and financial skills to maintain a business.

Home appliance repairers may exhibit their competence by passing one of several certification examinations offered by various organizations. Although voluntary, such certifications can be helpful when seeking employment. The National Ap-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Home appliance repairers | 49-9031 | 57,000 | 58,000 | 900 | 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*.

pliance Service Technician Certification (NASTeC), which is administered by the International Society of Certified Electronics Technicians (ISCET), requires repairers to pass a comprehensive examination that tests their competence in the diagnosis, repair, and maintenance of major home appliances. The Professional Service Association (PSA) administers a similar certification program. Those who pass the PSA examination earn the Certified Appliance Professional (CAP) designation.

Advancement. Repairers in large shops or service centers may be promoted to supervisor, assistant service manager, or service manager. Some repairers advance to managerial positions such as regional service manager or parts manager for appliance or tool manufacturers. Experienced repairers who have sufficient funds and knowledge of small-business management may open their own repair shops.

Employment

Many communities across the country employ home appliance repairers, but a high concentration of jobs can be found in more populated areas. Home appliance repairers held 57,000 jobs in 2006. About 36 percent of salaried repairers worked for retail trade establishments such as department stores and electronics and appliance stores. About 27 percent of repairers were self-employed. Another 21 percent work in household goods repair and maintenance.

Job Outlook

Little or no change in employment of home appliance repairers is projected. However, very good job opportunities are expected, particularly for individuals with formal training in appliance repair and electronics.

Employment change. The number of home appliance repairers will grow 2 percent between 2006 and 2016, reflecting little or no change. The number of home appliances in use is expected to increase with growth in the numbers of households. The decision to repair an appliance, however, often depends on the price to replace the appliance versus the cost to make the repairs. So while higher priced major appliances designed to have a long life are more likely to be repaired, small appliances are apt to be discarded rather than be repaired. With sales of high-end appliances growing, demand for major appliance repairers should be strong into the future.

Job prospects. In addition to new jobs created over the 2006-16 period, openings will arise as home appliance repairers retire or transfer to other occupations. Very good job opportunities are expected, with job openings continuing to outnumber jobseekers. Individuals with formal training in appliance repair and electronics should have the best opportunities.

Jobs are expected to be increasingly concentrated in larger companies as the number of smaller shops and family-owned

businesses decline. Employment is relatively steady and workers are rarely laid off because demand for major appliance repair services is fairly constant.

Earnings

Median hourly earnings, including commissions, of home appliance repairers were \$16.28 in May 2006. The middle 50 percent earned between \$12.37 and \$20.79 a year. The lowest 10 percent earned less than \$9.37, and the highest 10 percent earned more than \$25.84 a year. In May 2006, median hourly earnings of home appliance repairers in the largest employing industries were \$15.18 in electronics and appliance stores and \$17.02 in personal and household goods repair and maintenance.

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

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

Related Occupations

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

Sources of Additional Information

For general information on home appliance repairers, contact the following organizations:

- ▶ National Appliance Service Association, P.O. Box 2514, Kokomo, IN 46904.
- ▶ United Servicers Association, Inc., P.O. Box 31006, Albuquerque, NM 87190.

Internet: <http://www.unitedservicers.com>

For information on the National Appliance Service Technician Certification program, contact:

- ▶ International Society of Certified Electronics Technicians, 3608 Pershing Ave., Fort Worth, TX 76107.

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

For information on the Certified Appliance Professional program, contact:

- ▶ Professional Service Association, 71 Columbia St., Cohoes, NY 12047. Internet: <http://www.psaworld.com>

Industrial Machinery Mechanics and Maintenance Workers

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

Significant Points

- Most of these workers are employed in manufacturing, but a growing number work for industrial equipment dealers and repair shops.
- Machinery maintenance workers learn on the job, while industrial machinery mechanics usually need some education after high school plus experience working on specific machines.
- Applicants with broad skills in machine repair and maintenance should have favorable job prospects.

Nature of the Work

Imagine an automobile assembly line: a large conveyor system moves unfinished automobiles down the line, giant robotic welding arms bond the different body panels together, hydraulic lifts move the motor into the body of the car, and giant presses stamp body parts from flat sheets of steel. All of these machines—the hydraulic lifts, the robotic welders, the conveyor system, and the giant presses—sometimes break down. When the assembly line stops because a machine breaks down, it costs the company money. Industrial machinery mechanics and machinery maintenance workers maintain and repair these very different, and often very expensive, machines.

The most basic tasks are performed by *machinery maintenance workers*. These employees are responsible for cleaning and lubricating machinery, performing basic diagnostic tests, checking performance, and testing damaged machine parts to determine whether major repairs are necessary. In carrying out these tasks, maintenance workers must follow machine specifications and adhere to maintenance schedules. Maintenance workers may perform minor repairs, but major repairs are generally left to machinery mechanics.

Industrial machinery mechanics, also called industrial machinery repairers or maintenance machinists, are highly skilled workers who maintain and repair machinery in a plant or factory. To do this effectively, they must be able to detect minor problems and correct them before they become major. Machinery mechanics use technical manuals, their understanding of the equipment, and careful observation to discover the cause of the problem. For example, after hearing a vibration from a machine, the mechanic must decide whether it is due to worn belts, weak motor bearings, or some other problem. Mechanics need years of training and experience to diagnose problems, but computerized diagnostic systems and vibration analysis techniques provide aid in determining the nature of the problem.

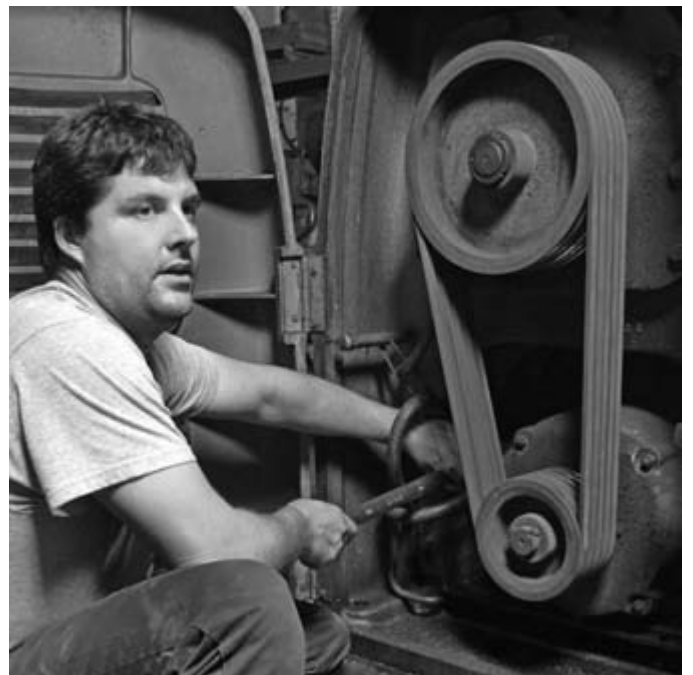
After diagnosing the problem, the industrial machinery mechanic disassembles the equipment to repair or replace the necessary parts. When repairing electronically controlled machinery, mechanics may work closely with electronic repairers or electricians who maintain the machine's electronic parts.

(Electrical and electronic installers and repairers, as well as electricians, appear elsewhere in the *Handbook*.) Increasingly, mechanics are expected to have the electrical, electronics, and computer programming skills to repair sophisticated equipment on their own. Once a repair is made, mechanics perform tests to ensure that the machine is running smoothly.

Primary responsibilities of industrial machinery mechanics also often include preventive maintenance and the installation of new machinery. For example, they adjust and calibrate automated manufacturing equipment, such as industrial robots. Part of setting up equipment is programming the programmable logic control (PLC), a frequently used type of computer used as the control system for automated industrial machines. Situating and installing machinery has traditionally been the job of millwrights, but as plants retool and invest in new equipment, companies increasingly rely on mechanics to do this task for some machinery. (A section on millwrights appears elsewhere in the *Handbook*.)

Industrial machinery mechanics and machinery maintenance workers use a variety of tools to perform repairs and preventive maintenance. They may use handtools to adjust a motor or a chain hoist to lift a heavy printing press off the ground. When replacements for broken or defective parts are not readily available, or when a machine must be quickly returned to production, mechanics may create a new part using lathes, grinders, or drill presses. Mechanics use catalogs to order replacement parts and often follow blueprints, technical manuals, and engineering specifications to maintain and fix equipment. By keeping complete and up-to-date records, mechanics try to anticipate trouble and service equipment before factory production is interrupted.

Work environment. In production facilities, these workers are subject to common shop injuries such as cuts, bruises, and strains. They also may work in awkward positions, including



Industrial machinery mechanics and maintenance workers replace worn drive belts.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Industrial machinery mechanics and maintenance workers..... | — | 345,000 | 368,000 | 23,000 | 7 |
| Industrial machinery mechanics | 49-9041 | 261,000 | 284,000 | 24,000 | 9 |
| Maintenance workers, machinery | 49-9043 | 84,000 | 83,000 | -900 | -1 |

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

on top of ladders or in cramped conditions under large machinery, which exposes them to additional hazards. They often use protective equipment such as hardhats, safety glasses, steel-tipped shoes, hearing protectors, and belts.

Because factories and other facilities cannot afford to have industrial machinery out of service for long periods, mechanics may be on call or assigned to work nights or on weekends. Overtime is common among full-time industrial machinery mechanics; about 30 percent work over 40 hours a week.

Training, Other Qualifications, and Advancement

Machinery maintenance workers can usually get a job with little more than a high school diploma or its equivalent—most learn on the job. Industrial machinery mechanics, on the other hand, usually need some education after high school plus experience working on specific machines before they can be considered a mechanic.

Education and training. Employers prefer to hire those who have taken courses in mechanical drawing, mathematics, blueprint reading, computer programming, or electronics. Entry-level machinery maintenance worker positions generally require a high school diploma, GED, or its equivalent. However, employers increasingly prefer to hire machinery maintenance workers with some training in industrial technology or an area of it, such as fluid power. Machinery maintenance workers typically receive on-the-job training lasting a few months to a year to perform routine tasks, such as setting up, cleaning, lubricating, and starting machinery. This training may be offered by experienced workers, professional trainers, or representatives of equipment manufacturers.

Industrial machinery mechanics usually need a year or more of formal education and training after high school to learn the growing range of mechanical and technical skills that they need. While mechanics used to specialize in one area, such as hydraulics or electronics, many factories now require every mechanic to have knowledge of electricity, electronics, hydraulics, and computer programming.

Workers can get this training in a number of different ways. Experience in the military repairing equipment, particularly ships, is highly valued by employers. Also, 2-year associate degree programs in industrial maintenance are good preparation. Some employers offer 4-year apprenticeship programs that combine classroom instruction with paid on-the-job-training. Apprenticeship programs usually are sponsored by a local trade union. Other mechanics may start as helpers or in other factory jobs and learn the skills of the trade informally and by taking courses offered through their employer. Classroom instruction focuses on subjects such as shop mathematics, blueprint reading, welding, electronics, and computer training. In addition to

classroom training, it is important that mechanics train on the specific machines they will repair. They can get this training on the job, through dealer or manufacturer's representatives or in a classroom.

Other qualifications. Mechanical aptitude and manual dexterity are important for workers in this occupation. Good reading comprehension is also necessary to understand the technical manuals of a wide range of machines. And, good physical conditioning and agility are necessary because repairers sometimes have to lift heavy objects or climb to reach equipment.

Advancement. Opportunities for advancement vary by specialty. Machinery maintenance workers, if they take classes and gain additional skills, may advance to industrial machinery mechanic or supervisor. Industrial machinery mechanics also advance by working with more complicated equipment and gaining additional repair skills. The most highly skilled repairers can be promoted to supervisor, master mechanic, or millwright.

Employment

Industrial machinery mechanics and maintenance workers held about 345,000 jobs in 2006. Of these, 261,000 were held by the more highly skilled industrial machinery mechanics, while machinery maintenance workers accounted for 84,000 jobs. The majority of both types of workers were employed in the manufacturing sector in industries such as food processing and chemical, fabricated metal product, machinery, and motor vehicle and parts manufacturing. Additionally, about 9 percent work in wholesale trade, mostly for dealers of industrial equipment. Manufacturers often rely on these dealers to make complex repairs to specific machines. About 7 percent of mechanics work for the commercial and industrial machinery and equipment repair and maintenance industry, often making site visits to companies to repair equipment. Local governments employ a number of machinery maintenance workers, but few mechanics.

Job Outlook

Employment of industrial machinery mechanics and maintenance workers is projected to grow about as fast as average, and job prospects should be favorable for those with a variety of repair skills.

Employment change. Employment of industrial machinery mechanics and maintenance workers is expected to grow 7 percent from 2006 to 2016, about as fast as the average for all occupations. As factories become increasingly automated, these workers will be needed to maintain and repair the automated equipment. However, many new machines are more reliable

and capable of self-diagnosis, making repairs easier and quicker and somewhat slowing the growth of repairer jobs.

Industrial machinery mechanics and maintenance workers are not as affected by changes in production levels as other manufacturing workers. During slack periods, when some plant workers are laid off, mechanics often are retained to do major overhaul jobs and to keep expensive machinery in working order. In addition, replacing highly skilled and experienced industrial maintenance workers is quite difficult, which discourages lay-offs.

Job prospects. Applicants with broad skills in machine repair and maintenance should have favorable job prospects. Many mechanics are expected to retire in coming years, and employers have reported difficulty in recruiting young workers with the necessary skills to be industrial machinery mechanics. In addition to openings from growth, most job openings will stem from the need to replace workers who transfer to other occupations or who retire or leave the labor force for other reasons.

Earnings

Median hourly wage-and-salary earnings of industrial machinery mechanics were \$19.74 in May 2006. The middle 50 percent earned between \$15.87 and \$24.46. The lowest 10 percent earned less than \$12.84, and the highest 10 percent earned more than \$29.85.

Machinery maintenance workers earned somewhat less than the higher skilled industrial machinery mechanics. Median hourly wage-and-salary earnings of machinery maintenance workers were \$16.61 in May 2006. The middle 50 percent earned between \$12.91 and \$21.53. The lowest 10 percent earned less than \$10.29, and the highest 10 percent earned more than \$26.46.

Earnings vary by industry and geographic region. Median hourly wage-and-salary earnings in the industries employing the largest numbers of industrial machinery mechanics are:

| | |
|---|---------|
| Electric power generation, transmission, and distribution | \$26.02 |
| Motor vehicle parts manufacturing | 24.97 |
| Machinery, equipment, and supplies merchant wholesalers..... | 18.94 |
| Plastics product manufacturing | 18.79 |
| Commercial and industrial machinery and equipment (except automotive and electronic) repair and maintenance..... | 17.78 |

About 18 percent of industrial machinery mechanics and maintenance workers are union members. Labor unions that represent these workers include the United Steelworkers of America; the United Auto Workers; the International Association of Machinists and Aerospace Workers; the United Brotherhood of Carpenters and Joiners of America; and the International Union of Electronic, Electrical, Salaried, Machine, and Furniture Workers-Communications Workers of America.

Related Occupations

Other occupations that involve repairing and maintaining industrial machinery include machinists; maintenance and repair workers, general; millwrights; electrical and electronics install-

ers and repairers; electricians; and pipelayers, plumbers, pipefitters, and steamfitters.

Sources of Additional Information

Information about employment and apprenticeship opportunities may be obtained from local employers and from local offices of the State employment service. For further information on apprenticeship programs, write to the Apprenticeship Council of your State's labor department or local firms that employ machinery mechanics and repairers. You can also find information on registered apprenticeships, together with links to State apprenticeship programs, on the U.S. Department of Labor'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

Line Installers and Repairers

(O*NET 49-9051.00, 49-9052.00)

Significant Points

- Earnings are higher than in most other occupations that do not require postsecondary education.
- A growing number of retirements should create very good job opportunities, especially for electrical power-line installers and repairers.
- Line installers and repairers often work outdoors, and conditions can be hazardous.
- Most line installers and repairers require several years of long-term on-the-job training.

Nature of the Work

Line installers and repairers work on the vast networks of wires and cables that provide customers with electrical power and voice, video and data communications services. *Electrical power-line installers and repairers*, also called *line erectors*, install and maintain the networks of powerlines that go from generating plants to the customer. *Telecommunications line installers and repairers* install and repair the lines and cable that provide such services as cable television, telephone service, and the Internet to residential and commercial customers.

All line installers construct new lines by erecting utility poles and towers, or digging underground trenches, to carry the wires and cables. They may use a variety of construction equipment, including digger derricks, trenchers, cable plows, and borers. Digger derricks are trucks equipped with augers and cranes. Workers use augers to dig holes in the ground and use cranes to set utility poles in place. Trenchers and cable plows are used to cut openings in the earth for the laying of underground cables. Borers, which tunnel under the earth, are used to install tubes for the wire without opening a trench in the soil.

When construction is complete, line installers string cable along poles and towers or through tunnels and trenches. While working on poles and towers, installers use truck-mounted buckets to elevate themselves to the top of the structure, but

sometimes they have to physically climb the pole or tower. Next, they pull up cable from large reels mounted on trucks, set the line in place, and pull up the slack so that it has the correct amount of tension. Finally, line installers attach the cable securely to the structure using hand and hydraulic tools. When working with electrical powerlines, installers bolt or clamp insulators onto the poles before attaching the cable. Underground cable is laid directly in a trench, pulled through a tunnel, or strung through a conduit running through a trench.

Other installation duties include setting up service for customers and installing network equipment. To set up service, line installers string cable between the customers' premises and the nearest lines running on poles or towers or in trenches. They connect wiring to houses and check the connection for proper voltage readings. Line installers also may install a variety of network equipment. When setting up telephone and cable television lines, they install amplifiers and repeaters that maintain the strength of communications transmissions. When running electrical powerlines, they install and replace transformers, circuitbreakers, switches, fuses, and other equipment to control and direct the electrical current.

In addition to installation, line installers and repairers are responsible for maintenance of electrical, telecommunications, and cable television lines. Workers periodically travel in trucks, helicopters, and airplanes to visually inspect the wires and cables. Sensitive monitoring equipment can automatically detect malfunctions on the network, such as loss of current flow. When line repairers identify a problem, they travel to the location of the malfunction and repair or replace defective cables or equipment.

Bad weather or natural disasters can cause extensive damage to networks of lines. Line installers and repairers must respond quickly to these emergencies to restore critical utility and communications services. This can often involve working outdoors in adverse weather conditions.

Installation and repair work may require splicing, or joining together, separate pieces of cable. Each cable contains numerous individual wires; splicing the cables together requires that each wire in one piece of cable be joined to another wire in the matching piece. Line installers join these wires and the surrounding cables using small hand tools, epoxy (an especially strong glue), or mechanical equipment. At each splice, they place insulation over the conductor and seal the splice with moistureproof covering. At some companies, specialized *cable splicing technicians* perform splices on larger lines.

Telecommunications networks are in the process of replacing older conventional wire or metal cables with new fiber optic cables. Fiber optic cables are made of hair-thin strands of glass, which convey pulses of light. These cables carry much more information at higher speeds than conventional cables. Splicing fiber optic cable requires specialized equipment that carefully slices, matches, and aligns individual glass fibers. The fibers are joined by either electrical fusion (welding) or a mechanical fixture and gel (glue).

The work performed by electrical power-line installers and telecommunications line installers and is quite similar, but there are some differences. Working with powerlines requires specialized knowledge of transformers, electrical power distribu-



Line installers and repairers wear safety gear to protect themselves from electrical current.

tion systems, and substations. In contrast, working with telecommunications lines requires specialized knowledge of fiber optics and telecommunications switches and routers.

Work environment. Line installers and repairers must climb and maintain their balance while working on poles and towers. They lift equipment and work in a variety of positions, such as stooping or kneeling. Their work often requires that they drive utility vehicles, travel long distances, and work outdoors under a variety of weather conditions.

Line installers and repairers encounter serious hazards on their jobs and must follow safety procedures to minimize potential danger. They wear safety equipment when entering utility holes and test for the presence of gas before going underground. Electric powerline workers have the more hazardous jobs. High-voltage powerlines can instantly electrocute a worker who comes in contact with a live cable, so line installers and repairers must use electrically insulated protective devices and tools when working with such cables. Powerlines are typically higher than telephone and cable television lines, increasing the risk of severe injury due to falls. To prevent these injuries, line installers and repairers must use fall-protection equipment when working on poles or towers.

Since line installers and repairers fix damage from storms, they may be asked to work long and irregular hours. They can expect frequently to be on-call and work overtime. When performing normal maintenance and constructing new lines, line installers work more normal hours.

Training, Other Qualifications, and Advancement

Most line installers and repairers require several years of long-term on-the-job training and some classroom work to become proficient. Formal apprenticeships are common.

Education and training. Line installers and repairers usually need at least a high school diploma. Employers look for people with basic knowledge of algebra and trigonometry and good reading and writing skills. Some also prefer to hire people with technical knowledge of electricity or electronics obtained through vocational programs, community colleges, or the Armed Forces.

Programs in telecommunications, electronics, or electricity, many of which are operated with assistance from local employ-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Line installers and repairers | 49-9050 | 275,000 | 290,000 | 16,000 | 6 |
| Electrical power-line installers and repairers..... | 49-9051 | 112,000 | 120,000 | 8,100 | 7 |
| Telecommunications line installers and repairers | 49-9052 | 162,000 | 170,000 | 7,500 | 5 |

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

ers and unions, are offered by many community or technical colleges. Some programs work with local companies to offer 1-year certificates that emphasize hands-on field work. More advanced 2-year associate degree programs provide students with a broader knowledge of the technology used in telecommunications and electrical utilities. They offer courses in electricity, electronics, fiber optics, and microwave transmission. Employers often prefer to hire graduates of these programs for line installer and repairer jobs.

Line installers and repairers receive most of their training on the job. Electrical line installers and repairers often must complete formal apprenticeships or other employer training programs. These programs, which can last up to 5 years, combine on-the-job training with formal classroom courses and are sometimes administered jointly by the employer and the union representing the workers. Unions include the International Brotherhood of Electrical Workers, the Communications Workers of America, and the Utility Workers Union of America. Government safety regulations strictly define the training and education requirements for apprentice electrical line installers.

Line installers and repairers working for telephone and cable television companies receive several years of on-the-job training. They also may attend training or take online courses provided by equipment manufacturers, schools, unions, or industry training organizations.

Other qualifications. Line installers and repairers must be able to read instructions, write reports, and solve problems. If they deal directly with customers, they also must have good customer service skills. They should also be mechanically inclined and like working with computers and new technology.

Physical fitness is important because they must be able to climb, lift heavy objects (many employers require applicants to be able to lift at least 50 pounds), and do other physical activity that requires stamina, strength, and coordination. Line installers and repairers often must work at a considerable height above the ground so they cannot be afraid of heights. Normal ability to distinguish colors is necessary because wires and cables may be color-coded. In addition, they often need a commercial driver's licenses to operate company-owned vehicles, so a good driving record is important.

Certification and advancement. Entry-level line installers may be hired as ground workers, helpers, or tree trimmers, who clear branches from telephone and powerlines. These workers may advance to positions stringing cable and performing service installations. With experience, they may advance to more sophisticated maintenance and repair positions responsible for increasingly larger portions of the network. Promotion to supervisory or training positions also is possible, but more advanced supervisory positions often require a college degree.

Advancement for telecommunications line installers is also made easier by earning certifications—formal recognition by a respected organization of one's knowledge of current technology. The Society of Cable Television Engineers (SCTE), for example, offers certification programs for line installers and repairers employed in the cable television industry. Candidates for certification can attend training sessions at local SCTE chapters.

Employment

Line installers and repairers held about 275,000 jobs in 2006. Approximately 162,000 were telecommunications line installers and repairers; the remainder were electrical power-line installers and repairers. Nearly all line installers and repairers worked for telecommunications companies, including both cable television distribution and telecommunications companies; construction contractors; or electric power generation, transmission, and distribution companies.

Approximately 6,100 line installers and repairers were self-employed. Many of these were contractors employed by the telecommunications companies to handle customer service problems and installations.

Job Outlook

Employment of line installers and repairers is projected to grow more slowly than average, but retirements are expected to create very good job opportunities for new workers, particularly for electrical power-line installers.

Employment change. Overall employment of line installers and repairers will grow 6 percent between 2006 and 2016, slower than the average for all occupations. Growth will reflect an increasing demand for electricity and telecommunications services as the population grows. However, productivity gains—particularly in maintaining these networks—will keep employment growth slow.

Employment of telecommunications line installers and repairers will grow more slowly than the average for all occupations. As the population expands, installers will be needed to lay the wiring for new developments and provide new telecommunications and cable television services. Additionally, old copper wiring will need to be replaced with fiber optic cable, also requiring more installers. The fiber optic lines will allow companies to give customers high-speed access to data, video, and graphics. Fiber optic lines allow for greater amounts of data to be transmitted through the cables at a faster rate. Fiber optic lines are expected to be more reliable in the long run, however, so they will require fewer workers.

Growth of wireless communications will also slow job increases for line installers and repairers in the long run. More

households are switching to wireless delivery of their communications, video, and data services. Although wireless networks use lines to connect cellular towers to central offices, they do not require as many line installers to maintain and expand their systems. Satellite television providers—another major portion of the wireless communications industry—will also reduce demand for wire-based phone, Internet, and cable TV.

Employment of electrical power-line installers and repairers is expected to grow about as fast as the average for all occupations. Despite consistently rising demand for electricity, power companies will cut costs by shifting more work to outside contractors and hire fewer installers and repairers. Most new jobs for electrical power-line installers and repairers are expected to arise among contracting firms in the construction industry.

Job prospects. Very good job opportunities are expected, especially for electrical power-line installers and repairers. A growing number of retirements will create many job openings.

Earnings

Earnings for line installers and repairers are higher than those in most other occupations that do not require postsecondary education. Median hourly earnings for electrical power-line installers and repairers were \$24.41 in May 2006. The middle 50 percent earned between \$18.73 and \$28.90. The lowest 10 percent earned less than \$13.96, and the highest 10 percent earned more than \$34.20. Median hourly earnings in the industries employing the largest numbers of electrical power-line installers and repairers in May 2006 are shown below:

| | |
|---|---------|
| Electric power generation, transmission, and distribution | \$25.90 |
| Wired telecommunications carriers | 24.82 |
| Local government | 23.06 |
| Building equipment contractors | 22.04 |
| Utility system construction | 19.29 |

Median hourly earnings for telecommunications line installers and repairers were \$22.25 in May 2006. The middle 50 percent earned between \$15.56 and \$28.40. The lowest 10 percent earned less than \$11.88, and the highest 10 percent earned more than \$32.80. Median hourly earnings in the industries employing the largest numbers of telecommunications line installers and repairers in May 2006 are shown below:

| | |
|--|---------|
| Wired telecommunications carriers | \$27.61 |
| Building equipment contractors | 17.89 |
| Cable and other subscription programming | 17.72 |
| Cable and other program distribution | 17.45 |
| Utility system construction | 15.41 |

Many line installers and repairers belong to unions, principally the Communications Workers of America, the International Brotherhood of Electrical Workers, and the Utility Workers Union of America. For these workers, union contracts set wage rates, wage increases, and the time needed to advance from one job level to the next.

Good health, education, and vacation benefits are common in the occupation.

Related Occupations

Other workers who install and repair electrical and electronic equipment include electricians; power plant operators, distributors, and dispatchers; and radio and telecommunications equipment installers and repairers.

Sources of Additional Information

For more details about employment opportunities, contact the telephone, cable television, or electrical power companies in your community. For general information and educational resources on line installer and repairer jobs, contact:

➤ Communications Workers of America, 501 3rd St.NW., Washington, DC 20001.

Internet: <http://www.cwa-union.org/jobs>

➤ National Joint Apprenticeship and Training Center (NJATC), 301 Prince Georges Blvd., Suite D, Upper Marlboro MD 20774.

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

For information on training and professional certifications for those already employed by cable telecommunications firms, contact:

➤ Society of Cable Telecommunications Engineers, Certification Department, 140 Phillips Rd., Exton, PA 19341-1318. Internet: <http://www.scte.org>

Maintenance and Repair Workers, General

(O*NET 49-9042.00)

Significant Points

- General maintenance and repair workers are employed in almost every industry.
- Many workers learn their skills informally on the job.
- Job growth and turnover in this large occupation should result in excellent job opportunities, especially for people with experience in maintenance and related fields.

Nature of the Work

Most craft workers specialize in one kind of work, such as plumbing or carpentry. General maintenance and repair workers, however, have skills in many different crafts. They repair and maintain machines, mechanical equipment, and buildings and work on plumbing, electrical, and air-conditioning and heating systems. They build partitions, make plaster or drywall repairs, and fix or paint roofs, windows, doors, floors, woodwork, and other parts of building structures. They also maintain and repair specialized equipment and machinery found in cafeterias, laundries, hospitals, stores, offices, and factories.

Typical duties include troubleshooting and fixing faulty electrical switches, repairing air-conditioning motors, and unclogging drains. New buildings sometimes have computer-controlled systems that allow maintenance workers to make adjustments in building settings and monitor for problems from



General maintenance and repair workers inspect, diagnose problems, and determine the best way to correct them.

a central location. For example, they can remotely control light sensors that turn off lights automatically after a set amount of time or identify a broken ventilation fan that needs to be replaced.

General maintenance and repair workers inspect and diagnose problems and determine the best way to correct them, frequently checking blueprints, repair manuals, and parts catalogs. They obtain supplies and repair parts from distributors or store-rooms. Using common hand and power tools such as screwdrivers, saws, drills, wrenches, and hammers, as well as specialized equipment and electronic testing devices, these workers replace or fix worn or broken parts, where necessary, or make adjustments to correct malfunctioning equipment and machines.

General maintenance and repair workers also perform routine preventive maintenance and ensure that machines continue to run smoothly, building systems operate efficiently, and the physical condition of buildings does not deteriorate. Following a checklist, they may inspect drives, motors, and belts, check fluid levels, replace filters, and perform other maintenance actions. Maintenance and repair workers keep records of their work.

Employees in small establishments, where they are often the only maintenance worker, make all repairs, except for very large or difficult jobs. In larger establishments, duties may be limited to the maintenance of everything in a workshop or a particular area.

Work environment. General maintenance and repair workers often carry out several different tasks in a single day, at any number of locations. They may work inside a single building or in several different buildings. They may have to stand for long periods, lift heavy objects, and work in uncomfortably hot or cold environments, in awkward and cramped positions, or on ladders. Those employed in small establishments often work with only limited supervision. Those in larger establishments frequently work under the direct supervision of an experienced worker. Some tasks put workers at risk of electrical shock, burns, falls, cuts, and bruises.

Most general maintenance workers work a 40-hour week. Some work evening, night, or weekend shifts or are on call for emergency repairs.

Training, Other Qualifications, and Advancement

Many general maintenance and repair workers learn their skills informally on the job as helpers to other repairers or to carpenters, electricians, and other construction workers.

Education and training. General maintenance and repair workers often learn their skills informally on the job. They start as helpers, watching and learning from skilled maintenance workers. Helpers begin by doing simple jobs, such as fixing leaky faucets and replacing light bulbs, and progress to more difficult tasks, such as overhauling machinery or building walls. Some learn their skills by working as helpers to other types of repair or construction workers, including machinery repairers, carpenters, or electricians.

Several months of on-the-job training are required to become fully qualified, depending on the skill level required. Some jobs require a year or more to become fully qualified. Because a growing number of new buildings rely on computers to control their systems, general maintenance and repair workers may need basic computer skills, such as how to log onto a central computer system and navigate through a series of menus. Companies that install computer-controlled equipment usually provide on-site training for general maintenance and repair workers.

Many employers prefer to hire high school graduates. High school courses in mechanical drawing, electricity, woodworking, blueprint reading, science, mathematics, and computers are useful. Because of the wide variety of tasks performed by maintenance and repair workers, technical education is an important part of their training. Maintenance and repair workers often need to do work that involves electrical, plumbing, and heating and air-conditioning systems, or painting and roofing tasks. Although these basic tasks may not require a license to do the work, a good working knowledge of many repair and maintenance tasks is required. Many maintenance and repair workers learn some of these skills in high school shop classes and postsecondary trade or vocational schools or community colleges.

Licensure. Licensing requirements vary by State and locality. In some cases, workers may need to be licensed in a particular specialty such as electrical or plumbing work.

Other qualifications. Mechanical aptitude, the ability to use shop mathematics, and manual dexterity are important. Good health is necessary because the job involves much walking, standing, reaching, and heavy lifting. Difficult jobs require problem-solving ability, and many positions require the ability to work without direct supervision.

Advancement. Many general maintenance and repair workers in large organizations advance to maintenance supervisor or become craftworkers such as electricians, heating and air-conditioning mechanics, or plumbers. Within small organizations, promotion opportunities may be limited.

Employment

General maintenance and repair workers held 1.4 million jobs in 2006. They were employed in almost every industry. Around 19 percent worked in manufacturing industries, almost evenly distributed through all sectors, while about 10 percent worked for Federal, State, and local governments. Others worked for

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Maintenance and repair workers, general | 49-9042 | 1,391,000 | 1,531,000 | 140,000 | 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*.

wholesale and retail firms and for real estate firms that operate office and apartment buildings.

Job Outlook

Average employment growth is expected. Job growth and the need to replace those who leave this large occupation should result in excellent job opportunities, especially for those with experience in maintenance and related fields.

Employment change. Employment of general maintenance and repair workers is expected to grow 10 percent during the 2006-16 decade, about as fast as the average for all occupations. Employment is related to the number of buildings—for example, office and apartment buildings, stores, schools, hospitals, hotels, and factories—and the amount of equipment needing maintenance and repair. One factor limiting job growth is that computers allow buildings to be monitored more efficiently, partially reducing the need for workers.

Job prospects. Job opportunities should be excellent, especially for those with experience in maintenance or related fields. General maintenance and repair is a large occupation, generating many job openings due to growth and the need to replace those who leave the occupation. Many job openings are expected to result from the retirement of experienced maintenance workers over the next decade.

Earnings

Median hourly earnings of general maintenance and repair workers were \$15.34 in May 2006. The middle 50 percent earned between \$11.66 and \$19.90. The lowest 10 percent earned less than \$9.20, and the highest 10 percent earned more than \$24.44. Median hourly earnings in the industries employing the largest numbers of general maintenance and repair workers in May 2006 are shown in the following tabulation:

| | |
|---|---------|
| Local government | \$15.85 |
| Elementary and secondary schools | 15.76 |
| Activities related to real estate | 13.44 |
| Lessors of real estate | 13.06 |
| Traveler accommodation..... | 11.76 |

Some general maintenance and repair workers are members of unions including the American Federation of State, County, and Municipal Employees and the United Auto Workers.

Related Occupations

Some duties of general maintenance and repair workers are similar to those of carpenters; pipelayers, plumbers, pipefitters, and steamfitters; electricians; and heating, air-conditioning, and refrigeration mechanics. Other duties are similar to those of coin, vending, and amusement machine servicers and repairers; electrical and electronics installers and repairers; electronic home

entertainment equipment installers and repairers; and radio and telecommunications equipment installers and repairers.

Sources of Additional Information

Information about job opportunities may be obtained from local employers and local offices of the State.

For information related to maintenance managers contact:

► International Maintenance Institute, P.O. Box 751896, Houston, TX 77275-1896.

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

Millwrights

(O*NET 49-9044.00)

Significant Points

- Millwrights usually train in 4-year to 5-year apprenticeships; some learn through community college programs coupled with informal paid on-the-job training.
- Despite projected slower-than-average employment growth, well-qualified applicants should have excellent job opportunities.
- About 50 percent of millwrights belong to labor unions, one of the highest rates of membership in the economy.

Nature of the Work

Millwrights install, replace, dismantle, and repair machinery and heavy equipment used in power generation, including wind power, hydroelectric dams, and natural gas turbines, and in manufacturing plants, construction sites, and mining operations. The development of new technologies requires millwrights to work with new industry-specific and highly complex precision machines. Some of these machines have tolerances smaller than the width of a human hair.

The millwright's responsibilities begin before a new piece of machinery arrives at the jobsite. Millwrights consult with production managers, industrial engineers, and others to determine the optimal placement of the machine in the plant. Some equipment, such as a metal forging press, is so heavy that it must be placed on a new foundation. Millwrights either prepare the foundation themselves or supervise its construction. As a result, they must know how to read blueprints and to work with a variety of building materials.

When the new machine arrives, millwrights unload, inspect, and move the equipment into position. To lift and move light machinery, millwrights use rigging and hoisting devices, such as pulleys

and cables. With heavier equipment, they may use hydraulic-lift trucks or cranes. Lifting such heavy equipment requires millwrights to understand the load properties of cables, ropes, hoists, and cranes. Parts of power plant turbines and other machinery can weigh more than 100 tons and must be precisely positioned; even nuts and bolts can weigh a few hundred pounds each and require a crane to move.

Next, millwrights assemble the machinery. They 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, so millwrights measure angles, material thickness, and small distances with calipers, squares, micrometers, and other tools. When a high level of precision is required, they use devices such as lasers and ultrasonic measuring and alignment tools. Millwrights also work with hand and power tools, such as cutting torches, welding machines, hydraulic torque wrenches, hydraulic stud tensioners, soldering guns, and with metalworking equipment, including lathes and grinding machines.

In addition to installing and dismantling machinery, many millwrights work with industrial mechanics and maintenance workers to repair and maintain equipment. This includes preventive maintenance, such as lubrication and fixing or replacing worn parts. If a spare part is unavailable, a millwright may use a lathe or other machine tool to cut a new part. (For further information on machinery maintenance, see the section on industrial machinery mechanics and maintenance workers elsewhere in the *Handbook*.)

Increasingly sophisticated automation means more complicated machines for millwrights to install and maintain, requiring millwrights to specialize in certain machines or machine brands. For example, some millwrights specialize in installing and maintaining turbines in power plants that can weigh hundreds of tons and contain thousands of parts. This machinery requires special care and knowledge, so millwrights receive additional training and are required to be certified by the turbine manufacturer.

Work environment. Millwrights in manufacturing often work in a machine shop and use protective equipment, such as safety belts, protective glasses, and hardhats, to avoid injuries from falling objects or machinery. Those employed in construction may work outdoors in difficult weather conditions.



Millwrights repair complex industrial machinery.

Millwrights at construction sites may travel long distances to worksites. For example, millwrights who specialize in turbine installation travel to wherever new power plants are being built.

Advanced equipment, such as hydraulic wrenches and hydraulic stud tensioners, have made the work safer and eliminated the need for millwrights to use sledge hammers to pound bolts into position. Other equipment has reduced the strenuous tasks that caused injuries in the past.

Millwrights work independently or as part of a team. Because disabled machinery costs time and money, many millwrights work overtime and some work in shifts; about 39 percent of millwrights report working more than 40 hours during a typical week. During power outages or other emergencies, millwrights often work overtime.

Training, Other Qualifications, and Advancement

Millwrights usually train in 4-year to 5-year apprenticeships that combine paid on-the-job training with classroom instruction. Some learn through community college programs coupled with informal paid on-the-job training.

Education and training. Employers prefer applicants who have a high school diploma, GED, or the equivalent and some vocational training or experience. Courses in science, mathematics, mechanical drawing, computers, and machine shop practice are useful. Once hired, millwrights are trained through 4-year to 5-year apprenticeship programs that combine on-the-job training with classroom instruction, or through community college programs coupled with informal on-the-job training.

Apprenticeships include training in dismantling, moving, erecting, and repairing machinery. Trainees also might learn carpentry, welding, use of concrete, sheet-metal work, and other skills related to installation and repair. Millwright apprentices often attend about 1 week of classes every 3 months. Classroom instruction covers mathematics, blueprint reading, hydraulics, vibration analysis, conveyor systems, electricity, computers, electronics, machining, and instruction in specific machinery. Millwrights are expected to keep their skills up-to-date and may need additional training on technological advances, such as laser shaft alignment.

Other qualifications. Because millwrights assemble and disassemble complicated machinery, mechanical aptitude is very important. Strength and agility also are necessary for lifting and climbing. Millwrights need good interpersonal and communication skills to work as part of a team and to effectively give detailed instructions to others.

Advancement. Advancement for millwrights usually takes the form of higher wages. Some advance to the position of supervisor or superintendent; others may become self-employed contractors.

Employment

Millwrights held about 55,000 jobs in 2006. About half work in manufacturing, primarily in industries such as transportation equipment manufacturing and primary metals manufacturing. About 40 percent of millwrights are employed in construction, where most work for contracting firms that assemble and maintain machinery and equipment for the manufacturing and utility industries, among others. Although millwrights work in every State, employment is concentrated in heavily industrialized areas.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--------------------|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Millwrights..... | 49-9044 | 55,000 | 58,000 | 3,200 | 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*.

Job Outlook

Employment of millwrights is projected to grow more slowly than average. Opportunities for well-qualified applicants should be excellent, however, as many experienced millwrights retire.

Employment change. Employment of millwrights is projected to grow 6 percent during the 2006-16 decade, slower than the average for all occupations. To remain competitive in coming years, firms will continue to need millwrights to dismantle old equipment and install new high-technology machinery. Highly automated systems that are installed and maintained by millwrights often allow manufacturing companies to remain competitive with producers in lower-wage countries. Warehouse and distribution companies also are deploying highly automated conveyor systems, which are assembled and maintained by millwrights. In addition, growth in both power generation, including wind power and turbines for natural gas and coal plants, and oil and gas extraction and refining will help drive employment growth.

Employment growth will be dampened somewhat by foreign competition in manufacturing. In addition, the demand for millwrights will be adversely affected as other workers, such as industrial machinery mechanics and maintenance workers, assume some installation and maintenance duties.

Job prospects. The large number of expected retirements and the difficulty of recruiting new workers will create excellent job opportunities for well-qualified applicants. Job prospects should be especially good for those who have experience in machining, welding, or doing mechanical work. Employment prospects for millwrights are better than for some other manufacturing workers because they work across a wide range of industries, including power generation, paper mills, mining, and motor vehicle parts manufacturing. When a downturn occurs in one industry, millwrights can more easily switch to another industry. There will always be a need to maintain and repair existing machinery, dismantle old machinery, and install new equipment.

Earnings

Median hourly wage-and-salary earnings of millwrights were \$21.94 in May 2006. The middle 50 percent earned between \$17.13 and \$29.42. The lowest 10 percent earned less than \$13.84, and the highest 10 percent earned more than \$34.39. Earnings vary by industry and geographic location. Median hourly wage-and-salary earnings in the industries employing the largest numbers of millwrights were:

| | |
|---|---------|
| Pulp, paper, and paperboard mills | \$25.43 |
| Iron and steel mills and ferroalloy manufacturing | 20.91 |
| Nonresidential building construction..... | 20.34 |
| Building equipment contractors..... | 19.67 |
| Sawmills and wood preservation..... | 17.55 |

About 50 percent of millwrights belong to labor unions, one of the highest rates of membership in the economy.

Related Occupations

Other workers who install and maintain manufacturing equipment include industrial machinery mechanics and maintenance workers; tool and die makers; aircraft and avionics equipment mechanics and service technicians; structural and reinforcing iron and metal workers; boilermakers; and assemblers and fabricators. Millwrights also machine parts and operate computer-controlled machine tools as do machinists and computer control programmers and operators. Millwrights often use welding and soldering to assemble and repair machines as do welding, soldering, and brazing workers.

Sources of Additional Information

For further information on apprenticeship programs, write to the Apprenticeship Council of your State's labor department, local offices of your State employment service, or local firms that employ millwrights. 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 tollfree helpline: (877) 872-5627.

In addition, you may contact:

- Associated Builders and Contractors, Workforce Development Dept., 4250 N. Fairfax Dr., 9th Floor, Arlington, VA 22203. Internet: <http://www.trytools.org>
- United Brotherhood of Carpenters and Joiners of America, 6801 Placid St., Las Vegas, NV 89119. Internet: <http://www.ubcmillwrights.org>

Precision Instrument and Equipment Repairers

(O*NET 49-9061.00, 49-9062.00, 49-9063.00, 49-9064.00, 49-9069.99)

Significant Points

- Training requirements include a high school diploma and, in most cases, postsecondary education, coupled with significant on-the-job training.
- Overall employment is expected to grow about as fast as average, and good opportunities are expected for most types of jobs.
- About 1 out of 6 are self-employed.

Nature of the Work

Repairing and maintaining watches, cameras, musical instruments, medical equipment, and other precision instruments requires a high level of skill and attention to detail. Some devices contain tiny gears that must be manufactured to within one one-hundredth of a millimeter of design specifications, and other devices contain sophisticated electronic controls. Job descriptions vary greatly, depending on the type of instrument being repaired.

Camera and photographic equipment repairers fix broken cameras and other optical devices. The repairer must first determine whether a repair should be attempted, because many inexpensive cameras cost more to repair than to replace. The most complicated or expensive repairs are usually referred back to the manufacturer or to a large repair center. If the repairer decides to proceed with the job, the problem must be diagnosed, often by disassembling numerous small parts in order to reach the source. The defective parts are then replaced or repaired. Many problems are caused by the electronic circuits used in cameras, and fixing these circuits requires an understanding of electronics. Camera repairers also maintain cameras by removing and replacing broken or worn parts and cleaning and lubricating gears and springs. Because many of the components involved are extremely small, repairers must have a great deal of manual dexterity. Frequently, older camera parts are no longer available, requiring repairers to build replacement parts or to strip junked cameras. When machining new parts, workers often use a small lathe, a grinding wheel, and other metalworking tools.

Repairs on digital cameras are similar to those on conventional cameras, but because digital cameras have no film to wind, they have fewer moving parts. Digital cameras rely on software, so any repair to the lens requires that it be calibrated with the use of software and by connecting the camera to a personal computer. Because digital cameras are generally more



Watch repairers must work with very small, sensitive parts.

expensive and more widely used than film cameras, they are quickly becoming the most important source of business for camera repairers.

Watch and clock repairers work almost exclusively on expensive and antique timepieces, because moderately priced timepieces are cheaper to replace than to repair. Electrically powered clocks and quartz watches and clocks function with almost no moving parts, limiting necessary maintenance to replacing the battery. Many expensive timepieces still employ old-style mechanical movements and a manual or automatic winding mechanism. This type of timepiece must be regularly adjusted and maintained. Repair and maintenance work on a mechanical timepiece requires using hand tools to disassemble many fine gears and components. Each part is inspected for signs of wear. Some gears or springs may need to be replaced or machined. Exterior portions of the watch may require polishing and buffing. Specialized machines are used to clean all of the parts with ultrasonic waves and a series of baths in cleaning agents. Reassembling a watch often requires lubricating key parts.

As with older cameras, replacement parts are frequently unavailable for antique watches or clocks. In such cases, watch repairers must machine their own parts. They employ small lathes and other machines in creating tiny parts.

Musical instrument repairers and tuners combine their love of music with a highly skilled craft. These artisans, often referred to as technicians, work in four specialties: Band instruments, pianos and organs, orchestral string instruments, and guitars. (Repairers and tuners who work on electronic organs are discussed in the *Handbook* statement on electronic home entertainment equipment installers and repairers.)

Band instrument repairers, brass and wind instrument repairers, and percussion instrument repairers focus on woodwind, brass, reed, and percussion instruments damaged through deterioration or by accident. In most cases, the problem with the instrument will be clear, but in some cases the repairers must diagnose the issue. They may unscrew and remove rod pins, keys, worn cork pads, and pistons and remove soldered parts by means of gas torches. Using filling techniques or a mallet, they repair dents in metal and wood. They also use gas torches, grinding wheels, lathes, shears, mallets, and small hand tools and, are skilled in metalworking and woodworking.

Violin and guitar repairers adjust and repair stringed instruments. Some repairers work on both stringed and band instruments. Initially, repairers play and inspect the instrument to find any defects. They replace or repair cracked or broken sections and damaged parts. They also restring the instruments and repair damage to their finish. Because the specifications of all types of instruments vary greatly, custom parts machining is considered an essential skill.

Piano tuners and repairers use different techniques, skills, and tools. Most workers in this group are tuners; only a few workers in this occupation specialize in refurbishing older pianos. Tuning involves tightening and loosening different strings to achieve the proper tone or pitch. Pitch matching is usually done by ear—an experienced tuner can compare the sound of a pitch with a tuning fork, and then with other pitches on the piano to make sure it is tuned properly. Tuners must make house calls, as piano tuning is sensitive to movement and most pianos

cannot be transported easily. Some repairers specialize in restoring older pianos. Restoration is complicated work, often involving replacing many of the parts, which number more than 12,000 in some pianos. With proper maintenance and restoration, pianos often survive more than 100 years.

Pipe organ repairers do work similar to that of piano repairers, but with organ pipes rather than piano strings. Tuning pipe organs is very complicated, as most organs have thousands of pipes, and different pipes are tuned in different ways. Additionally, many repairers assemble new organs or expand organs with new ranks of pipes. Even with repairers working in teams or with assistants, organ maintenance can take several weeks or even months, depending upon the size of the organ.

Medical equipment repairers, also known as *biomedical equipment technicians*, maintain, adjust, calibrate, and repair electronic, electromechanical, and hydraulic equipment used in hospitals and other medical environments. They use various tools, including multimeters, specialized software, and computers designed to communicate with specific pieces of hardware. These repairers use hand tools, soldering irons, and other electronic tools to repair and adjust equipment. Among the tools they use is equipment designed to simulate water or air pressure. Faulty circuit boards and other parts are normally removed and replaced. Medical equipment repairers must maintain careful, detailed logs of all maintenance and repair that they perform on each piece of equipment.

Medical equipment repairers work on medical equipment such as defibrillators, heart monitors, medical imaging equipment (x-rays, CAT scanners, and ultrasound equipment), voice-controlled operating tables, and electric wheelchairs. Because most equipment repairs take place within a hospital, medical equipment repairers must be comfortable working around patients. In some cases, repairs may take place while equipment is being used. When this is the case, the repairer must take great care to make sure that repairs do not disturb the patient.

Other precision instrument and equipment repairers service, repair, and replace a wide range of equipment associated with automated or instrument-controlled manufacturing processes. For most of these repairers, the emphasis is on determining the problem and how to best approach the solution. In many cases, replacement is preferable to repair, since precision parts are often very sensitive and may cost more to repair than replace. Replacement parts are not always available, so repairers sometimes machine or fabricate new parts. Repairers may also be responsible for preventive maintenance and calibration, which involves regular lubrication, cleaning, and adjustment of many measuring devices. Increasingly, it also involves solving computer software problems as more control devices, such as valves, are controlled by software. To adjust a control device, a technician may need to connect a laptop computer to the control device's computer and make adjustments through changes to the software commands.

Work environment. Camera, watch, and musical instrument repairers work under fairly similar solitary, low-stress conditions with minimal supervision. A quiet, well-lit workshop or repair shop is typical. Piano and organ tuners must travel to the instruments being repaired. Often, these workers can adjust their schedules, allowing for second jobs as needed. Musical

instrument repairer jobs are attractive to many professional musicians and retirees because the flexible hours common to repair work allow these individuals time for other pursuits.

Medical equipment and other precision instrument and equipment repairers normally work daytime hours, but are often expected to be on call. Still, like other hospital and factory employees, some repairers work irregular hours. Medical equipment repairers must work in a patient environment, which has the potential to expose them to diseases and other health risks, but occupational injuries are relatively uncommon.

Precision instrument repairers work under a wide array of conditions, from hot, dirty, noisy factories, to air-conditioned workshops, to the outdoors on fieldwork. Attention to safety is essential, as the work sometimes involves dangerous machinery, toxic chemicals, or radiation. Due to the individualized nature of the work, supervision is fairly minimal.

Training, Other Qualifications, and Advancement

For most precision equipment repairers, the most significant source of postsecondary education is on-the-job training. Even in positions where an associate or bachelor's degree is required, an internship or apprenticeship is generally required before a technician is fully qualified. In some cases, learning these trades can take as many as seven years.

Education and training. Most employers require at least a high school diploma for beginning precision instrument and equipment repairers. Many employers prefer applicants with some postsecondary education.

The educational background required for camera and photographic equipment repairers varies, but some knowledge of electronics is necessary. Some workers complete postsecondary training, such as an associate degree, in electronics. The job requires the ability to read electronic schematic diagrams and comprehend other technical information, in addition to manual dexterity. New employees are trained on the job in two stages over about a year. First, they learn to repair a single product over a couple of weeks. Then, they learn to repair other products and refine their skills for 6 to 12 months while working under the close supervision of an experienced repairer. Finally, repairers continually teach themselves through studying manuals and attending manufacturer-sponsored seminars on the specifics of new models.

Training also varies for watch and clock repairers. Several associations, including the American Watchmakers-Clockmakers Institute and the National Association of Watch and Clock Collectors, offer certifications. Some certifications can be completed in a few months; others require simply passing an examination; the most demanding certifications require 3,000 hours, taken over 2 years, of classroom time in technical institutes or colleges. Those who have earned the most demanding certifications are usually the most sought-after by employers. Clock repairers generally require less training than do watch repairers, because watches have smaller components and require greater precision. Some repairers opt to learn through assisting a master watch repairer. Nevertheless, developing proficiency in watch or clock repair requires several years of education and experience.

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|--|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Precision instrument and equipment repairers..... | 49-9060 | 68,000 | 77,000 | 8,700 | 13 |
| Camera and photographic equipment repairers | 49-9061 | 4,400 | 4,300 | -100 | -2 |
| Medical equipment repairers..... | 49-9062 | 38,000 | 46,000 | 8,200 | 22 |
| Musical instrument repairers and tuners | 49-9063 | 6,000 | 6,200 | 200 | 3 |
| Watch repairers | 49-9064 | 3,800 | 3,600 | -200 | -5 |
| Precision instrument and equipment repairers, all other..... | 49-9069 | 16,000 | 17,000 | 700 | 4 |

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

For musical instrument repairers and tuners, employers prefer individuals with post-high school training in music repair technology. According to a Piano Technicians Guild membership survey, the overwhelming majority of respondents had at least some college education; most had a bachelor's or higher degree, although not always in music repair technology. Almost all repairers have a strong musical background; many are musicians themselves. Also, a basic ability to play the instruments being repaired is normally required. Courses in instrument repair are offered only at a few technical schools and colleges. Correspondence courses are common for piano tuners. Graduates of these programs normally receive additional training on the job, working with an experienced repairer. Many musical instrument repairers and tuners begin learning their trade on the job as assistants or apprentices. Trainees perform a variety of tasks around the shop. Full qualification usually requires 2 to 5 years of training and practice. Musical instrument repair and tuning requires good manual dexterity, a strong sense of pitch, and good hand-eye coordination.

Medical equipment repairers' training includes on-the-job training, manufacturer training classes, and associate degree programs. While an associate degree in electronics or medical technology is normally required, training varies by specialty. For those with a background in electronics, on-the-job training is more common for workers repairing less electronically sophisticated equipment, such as hospital beds or electric wheelchairs. An associate or even a bachelor's degree, often in medical technology or engineering, and a passing grade on a certification exam is likely to be required of persons repairing more complicated equipment, such as CAT scanners and defibrillators. Many repairers are trained in the military. New repairers begin by observing and assisting an experienced worker over a period of 3 to 6 months, learning a single piece of equipment at a time. Gradually, they begin working independently, while still under close supervision. Biomedical equipment repairers are constantly learning new technologies and equipment through seminars, self-study, and certification exams.

Educational requirements for other precision instrument and equipment repair jobs also vary, but include a high school diploma, with a focus on mathematics and science courses. Because repairers need to understand blueprints, electrical schematic diagrams, and electrical, hydraulic, and electromechanical systems, most employers require an associate or sometimes a bachelor's degree in instrumentation and control, electronics, or a related engineering field. In addition to formal education, a year or two of on-the-job training is required before a repairer

is considered fully qualified. Many instrument and equipment repairers begin by working in a factory in another capacity, such as repairing electrical equipment. As companies seek to improve efficiency, other types of repair workers are trained to repair precision measuring equipment.

Certification and other qualifications. Much training takes place on the job. The ability to read and understand technical manuals is important. Necessary physical qualities include good fine-motor skills and acute vision. Those working with musical instruments must also have good hearing. Also, precision equipment repairers must be able to pay close attention to details, enjoy problem solving, and have the desire to disassemble machines to see how they work. Most precision equipment repairers must be able to work alone with minimal supervision.

Because many precision instrument and equipment repairers are self-employed, they must also have business skills. Although business most often comes from word-of-mouth advertising, repairers must nevertheless work to establish themselves in the industry. Further, they must manage their business operations, which may mean purchasing insurance and managing their own accounting.

Although most of the positions in this field do not require certification, it may be helpful in finding a job or demonstrating competency to prospective clients. There are several certifications possible in this diverse group of repairers. Information on various certifications is available from the sources of additional information at the end of the statement.

Advancement. Advancement opportunities vary greatly among precision instrument and equipment repairers. For self-employed repairers, advancement may mean the ability to charge more for their services. For workers who are employed by firms, supervisory opportunities are available. In both cases, an experienced worker may become a mentor to someone who is new to the field.

Employment

Precision instrument and equipment repairers held 68,000 jobs in 2006. Employment was distributed among the detailed occupations as follows:

| | |
|--|--------|
| Medical equipment repairers..... | 38,000 |
| Musical instrument repairers and tuners | 6,000 |
| Camera and photographic equipment repairers | 4,400 |
| Watch repairers | 3,800 |
| Precision instrument and equipment repairers, all other..... | 16,000 |

Medical equipment repairers often work for hospitals or wholesale equipment suppliers, while those in the occupation titled “all other precision instrument repairers” frequently work for manufacturing companies and wholesalers of durable goods. About 1 out of 6 precision instrument and equipment repairers was self-employed—most are proprietors of jewelry, camera, medical equipment, or music repair services.

Job Outlook

Good opportunities are expected for most types of precision instrument and equipment repairer jobs. Overall employment growth is projected to be about as fast as the average for all occupations over the 2006-16 period; however, projected growth varies by detailed occupation.

Employment change. Projected employment growth for precision instrument and equipment repairers varies greatly by specialty.

Employment of camera and photographic equipment repairers is projected to decline by about 2 percent between 2006 and 2016, and employment of watch repairers is projected to decline 5 percent over the same period. These occupations are in decline primarily because the products they service are often less expensive to replace than to repair. Most of the workers who remain in this industry will specialize in repair of expensive watches and cameras, as well as antiques.

Over the same time period, the employment of musical instrument repairers and tuners is projected to increase 3 percent, which is slower than average. Band and orchestra programs in high schools continue to provide most of the business for these workers, and they have been declining for several years. With fewer new musicians, there will be a slump in instrument rentals, purchases, and repairs. In the meantime, however, there continues to be a demand for these services, and new opportunities should continue to arise as the population grows.

The medical equipment repairer occupation is projected to increase 22 percent between 2006 and 2016, which is much faster than the average for all occupations, as a result of increased demand for medical services and increasing complexity of the equipment used in hospitals and clinics. Opportunities should be increasingly good for those who have a strong understanding of software and electronics, as many new medical devices are increasingly reliant on computers.

Over the same time period, employment of other precision instrument and equipment repairers is projected to increase 4 percent, more slowly than average, as most of them work in declining manufacturing industries. Nevertheless, these workers can expect to play an increasingly large role in those industries, as automation continues to dominate modern manufacturing.

Job prospects. Despite varying levels of growth in the various occupations, almost all workers in these fields can expect good job prospects over the next decade. As the baby boomer generation nears retirement, many skilled workers in these occupations are expected to leave the workforce. Additionally, many technical schools and other programs offering courses in these occupations have closed, leading to a shortage of qualified workers. Individuals with strong apprenticeships or internships should have the best prospects as instrumentation continues to become more complex and requires ever greater skill to repair.

Earnings

The following tabulation shows median annual earnings for various precision instrument and equipment repairers in May 2006:

| | |
|--|----------|
| Medical equipment repairers..... | \$40,580 |
| Camera and photographic equipment repairers | 34,850 |
| Watch repairers | 30,900 |
| Musical instrument repairers and tuners | 29,200 |
| Precision instrument and equipment repairers, all other..... | 46,250 |

Earnings ranged from less than \$16,230 for the lowest 10 percent of musical instrument repairers and tuners to more than \$69,280 for the highest 10 percent in the occupation all other precision instrument and equipment repairers in May 2006.

Earnings within the different occupations vary significantly, depending upon skill levels. For example, a lesser skilled watch and clock repairer may simply change batteries and replace worn wrist straps, while a highly skilled watch and clock repairer with years of training and experience may rebuild and replace worn parts.

Related Occupations

Many precision instrument and equipment repairers work with precision mechanical and electronic equipment. Other workers who repair precision mechanical and electronic equipment include computer, automated teller, and office machine repairers and coin, vending, and amusement machine servicers and repairers. Other workers who make precision items include medical, dental, and ophthalmic laboratory technicians. Some precision instrument and equipment repairers work with a wide array of industrial equipment. Their work environment and responsibilities are similar to those of industrial machinery mechanics and maintenance workers. Much of the work of watch repairers is similar to that of jewelers and precious stone and metal workers. Camera repairers' work is similar to that of electronic home entertainment equipment installers and repairers; both occupations work with consumer electronics that are based around a circuit board, but that also involve numerous moving mechanical parts.

Sources of Additional Information

For information on musical instrument repair, including schools offering training, contact:

► National Association of Professional Band Instrument Repair Technicians (NAPBIRT), P.O. Box 51, Normal, IL 61761. Internet: <http://www.napbirt.org>

For additional information on piano tuning and repair work, contact:

► Piano Technicians Guild, 4444 Forest Ave., Kansas City, KS 66106. Internet: <http://www.ptg.org>

For information about training, mentoring programs, employers, and schools with programs in precision instrumentation, automation, and control, contact:

► ISA-The Instrumentation, Systems, and Automation Society, 67 Alexander Dr, Research Triangle Park, NC 27709.

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

For information about watch and clock repair and a list of schools with related programs of study, contact:

► American Watchmakers-Clockmakers Institute (AWI), 701 Enterprise Dr., Harrison, OH 45030-1696.

Internet: <http://www.awi-net.org>

► National Association of Watch and Clock Collectors, 514 Poplar St., Columbia, PA 17512-2130.

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

For information about medical equipment technicians and a list of schools with related programs of study, contact:

► Association for the Advancement of Medical Instrumentation (AAMI), 1110 North Glebe Rd., Suite 220, Arlington, VA 22201-4795. Internet: <http://www.aami.org>

Radio and Telecommunications Equipment Installers and Repairers

(O*NET 49-2021.00, 49-2022.00)

Significant Points

- Little or no change in employment is projected.
- Job opportunities vary by specialty; good opportunities are expected for central office installers and repairers, but station installers and repairers can expect keen competition.
- Applicants with computer skills and postsecondary electronics training should have the best opportunities.
- Repairers may be on-call around the clock in case of emergencies—night, weekend, and holiday hours are common.

Nature of the Work

Telephones, computers, and radios depend on a variety of equipment to transmit communications signals and connect to the Internet. From electronic and optical switches that route telephone calls and packets of data to their destinations to radio transmitters and receivers that relay signals from radios in airplanes, boats, and emergency vehicles, complex equipment is needed to keep us communicating. The workers who set up and maintain this sophisticated equipment are called radio and telecommunications equipment installers and repairers.

Telecommunications equipment installers and repairers have a range of skills and abilities, which vary by the type of work they do and where it is performed. Most work indoors. (Equipment installers who work mainly outdoors are classified as telecommunications line installers and repairers—a separate occupation discussed elsewhere in the *Handbook*.)

Central office installers and repairers—telecommunications equipment installers and repairers who work at switching hubs called central offices—do some of the most complex work. Switching hubs contain the switches and routers that direct packets of information to their destinations. Installers and repairers set up those switches and routers as well as cables and other equipment.

Although most telephone lines connecting houses to central offices and switching stations are still copper, the lines connecting central hubs to each other are fiber optic. Fiber optic lines, along with newer packet switching equipment, have greatly increased the transmission capacity of each line, allowing an ever increasing amount of information to pass through the lines. Switches and routers are used to transmit, process, amplify, and direct a massive amount of information. Installing and maintaining this equipment requires a high level of special technical knowledge.

The increasing reliability of switches and routers has simplified maintenance, however. New self-monitoring telecommunications switches alert central office repairers to malfunctions. Some switches allow repairers to diagnose and correct problems from remote locations. When faced with a malfunction, the repairer may refer to manufacturers' manuals that provide maintenance instructions.

As cable television and telecommunications technology converge, the equipment used in both technologies is becoming more similar. The distribution centers for cable television companies, which are similar to central offices in the telecommunications sector, are called *headends*. Headend technicians perform essentially the same work as central office technicians, but they work in the cable industry.

When problems with telecommunications equipment arise, telecommunications equipment repairers diagnose the source of the problem by testing each part of the equipment. This requires understanding how the software and hardware interact. Repairers often use spectrum analyzers, network analyzers, or both to locate the problem. A network analyzer sends a signal through the equipment to detect any distortion in the signal. The nature of the signal distortion often directs the repairer to the source of the problem. To fix the equipment, repairers may use small hand tools, including pliers and screwdrivers, to remove and replace defective components such as circuit boards or wiring. Newer equipment is easier to repair because whole boards and parts are designed to be quickly removed and replaced. Repairers also may install updated software or programs that maintain existing software.

Another type of telecommunications installer and repairer, *PBX installers and repairers* set up private branch exchange (PBX) switchboards, which relay incoming, outgoing, and interoffice telephone calls within a single location or organization. To install switches and switchboards, installers first connect the equipment to power lines and communications cables and install frames and supports. They test the connections to ensure that adequate power is available and that the communication links work properly. They also install equipment such as power systems, alarms, and telephone sets. New switches and switchboards are computerized and workers often need to install software or program the equipment to provide specific features. Finally, the installer performs tests to verify that the newly installed equipment functions properly. If a problem arises, PBX repairers determine whether it is located within the PBX system or whether it originates in the telephone lines maintained by the local telephone company. Newer installations use voice-over Internet protocol (VoIP) systems. VoIP systems operate like a PBX system, but they use a company's computer wiring to

run Internet access, network applications, and telephone communications.

Station installers and repairers, telephone—commonly known as *home installers and repairers* or *telecommunications service technicians*—install and repair telecommunications wiring and equipment in customers' home or business premises. They install telephone, VoIP, Internet, and other communications services by installing wiring inside the home or connecting existing wiring to outside service lines. Depending upon the service required, they may setup television capability or connect modems and install software on a customer's computer. To complete the connection to an outside service line, the installer may need to climb telephone poles or ladders and test the line. Later on, if a maintenance problem occurs, station repairers test the customer's lines to determine if the problem is located in the customer's premises or in the outside service lines and attempt to fix the problem if it is inside. If the problem is with the outside service lines, telecommunications line repairers are usually called to fix it.

Radio mechanics install and maintain radio transmitting and receiving equipment, excluding cellular communications systems. This includes stationary equipment mounted on transmission towers or tall buildings and mobile equipment, such as two-way radio communications systems in taxis, airplanes, ships, and emergency vehicles. Aviation and marine radio mechanics also may work on other electronic equipment, in addition to radios. Newer radio equipment is self-monitoring and may alert mechanics to potential malfunctions. When malfunctions occur, these mechanics examine equipment for damaged components and either fix them, replace the part, or make a software modification. They may use electrical measuring instruments to monitor signal strength, transmission capacity, interference, and signal delay, as well as hand tools to replace defective components and parts and to adjust equipment so that it performs within required specifications.

Work environment. Radio and telecommunications equipment installers and repairers generally work in clean, well-lit, air-conditioned surroundings, such as a telecommunications company's central office, a customer's location, or an electronic repair shop or service center. Traveling to the site of the installation or repair is common among station installers and repairers, PBX and VoIP installers and repairers, and radio mechanics. The installation may require access to rooftops, ladders, and telephone poles to complete the repair. Radio mechanics may need to work on transmissions towers, which may be located on top of tall buildings or mountains, as well as aboard airplanes and ships. These workers are subject to a variety of weather conditions while working outdoors.

The work of most repairers involves lifting, reaching, stooping, crouching, and crawling. Adherence to safety precautions is important in order to guard against work hazards. These hazards include falls, minor burns, electrical shock, and contact with hazardous materials.

Nearly all radio and telecommunications equipment installers and repairers work full time. Many work regular business hours to meet the demand for repair services during the workday. Schedules are more irregular at employers that provide repair services 24 hours a day, such as for police radio com-



Telecommunications equipment installers make adjustments in central offices.

munications operations or where installation and maintenance must take place after normal business hours. At these locations, mechanics work a variety of shifts, including weekend and holiday hours. Repairers may be on call around the clock, in case of emergencies, and may have to work overtime.

Training, Other Qualifications, and Advancement

Postsecondary education in electronics and computer technology is increasingly required for radio and telecommunications equipment installers and repairer jobs, and a few employers even prefer people with a bachelor's degree for some of the most complex types of work. About half of all radio and telecommunications equipment installers and repairers have completed some college courses or an associate degree.

Education and training. As telecommunications technology becomes more complex, the education required for radio and telecommunications equipment installers and repairer jobs has increased. Most employers prefer applicants with postsecondary training in electronics and familiarity with computers. The education needed for these jobs may vary from a certification to work on certain equipment to a 2- or 4-year degree in electronics or a related subject. Sources of training include 2- and 4-year college programs in electronics or communications technology, military experience in radios and electronics, trade schools, and programs offered by equipment and software manufacturers. Educational requirements are higher for central office installers and repairers and for those working in nonresidential settings.

Many in the telecommunications industry work their way up into this occupation by gaining experience at less difficult jobs. Experience as a telecommunications line installer or station installer is helpful before moving up to the job of central office installer and other more complex jobs, for example. Military experience with communications equipment is also valued by many employers in both telecommunications and radio repair.

Newly hired repairers usually receive some training from their employers. This may include formal classroom training in electronics, communications systems, or software and informal hands-on training assisting an experienced repairer. Large companies may send repairers to outside training sessions to learn about new equipment and service procedures. As networks

have become more sophisticated—often including equipment from a variety of companies—the knowledge needed for installation and maintenance also has increased.

Licensure. Aviation and marine radio mechanics are required to have a license from the Federal Communications Commission before they can work on these types of radios. This requires passing several exams on radio law, electronics fundamentals, and maintenance practices.

Other qualifications. Familiarity with computers, being mechanically inclined, and being able to solve problems are traits that are highly regarded by employers. Repairers must also be able to distinguish colors, because wires are color-coded. For positions that require climbing poles and towers, workers must be in good physical shape and not afraid of heights. Repairers who handle assignments alone at a customer's site must be able to work without close supervision. For workers who frequently contact customers, a pleasant personality, neat appearance, and good communications skills also are important.

Certification and advancement. This is an occupation where the technology is changing rapidly. Workers must keep abreast of the latest equipment available and know how to repair it. Telecommunications equipment installers and repairers often need to be certified to perform certain tasks or to work on specific equipment. Certification often requires taking classes. Some of certifications are needed before entering an occupation; others are meant to improve one's current abilities or to advance in the occupation.

The Society of Cable and Telecommunications Engineers and the Telecommunications Industry Association offer voluntary certifications to workers in this field. Telecommunications equipment manufacturers also provide training on specific equipment.

Experienced repairers with advanced training may become specialists or troubleshooters who help other repairers diagnose difficult problems, or may work with engineers in designing equipment and developing maintenance procedures. Home installers may advance to wiring computer networks or working as a central office installer and repairer. Because of their familiarity with equipment, repairers are particularly well qualified to become manufacturers' sales workers. Workers with leadership ability also may become maintenance supervisors or service managers. Some experienced workers open their own repair services or shops, or become wholesalers or retailers of electronic equipment.

Employment

Radio and telecommunications equipment installers and repairers held about 205,000 jobs in 2006. About 198,000 were tele-

communications equipment installers and repairers, except line installers. The remaining 6,500 were radio mechanics.

Telecommunications equipment installers and repairers work mostly in the telecommunications industry. Increasingly, however, they can be found in the construction industry working as contractors to the telecommunications industry.

Radio mechanics work in the electronic and precision equipment repair and maintenance industry, the telecommunications industry, electronics and appliance stores, government, and other industries.

Job Outlook

Little or no change in employment of radio and telecommunications equipment installers and repairers is projected. Job opportunities vary by specialty. Job prospects are best for those with computer skills and postsecondary training in electronics.

Employment change. Employment of radio and telecommunications equipment installers and repairers is expected to increase 2 percent, reflecting little or no change, during the 2006-16 period. Over the next decade, telecommunications companies will provide faster Internet connections, provide video-on-demand, add hundreds of television stations, and many services that haven't even been invented yet. Although building the new networks required to provide these services will create jobs, these gains will be offset by a decline in maintenance work. The new equipment requires much less maintenance work because it is newer, more reliable, easier to repair, and more resistant to damage from the elements.

The increased reliability of radio equipment and the use of self-monitoring systems also will continue to lessen the need for radio mechanics. However, technological changes are also creating new wireless applications that create jobs for radio mechanics.

Job prospects. Applicants with computer skills and postsecondary training in electronics should have the best opportunities for radio and telecommunications equipment installer and repairer jobs, but opportunities will vary by specialty. Good opportunities should be available for central office and PBX installers and repairers experienced in current technology, as the growing popularity of VoIP, expanded multimedia offerings such as video on demand, and other telecommunications services continue to place additional demand on telecommunications networks. These new services require high data transfer rates, which can be achieved only by installing new optical switching and routing equipment. Extending high-speed communications from central offices to customers also will require telecommunications equipment installers to put in place more advanced switching and routing equipment, but opportunities for repair-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Radio and telecommunications equipment installers and repairers.. | 49-2020 | 205,000 | 209,000 | 4,800 | 2 |
| Radio mechanics | 49-2021 | 6,500 | 6,300 | -300 | -4 |
| Telecommunications equipment installers and repairers, except line installers | 49-2022 | 198,000 | 203,000 | 5,000 | 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*.

ers will be limited by the increased reliability and automation of the new switching equipment.

Station installers and repairers can expect keen competition. Prewired buildings and the increasing reliability of telephone equipment will reduce the need for installation and maintenance of customers' telephones, as will the declining number of pay telephones in operation as use of cellular telephones grows. However, some of these losses should be offset by the need to upgrade internal lines in businesses and the wiring of new homes and businesses with fiber optic lines.

Radio mechanics should find good opportunities if they have a strong background in electronics and an ability to work independently. Increasing competition from cellular services is limiting the growth of radio services, but employers report difficulty finding adequate numbers of qualified radio mechanics to perform repair work.

Earnings

In May 2006, median hourly earnings of telecommunications equipment installers and repairers, except line installers were \$25.21. The middle 50 percent earned between \$20.43 and \$28.66. The bottom 10 percent earned less than \$14.96, whereas the top 10 percent earned more than \$32.84. The median hourly earnings of these workers in the wired telecommunications carriers industry were \$26.25 in May 2006.

Median hourly earnings of radio mechanics in May 2006 were \$18.12. The middle 50 percent earned between 14.04 and \$23.02. The bottom 10 percent earned less than \$10.94, whereas the top 10 percent earned more than \$28.54.

About 4 percent of radio and telecommunications equipment installers and repairers were self-employed. About 26 percent of radio and telecommunication equipment installers and repairers are members of unions, such as the Communications Workers of America (CWA) and the International Brotherhood of Electrical Workers (IBEW.)

Telecommunications equipment installers and repairers employed by large telecommunications companies who also belong to unions often have very good benefits, including health, dental, vision, and life insurance. They also usually have good retirement and leave policies. Those working for small independent companies and contractors may get fewer benefits.

Radio mechanics tend to work for small electronics firms or government. Benefits vary widely depending upon the type of work and size of firm. Government jobs usually have good benefits.

Related Occupations

Related occupations that involve work with electronic equipment include broadcast and sound engineering technicians and radio operators; computer, automated teller, and office machine repairers; and electrical and electronics installers and repairers. Line installers and repairers also set up and install telecommunications equipment. Engineering technicians also may repair electronic equipment as part of their duties.

Sources of Additional Information

For information on career and training opportunities, contact:

► International Brotherhood of Electrical Workers, Telecommunications Department, 900 7th St.NW., Washington, DC 20001.

► Communications Workers of America, 501 3rd St.NW., Washington, DC 20001.

Internet: <http://www.cwa-union.org/jobs>

For information on training and professional certifications for those already employed by cable telecommunications firms, contact:

► Society of Cable Telecommunications Engineers, Certification Department, 140 Phillips Rd., Exton, PA 19341-1318. Internet: <http://www.scte.org>

For information on training and licensing for aviation and marine radio mechanics, contact:

► The Federal Communications Commission (FCC), 445 12th St.SW., Washington, DC 20554.

Internet: <http://wireless.fcc.gov/commoperators>

For more information on employers, education, and training in marine electronics and radios, contact:

► National Marine Electronics Association, 7 Riggs Ave., Severna Park, MD 21164. Internet: <http://www.nmea.org>

Small Engine Mechanics

(O*NET 49-3051.00, 49-3052.00, 49-3053.00)

Significant Points

- Job prospects should be excellent for people who complete formal training programs.
- Most mechanics learn their skills on the job or while working in related occupations.
- Use of motorcycles, motorboats, and outdoor power equipment is seasonal in many areas, so mechanics may service other types of equipment or work reduced hours in the winter.

Nature of the Work

Small engine mechanics repair and service power equipment ranging from jet skis to chainsaws. Mechanics usually specialize in the service and repair of one type of equipment, although they may work on closely-related products.

When a piece of equipment breaks down, mechanics use various techniques to diagnose the source and extent of the problem. The mark of a skilled mechanic is the ability to diagnose mechanical, fuel, and electrical problems and to make repairs quickly. Quick and accurate diagnosis requires problem-solving ability and a thorough knowledge of the equipment's operation.

Some jobs require minor adjustments or the replacement of a single item, whereas a complete engine overhaul requires hours to disassemble the engine and replace worn valves, pistons, bearings, and other internal parts. Some highly skilled mechanics use specialized components and the latest computerized equipment to customize and tune motorcycles and motorboats for racing.

Handtools are the most important work possessions of mechanics. Small engine mechanics use wrenches, pliers, and screwdrivers on a regular basis. Mechanics usually provide their own tools, although employers will furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment. Computerized engine analyzers, compression gauges, ammeters and voltmeters, and other testing devices help mechanics locate faulty parts and tune engines. This equipment provides a systematic performance report of various components to compare against normal ratings. After pinpointing the problem, the mechanic makes the needed adjustments, repairs, or replacements.

Small engines also require periodic service to minimize the chance of breakdowns and to keep them operating at peak performance. During routine maintenance, mechanics follow a checklist that includes the inspection and cleaning of brakes, electrical systems, fuel injection systems, plugs, carburetors, and other parts. Following inspection, mechanics usually repair or adjust parts that do not work properly or replace unfixable parts.

Motorcycle mechanics specialize in the repair and overhaul of motorcycles, motor scooters, mopeds, dirt bikes, and all-terrain vehicles. Besides repairing engines, they may work on transmissions, brakes, and ignition systems and make minor body repairs. Mechanics often service just a few makes and models of motorcycles because most work for dealers that service only the products they sell.

Motorboat mechanics, or *marine equipment mechanics*, repair and adjust the electrical and mechanical equipment of inboard and outboard boat engines. Most small boats have portable outboard engines that are removed and brought into the repair shop. Larger craft, such as cabin cruisers and commercial fishing boats, are powered by diesel or gasoline inboard or inboard-outboard engines, which are removed only for major overhauls. Most of these repairs, therefore, are performed at docks or marinas. Motorboat mechanics also may work on propellers, steering mechanisms, marine plumbing, and other boat equipment.

Outdoor power equipment and other small engine mechanics service and repair outdoor power equipment such as lawnmowers, garden tractors, edge trimmers, and chain saws. They



Small engine mechanics may work on motorcycles, motorboats, lawnmowers, or other outdoor power equipment.

also may occasionally work on portable generators and go-carts. In addition, small engine mechanics in certain parts of the country may work on snowblowers and snowmobiles, but demand for this type of repair is both seasonal and regional.

Work environment. Small engine mechanics usually work in repair shops that are well lighted and ventilated but are sometimes noisy when engines are tested. Motorboat mechanics may work outdoors in poor weather conditions when making repairs aboard boats. They may also work in cramped or awkward positions to reach a boat's engine. Outdoor power equipment mechanics face similar conditions when they need to make on-site repairs.

During the winter months in the northern United States, mechanics may work fewer than 40 hours a week because the amount of repair and service work declines when lawnmowers, motorboats, and motorcycles are not in use. Many mechanics work full-time only during the busy spring and summer seasons. However, they often schedule time-consuming engine overhauls or work on snowmobiles and snowblowers during winter downtime. Mechanics may work considerably more than 40 hours a week when demand is strong.

Training, Other Qualifications, and Advancement

Due to the increasing complexity of motorcycles and motorboats, employers prefer to hire mechanics who have graduated from formal training programs. However, because the number of these specialized postsecondary programs is limited, most mechanics still learn their skills on the job or while working in related occupations.

Education and training. Employers prefer to hire high school graduates for trainee mechanic positions, but many will accept applicants with less education if they possess adequate reading, writing, and math skills. Helpful high school courses include small engine repair, automobile mechanics, science, and business math. Many equipment dealers employ high school students part time and during the summer to help assemble new equipment and perform minor repairs.

Once employed, trainees learn routine service tasks under the guidance of experienced mechanics by replacing ignition points and spark plugs or by taking apart, assembling, and testing new equipment. As they gain experience and proficiency, trainees progress to more difficult tasks, such as advanced computerized diagnosis and engine overhauls. Anywhere from 3 to 5 years of on-the-job training may be necessary before a novice worker becomes competent in all aspects of the repair of motorcycle and motorboat engines. Repair of outdoor equipment, because of fewer moving parts, requires less on-the-job training.

A growing number of motorcycle and marine equipment mechanics graduate from formal motorcycle and motorboat postsecondary programs. Employers prefer to hire these workers for their advanced knowledge of small engine repair. These workers also tend to advance quickly to more demanding small engine repair jobs.

Employers often send mechanics and trainees to courses conducted by motorcycle, motorboat, and outdoor power equipment manufacturers or distributors. These courses, which can last up to 2 weeks, upgrade workers' skills and provide infor-

Projections data from the National Employment Matrix

| Occupational Title | SOC Code | Employment, 2006 | Projected employment, 2016 | Change, 2006-16 | |
|---|----------|------------------|----------------------------|-----------------|---------|
| | | | | Number | Percent |
| Small engine mechanics..... | 49-3050 | 78,000 | 87,000 | 9,100 | 12 |
| Motorboat mechanics..... | 49-3051 | 24,000 | 29,000 | 4,600 | 19 |
| Motorcycle mechanics..... | 49-3052 | 21,000 | 24,000 | 2,600 | 12 |
| Outdoor power equipment and other small engine mechanics..... | 49-3053 | 33,000 | 35,000 | 1,800 | 6 |

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

mation on repairing new models. Manufacturer classes are usually a prerequisite for any mechanic who performs warranty work for manufacturers or insurance companies.

Other qualifications. For trainee jobs, employers hire people with mechanical aptitude who are knowledgeable about the fundamentals of small 2- and 4-stroke engines. Many trainees get their start by working on automobiles, motorcycles, motorboats, or outdoor power equipment as a hobby. Knowledge of basic electronics is essential because many parts of small vehicles and engines are electric.

Advancement. The skills needed for small engine repair can transfer to other occupations, such as automobile, diesel, or heavy vehicle and mobile equipment mechanics. Experienced mechanics with leadership ability may advance to shop supervisor or service manager jobs. Mechanics with sales ability sometimes become sales representatives or open their own repair shops.

Employment

Small engine mechanics held about 78,000 jobs in 2006. Motorcycle mechanics held around 21,000 jobs. Motorboat mechanics held approximately 24,000 and outdoor power equipment and other small engine mechanics about 33,000. Almost half, 47 percent, of small engine mechanics worked for either other motor vehicle dealers—an industry that includes retail dealers of motorcycles, boats, and miscellaneous vehicles—or for retail hardware, lawn, and garden stores. Most of the remainder were employed by independent repair shops, marinas and boatyards, equipment rental companies, wholesale distributors, and landscaping services. About 23 percent were self-employed, compared to about 7 percent of workers in all installation, maintenance, and repair occupations.

Job Outlook

Average employment growth is projected for of small engine mechanics. Job prospects should be excellent for people who complete formal training programs.

Employment change. Employment of small engine mechanics is expected to grow 12 percent between 2006 and 2016, about as fast as the average for all occupations. An increase in the population of retired people is expected to increase the number of people who have leisure time and income to spend on recreational equipment such as motorcycles and motorboats. Moreover, the increase in the population of coastal and lake regions should add to the popularity of motorboats, and continued motorcycle use among 18- to 24-year-olds will contribute to rising motorcycle sales. The need for

mechanics to maintain and repair motorcycles and motorboats is expected to increase with sales.

Outdoor equipment mechanics will not experience the same level of growth. Although the construction of new single-family houses will result in an increase in the sale of lawn and garden machinery and the need for mechanics to repair it, growth will be strongly tempered by a trend toward smaller lawns and the contracting out of maintenance to landscaping firms that often repair their own equipment. Small engine mechanics' growth also will be tempered by the tendency of many consumers to replace relatively inexpensive items rather than have them repaired.

Job prospects. Job prospects should be excellent for people who complete formal training programs. Employers prefer mechanics who have knowledge of both 2- and 4-stroke engines and other emissions-reducing technology as the government increases regulation of the emissions produced by small engines. Many of the job openings for small engine mechanics will result from the need to replace the many experienced small engine mechanics who are expected to transfer to other occupations, retire, or stop working for other reasons.

Work tends to be more available in summer months.

Earnings

Median wage-and-salary earnings of motorcycle mechanics were \$14.45 an hour in May 2006, as compared to \$17.65 for all installation, maintenance, and repair occupations. The middle 50 percent earned between \$11.31 and \$18.41. The lowest 10 percent earned less than \$8.96, and the highest 10 percent earned more than \$23.31. Median hourly earnings in other motor vehicle dealers, the industry employing the largest number of motorcycle mechanics, were \$14.42.

Median wage-and-salary earnings of motorboat mechanics were \$15.96 an hour in May 2006. The middle 50 percent earned between \$12.66 and \$20.01. The lowest 10 percent earned less than \$9.94, and the highest 10 percent earned more than \$24.40. Median hourly earnings in other motor vehicle dealers, the industry employing the largest number of motorboat mechanics, were \$15.68.

Median wage-and-salary earnings of outdoor power equipment and other small engine mechanics were \$12.94 an hour in May 2006. The middle 50 percent earned between \$10.36 and \$16.05. The lowest 10 percent earned less than \$8.31, and the highest 10 percent earned more than \$19.31. Median hourly earnings in lawn and garden equipment and supplies stores, the industry employing the largest number of outdoor power equipment and other small engine mechanics, were \$12.74.

Small engine mechanics in small shops usually receive few benefits, but those employed in larger shops often receive paid vacations, sick leave, and health insurance. Some employers also pay for work-related training, provide uniforms, and help mechanics purchase new tools.

Related Occupations

Mechanics and repairers who work on durable equipment other than small engines include automotive service technicians and mechanics, diesel service technicians and mechanics, heavy ve-

hicle and mobile equipment service technicians and mechanics, and home appliance repairers.

Sources of Additional Information

To learn about work opportunities, contact local motorcycle, motorboat, and lawn and garden equipment dealers, boatyards, and marinas. Local offices of the State employment service also may have information about employment and training opportunities.