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Mechanics, Equipment Installers, and Repairers



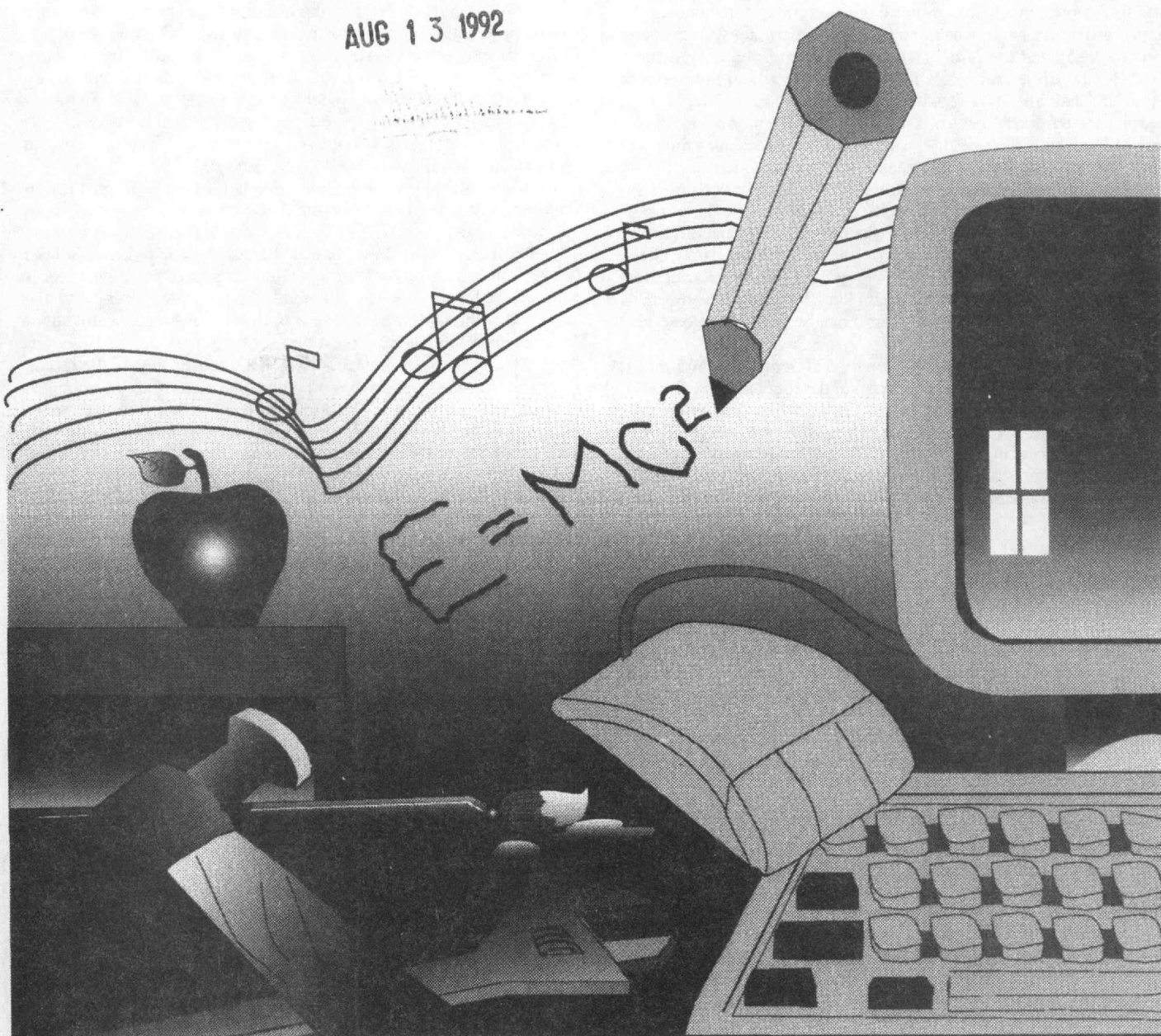
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Aircraft Mechanics and Engine Specialists

(D.O.T. 621.281 except -030, .381-010, -014, .684-014; 806.281-038, .684-110; 807.261, .381-014, .684-018)

Nature of the Work

Most travelers hardly think twice about flying thousands of feet above the ground. The confidence they have in aircraft is a tribute to the mechanics (also referred to as technicians) who keep them in top operating condition.

Many mechanics specialize in scheduled maintenance required by the Federal Aviation Administration (FAA). Following a schedule that is based on the number of hours flown, calendar days, cycles of operation, or a combination of these factors, mechanics inspect the 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. They may examine an engine through specially designed openings while working from ladders or scaffolds, or use hoists or lifts to remove the entire engine from the craft. After taking the engine apart, mechanics may use precision instruments to measure parts for wear, and use X-ray and magnetic inspection equipment to check for invisible cracks. Worn or defective parts are repaired or replaced. They also may repair sheet-metal or composite surfaces, measure the tension of control cables, or check for corrosion, distortion, and cracks in the fuselage, wings, and tail. Mechanics must test the equipment to make sure the repairs were made properly.

Mechanics specializing in repair work rely on the pilot's description of a problem to find and fix faulty equipment. 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 check the electrical connections, replace the gauge, or use electrical test equipment to make sure no wires are broken or shorted. They work as fast as safety permits so that the aircraft can be put back into service quickly.

Mechanics may work on one or many different types of aircraft, such as jets, propeller-driven airplanes, and helicopters, or, for efficiency, may specialize in one section of a particular type of aircraft, such as the engine, hydraulic, or electrical system. As a result of technological advances, mechanics spend an increasing amount of time repairing electronic systems such as computerized controls. In small, independent repair shops, mechanics usually inspect and repair many different types of aircraft.

Working Conditions

Mechanics usually work in hangars or other indoor areas, although they may work outdoors, sometimes in unpleasant weather, when the hangars are full or when repairs must be made quickly. This occurs most often to airline mechanics who work at airports because, to save time, minor repairs and preflight checks often are made at the terminal. 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 as much as 50 pounds. They often stand, lie, or kneel in awkward positions and occasionally must work in precarious positions on scaffolds or ladders. Noise and vibration are common when testing engines. Aircraft mechanics generally work 40 hours a week on 8-hour shifts around the clock.

Employment

Aircraft mechanics held about 122,000 jobs in 1990. Over three-fifths of salaried mechanics worked for airlines, nearly one-fifth for aircraft assembly firms, and nearly one-sixth for the Federal Government. Most of the rest were general aviation mechanics, the majority of

whom worked for independent repair shops or companies that operate their own planes to transport executives and cargo. Very few mechanics were self-employed. (The accompanying chart indicates the percent distribution of wage and salary jobs by industry.)

Most airline mechanics work near large cities at the airlines' main stops. Many are civilians employed by the Armed Forces and work at military aviation installations. Others work for the FAA, many in the headquarters at Oklahoma City. Mechanics for independent repair shops work at airports in every part of the country.

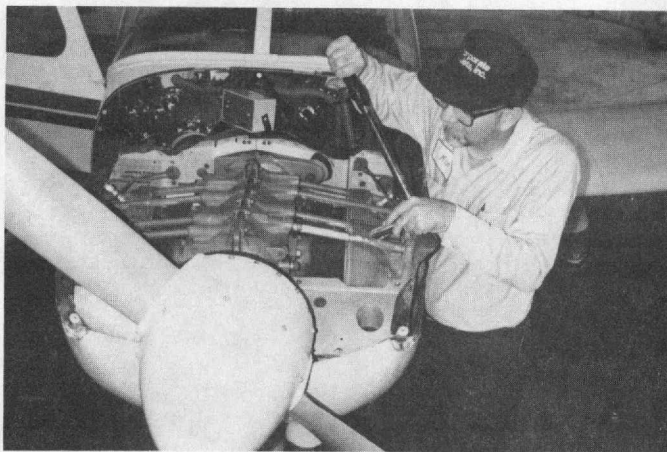
Training, Other Qualifications, and Advancement

The majority of mechanics who work on civilian aircraft are certified by the FAA as "airframe mechanic," "powerplant mechanic," or "repairer." Airframe mechanics are authorized to work on any part of the aircraft except the instruments, powerplants, and propellers. Powerplant mechanics are authorized to work on engines and to do limited work on propellers. Technicians called repairers—who are employed by appropriately rated FAA-certificated repair stations and air carriers—do work on instruments and major work on propellers. Combination airframe-and-powerplant mechanics can work on any part of the plane, and those with an inspector's authorization can certify inspection work completed by other mechanics. Uncertificated mechanics are supervised by those with certificates.

The FAA requires at least 18 months of work experience for an airframe, powerplant, or repairman's certificate. For a combined airframe-and-powerplant certificate, at least 30 months of experience working with both engines and airframes are required. To obtain an inspector's authorization, a mechanic must have held an airframe-and-powerplant certificate for at least 3 years. Applicants for all certificates also must pass written and oral tests and demonstrate that they can do the work authorized by the certificate.

Although a few people become mechanics through on-the-job training, most learn their job in the Armed Forces or in one of about 150 trade schools certified by the FAA. Student enrollment in these schools varies greatly; some have as few as 50 students while at least one school has about 600 students. Courses in these trade schools generally last from 2 years to 30 months and provide training with the tools and equipment used on the job. For an FAA certificate, attendance at such schools may substitute for work experience. However, these schools do not guarantee jobs or FAA certificates. In the future, mechanic schools will place more emphasis on the newer technologies such as turbine engines, aviation electronics, and composite materials including graphite, fiberglass, and boron, all of which are increasingly being used in the construction of new aircraft.

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. Generally, however, jobs in the military services are too specialized to provide the broad experience required by the FAA. Most



Aircraft mechanics inspect aircraft on a scheduled basis.

mechanics have to complete the entire training program at a trade school, 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 trade school graduates who have this experience to be the most desirable applicants.

Courses in mathematics, physics, chemistry, electronics, computer science, and mechanical drawing are helpful because many of their principles are involved in the operation of an aircraft and knowledge of the principles often is necessary to make repairs. Courses that develop writing skills are also important since mechanics are often required to submit reports.

As new and more complex aircraft are designed, mechanics must update their skills. Recent technological advances in aircraft maintenance necessitate a strong background in electronics—both for acquiring and retaining jobs in this field. Many mechanics take courses offered by manufacturers or employers, usually through outside contractors.

Aircraft mechanics must do careful and thorough work which requires high mechanical aptitude. Employers seek applicants who are motivated, enthusiastic, and able to diagnose and solve complex mechanical problems. Agility is important for the reaching and climbing necessary for the job. Aircraft mechanics must not be afraid of heights since they may work on the top of wings and fuselages on large jet planes.

As aircraft mechanics gain experience, they have the opportunity for advancement. Opportunities are best for those who have an aircraft inspector's authorization. A mechanic may advance to lead mechanic (or crew chief), inspector, lead inspector, and shop supervisor. In the airlines, where promotion is often determined by examination, supervisors may advance to executive positions. Those with broad experience in maintenance and overhaul have become inspectors with the FAA. With additional business and management training, some open their own aircraft maintenance facilities.

Job Outlook

The number of aircraft mechanics is expected to increase about as fast as the average for all occupations through the year 2005. A growing population and rising incomes are expected to stimulate the demand for airline transportation, and the number of aircraft is expected to grow. However, employment growth will be restricted somewhat by increases in productivity resulting from greater use of automated inventory control and modular systems which speed repairs and parts replacement.

Overall, aircraft mechanics—particularly those with work experience—are expected to have excellent job opportunities since the number of job openings is expected to exceed the supply of qualified applicants. Growth in demand for the services of aircraft mechanics coupled with an expected large number of retirements should provide many job openings.

Job opportunities are likely to be best in general aviation. Since wages in small companies tend to be relatively low, there generally are fewer applicants for these jobs than for airline jobs. Also, some jobs will become available as experienced mechanics leave for better paying jobs with airlines or large private companies. Mechanics may face some competition for airline jobs because the high wages and travel benefits attract more qualified applicants. The number of job openings for aircraft mechanics in the Federal Government will fluctuate with changes in defense spending. Mechanics who keep abreast of technological advances in electronics, composite materials, and other areas will be in greatest demand.

Declines in air travel during recessions force airlines to curtail the number of flights, which results in less aircraft maintenance and, consequently, layoffs for aircraft mechanics.

Earnings

In 1990, the median annual salary of aircraft mechanics was about \$30,000. Mechanics who worked on jets generally earned more than those working on other aircraft. The top 10 percent of all aircraft mechanics earned over \$45,000 a year. Airline mechanics and their immediate families receive reduced fare transportation on their own and most other airlines.

Earnings of airline mechanics generally are higher than mechanics working for other employers. Beginning aircraft mechanics employed by the airlines earned from \$10 to \$15 an hour in 1990, according to the Future Aviation Professionals of America. Earnings of experienced mechanics ranged from \$15 to \$25 an hour.

Mechanics employed by the Federal Government averaged \$32,400 a year in 1990.

Some mechanics, including those employed by some major airlines, are 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, Chauffeurs, Warehousemen and Helpers of America (Ind.).

Related Occupations

Workers in some other occupations that involve similar mechanical and electrical work are electricians, elevator repairers, and telephone maintenance mechanics.

Sources of Additional Information

Information about jobs in a particular airline may be obtained by writing to the personnel manager of the company. For addresses of airline companies and information about job opportunities and salaries, contact:

• Future Aviation Professionals of America, 4959 Massachusetts Blvd., Atlanta, GA 30337. (This organization may be called toll free at 800-JET-JOBS.)

For general information about aircraft mechanics, write to:

• Aviation Maintenance Foundation, P.O. Box 2826, Redmond, WA 98073.

• Professional Aviation Maintenance Association, 500 Northwest Plaza, Suite 401, St. Ann, MO 63074.

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

Automotive Body Repairers

(D.O.T. 620.364, .684-034; 807.267; .281; .361-010; .381-010, -018, -022; .484; .684-010; 865.684-010)

Nature of the Work

Thousands of motor vehicles are damaged in traffic accidents every day. Although some are sold for salvage or scrapped, most can be repaired to look and drive like new. Automotive body repairers straighten bent bodies, remove dents, and replace crumpled parts that are beyond repair. Usually, they can repair all types of vehicles, but most body repairers work on cars and small trucks. A few work on large trucks, buses, or tractor-trailers.

When a damaged vehicle is brought into the shop, body repairers generally receive instructions from their supervisors, who have determined which parts are to be restored or replaced and how much time the job should take.

Automotive body repairers use special machines to restore damaged metal frames and body sections to their original shape and location. They chain or clamp the frames and sections to alignment machines that usually use hydraulic pressure to align the damaged metal. For "unibody" designs, which are built without frames, they also use bench systems to return body sections to precise alignment.

Body repairers remove badly damaged sections of body panels with a pneumatic metal-cutting gun or acetylene torch and weld in new sections to replace them. Repairers pull out less serious dents with a hydraulic jack or hand prying bar, or knock them out with handtools or pneumatic hammers. They smooth out small dents and creases in the metal by holding a small anvil against one side of the damaged area while hammering the opposite side. They remove very small pits and dimples with pick hammers and punches.

Body repairers also repair or replace the plastic body parts used increasingly on newer model vehicles. They remove the damaged panels and determine the type of plastic from which they are made.

With most types, they can apply heat from a hot-air welding gun or by immersion in hot water, and press the softened panel back into its original shape by hand. They replace plastic parts which are more difficult to repair.

Body repairers use plastic or solder to fill small dents which cannot be worked out of the plastic or metal panel. On metal panels, they then file or grind the hardened filler to the original shape and sand it before painting. In many shops, automotive painters do the painting. (These workers are discussed in the *Handbook* statement on painting and coating machine operators.) In smaller shops, workers often do both body repairing and painting. A few body repairers specialize in repairing fiberglass car bodies.

In large shops, body repairers may specialize in one type of repair, such as frame straightening or door and fender repairing. Some body repairers also specialize in installing glass in automobiles and other vehicles. Glass installers remove broken, cracked, or pitted windshields and window glass. Curved windows sometimes must be cut from a sheet of safety glass. Glass installers apply a moisture-proofing compound along the edges of the glass, place it in the vehicle, and install rubber strips around the sides of the windshield or window to make it secure and weatherproof.

Body repair work has variety and challenge—each damaged vehicle presents a different problem. Repairers must develop appropriate methods for each job, using their broad knowledge of automotive construction and repair techniques.

Body repairers usually work alone with only general directions from supervisors. In some shops, they may be assisted by helpers or apprentices.

Working Conditions

Most automotive body repairers work 40 to 60 hours a week. They work indoors in body shops which are noisy because of the banging of hammers against metal and the whirl 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.

Employment

Automotive body repairers held about 219,000 jobs in 1990. Most worked for shops that specialized in body repairs and painting, and

for automobile and truck dealers. Others worked for organizations that maintain their own motor vehicles, such as trucking companies and automobile rental companies. A few worked for motor vehicle manufacturers. About 1 automotive body repairer out of 5 was self-employed.

Training, Other Qualifications, and Advancement

Many automotive body repairers enter the occupation by transferring from related helper positions. Persons in good physical condition who know how to use handtools learn the trade as helpers, picking up skills on the job from experienced body repairers. Helpers begin by assisting body repairers in tasks such as removing damaged parts and installing repaired parts. They learn to remove small dents and to make other minor repairs. They then progress to more difficult tasks such as straightening body parts and returning them to their correct alignment. Generally, skill in all aspects of body repair requires 3 to 4 years of on-the-job training.

Most employers prefer to hire persons who have completed formal training programs in automotive body repair, but the small number of these programs are able to supply only a portion of employers' needs. Formal training is highly desirable because advances in technology in recent years have greatly changed the structure, the components, and even the materials used in automobiles. As a result, many new repair problems have been created and many new skills are required. For example, the bodies of newer automobiles are increasingly made of a combination of materials—the traditional steel, plus aluminum and a growing variety of metal alloys and plastics—each requiring the use of somewhat different techniques to reshape and smooth out dents and small pits. Automotive body repair training programs are offered by high schools, vocational schools, private trade schools, and community colleges. Formal training in automotive body repair can enhance chances for employment and speed promotion to a journeyman position.

Employers hire many persons without formal automotive body repair training, but most prefer to hire high school graduates. Good reading and basic mathematics skills are essential because restoring unibody automobiles to their original form requires such precision that body repairers often must follow instructions and diagrams in technical manuals and make very precise measurements of the position of one body section relative to another.

Certification by the National Institute for Automotive Service Excellence (ASE), which is voluntary, is recognized as a standard of achievement for automotive body repairers. To be certified, a body repairer must pass a written examination and must have at least 2 years of experience in the trade. Completion of a high school, vocational school, trade school, or community college program in automotive body repair may be substituted for 1 year of work experience. Automotive body repairers must retake the examination at least every 5 years to retain certification.

Automotive body repairers must buy their own handtools, but employers usually furnish power tools. Trainees generally accumulate tools as they gain experience, and many workers have thousands of dollars invested in tools.

An experienced automotive body repairer with supervisory ability may advance to shop supervisor. Some workers open their own body repair shops. Others become automobile damage appraisers for insurance companies.

Job Outlook

Employment of automotive body repairers is expected to increase about as fast as the average for all occupations through the year 2005. Opportunities should be best for persons with formal training in automotive body repair and mechanics.

Requirements for body repairers will increase because as the number of motor vehicles in operation grows with the Nation's population, the number damaged in accidents will increase as well. New automobile designs increasingly have body parts made of steel alloys, aluminum, and plastics—materials that are more difficult to work with than the traditional steel body parts. Also, new, lighter weight automotive designs are prone to greater collision damage than older, heavier designs and, consequently, are more



Automotive body repairers restore damaged body panels to their original shape and position.

time consuming to repair. Nevertheless, the need to replace experienced repairers who transfer to other occupations or retire or stop working for other reasons will still account for the majority of job openings.

The automotive repair business is not very sensitive to changes in economic conditions, and experienced body repairers are rarely laid off. However, most employers hire fewer new workers during an economic slowdown. Although major body damage must be repaired if a vehicle is to be restored to safe operating condition, repair of minor dents and crumpled fenders can often be deferred. As a result, persons seeking to enter this occupation may face increased competition for jobs during recessions.

Earnings

Body repairers employed by automobile dealers in 18 large metropolitan areas had average hourly earnings of \$18.25 in 1990. Average earnings generally were highest in the South and lowest in the Northeast. Helpers and trainees usually earn from 30 to 60 percent of the earnings of skilled workers.

The majority of body repairers employed by automotive dealers and repair shops are paid on an incentive basis. Under this method, body repairers are paid a predetermined amount for various tasks, and earnings depend on the amount of work assigned to the repairer and how fast it is completed. Employers frequently guarantee workers a minimum weekly salary. Helpers and trainees usually receive an hourly rate until they are skilled enough to be paid on an incentive basis. Body repairers who work for trucking companies, buslines, and other organizations that maintain their own vehicles usually receive an hourly wage.

Many automotive body repairers are members of unions, including 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, Chauffeurs, Warehousemen and Helpers of America. Most body repairers who are union members work for large automobile dealers, trucking companies, and buslines.

Related Occupations

Repairing damaged motor vehicles often involves working on their mechanical components as well as their bodies. Automotive body repairers often work closely with several related occupations including automotive and diesel mechanics, automotive repair service estimators, painters, and body customizers.

Sources of Additional Information

More details about work opportunities may be obtained from automotive body repair shops and motor vehicle dealers; locals of the unions previously mentioned; or the local office of the State employment service. The State employment service also is a source of information about training programs.

For general information about automotive body repairer careers, write to:

- Automotive Service Association, Inc., P.O. Box 929, Bedford, TX 76095-0929.
- Automotive Service Industry Association, 444 North Michigan Ave., Chicago, IL 60611.
- Motor Vehicle Manufacturers Association of the U.S., Inc., Suite 300, 7430 Second Ave., Detroit, MI 48202.

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

- ASE, 13505 Dulles Technology Dr., Herndon, VA 22071-3415.

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

- National Automotive Technician Education Foundation, 13505 Dulles Technology Dr., Herndon, VA 22071.

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

- National Association of Trade and Technical Schools, Department BL, P.O. Box 2006, Annapolis Junction, MD 20701-2006.

Automotive Mechanics

(D.O.T. 620.261-010, -012, -030, -034; .281-010, -026, -034, -038, -062, -066, -070; .381-010, -022; .684-018, -022; 706.381-046; 721.281-010; 806.361-026, .684-038; 807.664, .684-022; 825.381-014)

Nature of the Work

Automotive mechanics, often called automotive service technicians, repair and service automobiles and occasionally light trucks, such as vans and pickups, with gasoline engines. (Mechanics who work on diesel-powered trucks, buses, and equipment are discussed in the *Handbook* statement on diesel mechanics. Motorcycle mechanics—who repair and service motorcycles, motorscooters, mopeds, and occasionally small all-terrain vehicles—are discussed in the *Handbook* statement on motorcycle, boat, and small-engine mechanics.)

Anyone whose car or light truck has broken down knows the importance of the mechanic's job. The ability to diagnose the source of the problem quickly and accurately, one of the mechanic's most valuable skills, requires good reasoning ability and a thorough knowledge of automobiles. In fact, many mechanics consider diagnosing "hard to find" troubles one of their most challenging and satisfying duties.

When mechanical or electrical troubles occur, mechanics first get a description of the symptoms from the owner or, if they work in a dealership or large shop, the repair service estimator who wrote the repair order. The mechanic may have to test drive the vehicle or use a variety of testing equipment, such as engine analyzers, spark plug testers, or compression gauges, to locate the problem. Once the cause of the problem is found, mechanics make adjustments or repairs. If a part is damaged or worn beyond repair, or cannot be fixed at a reasonable cost, they replace it, usually after consultation with the vehicle owner.

During routine service, mechanics inspect, lubricate, and adjust engines and other components, repairing or replacing parts before they cause breakdowns. They usually follow a checklist to be sure they examine all important parts, such as belts, hoses, steering systems, spark plugs, brake and fuel systems, wheel bearings, and other potentially troublesome items.

Mechanics use a variety of tools in their work. They use power tools such as pneumatic wrenches to remove bolts quickly; machine tools such as lathes and grinding machines to rebuild brakes and other parts; welding and flame-cutting equipment to remove and repair exhaust systems and other parts; jacks and hoists to lift cars and engines; and a growing variety of electronic service equipment, such as infrared engine analyzers and computerized diagnostic devices. They also use many common handtools such as screwdrivers, pliers, and wrenches to work on small parts and get at hard-to-reach places.

Automotive mechanics in larger shops increasingly specialize. For example, *automatic transmission mechanics* work on gear trains, couplings, hydraulic pumps, and other parts of automatic transmissions. Because these are complex mechanisms and include electronic parts, their repair requires considerable experience and training, including a knowledge of hydraulics. *Tune-up mechanics* adjust the ignition timing and valves, and adjust or replace spark plugs and other parts to ensure efficient engine performance. They often use electronic test equipment to help them adjust and locate malfunctions in fuel, ignition, and emissions control systems.

Automotive air-conditioning mechanics install and repair air-conditioners and service components such as compressors and condensers. *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, repair hydraulic cylinders, turn discs and drums, and make other repairs on brake systems. Some mechanics specialize in both brake and front-end work.

Automotive-radiator mechanics clean radiators with caustic solutions, locate and solder leaks, and install new radiator cores or complete replacement radiators. They also may repair heaters and air-conditioners, and solder leaks in gasoline tanks.

Working Conditions

Most automotive mechanics work a standard 40-hour week, but some self-employed mechanics work longer hours. Generally, mechanics work indoors. Most repair shops are well ventilated and lighted, but some are drafty and noisy. Mechanics frequently work with dirty and greasy parts, and in awkward positions. They often must lift heavy parts and tools. Minor cuts, burns, and bruises are common, but serious accidents may be avoided when the shop is kept clean and orderly and safety practices are observed.

Employment

Automotive mechanics held about 757,000 jobs in 1990. The majority worked for retail and wholesale automotive dealers, independent automotive repair shops, and gasoline service stations. Others were employed at automotive service facilities at department, automotive, and home supply stores, or maintained the automobile fleets of taxicab and automobile leasing companies, Federal, State, and local governments, and other organizations. Motor vehicle manufacturers employed some mechanics to test, adjust, and repair cars at the end of assembly lines. About 20 percent of automotive mechanics were self-employed.

Training, Other Qualifications, and Advancement

Automotive technology is rapidly increasing in sophistication, and most training authorities recommend that persons seeking trainee automotive mechanic jobs complete a formal training program after graduating from high school. However, some automotive mechanics still learn the trade solely by assisting and working with experienced mechanics.

Automotive mechanic training programs are offered in high schools, community colleges, and public and private vocational and technical schools, but postsecondary programs generally provide more thorough career preparation than high school programs. High school programs, while an asset, vary greatly in quality. Some offer only an introduction to automotive technology and service for the future consumer or hobbyist, while others aim to equip graduates with enough skills to get a job as a mechanic's helper or trainee mechanic after graduation.

Postsecondary automotive mechanic training programs vary greatly in format, but generally provide intensive career preparation through a combination of classroom instruction and hands-on practice. Some trade and technical school programs concentrate the instruction in only 6 months or a year, depending on how many hours the student must attend each week. Community college programs normally spread the training out over 2 years, supplement the automotive training with instruction in English, basic mathematics, and other subjects, and award an associate degree.

The various automobile manufacturers and their participating dealers sponsor 2-year associate degree programs at about 110 community colleges across the Nation. The manufacturers provide service equip-

ment and late model cars on which students practice new skills, and insure that the programs teach the latest automotive technology. 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. Because students spend time gaining valuable work experience, these programs may take as long as 4 years to complete, instead of the normal 2 years required to earn an associate degree in automotive service technology. However, they offer students the opportunity to earn money while going to school and promise a job upon graduation. Also, some sponsoring dealers provide students with financial assistance for tuition or the purchase of tools.

The National Automotive Technicians Education Foundation (NATEF), an affiliate of the National Institute for Automotive Service Excellence (ASE), certifies automobile mechanic training programs offered by high schools and postsecondary trade schools, technical institutes, and community colleges. While NATEF certification is voluntary, and many institutions have not sought it, certification does signify that the program meets uniform standards for instructional facilities, equipment, staff credentials, and curriculum. In early 1991, over 502 high school and postsecondary automotive mechanic training programs had been certified by NATEF, and over 1,500 additional programs were in the process of becoming certified.

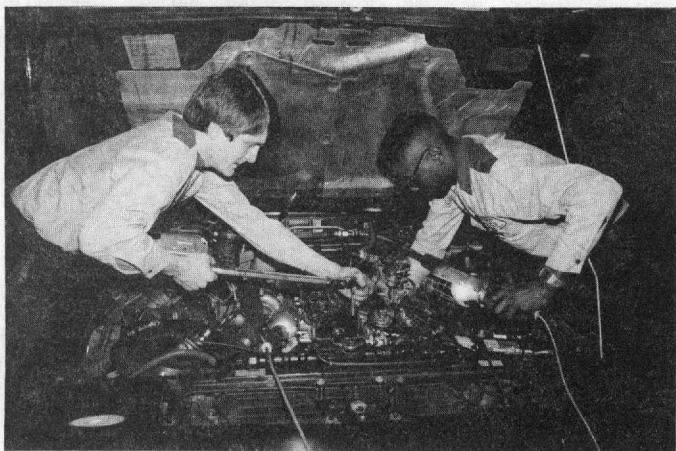
Knowledge of electronics is increasingly desirable for automotive mechanics because electronics is being used in a growing variety of automotive components. Engine controls and dashboard instruments were among the first components to use electronics, but now electronics are being used in brakes, transmissions, steering systems, and a variety of other components. In the past, problems involving electrical systems or electronics were usually handled by a specialist, but electronics are becoming so commonplace that most automotive mechanics must be familiar with at least the basic principles of electronics in order to recognize when an electronic malfunction may be responsible for a problem, and to be able to test and replace electronic components.

For trainee mechanic jobs, employers look for people with good reading and basic mathematics skills who can study technical manuals to keep abreast of new technology and learn new service and repair procedures and specifications. Trainees also must possess mechanical aptitude and knowledge of how automobiles work. Most employers regard the successful completion of a vocational training program in automotive mechanics at a postsecondary institution as the best preparation for trainee positions. Experience working on motor vehicles in the Armed Forces or as a hobby is also valuable. Completion of high school is required by a growing number of employers. Courses in automotive repair, electronics, physics, chemistry, English, and mathematics can provide a good basic educational background for a career as an automotive mechanic.

Beginners usually start as trainee mechanics, helpers, lubrication workers, or gasoline service station attendants and gradually acquire and practice their skills by working with experienced mechanics. Although a beginner can perform many routine service tasks and make simple repairs after a few months' experience, it usually takes 1 to 2 years of experience to acquire adequate proficiency to become a journeyman service mechanic and quickly perform the more difficult types of routine service and repairs. However, graduates of the better postsecondary mechanic training programs are often able to earn promotion to the journeyman level after only a few months on the job. An additional 1 to 2 years are usually required to become thoroughly experienced and familiar with all types of repairs. Difficult specialties, such as transmission repair, require another year or two of training and experience. In contrast, automotive radiator mechanics and brake specialists, who do not need an all-round knowledge of automotive repair, may learn their jobs in considerably less time.

In the past, many persons have entered automotive mechanics through 3- or 4-year formal apprenticeship programs. However, as formal automotive training programs have increased in popularity, the number of employers willing to make such a long-term apprenticeship commitment has greatly declined.

Mechanics usually buy their handtools, and beginners are expected to accumulate tools as they gain experience. Many experienced mechanics have thousands of dollars invested in tools. Employers furnish power tools, engine analyzers, and other test equipment.



Automotive mechanic trainees practice their skills by working with experienced mechanics.

Employers increasingly send experienced automotive mechanics to factory 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 may also send promising beginners to factory-sponsored mechanic training programs. Factory representatives come to many shops to conduct short training sessions.

Voluntary certification by ASE is widely recognized as a standard of achievement for automotive mechanics. Mechanics are certified in one or more of eight different service areas, such as electrical systems, engine repair, and brakes, suspension, and steering. Master automotive mechanics are certified in all eight areas. For certification in each area, mechanics must have at least 2 years of experience and pass a written examination; completion of an automotive mechanic program in high school, vocational or trade school, or community or junior college may be substituted for 1 year of experience. Certified mechanics must retake the examination at least every 5 years.

Experienced mechanics who have leadership ability may advance to shop supervisor or service manager. Mechanics who work well with customers may become automotive repair service estimators. Some with sufficient funds open independent repair shops.

Job Outlook

Job opportunities in automotive mechanics are expected to be plentiful for persons who complete automotive training programs in high school, vocational and technical schools, or community colleges. Persons whose programs include some basic electronics should have the best opportunities. Persons without formal mechanic training are likely to face competition for entry level jobs. Mechanic careers are attractive to many because they afford the opportunity for good pay and the satisfaction of skilled work with one's hands.

Employment of automotive mechanics is expected to increase about as fast as the average for all occupations through the year 2005. Growth in mechanic employment in automobile dealerships, independent automotive repair shops, specialty car care chains, and other establishments will be offset somewhat by declining employment in gasoline service stations, as fewer stations offer repair services.

Nevertheless, the number of mechanics is expected to increase because expansion of the driving age population will increase the number of motor vehicles on the road. The growing complexity of automotive technology, such as the use of electronic and emissions control equipment, increasingly necessitates that cars be serviced by skilled workers, contributing to growth in demand for highly trained mechanics. In addition, if the average age of automobiles in operation continues to be high, a significant proportion of consumers' vehicle operating expenditures will be spent on service and repairs, and less on purchasing vehicles. However, improvements in the reliability of automobiles, together with less frequent requirements for routine service, are expected to result in continued declines in the service and repair needs of cars.

More job openings are expected for automotive mechanics than for most other occupations because replacement needs, the main source of job openings, will be substantial, due in large part to the size of the occupation. Replacements will be needed as experienced workers transfer to other occupations or retire or stop working for other reasons.

Most persons who enter the occupation may expect steady work because changes in economic conditions have little effect on the automotive repair business. During a downturn, however, some employers may be more reluctant to hire inexperienced workers.

Earnings

Highly skilled automotive mechanics employed by automobile dealers in 18 metropolitan areas had average hourly earnings of \$18.62 in 1990. Less skilled mechanics who perform routine service and make minor repairs had estimated average hourly earnings of \$13.27; semi-skilled mechanics, \$9.31.

Many experienced mechanics employed by automotive dealers and independent repair shops receive a commission related to the labor cost charged to the customer. Under this method, weekly earnings depend on the amount of work completed by the mechanic. Employ-

ers frequently guarantee commissioned mechanics a minimum weekly salary.

Some mechanics are members of labor unions. The unions include 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, Chauffeurs, Warehousemen and Helpers of America.

Related Occupations

Other workers who repair and service motor vehicles include diesel truck and bus mechanics, motorcycle mechanics, and automotive body repairers, painters, customizers, and repair service estimators.

Sources of Additional Information

For more details about work opportunities, contact local automotive dealers and repair shops, or the local office of the State employment service. The State employment service also may have information about training programs.

A list of certified automotive mechanic training programs may be obtained from:

- National Automotive Technicians Education Foundation, 13505 Dulles Technology Dr., Herndon, VA 22071-3415.

Information on automobile manufacturer sponsored 2-year associate degree programs in automotive service technology may be obtained from:

- ASSET Program, Training Department, Ford Parts and Service Division, Ford Motor Company, Room 109, 3000 Schaefer Rd., Dearborn, MI 48121.

- Chrysler Dealer Apprenticeship Program, National C.A.P. Coordinator, CIMS 423-21-06, 26001 Lawrence Ave., Center Line, MI 48015.

- General Motors Automotive Service Educational Program, National College Coordinator, General Motors Service Technology Group, 30501 Van Dyke Ave., Warren, MI 48090.

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

- ASE, 13505 Dulles Technology Dr., Herndon, VA 22071-3415.

For general information about the work of automotive mechanics, write to:

- Automotive Service Association, Inc., P.O. Box 929, Bedford, TX 76021-0929.

- Automotive Service Industry Association, 444 North Michigan Ave., Chicago, IL 60611.

- Motor Vehicle Manufacturers Association of the U.S., Inc., Suite 300, 7430 Second Ave., Detroit, MI 48202.

Diesel Mechanics

(D.O.T. 620.281-046, -050, -058; 623.281-018, -026; 625.261, .281-010, -014, .361)

Nature of the Work

Diesel engines usually are more durable and thus usually are heavier than gasoline engines. In addition, they use fuel more efficiently than gasoline engines, in part because the higher compression ratios found in diesel engines help convert a higher percentage of the fuel into power. Because of their greater durability and efficiency, diesel engines are used to power most of the Nation's heavy vehicles and equipment.

Diesel mechanics repair and maintain diesel engines that power transportation equipment, such as heavy trucks, buses, and locomotives; construction equipment such as bulldozers, cranes, and road graders; and farm equipment such as tractors and combines. A small number work on diesel-powered automobiles. Diesel mechanics also service a variety of other diesel-powered equipment, such as electric generators and compressors and pumps used in oil well drilling and in irrigation.

Most diesel mechanics work on heavy trucks used in industries such as mining and construction to carry ore and building materials, and by private and commercial trucking lines for general freight hauling. Most light trucks are gasoline powered, and although some diesel mechanics may occasionally service gasoline engines, most work pri-

marily on diesel engines. For information on mechanics who work primarily on gasoline engines, see the *Handbook* statement on automotive mechanics.

Mechanics who work for organizations that maintain their own vehicles may spend much time doing preventive maintenance to assure safe operation, prevent wear and damage to parts, and reduce costly breakdowns. During a maintenance check on a truck, for example, they usually follow a regular checklist that includes the inspection of brake systems, steering mechanisms, wheel bearings, and other important parts. They usually can repair or adjust a part that is not working properly. Parts that cannot be fixed are replaced.

In many shops, mechanics do all kinds of repairs, working on a vehicle's electrical system one day and doing major engine repairs the next. In some large shops, mechanics specialize in one or two types of work. For example, one mechanic may specialize in major engine repair, another in transmission work, another in electrical systems, and yet another in suspension or brake systems.

Diesel mechanics use a variety of tools in their work. They use power tools such as pneumatic wrenches to remove bolts quickly; machine tools such as lathes and grinding machines to rebuild brakes and other parts; welding and flame-cutting equipment to remove and repair exhaust systems and other parts; common handtools such as screwdrivers, pliers, and wrenches to work on small parts and get at hard-to-reach places; and jacks and hoists to lift and move large parts. Diesel mechanics also use a variety of testing equipment, including ohmmeters, ammeters, and voltmeters when working on electrical systems and electronic components; and tachometers, dynamometers, and engine analyzers to locate engine malfunctions.

For heavy work, such as removing engines and transmissions, two mechanics may work as a team, or a mechanic may be assisted by an apprentice or helper. Mechanics generally get their assignments from shop supervisors or service managers, who may check the mechanics' work or assist in diagnosing problems.

Working Conditions

Diesel mechanics usually work indoors, although they may occasionally make repairs on the road. They are subject to the usual shop hazards such as cuts and bruises. Mechanics handle greasy and dirty parts and may stand or lie in awkward or cramped positions to repair vehicles and equipment. Work areas usually are well lighted, heated, and ventilated, and many employers provide locker rooms and shower facilities.

Employment

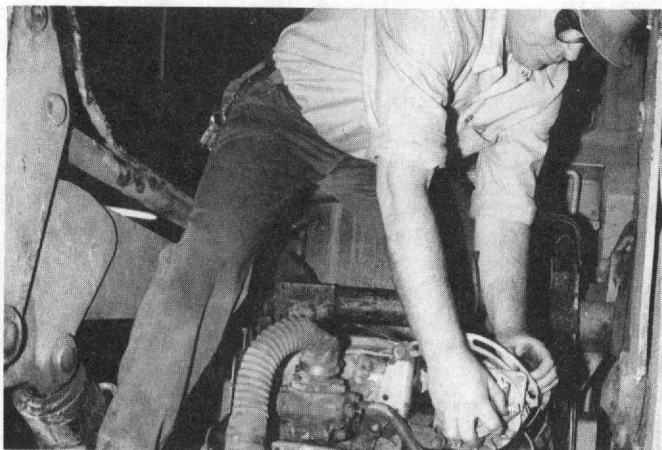
Diesel mechanics held about 268,000 jobs in 1990. Nearly one-third serviced trucks and other diesel-powered equipment for customers of vehicle and equipment dealers, leasing companies, and independent automotive repair shops. Over one-fifth worked for local and long-distance trucking companies, and over one-fifth maintained the buses and trucks of buslines, public transit companies, school systems, and Federal, State, and local government. The remainder maintained the fleets of trucks and other equipment of manufacturing, construction, and other companies. A relatively small number were self-employed.

Diesel mechanics are employed in every section of the country, but most work in towns and cities where trucking companies, buslines, and other fleet owners have large repair shops.

Training, Other Qualifications, and Advancement

Most employers prefer to hire graduates of formal post-secondary training programs in diesel mechanics, but the number of persons who complete such programs are too few to meet their needs. As a result, many diesel mechanics still learn their skills on the job. Unskilled beginners usually do tasks such as cleaning parts, fueling, lubricating, and driving vehicles in and out of the shop. As beginners gain experience and as vacancies become available, they usually are promoted to mechanics' helpers. In some shops, beginners—especially those having automobile service experience—start as mechanics' helpers.

Most helpers can perform routine service tasks and make minor repairs after a few months' experience. They advance to increasingly difficult jobs as they prove their ability. After they master the repair and service of diesel engines, they learn to work on related compo-



Diesel mechanics handle greasy and dirty parts and may stand or lie in awkward positions to repair vehicles and equipment.

nents such as brakes, transmissions, or electrical systems. Generally, at least 3 to 4 years of on-the-job experience are necessary to qualify as an all-round diesel truck or bus mechanic. Additional training on other components, such as hydraulic systems, may be necessary for mechanics who wish to specialize in other types of diesel equipment.

For unskilled entry-level jobs, employers generally look for applicants who have mechanical aptitude and are at least 18 years of age and in good physical condition. Completion of high school is required by a growing number of employers. Courses in automotive repair, electronics, English, mathematics, and physics provide a good basic educational background for a career as a diesel mechanic. Good reading and basic mathematics skills are needed to study technical manuals to keep abreast of new technology and learn new service and repair procedures and specifications. A State chauffeur's license is needed for test driving trucks or buses on public roads. Practical experience in automobile repair in a gasoline service station, in the Armed Forces, or as a hobby also is valuable.

Most training authorities now recommend that persons seeking trainee diesel mechanic jobs complete a formal diesel mechanic training program. Diesel technology is becoming more sophisticated and diesel engines increasingly use electronic components to control a growing variety of functions. Knowledge of basic electronics is becoming essential for diesel mechanics to diagnose whether a malfunction is caused by an electronic component or whether it can be traced to another source. Most employers prefer to hire graduates of formal training programs in diesel mechanics, and completion of such a program can speed advancement to the journeyman mechanic level. These 1- to 2-year programs, given by vocational and technical schools and community and junior colleges, lead to a certificate of completion or an associate degree. They provide a foundation in the basics of the latest diesel technology and electronics, and enable trainees to more quickly master the service and repair of the actual vehicles and equipment encountered on the job.

A formal 4-year apprenticeship is another good way to learn diesel mechanics. However, apprenticeships are becoming less common because employers are reluctant to make such a long-term investment in training, especially when graduates of postsecondary diesel mechanic programs are increasing in number. Competition for the limited number of apprenticeship slots is often extremely keen. Typical apprenticeship programs for diesel truck and bus mechanics consist of approximately 8,000 hours of practical experience working on transmissions, engines, and other components and at least 576 hours of formal instruction to learn blueprint reading, mathematics, engine theory, and safety. Frequently, these programs include training in both diesel and gasoline engine repair.

Most mechanics must buy their own handtools. Experienced mechanics often have thousands of dollars invested in tools.

Employers sometimes send experienced mechanics to special training classes conducted by truck, bus, diesel engine, parts, and equipment manufacturers where they learn the latest technology or receive

special training in subjects such as diagnosing engine malfunctions. Mechanics also must read service and repair manuals to keep abreast of engineering changes.

Voluntary certification by the National Institute for Automotive Service Excellence (ASE) is recognized as a standard of achievement for diesel mechanics. Mechanics may be certified as Master Heavy-Duty Truck Technician or may be certified in one or more of six different areas of heavy-duty truck repair: Brakes, gasoline engines, diesel engines, drive trains, electrical systems, and suspension and steering. For certification in each area, mechanics 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 gasoline or diesel engine repair may substitute for up to 1 year of experience. To retain certification, mechanics must retake the tests at least every 5 years.

Experienced mechanics who have leadership ability may advance to shop supervisors or service managers. Mechanics who have sales ability sometimes become sales representatives. A few mechanics open their own repair shops.

Job Outlook

Employment of diesel mechanics is expected to increase about as fast as the average for all occupations through the year 2005. Because this is a large occupation, more job openings are expected for diesel mechanics than for most other occupations. Although employment growth will create many new jobs, most job openings will arise from the need to replace diesel mechanics who retire or stop working for other reasons.

Employment of diesel mechanics is expected to grow as freight transportation by truck increases. More trucks will be needed for both local and intercity hauling due to the increased production of goods. Additional diesel mechanics will be needed to repair and maintain growing numbers of buses and heavy construction graders, cranes, earthmovers, and other equipment. Due to the greater durability and economy of the diesel relative to the gasoline engine, buses and trucks of all sizes are expected to be increasingly powered by diesels, also creating new jobs for diesel mechanics.

Careers in diesel mechanics are attractive to many because wages are relatively high and skilled repair work is challenging and varied. Opportunities should be good for persons who complete formal training in diesel mechanics at community and junior colleges and vocational and technical schools, but others may face competition for entry-level jobs.

Earnings

Diesel mechanics employed by trucking companies, buslines, and other firms that maintain their own vehicles had average hourly earnings of \$14.39 in 1990. Earnings generally were highest in the West and Midwest and lowest in the South. They varied by industry as follows:

Transportation.....	\$15.04
Manufacturing	14.11
Wholesale trade	13.79
Retail trade.....	13.05
Services.....	12.95

Beginning apprentices usually earn from 50 to 75 percent of the rate of skilled workers and receive increases about every 6 months until they complete their apprenticeship and reach the rate of skilled mechanics.

Most mechanics work between 40 and 59 hours per week. Those employed by truck and bus firms which provide service around the clock may work evenings, nights, and weekends. They usually receive a higher rate of pay for this work.

Many diesel 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, Chauffeurs, Warehousemen and Helpers of America.

Related Occupations

Diesel mechanics repair trucks, buses, and other diesel-powered equipment and keep them in good working order. Related mechanic occupations include aircraft mechanics, automotive mechanics, boat engine mechanics, farm equipment mechanics, mobile heavy equipment mechanics, and motorcycle mechanics and small-engine specialists.

Sources of Additional Information

More details about work opportunities for diesel mechanics may be obtained from local employers such as trucking companies, truck dealers, or bus lines; locals of the unions previously mentioned; or the local office of the State employment service. Local State employment service offices also may have information about apprenticeships and other training programs.

For general information about careers as truck, bus, and diesel mechanics, write to:

• Automotive Service Industry Association, 444 North Michigan Ave., Chicago, IL 60611.

• American Trucking Associations, Inc., 2200 Mill Rd., Alexandria, VA 22314-4677.

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

• National Association of Trade and Technical Schools, Department BL, P.O. Box 2006, Annapolis Junction, MD 20701-2006.

Information on how to become a certified heavy-duty diesel mechanic is available from:

• ASE, 13505 Dulles Technology Dr., Herndon, VA 22071-3415.

Electronic Equipment Repairers

Nature of the Work

Electronic equipment repairers, also called service technicians or field service representatives, install, maintain, and repair electronic equipment used in offices, factories, homes, hospitals, aircraft, and other places. Equipment includes television sets, radar, industrial equipment controls, computers, telephone systems, and medical diagnosing equipment. Repairers have numerous job titles, which often refer to the kind of equipment they work with. (Electronics technicians, who use the principles and theories of science, engineering, and mathematics in their work, but may also do some repairs, are discussed in the statement on engineering technicians elsewhere in the *Handbook*. For information on workers who operate and maintain electronic equipment used to record and transmit radio and television programs, see the statement on broadcast technicians. Additional information about electronic equipment repairers is given in the separate statements in this section.)

Electronic repairers install, test, and calibrate equipment to ensure that it functions properly. They also periodically check, clean, and repair equipment to prevent or detect malfunctions. They keep detailed records on each piece of equipment to provide a history of tests, performance problems, and repairs.

When equipment breaks down, repairers first examine work orders, which indicate problems, or talk to equipment operators. Then they 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 blueprints and manufacturers' specifications that show connections and provide instruction on how to locate problems. They use voltmeters, ohmmeters, signal generators, ammeters, and oscilloscopes and run diagnostic programs to pinpoint malfunctions. It may take several hours to locate a problem but only a few minutes to fix it. However, more equipment now has self-diagnosing features, which greatly simplifies the work. To make repairs, they may replace defective components, circuit boards, or wiring, or adjust and calibrate equipment, using small handtools such as pliers, screwdrivers, and soldering irons.

Field repairers visit worksites in their assigned area on a regular basis to do preventive maintenance according to manufacturers' recommended schedules, and whenever emergencies arise. During these

calls, repairers may also advise customers on how to use equipment more efficiently and how to spot problems in their early stages. They also listen to customers' complaints and answer questions, promoting customer satisfaction and good will. Some field repairers work full time at installations of clients with a lot of equipment.

Bench repairers work at repair facilities, in stores, factories, or service centers. They repair portable equipment such as television sets and personal computers brought in by customers or defective components and machines requiring extensive repairs that have been sent in by field repairers. They determine the source of a problem in the equipment, and may estimate whether it is wiser to buy a new part or machine or to fix the broken one.

Working Conditions

Some electronic equipment repairers work shifts, including weekends and holidays, to service equipment in computer centers, manufacturing plants, hospitals, and telephone companies which operate round the clock. Shifts are generally assigned on the basis of seniority. Repairers may also be on call at any time to handle equipment failure.

Repairers generally work in clean, well-lighted, air-conditioned surroundings—an electronic repair shop or service center, hospital, military installation, or a telephone company's central office. However, some, such as commercial and industrial electronic equipment repairers, may be exposed to heat, grease, and noise on factory floors. Some may have to work in cramped spaces. Telephone installers and repairers may work on rooftops, ladders, and telephone poles.

The work of most repairers involves lifting, reaching, stooping, crouching, and crawling. Adherence to safety precautions is essential to guard against work hazards such as minor burns and electrical shock.

Employment

Electronic equipment repairers held about 444,000 jobs in 1990. Many worked for telephone companies. Others worked for electronic and transportation equipment manufacturers, machinery and equipment wholesalers, hospitals, electronic repair shops, and firms that provide maintenance under contract (called third-party maintenance firms). The distribution of employment in each occupation is presented in the following tabulation:

Computer and office machine repairers	156,000
Communications equipment repairers	125,000
Commercial and industrial electronic equipment repairers	75,000
Telephone installers and repairers	47,000
Electronic home entertainment equipment repairers	41,000

Training, Other Qualifications, and Advancement

Training in electronics—acquired formally or on the job—is required for entry level jobs. Formal training is offered by public post secondary vocational-technical schools, private vocational schools and technical institutes, junior and community colleges, and some high schools and correspondence schools. Programs take 1 to 2 years. The military services also offer formal training and work experience.

Training includes general courses in mathematics, physics, electricity, electronics, schematic reading, and troubleshooting. Students also choose courses which prepare them for a specialty, such as computers, commercial and industrial equipment, or home entertainment equipment. A few repairers complete formal apprenticeship programs sponsored jointly by employers and locals of the International Brotherhood of Electrical Workers.

Applicants for entry jobs may have to pass tests that measure mechanical aptitude, knowledge of electricity or electronics, manual dexterity, and general intelligence. Newly hired repairers, even those with formal training, usually receive some training from their employer. They may study electronic and circuit theory and math. They also get hands-on experience with equipment, doing basic maintenance, and using diagnostic programs to locate malfunctions. Training may be in a classroom or it may be self-instruction, consisting of videotapes, programmed computer software, or workbooks that allow trainees to learn at their own pace.

Experienced technicians attend training sessions and read manuals to keep up with design changes and revised service procedures. Many technicians also take advanced training in a particular system or type of repair.

Good eyesight and color vision are needed to inspect and work on small, delicate parts and good hearing to detect malfunctions revealed by sound. Because field repairers usually handle jobs alone, they must be able to work without close supervision. For those who have frequent contact with customers, a pleasant personality, neat appearance, and good communications skills are important. Repairers must also be trustworthy because they may be exposed to money and other valuables in places like banks and securities offices, and some employers require that they be bonded. A security clearance may be required for technicians who repair equipment or service machines in areas where people are engaged in activities related to national security.

The International Society of Certified Electronics Technicians and the Electronics Technicians Association each administered as a voluntary certification program. In both, an electronics repairer with 4 years of experience may become a Certified Electronics Technician. Certification, which is by examination, is offered in computer, radio-TV, industrial and commercial equipment, audio, and radar systems repair. An Associate Level Test, covering basic electronics, is offered for students or repairers with less than 4 years of experience. Those who test and repair radio transmitting equipment, other than business and land mobile radios, need a General Operators License from the Federal Communications Commission.

Experienced repairers with advanced training may become specialists or troubleshooters who help other repairers diagnose difficult problems, or work with engineers in designing equipment and developing maintenance procedures.

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.

Job Outlook

Overall, employment of electronic equipment repairers is expected to show little change through the year 2005. Although the amount of electronic equipment in use will grow very rapidly, improvements in product reliability and ease of service and lower equipment prices will limit growth in the need for repairers, or even cause a decline. The following tabulation presents the expected 1990-2005 percent change in employment for the various electronic equipment repairer occupations:

Computer and office machine repairers.....	38
Commercial and industrial electronic equipment repairers.....	17
Electronic home entertainment equipment repairers	13
Communications equipment repairers	-38
Telephone installers and repairers	-55

Employment of computer equipment repairers will grow much faster than average for all occupations through the year 2005 as the number of computers in service increases rapidly. Employment of industrial equipment repairers outside the Federal Government will increase about as fast as the average as the amount of equipment grows. Mainly because of cuts in the defense budget, employment of repairers in the Federal Government will show little or no growth. Employment of repairers who handle telephone industry equipment—telephone installers and repairers and communication equipment repairers—is expected to decline because of improvements in equipment reliability and ease of maintenance.

Earnings

In 1990, median weekly earnings of full-time electronic equipment repairers were \$542. The middle 50 percent earned between \$415 and \$689. The bottom 10 percent earned less than \$309, while the top 10 percent earned more than \$819. Median earnings vary widely by

occupation and the type of equipment repaired, as shown in the following tabulations:

Telephone installers and repairers	\$626
Data processing equipment repairers.....	585
Electronic repairers, communications and industrial	472
Office machine repairers	452

Central office installers, central office technicians and PBX installers employed by AT&T and the Bell Operating Companies and represented by the Communications Workers of America earned an average weekly salary of \$700 in 1990; frame attendants averaged \$600; and telephone installers and repairers average \$690.

Related Occupations

Workers in other occupations who repair and maintain the circuits and mechanical parts of electronic equipment include appliance and power tool repairers, automotive electricians, electronic organ technicians, and vending machine repairers.

Sources of Additional Information

For career and certification information, contact:

• The International Society of Certified Electronics Technicians, 2708 West Berry St., Fort Worth, TX 76109.

For certification, career, and placement information, contact:

• Electronics Technicians Association, 604 North Jackson, Greencastle, IN 46135.

For information about the general radiotelephone operator license, write to:

• Federal Communications Commission, 1919 M St. NW., Washington, DC 20554.

For information on the telephone industry and career opportunities in it, request copies of *Phonefacts* and *Is It For You? A Career in the Telephone Industry* from:

• United States Telephone Association, 900 19th St. NW., Suite 800, Washington, DC 20006.

Commercial and Industrial Electronic Equipment Repairers

(D.O.T. 638.261-026; 726.361-022, .381-014, .684-090; 828.251-010, .261-014, .281-010, -014, and -022)

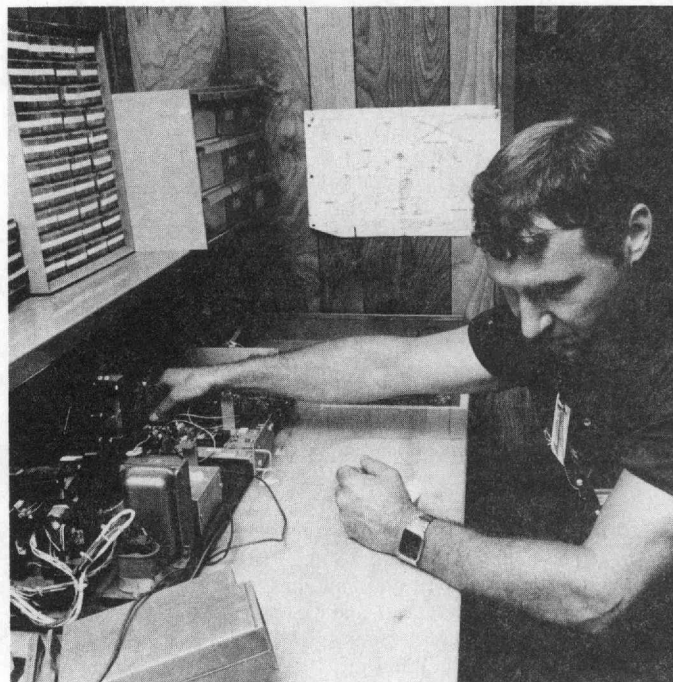
Nature of the Work

Commercial and industrial electronic equipment repairers, also called industrial electronics technicians, install and repair industrial controls, radar and missile control systems, medical diagnostic equipment, and communications equipment.

Those who work for the Defense Department install radar, missile control, and communication systems on aircraft, ships, and tanks, and in buildings and other structures. Some install and service computerized axial tomography (CAT scan), magnetic resonance imaging (MRI), and similar equipment in hospitals, or set up and service electronic equipment which controls machines and production processes in factories. They often coordinate their efforts with workers installing mechanical or electromechanical components. (See the statements on industrial machinery repairers and millwrights elsewhere in the *Handbook*).

Employment

Commercial and industrial electronic equipment repairers held about 75,000 jobs in 1990. About 1 out of 3 repairers was employed by the Federal Government, almost all in the Department of Defense at military installations around the country. Repairers also were employed by electronic and transportation equipment manufacturers, machinery and equipment wholesalers, telephone companies, hospitals, electronic repair shops, and firms that provide maintenance under contract (called third-party maintenance firms).



About 1 out of 3 commercial and industrial equipment repairers was employed by the Federal Government.

Job Outlook

Employment of commercial and industrial electronic equipment repairers is expected to increase about as fast as the average for all occupations through the year 2005. Employment in nondefense industries is expected to grow faster than the average for all occupations, as business and industrial firms install more electronic equipment to boost productivity and improve product quality. In addition, more electronic equipment will be used in medicine, energy conservation, and pollution control. Because of anticipated cuts in the defense budget, however, little if any employment growth is expected in the Federal Government. Besides employment growth arising from increased demand for these workers, many job openings will result from the need to replace workers who transfer to other occupations or leave the labor force.

(See introductory part of this section for information on working conditions, training requirements, earnings, and sources of additional information.)

Communications Equipment Mechanics

(D.O.T. 722.281; 726.381-014; 822.261-010, .281-010, -014, -022, -026, -030 and -034, .361-014, .381-010, -018, -022, and .684-010; 823.261-010, -018, and -022, .281-010, -014, and -022; 825.261-010; and 829.281-022)

Nature of the Work

Installing, repairing, and maintaining complex and sophisticated telephone communications equipment are the responsibilities of communications equipment mechanics. Most communications equipment mechanics—sometimes referred to as telecommunication technicians—work either in telephone company central offices or on customers' premises installing and repairing telephone switching and transmission systems.

Central office equipment installers, or equipment installation technicians, set up, rearrange, and remove the switching and dialing equipment used in central offices. They install equipment in new central offices, add equipment in expanding offices, or replace outdated equipment.

Frame wirers, sometimes referred to as frame workers or frame attendants, connect, disconnect, inspect, and repair wires that run from telephone lines and cables to the central office. *Central office*

repairers, often referred to as central office technicians or switching equipment technicians, test, repair, and maintain all types of local and toll switching equipment that automatically connects lines when customers dial numbers. When customers report trouble with their telephones, *trouble locators* working at special switchboards—sometimes called testboards—find the source of the problem. Trouble locators who work for cable television companies ensure that subscribers' television sets receive the proper signal. They may work with cable installers to track down the cause of the interference and make repairs.

Most telephone companies are replacing trouble locators with *maintenance administrators*. Their jobs are largely automated; instead of using testboards and associated equipment to perform complex circuit tests, they enter instructions into a computer terminal and analyze the output. Maintenance administrators also update and maintain computerized files of trouble status reports.

PBX installers, also called systems technicians, install complex telephone equipment, often creating customized switchboard systems.

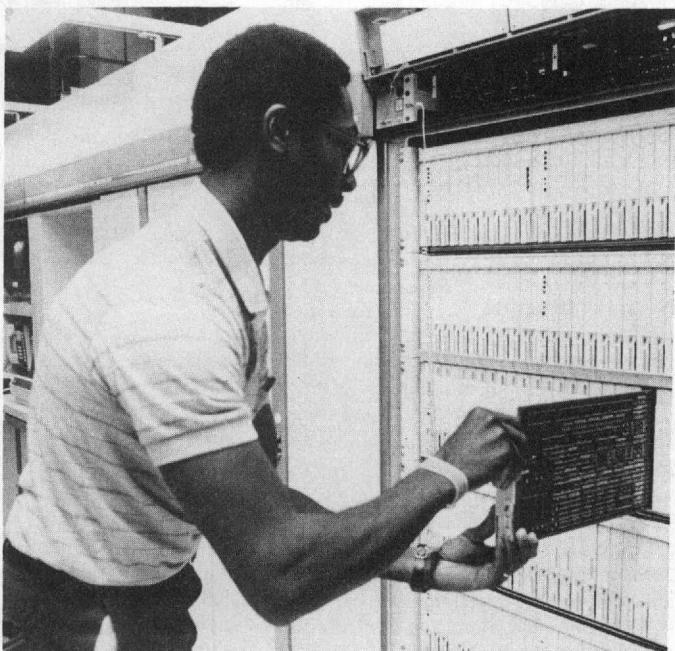
PBX repairers, with the assistance of trouble locators, locate the malfunction in customers' PBX or other telephone systems and make the necessary repairs. They also maintain associated equipment such as batteries, relays, and powerplants. Some PBX repairers maintain and repair equipment for mobile radiophones, microwave transmission equipment, switching equipment, and data processing equipment.

Radio repairers and mechanics install and repair stationary and mobile radio transmitting and receiving equipment. Some repair microwave and fiber optics installations. *Office electricians* handle submarine cable repeater and terminal circuits and related equipment. When trouble arises, they may rearrange cable connections to ensure that service is not interrupted. *Submarine cable equipment technicians* repair, adjust, and maintain the machines and equipment used in submarine cable offices or stations to control cable traffic. *Avionics technicians* inspect and repair aircraft communication, navigation, and flight control systems. Signal or track switch maintainers install electric gate crossings, signals, track switches, and communication systems in a railroad network.

Other communications equipment mechanics include *instrument repairers*, sometimes referred to as shop repairers or shop technicians, who repair, test, and modify a variety of communications equipment.

Employment

Communications equipment mechanics held about 125,000 jobs in 1990. Most worked for telephone companies. Others worked for electrical repair shops, cable television firms, railroads, air transportation, and the Federal Government.



Most communications equipment mechanics work for telephone companies.

Job Outlook

Employment of communications equipment mechanics is expected to decline through the year 2005. The telephone industry is in the midst of a dramatic transformation from an electromechanical system to a completely electronic one. Digital systems, the most recent version of electronic switching, use computers and software to switch calls. Fewer workers are needed for maintenance and repair because the new systems are more reliable and compact and permit more efficient centralized maintenance. In addition, the systems have self-diagnosing features which detect the source of problems and direct repairers to the defective part, which usually can simply be replaced. Once the transformation of the system has been completed, some time before 2005, the need for installers will drop sharply.

Decreased labor requirements due to improved technology have already caused layoffs of communications equipment mechanics. Competition for available openings should intensify, making it much more difficult for other telephone workers to move into these positions without experience or formal training and virtually impossible for "outsiders" without the necessary skills to compete for jobs.

(See introductory part of this section for information on working conditions, training requirements, earnings, and sources of additional information.)

Computer and Office Machine Repairers

(D.O.T. 633.261-010, -014, .281 except -026; 706.381-010 and -030; 828.261-014, .281-010, and -014)

Nature of the Work

Computer and office machine repairers install new machines, do preventive maintenance, and correct emergency problems.

Computer equipment repairers work on computers (mainframes, minis, and micros), peripheral equipment, and word processing systems, while office machine repairers work on photocopiers, cash registers, and similar equipment. They may make special cable and wiring connections when installing equipment. Repairers work closely with electricians, who install the wiring for the new system, to ensure proper layout. (A description of the work of electricians can be found elsewhere in the *Handbook*.)

Despite frequent preventive maintenance, computers and other machines do break down. To locate the cause of failures, repairers run diagnostic programs that pinpoint malfunctions. Although some of the most modern and sophisticated computers have a self-diagnosing capacity that directs the repairer to the source of the problem, computer repairers must know enough about systems software to determine if the malfunction is due to an error in the hardware or in the software.

Employment

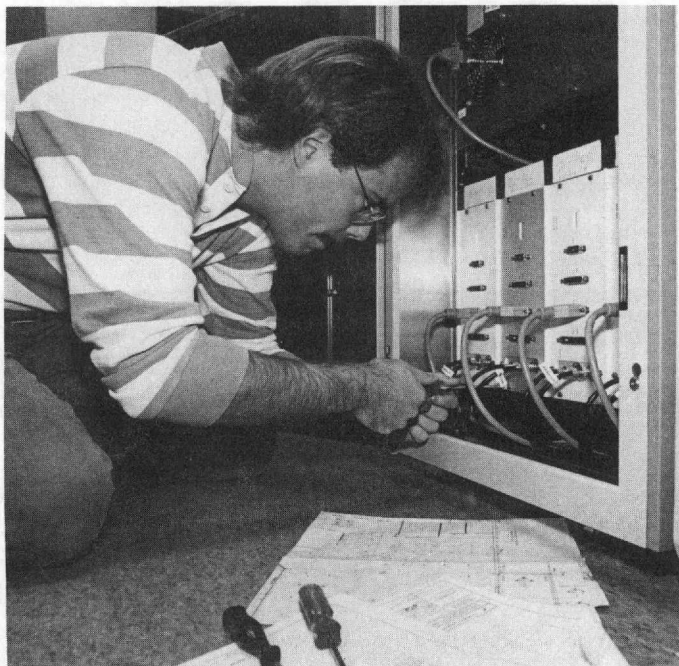
Computer and office machine repairers held about 156,000 jobs in 1990. Approximately 83,000 worked mainly on computer equipment, and the other 73,000 repaired mainly office machines. Three of every four were employed by wholesalers of computers and other office equipment and by firms that provide maintenance services for a fee. The remainder worked for equipment manufacturers, retail establishments, and organizations with enough equipment and funding to warrant a full-time service staff.

Repairers work throughout the country, even in relatively small communities. Most repairers, however, work in large cities, where computer and office equipment is concentrated.

Job Outlook

Employment of computer and office machine repairers is expected to grow much faster than the average for all occupations through the year 2005. All growth will be in computer repair. Employment of office machine repairers is not expected to grow at all.

Employment of computer repairers will grow as the number of computers and other office equipment increases—as organizations throughout the economy continue to automate their operations in



Computer and office machine repairers run diagnostic programs that pinpoint malfunctions.

search of greater productivity and improved service. The development of new applications for computers, and lower computer prices, will also spur demand. More repairers will be needed to install, maintain, and repair these machines. Employment of repairers is not expected to grow as rapidly as the amount of equipment in use, however, due to improvements that make equipment more reliable and easier to repair.

Computer and office machine repairers have been less likely than other workers to be laid off during downturns in economic activity. However, firms do restrict hiring during recessions, making it harder to enter the occupation.

(See introductory part of this section for information on working conditions, training requirements, earnings, and sources of additional information.)

Electronic Home Entertainment Equipment Repairers

(D.O.T. 720.281, 726.381-014, 729.281-010, 730.281-018, 823.361-010, and 828.261-010)

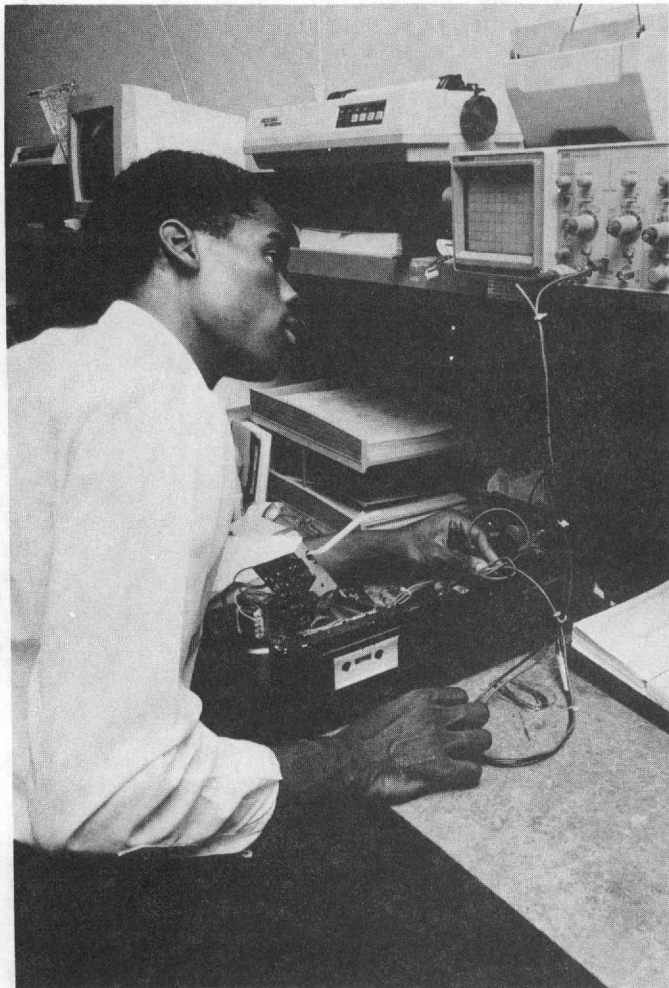
Nature of the Work

Electronic home entertainment equipment repairers, also called service technicians, repair radios, television sets, stereo components, video cameras, compact disk players, video games, home security systems, microwave ovens, and electronic organs. Some repairers specialize in one kind of equipment; others repair many types.

They replace faulty parts or make adjustments, such as focusing and converging the picture or correcting the color balance of a television set. They may also make recordings and listen to playbacks to detect problems. Some install radios in automobiles.

Employment

Electronic home entertainment equipment repairers held about 41,000 jobs in 1990. Nearly one-fourth were self-employed, a larger proportion than in most other repairer occupations. Most repairers work in electronic repair shops and service centers or in stores that sell and service electronic home entertainment products. Geographically, employment is distributed in much the same way as the population.



Some electronic home entertainment equipment repairers specialize in one kind of equipment; others repair many types.

Job Outlook

Employment of electronic home entertainment equipment repairers is expected to increase more slowly than the average for all occupations through the year 2005. As population grows, personal incomes rise, and new products are developed, there will be more home entertainment equipment to repair. However, improvements in technology should reduce service requirements so employment of repairers will not grow as fast as the amount of equipment. Opportunities for electronic home entertainment equipment repairers should be good, in large part because many people in this occupation transfer to higher paying occupations also requiring a knowledge of electronics, such as computer and office machine repairer.

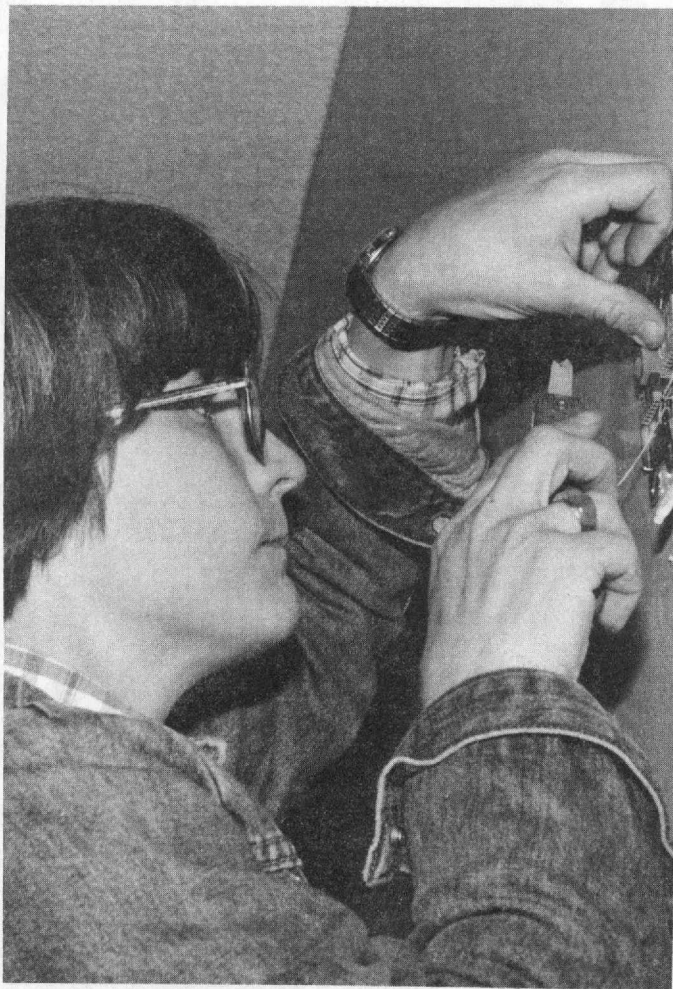
(See introductory part of this section for information on working conditions, training requirements, earnings, and sources of additional information.)

Telephone Installers and Repairers

(D.O.T. 822.261-022 and .281-018)

Nature of the Work

Telephone installers and repairers install, service, and repair telephones and other communications equipment on customers' property. When customers move or request new types of service, installers relocate telephones or make changes to existing equipment. In buildings under construction, they install wiring and telephone jacks.



Telephone installers and repairers relocate telephones or make changes to existing equipment.

Telephone installers, sometimes called station installers, assemble equipment and install wiring on the customers' premises. They connect telephones to outside service wires and sometimes climb poles or ladders to make these connections. In apartment and office buildings, they make connections to service wires or terminals in basements or in wire closets. After installation, they test equipment to make sure it works properly.

Some experienced installers and repairers have multiple skills. They are considered especially valuable by many small companies. In some areas, installers and repairers handle special cases such as complaints to public service commissions, illegal or unauthorized use of equipment, and electric or acoustic shocks.

Employment

Telephone installers and repairers held about 47,000 jobs in 1990. More than 9 out of 10 worked full time for telephone companies.

Job Outlook

Employment of telephone installers and repairers is expected to decline through the year 2005. Employment will fall as technological improvements make this work less labor intensive. For example, prewired buildings that enable customers to buy telephones and plug them into prewired jacks have effectively eliminated the functions of the installer. The modular assembly of telephones, where components plug in and out, also will reduce the time and skills needed for repair. Also, fewer phones will be worth repairing as prices continue to decline. In addition, the use of portable terminals which hook into a central testing system makes repairers more efficient.

With employment projected to decline, job openings will result exclusively from the need to replace persons who transfer to other

occupations or leave the labor force. Traditionally, most openings for telephone installers and repairers have been filled by workers in other telephone company jobs. As technology continues to displace installers and repairers, it will remain difficult for telephone workers without additional training and virtually impossible for "outsiders" without the necessary skills to get these jobs.

(See introductory part of this section for information on working conditions, training requirements, earnings, and sources of additional information.)

Elevator Installers and Repairers

(D.O.T. 825.261-014; .281-030, -034; and .361-010)

Nature of the Work

Elevator installers and repairers—also called elevator constructors or mechanics—assemble, install, and replace elevators, escalators, and similar equipment in new and old buildings. Once the equipment is in service, they maintain and repair it, and sometimes modernize older equipment.

In order to install, repair, and maintain modern elevators, which are almost all electronically controlled, elevator constructors must have a thorough knowledge of electronics, electricity, and hydraulics. Many elevators today are installed with microprocessors, which are programmed to constantly analyze traffic conditions to dispatch elevators in the most efficient manner. With these computer controls, it is now possible to get the greatest amount of service with the least number of cars.

Elevator constructors begin by studying blueprints to determine the equipment layout of the framework to install rails, machines, car enclosures, motors, pumps, cylinders, and plunger foundations. Once the layout analysis is completed, mechanics begin equipment installation. Working on scaffolding or working platforms, constructors bolt or weld steel rails to the walls of the shaft to guide the elevator up and down.

Elevator mechanics install electrical wires and controls by running tubing called conduit along the shaft's walls from floor to floor. Once the conduit is in place, mechanics pull plastic-covered electrical wires through it. They install electrical components and related devices required at each floor and at the main control panel in the machine room.

Mechanics bolt or weld together the steel frame of the elevator car at the bottom of the shaft, install the car's platform, walls, and doors, and attach guide shoes and rollers which minimize the lateral motion of the car as it travels through the shaft. Mechanics also install the outer doors and door frames at the elevator entrances on each floor.

For cable elevators, workers install a traction-type machine with a drive sheave which moves a heavy steel cable connected to the elevator car and counterweight. The counterweight moves in the opposite direction from the car and aids in its swift and smooth movement.

These workers also install elevators in which a car sits on a hydraulic plunger that is driven by a pump. Instead of pulling the car upward, the cylinder pushes the elevator car from underneath, like a lift in an auto service station.

Elevator constructors also install escalators. They put in place the steel framework, the electrically powered stairs, and the tracks, and install associated motors and electrical wiring.

In addition to elevators and escalators, elevator constructors install devices such as dumbwaiters and material lifts, which are similar to elevators in design, and powered walkways, which more closely resemble escalators.

After installation, adjusters fine-tune the equipment to make sure that the elevator is working according to specifications, such as stopping correctly at each floor or picking up passengers within a specified time period. Once an elevator is operating properly, it must be maintained and serviced regularly to keep it in safe, perfect condition. Maintenance mechanics generally do preventive maintenance—oiling and greasing moving parts, replacing worn parts, testing equipment

with meters and gauges, and adjusting equipment for optimal performance. They also do emergency repairs.

A repair crew usually handles major repairs—for example, repairing and setting doors back on their tracks. This may require cutting torches or rigging equipment—tools the maintenance mechanic doesn't normally carry. Repair crews also do major modernization and alteration work such as moving and replacing electrical motors, hydraulic pumps, and control panels.

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

Working Conditions

Most elevator constructors work a 40-hour week. However, maintenance and repair mechanics often work overtime when repairing essential elevator equipment. They are sometimes on 24-hour call. Maintenance mechanics, unlike most elevator constructors, are on their own most of the day and typically service the same elevators periodically. Elevator installers lift and carry heavy equipment and parts and are exposed to falls and electrical shocks. They may also work in cramped spaces or awkward positions. Since elevator constructors' work is performed indoors in buildings under construction or in existing buildings, they lose less worktime due to inclement weather than other building trades workers.

Employment

Elevator installers and repairers held about 19,000 jobs in 1990. Most were employed by special trade contractors. Others were employed by field offices of elevator manufacturers; wholesale distributors; small, local elevator maintenance and repair contractors; or by government agencies or businesses that do their own elevator maintenance and repair.

Training, Other Qualifications, and Advancement

Almost all elevator constructors learn their trade in programs administered by joint committees of employers and locals of the International Union of Elevator Constructors. These programs, through which the trainee learns everything from installation to repair, com-

bine on-the-job training with classroom instruction in electrical and electronic theory, mathematics, applications of physics, and safety. Most trainees or helpers assist experienced elevator mechanics. Beginners carry materials and tools, bolt rails to walls, and assemble elevator cars. Eventually, they learn to do more difficult tasks, such as wiring, which requires a knowledge of local and national electrical codes.

Generally, helpers must complete a 6-month probationary period. After successful completion, they work toward becoming fully qualified mechanics within 4 years. Most States and cities require elevator constructors to pass a licensing examination.

Many elevator installers and repairers receive training from their employers to become familiar with the company's particular equipment and to keep up with the rapid pace of technological developments in the industry. Elevator constructors typically receive training throughout their careers, either through correspondence courses or seminars.

Applicants for trainee positions must be at least 18 years old, have a high school education, and pass an aptitude test; courses in electricity, mathematics, and physics provide a useful background. As elevators become increasingly sophisticated, workers may find it necessary to acquire more advanced formal education—for example, in postsecondary technical school or junior college—with an emphasis on electronics. Workers with more formal education generally advance more quickly than their counterparts. Better educated workers can often forego some of the union training if they successfully complete the examinations that are offered. Good physical condition and mechanical aptitude are also important.

Some installers advance to mechanics-in-charge, adjusters, supervisors, or elevator inspectors. Others may move into management, sales, or product design.

Job Outlook

Employment of elevator installers and repairers is expected to increase about as fast as the average for all occupations through the year 2005. The job outlook for these workers is largely dependent on activity in the construction industry. Growth will occur as the construction of buildings with elevators and escalators increases and as the stock of equipment needing maintenance grows. In addition, demand will be spurred by the need to modernize older equipment, which can involve anything from improving appearance to introducing new computer controls. However, most job openings will result from replacement of experienced workers who transfer to other occupations or leave the labor force. Job prospects should be particularly favorable for those with postsecondary training in electronics.

Opportunities for elevator installers will fluctuate from year to year as conditions change in the construction industry. Economic downturns generally have less adverse effects on maintenance and repair mechanics because the equipment must still be kept in operating condition. More maintenance and repair work will also be needed as elevators become increasingly complex. The more intricate the equipment, the more maintenance it requires to keep it running smoothly.

Earnings

Weekly earnings for elevator installers and repairers were about \$695 in 1990, according to data from the International Union of Elevator Constructors. Probationary helpers started at about 50 percent of the rate for experienced elevator mechanics, or \$348 per week, while non-probationary helpers earned 70 percent of this rate, or \$486 per week. Mechanics-in-charge earned approximately \$780 a week.

In addition to free continuing education, elevator installers and repairers also receive a basic fringe benefit package including medical and dental benefits and a pension plan.

Virtually all elevator constructors are members of the International Union of Elevator Constructors (AFL-CIO).

Related Occupations

Elevator constructors combine electrical and mechanical skills with construction skills such as welding, rigging, measuring, and blueprint reading. Other occupations that require many of these skills are boil-



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

ermaker, electrician, industrial machinery repairer, millwright, sheet-metal worker, and structural ironworker.

Sources of Additional Information

For further details about opportunities as an elevator installer and repairer, contact elevator manufacturers, elevator repair and maintenance contractors, a local of the International Union of Elevator Constructors (AFL-CIO), or the nearest local public employment service office.

Farm Equipment Mechanics

(D.O.T. 624.281, .361-014, .381, .684; 629.281-018)

Nature of the Work

In today's world of large-scale, mechanized agriculture, few if any types of farming can be done economically without specialized machines. Farm equipment has grown enormously in size, complexity, and variety. Many farms have several tractors equipped with from 40- to 300-horsepower diesel engines. Self-propelled combines, hay balers, swathers, crop dryers, planters, tillage equipment, and elevators are common.

As farm machinery has grown larger with more electronic and hydraulic controls, farmers have increasingly turned to farm equipment dealers for service and repair of the machines they sell. Almost every dealer employs farm equipment mechanics, often called service technicians, to do this work and to maintain and repair the smaller lawn and garden tractors many dealers also sell to suburban homeowners.

Mechanics spend much of their time repairing and adjusting malfunctioning equipment that has been brought to the shop. But during planting and harvesting, they may travel to farms to make emergency repairs on equipment so that important farming operations are not unduly delayed.

Mechanics also perform preventive maintenance. Periodically, they test, adjust, and clean parts and tune engines. In large shops, mechanics may specialize in certain types of work, such as diesel engine overhaul, hydraulics, or clutch and transmission repair. Others specialize in repairing the air-conditioning units often included in the cabs of combines and large tractors, or in repairing certain types of equipment such as hay balers. Some mechanics also repair milking, irrigation, and other equipment on farms. In addition, some mechanics who work for dealers and equipment wholesalers assemble new implements and machinery and sometimes do body work, repairing dented or torn sheet metal on tractors or other machinery.

Mechanics use many basic handtools, including wrenches, pliers, hammers, and screwdrivers. They also may use precision equipment, such as micrometers and torque wrenches; engine testing equipment, such as dynamometers, to measure engine performance; engine analysis units and compression testers, to find worn piston rings or leaking cylinder valves. They may use welding equipment or power tools to repair broken parts.

Working Conditions

Generally, farm equipment mechanics work indoors. Modern farm equipment repair shops are well ventilated, lighted, and heated, but older shops may not offer these advantages. Farm equipment mechanics come in contact with grease, gasoline, rust, and dirt, and there is danger of injury when they repair heavy parts supported on jacks or by hoists. Care must also be used to avoid burns from hot engine parts, cuts from sharp edges of machinery, and hazards associated with farm chemicals.

As with most agricultural occupations, the hours of work of farm equipment mechanics vary according to the season of the year. During the busy planting and harvesting seasons, mechanics often work 6 or 7 days a week, 10 to 12 hours daily. In winter months, however, mechanics may work fewer than 40 hours a week and some may be laid off.



The ability to diagnose a problem quickly and accurately is one of the farm equipment mechanic's most valuable skills.

Employment

Farm equipment mechanics held nearly 48,000 jobs in 1990. Most worked in service departments of farm equipment dealers. Others worked in independent repair shops, and in shops on large farms. Most farm equipment mechanics worked in small repair shops. About 1 out of 7 farm equipment mechanics was self-employed.

Because some type of farming is done in nearly every area of the United States, farm equipment mechanics are employed throughout the country. Employment is concentrated in small cities and towns, making this an attractive career choice for people who do not wish to live in a large city. However, many mechanics work in the rural fringes of metropolitan areas, so farm equipment mechanics who prefer the conveniences of city life need not live in rural areas.

Training, Other Qualifications, and Advancement

Farm equipment mechanics must have an aptitude for mechanical work. With the development of more complex farm implements, technical training has become more important. A growing number of employers prefer to hire trainee farm equipment mechanics who have completed a 1- or 2-year training program in agricultural or diesel mechanics at a vocational or technical school or community or junior college. In general, employers seek persons with training or previous experience in diesel and gasoline engines, the maintenance and repair of hydraulics, and welding—subjects that may be learned in many high schools and vocational schools. Mechanics also need a basic knowledge of electronics and must be able to read circuit diagrams and blueprints in order to make complex repairs to electrical and other systems.

Most farm equipment mechanics enter the occupation as trainees and become proficient in their trade by assisting experienced mechanics. The length of training varies with the helper's aptitude and prior experience. At least 2 years of on-the-job training usually are necessary before a mechanic can efficiently do the more routine types of repair work, and additional training and experience are required for highly specialized repair and overhaul jobs.

Many farm equipment mechanics enter this occupation from a related occupation. For instance, they may have experience working as diesel mechanics, mobile heavy equipment mechanics, or automotive mechanics. A farm background is an advantage since working on a farm usually provides experience in basic farm equipment repairs. Persons who enter from related occupations also may start as trainees or helpers, but they may not require as long a period of on-the-job training.

A few farm equipment mechanics learn the trade by completing an apprenticeship program, which lasts from 3 to 4 years and includes on-the-job as well as classroom training in all phases of farm equipment repair and maintenance. Applicants for these programs usually are chosen from shop helpers.

Keeping abreast of changing farm equipment technology requires a great deal of careful study of service manuals and analysis of complex diagrams. Many farm equipment mechanics and trainees receive

refresher training in short-term programs conducted by farm equipment manufacturers. These programs usually last several days. A company service representative explains the design and function of equipment and teaches maintenance and repair on new models of farm equipment. In addition, some dealers may send employees to local vocational schools that hold special weeklong classes in subjects such as air-conditioning repair or hydraulics.

Persons considering a career in this field should have the manual dexterity needed to handle tools and equipment. Occasionally, strength is required to lift, move, or hold heavy parts in place. Difficult repair jobs require problem-solving abilities to diagnose the source of the machine's malfunction. Experienced mechanics should be able to work independently with minimum supervision.

Farm equipment mechanics usually must buy their own handtools, although employers furnish power tools and test equipment. Trainee mechanics are expected to accumulate their own tools as they gain experience. Experienced mechanics have thousands of dollars invested in tools.

Farm equipment mechanics may advance to shop supervisor, service manager, or manager of a farm equipment dealership. Some mechanics open their own repair shops. A few farm equipment mechanics advance to service representatives for farm equipment manufacturers.

Job Outlook

Employment of farm equipment mechanics is expected to increase more slowly than the average for all occupations through the year 2005. The increasing complexity of equipment will force more farmers to rely on mechanics for service and repairs, but the continued consolidation of farmland will allow equipment to be used more efficiently. Most job openings will arise from the need to replace experienced mechanics who retire. Opportunities should be good for persons who have completed formal training in farm equipment repair or diesel mechanics; persons without such training are expected to encounter increasing difficulty entering mechanic jobs.

The increasing sophistication of newer farm equipment is making it more difficult for farmers to do their own repairs, forcing them to rely more on skilled mechanics in the future. For instance, many newer tractors have much larger, electronically controlled engines and air-conditioned cabs, which have improved the comfort of the operator, and feature advanced transmissions with many speeds. New planting equipment uses electronics to spread seeds more uniformly, and electronic controls help harvesters reduce waste.

New equipment with advanced technology will replace older, less complex equipment more rapidly over the 1990-2005 period than in the past. Farm machinery is expensive and generally designed and manufactured to withstand many years of rugged use. However, during the 1980's many farmers delayed replacing equipment as they struggled to reduce excessive debt incurred during earlier, more prosperous times. Due to their past frugality, and generally renewed prosperity in the agricultural sector, the financial position of many farmers has improved, and farmers are expected to acquire more new equipment over the 1990-2005 period. More professional farm equipment mechanics will be needed to service and repair the growing stock of newer, more complex equipment.

Continued consolidation of farmland into fewer and larger farms and the withdrawal of land from agricultural production are expected to limit the growth in demand for farm equipment and slow the growth of farm equipment mechanic employment. However, a growing number of large farms are expected to employ their own mechanics.

Sales of smaller lawn and garden equipment constitute a growing share of the business of most farm equipment dealers. Most of the large manufacturers of farm equipment now offer a line of these smaller tractors and sell them through their established dealerships. Although relatively few mechanics are required to service this equipment, more will be needed as household demand for lawn and garden equipment increases as the Nation's population grows.

The agricultural equipment industry experiences periodic declines—mostly in sales. Layoffs of mechanics, however, are uncommon because farmers often elect to repair old equipment rather than purchase new equipment.

Earnings

Farm equipment mechanics had median hourly earnings of about \$8.40 in 1990. The middle 50 percent earned between \$6.90 and \$10.90 an hour. The top 10 percent earned over \$12.40 an hour. Most farm equipment mechanics also have the opportunity to work overtime during the planting and harvesting seasons, for which they generally are paid time and one-half.

Very few farm equipment mechanics belong to labor unions, but those who do are members of the International Association of Machinists and Aerospace Workers; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; and the International Brotherhood of Teamsters.

Related Occupations

Other workers who repair large mobile machinery include aircraft mechanics, automotive mechanics, diesel mechanics, and mobile heavy equipment mechanics:

Sources of Additional Information

Details about work opportunities may be obtained from local farm equipment dealers and local offices of the State employment service. For general information about the occupation, write to:

☛ North American Equipment Dealers Association, 10877 Watson Rd., St. Louis, MO 63127.

☛ John Deere and Co., John Deere Rd., Moline, IL 61265.

General Maintenance Mechanics

(D.O.T. 899.281-014 and .381-010)

Nature of the Work

Most craft workers specialize in one kind of work such as plumbing or carpentry. General maintenance mechanics are jacks-of-all-trades. 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 replacing faulty electrical switches, repairing air-conditioning motors, and unclogging drains.

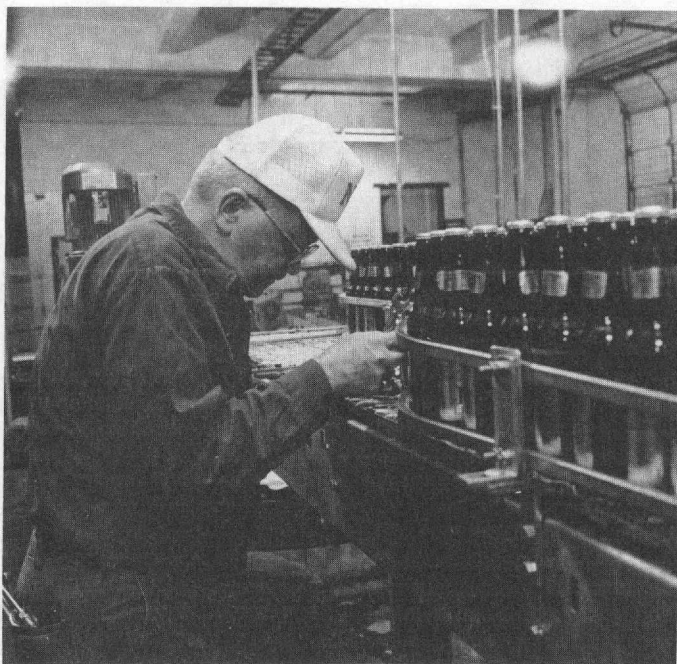
Those in small establishments, where they are often the only maintenance worker, do all repairs except for very large or difficult jobs. In larger establishments, their duties may be limited to a few tasks.

General maintenance mechanics inspect and diagnose problems and plan how work will be done, often checking blueprints, repair manuals, and parts catalogs. They obtain supplies and repair parts from distributors or storerooms. They use common hand and power tools such as screwdrivers, saws, drills, wrenches, and hammers as well as specialized equipment and electronic test devices. They replace or fix worn or broken parts, where necessary, or make adjustments.

They also do routine preventive maintenance to correct defects before equipment breaks down or buildings deteriorate. They may follow a check list, inspecting belts, checking fluid levels, replacing filters, and so forth. Maintenance mechanics also keep records of maintenance and repair work.

Working Conditions

General maintenance mechanics often do a variety of tasks in a single day, generally at a number of different locations in a building, or in several buildings. They may have to stand for long periods, lift heavy objects, and work in uncomfortably hot or cold environments. Like other maintenance craft workers, they may work in awkward and cramped positions or on ladders. They are subject to electrical shock, burns, falls, and cuts and bruises. Most general maintenance workers work a 40-hour week. Some work evening or night shifts or on weekends, or may be on call for emergency repairs.



This general maintenance mechanic may repair or maintain every machine in this plant.

Those employed in small establishments, where they may be the only maintenance worker, often operate with only limited supervision. Those working in larger establishments may work under the direct supervision of an experienced craft worker.

Employment

General maintenance mechanics held about 1,128,000 jobs in 1990. They worked in almost every industry. Nearly 3 out of 10 worked in service industries; most worked for elementary and secondary schools, colleges and universities, hospitals and nursing homes, and hotels. About 20 percent were employed in manufacturing industries. Others worked for real estate firms that operate office and apartment buildings and for wholesale and retail firms, government agencies, and gas and electric companies.

Training, Other Qualifications, and Advancement

Most general maintenance mechanics 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.

Others learn their skills by working as helpers to other repair or construction workers such as carpenters, electricians, or machinery repairers. Necessary skills can also be learned in high school shop classes and postsecondary trade or vocational schools. It generally takes from 1 to 4 years of on-the-job training or school, or a combination of both, to become fully qualified, depending on the skill level required.

Graduation from high school is preferred, but not always required, for entry into this occupation. High school courses in mechanical drawing, electricity, woodworking, blueprint reading, science, and mathematics are useful. Mechanical aptitude, ability to use shop math, 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.

Many general maintenance mechanics in large organizations advance to maintenance supervisor or to one of the crafts such as electrician, heating/air-conditioning mechanic, or plumber. In small organizations, promotion opportunities are limited.

Job Outlook

Employment of general maintenance mechanics is expected to grow about as fast as the average for all occupations through the year 2005. Employment is related to the number of buildings and amount of equipment needing maintenance and repair. Growth will occur as the number of office and apartment buildings, stores, schools, hospitals, hotels, and factories increases. In addition to jobs created by increased demand for maintenance mechanics, many more openings will arise as experienced workers transfer to other occupations or leave the labor force.

General maintenance mechanics who work in manufacturing industries may be laid off during recessions. Most mechanics, however, work in relatively stable nonmanufacturing industries and are not usually subject to layoff.

Earnings

Earnings vary widely by industry, geographic area, and skill level. General maintenance mechanics earned about \$10.40 an hour in manufacturing businesses and about \$8.70 in nonmanufacturing businesses in 1990. Wages generally are highest in transportation companies and public utilities and lowest in service firms. On average, workers in the Midwest and Northeast earned more than those in the West and South. Mechanics earn overtime pay for work in excess of 40 hours per week.

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

Related Occupations

Some of the work of general maintenance mechanics is similar to that of carpenters, plumbers, industrial machinery mechanics, electricians, and air-conditioning, refrigeration, and heating mechanics.

Sources of Additional Information

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

Heating, Air-Conditioning, and Refrigeration Technicians

(D.O.T. 637.261-014, -026, -030 and -034, and .381; 827.361-014; 862.281-018, .361-010; and 869.281-010)

Nature of the Work

What would those living in Buffalo do without heating, those in New Orleans do without air-conditioning, or blood banks in all parts of the country do without refrigeration? People always have sought ways to make their environment more comfortable. Today, 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 technicians install, maintain, and repair such systems.

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

Technicians may specialize in installation or in maintenance and repair. They may further specialize in one type of equipment, such as oil burners or commercial refrigerators. However, more and more technicians do both installation and servicing, and work with heating,

cooling, and refrigeration equipment. The following describes some of the specific jobs in this field.

Furnace installers, also called heating equipment technicians, follow blueprints or other specifications to install oil, gas, electric, solid-fuel, and multifuel heating systems. After putting the equipment in place, they may 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 insure the proper functioning of the system, furnace installers often use combustion test equipment such as carbon dioxide and oxygen testers.

After a furnace has been installed, technicians often perform routine maintenance and repair in order to keep the system operating efficiently. During the fall and winter, when the system is needed most, they service and adjust burners and blowers. If the system is not operating properly, they check the thermostat, burner nozzles, controls, and other parts in order to diagnose the problem and then correct it by adjusting or replacing parts. During the summer, technicians do maintenance work, such as replacing filters and vacuum-cleaning vents, ducts, and other parts of the heating system that may accumulate soot, ash, and dust during the operating season.

Air-conditioning and refrigeration technicians install and service central air-conditioning systems and a variety of refrigeration equipment. Technicians follow blueprints, design specifications, and manufacturers' instructions to install motors, compressors, condensing units, evaporators, and other components. They connect this equipment to the duct work, refrigerant lines, and electrical power source. After making the connections, they charge the system with refrigerant and check it for proper operation.

When air-conditioning and refrigeration equipment breaks down, technicians diagnose the problem and make repairs. To find defects, they test parts such as compressors, relays, and thermostats. During the winter, air-conditioning technicians inspect the systems and do required maintenance, such as overhauling compressors. When servicing equipment, heating, air-conditioning, and refrigeration technicians must use care to conserve, recover, and recycle chlorofluorocarbon (CFC) refrigerants used in air-conditioning and refrigeration systems. The release of CFC's contributes to the depletion of the stratospheric ozone layer, which protects plant and animal life from ultraviolet radiation. 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; and they recycle it for reuse with special filter-dryers.

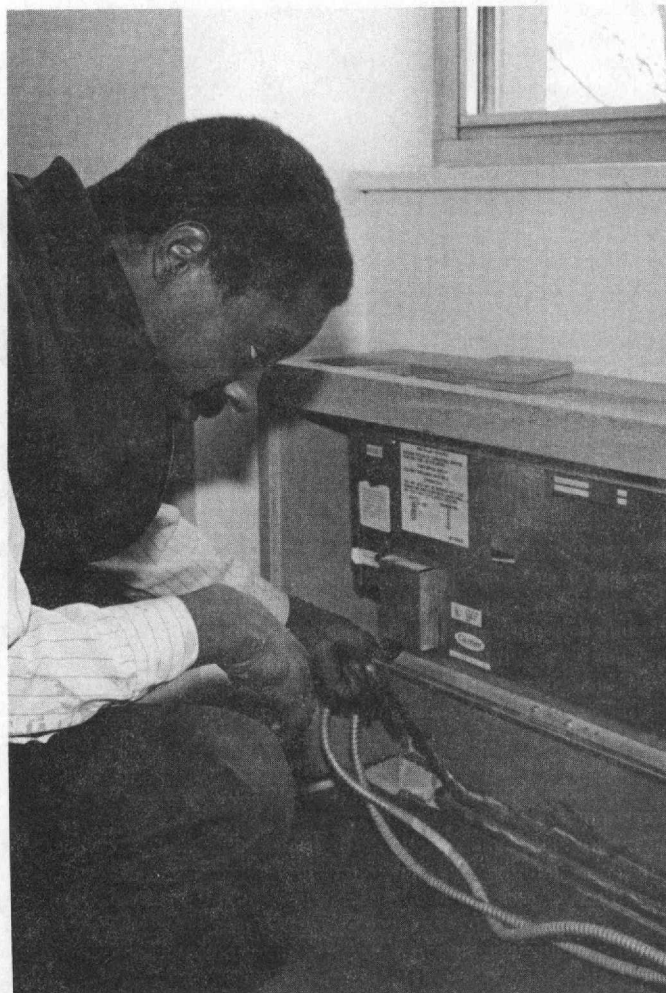
Heating, air-conditioning, and refrigeration technicians use a variety of tools, including hammers, wrenches, metal snips, electric drills, pipe cutters and benders, and acetylene torches, to work with refrigerant lines and air ducts. They use voltmeters, thermometers, pressure gauges, manometers, and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

Cooling and heating systems sometimes are installed or repaired by other craft workers. For example, on a large air-conditioning installation job, especially where workers are covered by union contracts, duct work might be done by sheet-metal workers; electrical work by electricians; and installation of piping, condensers, and other components by plumbers and pipefitters. Room air-conditioners and household refrigerators are serviced by home appliance repairers. Additional information about these occupations appears elsewhere in the *Handbook*.

Working Conditions

Heating, air-conditioning, and refrigeration technicians work in homes, supermarkets, hospitals, office buildings, factories—anywhere there is climate control equipment. They may be assigned to specific job sites at the beginning of each day or they may be dispatched to jobs by radio or telephone.

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 often 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.



Air-conditioning technicians test systems to determine if they are functioning properly.

Technicians usually work a 40-hour week, but during peak seasons they often work overtime or irregular hours. Maintenance workers, including those that provide maintenance services under contract, often work evening or weekend shifts, and are on call. Most employers try to provide a full workweek the year round by doing both installation and maintenance work. Therefore, in most shops that service both heating and air-conditioning equipment, employment is very stable throughout the year.

Employment

Heating, air-conditioning, and refrigeration technicians held about 219,000 jobs in 1990. About half worked for cooling and heating contractors. The remainder were employed in a wide variety of industries. Some worked for fuel oil dealers, utilities companies, and refrigeration and air-conditioning service and repair shops. Others were employed by the Federal Government, hospitals, office buildings, and other organizations that operate large air-conditioning, refrigeration, or heating systems. Approximately 1 of every 7 technicians was self-employed. Jobs are found throughout the country, reflecting our dependence on climate control systems.

Training, Other Qualifications, and Advancement

Because of the increased sophistication of heating, air-conditioning, and refrigeration systems, employers prefer to hire those with technical school or apprenticeship training. A sizable number of these workers, however, still learn the trade informally on the job.

Many secondary and postsecondary technical and trade schools, junior and community colleges, and the Armed Forces offer 1- to 2-year programs in heating, air-conditioning, and refrigeration. Students study theory, design, and equipment construction, as well as

electronics. They also learn the basics of installation, maintenance, and repair.

Apprenticeship programs are frequently run by joint committees representing local chapters of the Air-Conditioning Contractors of America, the Mechanical Contractors Association of America, the National Association of Plumbing, Heating, and Cooling Contractors, 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. Other apprenticeship programs are sponsored by local chapters of the Associated Builders and Contractors and the Home Builders Institute of the National Association of Home Builders. These programs generally last 4 or 5 years and combine on-the-job training with 144 hours of classroom instruction each year in related subjects, such as the use and care of tools, safety practices, blueprint reading, and air-conditioning theory. Applicants for these programs must have a high school diploma or its equivalent.

Those who acquire their skills on the job usually begin by assisting experienced technicians and doing simple jobs. They may carry materials, insulate refrigerant lines, or clean furnaces. In time, they do more difficult jobs, such as cutting and soldering pipes and sheet metal and checking electrical and electronic circuits. In 4 to 5 years, new technicians should be able to do all types of repair and installation.

Courses in shop math, mechanical drawing, applied physics and chemistry, electronics, and blueprint reading provide a good background for those interested in entering this occupation. A basic understanding of microelectronics is becoming more important because of the increasing use of this technology in solid-state 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.

To keep up with changes in technology and to expand their skills, experienced technicians may take courses offered by heating and air-conditioning equipment manufacturers and by associations such as the Refrigeration Service Engineers Society (RSES) and the Air Conditioning Contractors of America (ACCA). RSES also offers a basic self-study course for individuals with limited experience.

Advancement usually takes the form of higher wages. Some technicians advance to positions as supervisors. Those with sufficient money and managerial skill can open their own contracting business.

Job Outlook

Employment of heating, air-conditioning, and refrigeration technicians is expected to increase about as fast as the average for all occupations through the year 2005. As the population and economy grow and new residential, commercial, and industrial structures are built, more technicians will be needed to install and maintain climate control systems. A growing concern about energy management and conservation also should prompt installation of new energy-saving heating and air-conditioning systems in existing homes and buildings. Regulations in the 1990 Clean Air Act prohibiting the intentional discharge of CFC refrigerants and banning CFC production by the year 2000 could result in additional retrofit and replacement of existing equipment and create more jobs for heating, air-conditioning, and refrigeration technicians.

Those who specialize in the installation of new systems may experience periods of unemployment when the level of construction activity declines. On the other hand, employment of those doing maintenance work is relatively stable—people and businesses depend on their climate control systems regardless of economic conditions. Overall opportunities for air-conditioning, heating, and refrigeration technicians should be very good, although job availability will vary considerably based on local conditions.

In addition to jobs created by economic growth, many opportunities will result from the need to replace workers who transfer to other occupations or leave the labor force. Although relatively few heating, air-conditioning, and refrigeration technicians transfer to other occupations—reflecting their lengthy investment in training and the relatively high wages and benefits in this trade—the number of retirements is expected to rise as more of these workers reach retire-

ment age. Workers under 25 years of age have traditionally filled most training slots, a group that is expected to shrink through the year 2005. If employers and unions aren't successful in attracting more applicants to training programs, shortages of qualified workers could develop.

Earnings

Median weekly earnings of air-conditioning, heating, and refrigeration technicians who were wage and salary workers were \$447 in 1990. The middle 50 percent earned between \$319 and \$610. The lowest 10 percent earned less than \$261 a week, and the top 10 percent earned more than \$775 a week.

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 technicians enjoy a variety of employer-sponsored benefits. In addition to some typical benefits like health insurance and pension plans, some employers pay for work-related training and provide uniforms, company vans, and a few tools.

Related Occupations

Heating, air-conditioning, and refrigeration technicians work with sheet metal and piping, and repair machinery, such as electrical motors, compressors, and burners. Other workers who have similar skills are boilermakers, electrical appliance servicers, electricians, plumbers and pipefitters, and sheet-metal workers.

Sources of Additional Information

For more information about employment and training opportunities in this trade, contact local vocational and technical schools; local heating, air-conditioning, and refrigeration contractors; a local of the unions previously mentioned; a local joint union-management apprenticeship committee; a local chapter of the Associated Builders and Contractors; or the nearest office of the State employment service or State apprenticeship agency.

For information on career opportunities and training, write to:

- Associated Builders and Contractors, 729 15th St. NW., Washington, DC 20005.
- Refrigeration Service Engineers Society, 1666 Rand Rd., Des Plaines, IL 60016-3552.
- National Association of Home Builders, Home Builders Institute, 15th and M Sts. NW., Washington, DC 20005.
- National Association of Plumbing, Heating, and Cooling Contractors, P.O. Box 6808, Falls Church, VA 22040.
- New England Fuel Institute, P.O. Box 888, Watertown, MA 02272.
- Mechanical Contractors Association, 1385 Piccard Dr., Rockville, MD 20850-4329.
- Air Conditioning and Refrigeration Institute, 1501 Wilson Blvd., Arlington, VA 22209.

Home Appliance and Power Tool Repairers

(D.O.T. 637.261-010 and -018; 723.381 and .584; 729.281-022; and 827.261, .464, and .661)

Nature of the Work

Appliance and power tool repairers—sometimes called service technicians—repair ovens, washers, dryers, refrigerators, window air-conditioners, vacuum cleaners, and other home appliances as well as lawnmowers and power tools such as saws and drills.

Some repairers service small appliances such as microwaves and vacuum cleaners; others specialize in major appliances such as refrigerators, freezers, washers, and dryers; and others handle power tools. Some specialize in gas appliances.

To determine why an appliance or power tool fails to operate properly, repairers visually inspect it and run it to check for unusual noise.

es, excessive vibration, fluid leaks, or loose parts, and consult service manuals and troubleshooting guides. They may disassemble the appliance or tool to examine its internal parts. To check electrical systems for shorts and faulty connections, repairers follow wiring diagrams and use testing devices, such as ammeters, voltmeters, and wattmeters.

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

When servicing gas appliances, repairers may check the heating unit and replace pipes, thermocouples, thermostats, valves, and indicator spindles. Repairers also answer emergency calls for gas leaks.

To install gas appliances, they measure, lay out, cut, and thread pipe and connect it to a feeder line and to the appliance. They may saw holes in walls or floors and may hang steel supports from beams or joists to hold the pipe in place. Once the gas line is in place, they turn on the gas and check for leaks.

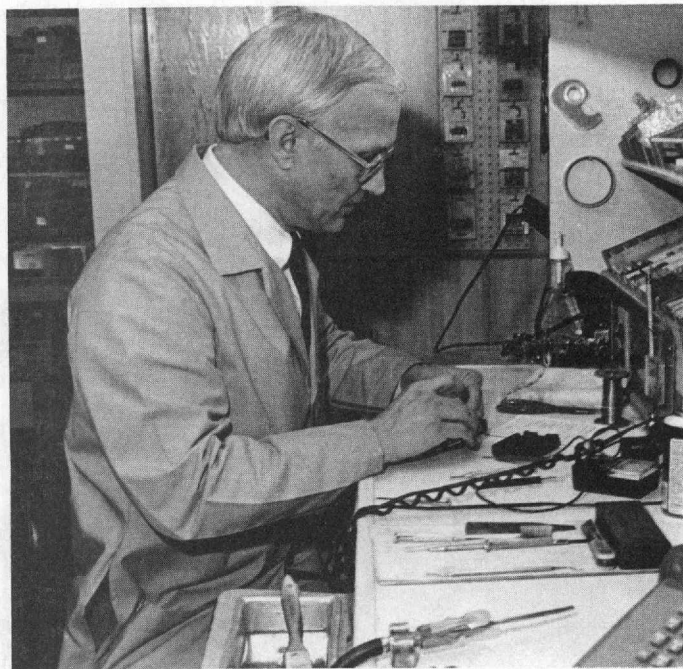
Repairers also answer customers' questions about the care and use of appliances. For example, they may demonstrate how to load automatic washing machines, arrange dishes in dishwashers, or sharpen chain saws.

Repairers may provide estimates of the cost of repairs, keep records of parts used and hours worked, prepare bills, and collect payment.

Working Conditions

Those who handle portable appliances usually work in repair shops which generally are quiet, well lighted, and adequately ventilated. Those who repair major appliances usually work in customers' homes. They carry their tools and a number of commonly used parts with them in a truck or van and may spend several hours a day driving.

They may work in clean comfortable kitchens or in other places amidst dirt and dust. Repairers sometimes work in cramped and uncomfortable positions. The work generally is safe, but repairers must exercise care and follow safety precautions to avoid electrical shocks and injuries when lifting and moving large appliances. When servicing gas appliances and microwave ovens, they must be aware of the dangers of gas and radiation leaks.



Home appliance and power tool repairers usually work with little or no direct supervision.

Many home appliance and power tool repairers work a standard 40-hour week. Some work early mornings, evenings, and Saturdays. During hot weather, those who repair air-conditioners and refrigerators may work overtime.

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

Employment

Home appliance and power tool repairers held about 71,000 jobs in 1990. Roughly 1 out of 10 was self-employed. About 6 out of 10 salaried repairers worked in retail establishments such as department stores, household appliance stores, and fuel dealers. Others worked for gas and electric utility companies, electrical repair shops, and wholesalers.

Appliance and power tool repairers are employed in almost every community, but are concentrated in the more highly populated areas.

Training, Other Qualifications, and Advancement

Many repairers complete 1- or 2-year formal training programs in appliance repair and related subjects in high schools, private vocational schools, and community colleges. Others learn on the job. No matter how their basic skills are developed, repairers usually get additional training from their employer.

In shops that fix portable appliances, trainees work on a single type of appliance, such as vacuum cleaners, until they master its repair. Then they move on to others, until they can repair all those handled by the shop. In companies that repair major appliances, beginners assist experienced repairers on service visits. They may also study on their own. They learn to read schematic drawings, to analyze problems, to determine whether to repair or replace parts, and to take safety precautions. Up to 3 years of on-the-job training may be needed to become skilled in all aspects of repair of the more complex appliances.

Some appliance and power tool manufacturers and department store chains have formal training programs which include home study and shop classes, where trainees work with demonstration appliances and other training equipment.

Many repairers receive supplemental instruction through 2- or 3-week seminars conducted by appliance and power tool manufacturers. Experienced repairers also attend training classes or study service manuals.

Employers generally require a high school diploma. Courses in basic electricity and electronics are desirable. Employers prefer to hire people with formal training in appliance repair and electronics. Mechanical aptitude also is desirable. Those who work in customers' homes must be courteous and tactful.

Some States and areas require repairers to be licensed or registered. Applicants for licensure must meet standards of education, training, and experience. They also must pass an examination, which can be written, practical, or a combination.

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

Job Outlook

Little or no change is expected in the employment of home appliance and power tool repairers through the year 2005. Although the number of home appliances and power tools in use is expected to increase as the number of households and businesses grows and new and improved appliances and tools are introduced, increasing use of electronic parts such as solid-state circuitry, microprocessors, and sensing devices in appliances reduce the frequency of repairs. Virtually all openings for repairers will arise from the need to replace workers who transfer to other occupations or leave the labor force.

Nevertheless, prospects should continue to be good for well-trained repairers, particularly those with strong a background in elec-

tronics. Most people with the electronics training needed to repair appliances go into other repairer occupations. Employment is relatively steady because the demand for appliance repair services continues even during economic downturns.

Earnings

Earnings of home appliance and power tool repairers vary widely according to skill level, geographic location, and the type of equipment serviced. According to the limited data available, average earnings for experienced repairers ranged from about \$8 to about \$14 an hour in 1990. Trainees earned less and senior technicians earned more. Earnings tend to be highest in large firms and for those servicing gas appliances.

Some home appliance and power tool repairers belong to the International Brotherhood of Electrical Workers.

Related Occupations

Other workers who service electrical and electronic equipment include heating, air-conditioning, and refrigeration mechanics; pinsetter mechanics; office machine and cash register servicers; electronic home entertainment equipment repairers; and vending machine servicers and repairers.

Sources of Additional Information

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

Information about training programs or work opportunities also is available from:

- Appliance Service News, P.O. Box 789, Lombard, IL 60148.
- National Association of Service Dealers, 10 E. 22nd St., Suite 310, Lombard IL 60148.

Industrial Machinery Repairers

(D.O.T. codes available on request from the Chief, Division of Occupational Outlook, Bureau of Labor Statistics, Washington, DC 20212.)

Nature of the Work

Industrial machinery repairers maintain and repair machinery found in a plant or factory. This must be done as accurately and as quickly as possible because when a machine is idle, production schedules are not met and if the machine is not repaired properly, damage can occur to expensive machinery and substandard goods may be produced. All these factors cost companies money.

Industrial machinery repairers—often called maintenance mechanics—spend much of their time doing preventive maintenance. This includes keeping machines and their parts well oiled, greased, and cleaned. Repairers regularly inspect machinery and check performance. For example, they adjust and calibrate automated manufacturing equipment such as industrial robots and align and lubricate gears, bearings, and other mechanical parts. By keeping complete and up-to-date records, mechanics try to anticipate trouble and service the machinery before factory production is interrupted.

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

After diagnosing the problem, the mechanic disassembles the equipment and repairs or replaces the necessary parts. The final step is to test the machine to ensure that it is running smoothly. When repairing electronically controlled machinery, these mechanics may work closely with electronic repairers or electricians who maintain

the machine's electronic parts. However, industrial machinery repairers increasingly need electronic skills to repair sophisticated equipment on their own. (Additional information about commercial and industrial electronic equipment repairers and electricians appears elsewhere in the *Handbook*.)

A wide range of tools may be used when doing preventive maintenance or making repairs. For example, repairers may use a screwdriver and wrench to adjust an engine, or a hoist to lift a 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, repairers may sketch a part that can be fabricated by the plant's machine shop. Repairers use catalogs to order replacement parts and often follow blueprints and engineering specifications to maintain and fix equipment.

Some of the industrial machinery repairer's duties may be performed by millwrights. (See the statement on millwrights elsewhere in the *Handbook*.)

Working Conditions

Working conditions for repairers who work in manufacturing are similar to those of production workers. However, they often work underneath or above large machinery in cramped conditions or on the top of a ladder. These workers are subject to common shop injuries such as cuts and bruises and often use protective equipment such as hard hats and safety belts.

Because factories and other organizations cannot afford breakdowns in industrial machinery, industrial machinery repairers may be called to the plant at night or on weekends for emergency repairs. However, most work a standard 40 hour week, but overtime is common.

Employment

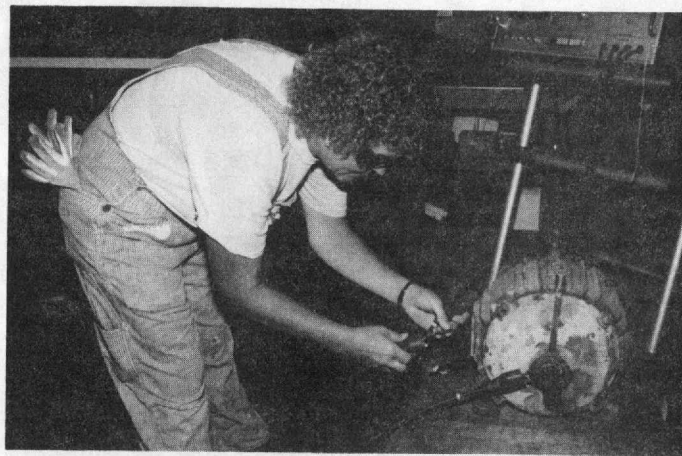
Industrial machinery repairers held about 474,000 jobs in 1990. Repairers work in every industry where machinery is used. However, about 70 percent work in manufacturing industries, primarily food processing, transportation equipment, textile mill products, fabricated metal products, and primary metals. Others work for government agencies, public utilities, and mining companies.

Because industrial machinery repairers work in a wide variety of plants, they are employed in every section of the country. Employment is concentrated, however, in heavily industrialized areas.

Training, Other Qualifications, and Advancement

Many workers learn their trade through a 4-year apprenticeship program that combines 144 hours of related classroom instruction training and on-the-job-training. These programs are usually sponsored by a local trade union. Others start as helpers and pick up the skills of the trade informally and by taking courses offered by machinery manufacturers.

Repairers learn from experienced repairers how to operate, disassemble, repair, and assemble machinery. Classroom instruction focus-



Industrial machine repairers check windings on electric motors.

es on subjects such as shop mathematics, blueprint reading, and welding. In addition, electronics and computer training are an increasingly important part of the apprenticeship program.

Most employers prefer to hire those who have completed high school. However, opportunities do exist for those without a high school diploma. High school courses in mechanical drawing, mathematics, blueprint reading, physics, and electronics are useful.

Mechanical aptitude and manual dexterity are important qualifications for workers in this trade. Good physical condition and agility are also necessary because repairers sometimes have to lift heavy objects or climb to reach equipment located high above the floor.

Opportunities for advancement are limited. Industrial machinery repairers advance either by working with more complicated equipment or by becoming a supervisor. Some of the most highly skilled repairers can be promoted to master mechanic or can become a machinist or a tool and die maker.

Job Outlook

Employment of industrial machinery repairers is expected to increase more slowly than the average for all occupations through the year 2005. However, many job openings will result from the need to replace repairers who transfer to other occupations or retire. U.S. firms, to remain competitive in world markets, are expected to introduce more automated production equipment. These machines, which require much preventive maintenance, will continue to need repairers to keep them in good working condition.

Industrial machinery repairers are not usually affected by seasonal changes in production. During slack periods, when some plant workers are laid off, repairers often are retained to do major overhaul jobs. Although these workers may face layoff or a reduced workweek when economic conditions are particularly severe, they generally are less affected than other workers because machines have to be maintained regardless of the level of production.

Earnings

Median weekly earnings of most industrial machinery repairers were \$480 in 1990; the middle 50 percent earned between \$376 and \$598 weekly. The lowest 10 percent earned less than \$289, and the top 10 percent earned more than \$724. However, earnings often vary by industry and the area of the country. The following tabulation shows the average hourly earnings by major region of the country.

<i>Region</i>	<i>Earnings</i>
All metropolitan areas	\$14.87
Midwest	16.17
West	14.96
Northeast.....	13.86
South.....	13.22

Labor unions to which most industrial machinery repairers belong include the United Steelworkers of America; the United Automobile, Aerospace and Agricultural Implement Workers of America; the International Association of Machinists and Aerospace Workers; and the International Union of Electronic, Electrical, Salaried, Machine, and Furniture Workers.

Related Occupations

Other occupations that involve repairing machinery include aircraft mechanics and engine specialists, automotive and motorcycle mechanics, diesel mechanics, elevator installers and repairers, farm equipment mechanics, machinists, general maintenance mechanics, heating, air-conditioning, and refrigeration mechanics, millwrights, and mobile heavy equipment mechanics.

Sources of Additional Information

Information about employment and apprenticeship opportunities in this field may be obtained from local offices of the State employment service or from:

• International Union of Electronic, Electrical, Salaried, Machine, and Furniture Workers, 1126 16th St. NW., Washington, DC 20036.

Line Installers and Cable Splicers

(D.O.T. 821.261-010, -014, -022, and -026, .281-010, .361-010, -018, -022, -026, -030, and -038, .687-010; 822.381-014; 823.261-014; 829.361-010 and -014; and 959.367-010)

Nature of the Work

Vast networks of wires and cables link the electric power produced in generating plants to individual customers, connect telephone central offices to customers' telephones and switchboards, and extend cable TV to residential and commercial customers. These networks are constructed and maintained by line installers and cable splicers and their helpers.

To install new electric power or telephone lines, line installers, often referred to as outside plant technicians or construction line workers, install poles and terminals and place wires and cables that lead from the source of the transmission to the customers' premises. They usually use power-driven equipment to dig holes and set in the poles that support cables. Line installers climb the poles or use truck-mounted buckets (aerial work platforms) and then use various handtools to attach the cables. When working with electric power lines, installers bolt or clamp insulators onto the pole before the cable can be attached. They may add other equipment to the erected poles and towers, such as lightning arrestors, transformers, circuit breakers, or switches. To bury cable underground, installers use trenchers, plows, and other special power-driven equipment.

Line installers also lay cable television lines underground or hang them on poles with the telephone and utility wires. These lines transmit the broadcast signal from a microwave tower to the customer's home. Cable television installers and repairers connect the customer's television set to the cable television line by installing a coaxial drop wire with connectors to the building. Sometimes additional wiring must be installed in the house or building so the cables can connect the outside line to one or more television sets.

After telephone line installers place cables in position, cable splicers, also referred to as cable splicing technicians, complete the line connections. (Electric power line workers install and splice the cables simultaneously.) Splicers connect individual wires or fibers within the cable and rearrange wires when lines have to be changed. They first read and interpret service orders and circuit diagrams to determine splicing specifications. Splices are then made by twisting, soldering, or joining wires and cables with small handtools, epoxy, and even with mechanical equipment. At each splice, they place insulation over the conductor, and seal the splice with a lead sleeve or cover the splice with some other type of protective covering. They may fill the cable sheathing on critical transmission routes with compressed air so that leaks in the sheathing can be monitored and repaired. Splicers work on poles, aerial ladders and platforms, in manholes, or in basements of large buildings.

Fiber optic cables are being used to replace worn or obsolete copper cables. These tiny hair-thin strands of glass are able to carry more signals per cable because they transmit pulses of light instead of electricity. Splices of fiber optic cables are completed in a van positioned near the splice point. These vans house workshops that contain all the necessary equipment, such as machines that heat the glass fibers so they can be joined.

Line installers and cable splicers also maintain and repair telephone, power, and cable television lines. In some areas, this is done by a separate group of workers called cable repair technicians or cable service technicians. Service technicians periodically check to make sure lines are clear of tree limbs or other obstructions that could cause problems. They also routinely check to make sure that insulation on cables is in good condition and that insulators and other equipment on line poles are working properly. When bad weather or earth quakes break wires or cables, or knock poles down or cause underground ducts to collapse, these workers make emergency repairs.

Working Conditions

Because telephone, electric, and television cables are strung from utility poles or are underground, line installers and cable splicers

must do a lot of climbing and lifting or work in stooped and cramped positions. They usually work outdoors in all kinds of weather and are subject to 24-hour call. For example, when severe weather damages transmission and distribution lines, they may be called upon to work long and irregular hours to restore service. At times, they may travel to distant locations—and occasionally stay for a lengthy period to help restore damaged facilities or build new ones.

Line installers and cable splicers face many situations in which safety procedures must be followed. They must wear safety equipment when entering manholes and are required to test for the presence of gas before going underground. They may be exposed to hazardous chemicals from the solvents and plugging compounds that they use when splicing cables. Electric power line workers have the most hazardous jobs. They typically work at higher elevations because the electric cable is always above telephone and cable TV lines. Moreover, all of the voltages electric power line workers come in contact with can cause death if safety procedures are not followed.

Employment

Line installers and cable splicers held about 232,000 jobs in 1990. More than half were telephone and cable TV line installers and repairers. Nearly all worked full time for telephone companies, cable television companies, electric power companies, or construction companies specializing in power line and cable TV construction.

Training, Other Qualifications, and Advancement

Line installers are often hired as helpers or ground workers. Most employers prefer high school graduates with specific qualifications for these positions. Many employers test applicants for basic verbal, arithmetic, and abstract reasoning skills. Some employees may give

entry tests of physical ability such as balance, coordination, and strength. Because the work entails a lot of climbing, applicants should have stamina and must be unafraid of heights. Applicants also may be tested for mechanical aptitude. Knowledge of the basic principles of electricity and training in installing telephone systems obtained in the Armed Forces or vocational education programs may be helpful. The ability to distinguish colors is necessary because wires and cables usually are coded by color. Motivation, self-discipline, and the ability to work as part of a team are needed to work efficiently and safely.

Line installers and cable splicers in electric companies and construction firms specializing in cable installation generally complete a formal apprenticeship program. These are administered jointly by the employer and the union representing the workers, either the International Brotherhood of Electrical Workers or the Communications Workers of America. These programs last several years and combine formal instruction with on-the-job training. Workers in telephone companies generally receive several years of informal on-the-job training, in some cases learning other skills like telephone installation and repair. They may also attend training provided by manufacturers who sell cable installation equipment to telephone, electric power, or cable TV companies.

A growing number of employers are using computer-assisted instruction, video cassettes, movies, or "programmed" workbooks. Some training facilities are equipped with poles, cable-supporting clamps, and other fixtures, to simulate working conditions as closely as possible. Trainees learn to work on poles while keeping their hands free. In one exercise, for example, they play catch with a basketball while on the poles. Trainees also are taught safety procedures to avoid falls and contact with power wires.

Formal training, which also may include instruction in electrical codes, blueprint reading, and beginning electrical theory, is followed by informal, on-the-job training. Trainees are assigned to work with a crew of experienced line installers under a line supervisor.

Line installers and cable splicers continue to receive training throughout their careers to qualify for more difficult assignments and to keep up with technological changes. For example, cable splicers who work for telephone companies are introduced to the techniques of fiber optic cable splicing. Because there have been fewer changes in electric power line installation and repair, less training is needed to update utility line workers.

Since deregulation of the telephone industry, many telephone companies have reduced the scope of their training programs in order to reduce their costs and to remain competitive. Increasingly, workers are responsible for their own training, which is provided by community colleges and postsecondary vocational schools.

For installers in the telephone industry, advancement may come about through promotion to splicer. Splicers can advance to engineering assistants or may move into other kinds of work, such as sales. Promotion to a supervisory position also is possible. In the electric industry, promotion is usually to a supervisory position.

Job Outlook

Overall employment of line installers and cable splicers is expected to decline through the year 2005. Technological advances will result in divergent trends within this occupation. Employment of electrical power line installers is expected to grow more slowly than the average for all occupations as the demand for electricity grows. Employment of telephone and cable TV line installers and repairers is expected to decline, despite growth in telephone and cable TV usage. Layoffs of telephone line workers have already occurred, and more are anticipated. This is due to the increased efficiency being built into telephone systems. New ways of transmitting information—satellites, microwave towers, and underground fiber optic cable, for example—are not as vulnerable to adverse weather conditions as aerial wires, and fewer workers are needed to maintain them. Fiber optic cables will continue to replace copper cables, and this will generate short-term demand for installers. Over the longer term, however, employment will fall as the job of conversion to fiber optics is completed and as maintenance requirements are reduced. Improved splicing techniques as well as new power tools and equipment also will con-



Line installers climb poles or use truck mounted buckets.

tinue to improve the efficiency of cable splicers. Finally, most areas of the country that can economically be served by cable TV have already been wired and at some point fewer installers will be needed.

Job prospects will be best for line workers employed by electric utilities and construction firms doing electrical work because the impact of technology is expected to be less severe in these industries than in telephone communication. In telephone companies, those who combine knowledge of line installation, fiber optic or copper cable splicing, telephone installation, and repair of many types of equipment should enjoy better prospects.

Earnings

Pay rates for line installers and cable splicers vary greatly across the country and depend on length of service; specific information may be obtained from local telephone, electric power, and cable TV companies. It generally takes about 5 years to go from the bottom to the top of the pay scale. In 1990, line installers and repairers earned a median weekly wage of \$596. The middle 50 percent earned between \$470 and \$716. The bottom 10 percent earned less than \$313; the top 10 percent earned more than \$716 a week. Line installers employed by AT&T and the Bell Operating Companies and represented by the Communications Workers of America earned an average weekly salary of \$710 in 1990; cable splicers also averaged \$710. Because of low job turnover in these occupations, many workers earn salaries near the top of the pay scale. Cable splicers working on fiber optics cables tend to earn more than those working on copper cables.

Most line installers and cable splicers belong to unions, principally the Communications Workers of America and the International Brotherhood of Electrical Workers. For these workers, union contracts set wage rates, wage increases, and the time needed to advance from one step to the next. These contracts require extra pay for overtime and for all work on Sundays and holidays. Most contracts provide for additional pay for night work. Time in service determines the length of paid vacations. Depending on the locality, there are 9 to 12 holidays a year.

Related Occupations

Workers in other skilled crafts and trades who work with tools and machines include communications equipment mechanics, biomedical equipment technicians, telephone installers and repairers, electricians, and sound technicians.

Sources of Additional Information

For more details about employment opportunities, contact the telephone or electric power company in your community or local offices of the unions that represent these workers. For general information on line installer and cable splicer jobs, write to:

• Communications Workers of America, 1925 K St. NW., Washington, DC 20006.

For additional information on the telephone industry and career opportunities in it, request copies of *Phonefacts* and *A Career in the Telephone Industry* from:

• United States Telephone Association, 900 19th St. NW., Suite 800, Washington, DC 20006.

Millwrights

(D.O.T. 638.261-010, -014, -018, .281-018, and -022)

Nature of the Work

Millwrights are often called "jacks of all trades" because of the variety of duties and skills their jobs entail. Millwrights install, repair, replace, and dismantle the machinery and heavy equipment used in almost every industry. These responsibilities require a wide range of skills—from blueprint reading and pouring concrete to diagnosing and solving mechanical problems.

The millwright's responsibilities begin when machinery arrives at the job site. The new equipment must be unloaded, inspected, and then moved into position. To lift and move light machinery, millwrights may use rigging and hoisting devices such as pulleys and

cables. In other cases, they require the assistance of hydraulic lift-truck or crane operators to position the machinery. Because millwrights often decide what device to use for moving machinery, they must know the load-bearing properties of ropes, cables, hoists, and cranes.

New machinery sometimes requires a new foundation. Millwrights either personally prepare the foundation or supervise its construction, so they must know how to read blueprints and work with building materials such as concrete, wood, and steel.

When assembling machinery, millwrights 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; millwrights must have good mathematical skills so that they can measure angles, material thickness, and small distances with tools such as squares, calipers, and micrometers. When a high level of precision is required, devices such as lasers may be used. Millwrights also use hand and power tools, cutting torches, welding machines, and soldering guns. Some millwrights use metalworking equipment such as lathes or grinders to modify parts to specifications.

The increasing level of automation found in most industries means that there are more sophisticated machines for millwrights to install and maintain. This machinery often requires special care and knowledge, so millwrights often work closely with computer or electronic experts, electricians, and manufacturer's representatives, to install it. (Additional information about commercial and industrial electronic equipment repairers and electricians appears elsewhere in the *Handbook*.)

In addition to installing and dismantling machinery, many millwrights repair and maintain equipment. This includes preventive maintenance, such as lubrication, and fixing or replacing worn parts. (For further information on machinery maintenance, see the statement on industrial machinery repairers elsewhere in the *Handbook*.)

Working Conditions

Working conditions of millwrights depend upon the industries in which they are employed. Millwrights employed in manufacturing often work in a typical shop setting and use protective equipment to avoid common hazards. For example, injury from falling objects or machinery are avoided by protective devices such as safety belts and hard hats.

Millwrights work independently as well as part of a team. They must work quickly and precisely because non-functioning machinery cost a company time and money. Millwrights generally work 40 hours per week but overtime is common during peak periods of production.

Employment

Millwrights held about 73,000 jobs in 1990. Almost 95 percent of these workers were employed in either manufacturing or construction. Over 70 percent worked in manufacturing, primarily in durable



Millwrights use a wide variety of skills in their work.

goods industries such as basic steel products and motor vehicles and equipment. Most of the rest were employed by construction firms and companies providing millwright services on a contract basis. Table 1 shows employment concentration by major industry.

Table 1. Distribution of millwrights by industry, 1990

Industry	Percent
Total	100
Special trade contractors	14
Transportation equipment	14
Primary metal industries	13
Paper and allied products	9
Fabricated metal products	7
Industrial machinery and equipment	7
Chemicals and allied products	6
Other industries	30

SOURCE: Bureau of Labor Statistics

Although millwrights work in every State, employment is concentrated in heavily industrialized areas.

Training, Other Qualifications, and Advancement

Millwrights receive their training from a formal apprenticeship program or informally on the job. Apprenticeship programs normally combine 4 years of on-the-job training with classroom instruction. Apprenticeship programs include training in dismantling, moving, erecting, and repairing machinery. Apprentices also may work with concrete and receive instruction in related skills such as carpentry, welding, and sheet-metal work. Classroom instruction is given in mathematics, blueprint reading, hydraulics, electricity, and increasingly, computers.

Most employers prefer applicants with a high school diploma or its equivalent. Courses in science, mathematics, mechanical drawing, and machine shop practice are useful. Because millwrights often take apart complicated machinery, mechanical aptitude is important.

Strength and agility also are important because the work can require a considerable amount of lifting and climbing. Millwrights need good interpersonal and communication abilities in order to work as part of a team and give detailed instructions to others.

Advancement for millwrights usually takes the form of higher wages. Some advance to supervisor.

Job Outlook

Employment of millwrights is expected to increase more slowly than the average for all occupations through the year 2005. However, many openings will arise annually as experienced millwrights transfer to other occupations or retire. Millwrights will continue to be needed to maintain and repair existing machinery, to dismantle old machinery, and to install and maintain new equipment.

Employment of millwrights is somewhat sensitive to changes in economic conditions. In the construction industry, for example, employment fluctuates with the level of commercial and industrial building activity. When construction activity falls, jobs are scarce, and even experienced millwrights may face layoffs or shortened workweeks. Millwrights who work in manufacturing plants are less likely to be laid off in downturns in the economy because, even though employers are not installing new equipment, existing machinery still needs to be maintained and repaired.

Efforts to reduce operating costs and increase productivity by contracting out for millwright services may limit opportunities in many industries. However, this will be offset by increased demand by firms providing the service.

Earnings

Median weekly earnings of full-time millwrights were \$550 in 1990; the middle 50 percent earned between \$422 and \$674. The lowest 10 percent earned less than \$317, and the top 10 percent earned more

than \$817. However, earnings vary by industry and geographic location. Many millwrights belong to labor unions.

Related Occupations

To set up machinery for use in a plant, millwrights must know how to use hoisting devices and how to assemble, disassemble, and in some cases repair machinery. Other workers with similar job duties are industrial machinery repairers, mobile heavy equipment mechanics, aircraft mechanics and engine specialists, diesel mechanics, farm equipment mechanics, ironworkers, and machine assemblers.

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.

Mobile Heavy Equipment Mechanics

(D.O.T. 620.261-022, .281-042, .381-014)

Nature of the Work

Mobile heavy equipment is indispensable to construction, logging, surface mining, and other industrial activities. Mobile heavy equipment mechanics service and repair the engines, transmissions, hydraulics, electrical systems, and other components of equipment such as motor graders, trenchers and backhoes, crawler-loaders, and stripping and loading shovels. (Mechanics who specialize in servicing only diesel engines are discussed in the *Handbook* statement on diesel mechanics.)

Mobile heavy equipment mechanics perform routine maintenance on the diesel engines that power most heavy equipment, and, if an operator reports a malfunction, they search for its cause. First, they inspect and operate the equipment to diagnose the nature of the repairs required. They may partially dismantle the engine, examining parts for damage or excessive wear. Then they repair, replace, clean, and lubricate the parts as necessary, and reassemble and test the engine for operating efficiency. If repairs to the drive train are needed, mechanics may remove and repair the transmission or differential.

Many types of mobile heavy equipment use hydraulics to raise and lower movable parts such as scoops, shovels, log forks, or scraper blades. Repairing malfunctioning hydraulic components is an important responsibility of mobile heavy equipment mechanics. When the hydraulic apparatus loses power, mechanics examine it for hydraulic fluid leaks and replace ruptured hoses or worn gaskets on fluid reservoirs. Occasionally, more extensive repairs are required, such as replacing a defective hydraulic pump.

Mobile heavy equipment mechanics perform a variety of other types of repairs. They diagnose and correct electrical problems and replace defective electronic components. They also may disassemble and repair crawler undercarriages and track assemblies. Occasionally, mechanics may weld broken body and structural parts, using electric or gas welders.

Many mechanics work in small repair shops of construction contractors, logging and mining companies, and local government road maintenance departments. They typically perform routine maintenance and minor repairs necessary to keep the equipment in operation. Mechanics in larger repair shops—particularly those of mobile heavy equipment dealers and the Federal Government—perform more difficult repairs, such as rebuilding or replacing engines, repairing hydraulic fluid pumps, or correcting electrical problems. Mechanics in some large shops specialize in one or two types of work, such as hydraulics or electrical systems.

Mobile heavy equipment mechanics use a variety of tools in their work, including common handtools such as pliers, wrenches, and screwdrivers and power tools such as pneumatic wrenches. They use micrometers and gauges to measure wear on parts, and a variety of testing equipment. For example, they often use tachometers and

dynamometers to locate engine malfunctions; when working on electrical systems, they may use ohmmeters, ammeters, and voltmeters.

Working Conditions

Most mobile heavy equipment repair shops are well ventilated, lighted, and heated. Many mechanics work mostly indoors in shops, but others work as field service mechanics and spend much of their time away from the shop working outdoors. When mobile heavy equipment breaks down at a construction site, it may be too difficult or expensive to bring it into a repair shop, so a field service mechanic is sent to the job site to make repairs. Generally, the most experienced mobile heavy equipment mechanics specialize in field service; they usually drive specially equipped trucks and sometimes must travel many miles to reach disabled machinery. For many mechanics, the independence and challenge of field work outweigh the occasional long hours or bad weather, but other mechanics are more comfortable with the routine of shop work and the opportunity to work as part of a team.

Mechanics handle greasy and dirty parts and often work in awkward or cramped positions. They sometimes must lift heavy tools and parts. Mechanics must be careful to avoid burns, bruises, and cuts from hot engine parts and sharp edges of machinery. However, serious accidents may be prevented when the shop is kept clean and orderly and safety practices are observed.

Employment

Mobile heavy equipment mechanics held about 104,000 jobs in 1990. Half worked for mobile heavy equipment dealers and construction contractors. Nearly one-fourth were employed by Federal, State, and

local governments; the Department of Defense is the primary Federal employer. Other mobile heavy equipment mechanics worked for surface mine operators, public utility companies, logging camps and contractors, and heavy equipment rental and leasing companies. Still others repaired equipment for machinery manufacturers, airlines, railroads, steel mills, and oil and gas field companies. Fewer than 1 out of 10 mobile heavy equipment mechanics was self-employed.

Mobile heavy equipment mechanics are employed in every section of the country, but most work near cities and towns, where most construction takes place.

Training, Other Qualifications, and Advancement

For trainee jobs, employers hire persons with mechanical aptitude who are high school graduates and at least 18 years of age. They seek persons knowledgeable about the fundamentals of diesel engines, transmissions, electrical systems, and hydraulics. Although some persons are able to acquire these skills on their own or by working as helpers to experienced mechanics, most employers prefer to hire graduates of formal training programs in diesel or heavy equipment mechanics.

Training programs in diesel and heavy equipment mechanics are given by vocational and technical schools and community and junior colleges. Some 1- to 2-year programs lead to a certificate of completion; others lead to an associate degree if they are supplemented with additional academic courses. They provide a foundation in the basics of diesel and heavy equipment technology, including hydraulics, and enable trainee mechanics to advance more rapidly to the journeyman, or experienced worker, level. Training in the fundamentals of electronics is also essential because new mobile heavy equipment increasingly features electronic controls and sensing devices.

High school courses in automobile mechanics, physics, chemistry, and mathematics provide a essential foundation for a career as a mechanic. Good reading and basic mathematics skills and a basic understanding of scientific principles are needed to help a mechanic learn important job skills and keep abreast of new technology through the study of technical manuals. Experience working on diesel engines and heavy equipment acquired in the Armed Forces also is valuable.

Persons who learn the basics of mobile heavy equipment mechanics largely on the job start as helpers—cleaning parts, lubricating, fueling equipment, and cleaning up the shop. By studying training and technical manuals and observing and working with experienced mechanics, they may earn promotion to a trainee mechanic position.

Through a combination of formal and on-the-job training, trainee mechanics acquire the knowledge and skills to efficiently service and repair the particular types of equipment handled by the shop. Beginners are assigned relatively simple service and repair tasks. As they gain experience and become more familiar with the equipment, they are assigned increasingly difficult jobs, and are exposed to a greater variety of equipment.

Many employers send trainee mechanics to training sessions conducted by heavy equipment manufacturers. These sessions, which typically last up to 1 week, provide intensive instruction in the repair of a manufacturer's equipment. Some sessions focus on particular components found in all of the manufacturer's equipment, such as diesel engines and transmissions or electrical systems. Other sessions focus on particular types of equipment, such as crawler-loaders and crawler-dozers. As they progress, trainees may periodically attend additional training sessions. Experienced mechanics also occasionally attend training sessions to gain familiarity with new technology or with types of equipment they may never have repaired.

Mobile heavy equipment mechanics usually must buy their own handtools, although employers furnish power tools and test equipment. Trainee mechanics are expected to accumulate their own tools as they gain experience. Many experienced mechanics have thousands of dollars invested in tools.

Experienced mechanics may advance to field service jobs, where they have greater opportunity to tackle problems independently and earn overtime pay. Mechanics who have leadership ability may become shop supervisors or service managers. Some mechanics open their own repair shops.



Repairing hydraulic components is an important responsibility of mobile heavy equipment mechanics.

Job Outlook

Employment of mobile heavy equipment mechanics is expected to grow more slowly than the average for all occupations through the year 2005. Increasing numbers of mechanics will be required in repair shops of equipment dealers and rental and leasing companies as the growing complexity of mobile heavy equipment necessitates more repairs being done by professionals. More mechanics also will be needed by all levels of government to service construction equipment and, at the Federal level, defense-related equipment. Employment of mechanics by construction contractors, in contrast, will increase more slowly as more of the equipment in use is rented or leased. The majority of job openings will result from the need to replace mechanics who retire or leave the labor force. Opportunities should generally be good for persons who have completed formal training programs in diesel or heavy equipment mechanics. Persons without formal training are expected to encounter growing difficulty entering this occupation.

As the economy grows, growth of construction activity should result in the use of more mobile heavy equipment, which would increase the requirements for periodic service and repair. Various kinds of equipment will be needed in increasing numbers to grade construction sites, excavate basements, lay water and sewer lines, and put in streets. In addition, construction of new highways and bridges and repair or rebuilding of existing ones will also require more mechanics for servicing the equipment.

Since construction and mining are sensitive to changes in the level of economic activity, mobile heavy equipment may be idled during downturns. In addition, winter is traditionally the slack season for construction activity, particularly in colder regions. Fewer mechanics may be needed during periods when equipment is used less intensively, but employers usually try to retain experienced workers. However, employers may be reluctant to hire inexperienced workers during slack periods.

Earnings

Median hourly earnings of mobile heavy equipment mechanics were about \$12 in 1990. The middle 50 percent earned from around \$10 to \$15 an hour; the lowest 10 percent earned less than \$8 an hour, while the top 10 percent earned over \$18 an hour in 1990.

Some mobile heavy equipment mechanics are members of unions. The unions include the International Association of Machinists and Aerospace Workers; the International Union of Operating Engineers; and the International Brotherhood of Teamsters, Chauffeurs, Warehousemen and Helpers of America.

Related Occupations

Workers in other occupations who repair and service diesel-powered vehicles and heavy equipment include railcar repairers and diesel, farm equipment, and mine machinery mechanics.

Sources of Additional Information

More details about work opportunities for mobile heavy equipment mechanics may be obtained from local mobile heavy equipment dealers, construction contractors, surface mining companies, and government agencies. Local offices of the State employment service may also have information on work opportunities and training programs.

Motorcycle, Boat, and Small-Engine Mechanics

(D.O.T. 620.281-054, -684-026; 623.261, -281-038, -042; 625.281-018, -026, -030, -034, -381; 721.281-022)

Nature of the Work

Although the engines that power motorcycles, boats, and lawn and garden equipment are usually smaller than those that power automo-

biles and trucks, they have many things in common, including breakdowns. Motorcycle, boat, and small-engine mechanics repair and service power equipment ranging from chain saws to yachts.

Small engines, like larger engines, require periodic servicing to minimize the possibility of breakdowns and keep them operating at peak efficiency. At routine intervals, mechanics adjust, clean, lubricate, and, when necessary, replace worn or defective parts such as spark plugs, ignition points, valves, and carburetors. Routine maintenance is normally a major part of the mechanic's work.

When breakdowns occur, mechanics diagnose the cause and repair or replace the faulty parts. The mark of a skilled mechanic is the ability to diagnose mechanical and electrical problems and to make repairs in a minimum of time. A quick and accurate diagnosis requires problem-solving ability as well as a thorough knowledge of the equipment's operation. The mechanic first obtains a description of the symptoms of the problem from the owner, and then, if possible, operates the equipment to observe the symptoms. The mechanic may have to use special testing equipment and disassemble some components for further examination. After pinpointing the cause of the problem, the needed adjustments, repairs, or replacements are made. Some jobs require only the adjustment or replacement of a single item, such as carburetor or fuel pump, and may be completed in less than an hour. In contrast, a complete engine overhaul may require a number of hours, because the mechanic must disassemble and reassemble the engine to replace worn valves, pistons, bearings, and other internal parts.

Motorcycle, boat, and small-engine mechanics use common handtools such as wrenches, pliers, and screwdrivers, as well as power tools such as drills and grinders. Engine analyzers, compression gauges, ammeters and voltmeters, and other testing devices help mechanics locate faulty parts and tune engines. Hoists may be used to lift heavy equipment such as motorcycles, snowmobiles, or boats. Mechanics often refer to service manuals for detailed directions and specifications while performing repairs.

Mechanics usually specialize in the service and repair of one type of equipment, although they may work on closely related products. Motorcycle mechanics repair and overhaul motorcycles, motor scooters, mopeds, and all-terrain vehicles. Besides engines, they may work on transmissions, brakes, and ignition systems, and make minor body repairs. Because many motorcycle mechanics work for dealers that service only the products they sell, mechanics may specialize in servicing only a few of the many makes and models of motorcycles.

Motorboat mechanics repair and adjust the engines and electrical and mechanical equipment of inboard and outboard marine engines. Most small boats have portable outboard engines that can be 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-outdrive engines, which are only removed for major overhauls. Motorboat mechanics may also work on propellers, steering mechanisms, marine toilets, and other boat equipment.

Small-engine mechanics service and repair outdoor power equipment such as lawnmowers, garden tractors, and chain saws. They also may occasionally work on portable generators, go-carts, and snowmobiles.

Working Conditions

Motorcycle, boat, and small-engine mechanics usually work in repair shops that are well lighted and ventilated, but which are sometimes noisy when engines are being tested. However, motorboat mechanics may work outdoors in all weather when repairing inboard engines aboard boats; they may have to work in cramped or awkward positions to reach a boat's engine.

In northern States, motorcycles, boats, lawnmowers, and other equipment are used less, or not at all, during the winter, and mechanics may work fewer than 40 hours a week; a relatively small number are laid off. Some of the winter slack is taken up by scheduling time-consuming engine overhauls and working on snowmobiles and snowblowers. Many mechanics may work considerably more than 40 hours a week when the weather is warmer in the spring, summer, and fall.



A motorcycle mechanic career is attractive to many because of the satisfaction of skilled work done with one's hands.

Employment

Motorcycle, boat, and small-engine mechanics held over 50,000 jobs in 1990. About 12,000 were motorcycle mechanics, while the remainder specialized in the repair of boats or outdoor power equipment such as lawnmowers, garden tractors, and chain saws. More than one-quarter of all motorcycle, boat, and small-engine mechanics worked for boat, motorcycle, and miscellaneous vehicle dealers. Others were employed by independent repair shops, marinas and boat yards, equipment rental companies, and hardware and lawn and garden stores. Nearly one-third were self-employed.

Training, Other Qualifications, and Advancement

Due to the increasing complexity of motorcycles, most employers prefer to hire motorcycle mechanics who are graduates of formal training programs. However, because technology has not had as great an impact on boat and outdoor power equipment, most boat and small-engine mechanics learn their skills on the job. For trainee jobs, employers hire persons with mechanical aptitude who are knowledgeable about the fundamentals of small 2- and 4-cycle engines. Many trainees develop an interest in mechanics and acquire some basic skills through working on automobiles, motorcycles, boats, or outdoor power equipment as a hobby, or through mechanic vocational training in high school, vocational and technical schools, or community colleges. A growing number also prepare for their careers by completing training programs in motorcycle, marine, or small-engine mechanics, but only a relatively small number of such specialized programs exist.

Trainees begin by learning routine service tasks under the guidance of experienced mechanics, such as replacing ignition points and spark plugs, or taking apart, assembling, and testing new equipment. Equipment manufacturers' service manuals are an important training tool. As trainees gain experience and proficiency, they progress to more difficult tasks, such as diagnosing the cause of breakdowns or overhauling engines. Up to 3 years of training on the job may be necessary before an inexperienced beginner becomes skilled in all aspects of the repair of some motorcycle and boat engines.

Employers sometimes send mechanics and trainees to special training courses conducted by motorcycle, boat, and outdoor power equipment manufacturers or distributors. These courses, which can last as long as 2 weeks, are designed to upgrade the worker's skills and provide information on repairing new models.

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

Knowledge of basic electronics is increasingly desirable for motorcycle, boat, and small-engine mechanics. Electronics are increasingly being used in engine controls, instrument displays, and a variety of other components of motorcycles, boats, and outdoor power equipment. Mechanics should be familiar with at least the basic principles of electronics in order to recognize when an electronic malfunction may be responsible for a problem, and be able to test and replace electronic components.

Motorcycle, boat, and small-engine mechanics are often required to furnish their own handtools. Employers generally provide some tools and test equipment, but beginners are expected to gradually accumulate handtools as they gain experience. Some experienced mechanics have thousands of dollars invested in tools.

Some mechanics are able to use skills learned through repairing motorcycles, boats, and outdoor power equipment to advance to higher paying jobs as automobile, truck, or heavy equipment mechanics. In larger shops, mechanics with leadership ability can advance to supervisory positions such as shop supervisor or service manager. Mechanics who are able to raise enough capital may open their own repair shops or equipment dealerships.

Job Outlook

Employment of motorcycle, boat, and small-engine mechanics is expected to grow more slowly than the average for all occupations through the year 2005. The majority of job openings are expected to occur because many experienced motorcycle, boat, and small-engine mechanics leave each year to transfer to other occupations, or retire or stop working for other reasons. Job prospects should be very favorable for persons who complete mechanic training programs in a high school, vocational school, or community college.

Growth of personal disposable income over the 1990-2005 period should provide consumers with more discretionary dollars to buy boats, lawn and garden power equipment, and motorcycles—requiring more mechanics to keep the growing amount of equipment in operation. In addition, beginning in the late 1990's, growth in the number of motorcycles should be sparked by the growth in the number of persons between the ages of 18 and 24, the age group with the greatest proportion of motorcycle enthusiasts. Recreational boating is expected to continue to be popular, and construction of new single-family houses will result in an increase in the lawn and garden equipment in operation, increasing the need for mechanics. The continuing shift of the Nation's population to the South and West where warm weather seasons are longer—and equipment use greater—should also contribute to an increase in demand for mechanics. In addition, more mechanics may be required if the growing complexity of the engines of motorcycles and boats forces more consumers to turn to professional mechanics for maintenance and repair services.

Earnings

Motorcycle, boat, and small-engine mechanics who usually worked full time had median earnings of about \$8.85 an hour in 1990. The middle 50 percent earned between \$6.30 and \$11.60 an hour. The lowest paid 10 percent earned \$5.10 an hour or less, while the highest paid 10 percent earned \$15.30 an hour or more.

Motorcycle, boat, and small-engine mechanics tend to receive few fringe benefits in small shops, but those employed in larger shops often receive paid vacations and sick leave and health insurance. Some employers also pay for work-related training and provide uniforms.

Related Occupations

The work of motorcycle, boat, and small-engine mechanics is closely related to that of mechanics and repairers who work on other types of mobile equipment powered by internal combustion engines. Related

occupations include automotive mechanic, diesel mechanic, farm equipment mechanic, and mobile heavy equipment mechanic.

Sources of Additional Information

For more details about work opportunities, contact local motorcycle, boat, and lawn and garden equipment dealers, and boat yards and marinas. Local offices of the State employment service also may have information about employment and training opportunities.

Information on motorcycle mechanic training is available from:
Motorcycle Mechanics Institute, 2844 West Deer Valley Rd., Phoenix, AZ 85027.

Musical Instrument Repairers and Tuners

(D.O.T. 730.281-014, -026, -038, -050, -054, .361, .381-010, -026, -034, -038, -042, -058, .681-010, .684-022, -026, and -094)

Nature of the Work

Musical instruments are a source of entertainment and recreation for millions of people. Maintaining these instruments so they perform properly is the job of musical instrument repairers and tuners. The occupation includes piano tuners and repairers (often called piano technicians); pipe-organ tuners and repairers; and brass, woodwind, percussion, or string instrument repairers.

Piano tuners adjust piano strings to the proper pitch. A string's pitch is the frequency at which it vibrates, and produces sound, when it is struck by one of the piano's wooden hammers. Tuners first adjust the pitch of the "A" string. Striking the key, the tuner compares the string's pitch with that of a tuning fork. Using a tuning hammer (also called a tuning lever or wrench), the tuner turns a steel pin to tighten or loosen the string until its pitch matches that of the tuning fork. The pitch of all the other strings is set in relation to the "A" string. The standard 88-key piano has 230 strings and can be tuned in about an hour and a half.

The performance of a piano also can be affected by problems in any of its thousands of wooden, steel, iron, ivory, and felt parts. Piano repairers locate and correct these problems. Repairers also tune pianos.

To diagnose problems, repairers talk with customers and partially dismantle pianos to inspect parts. Repairers may realign moving parts, replace old or worn ones, or completely rebuild pianos. Repairers use common handtools as well as special ones, such as regulating, repinning, and restringing tools.

Pipe-organ repairers tune, repair, and install organs that make music by forcing air through flue pipes or reed pipes. (Repairers who service electronic organs are included in the statement on electronic home entertainment equipment repairers elsewhere in the *Handbook*.) The flue pipe sounds when a current of air strikes a metal lip in the side of the pipe. The reed pipe sounds when a current of air vibrates a brass reed inside the pipe.

To tune an organ, repairers first match the pitch of the "A" pipes with that of a tuning fork. The pitch of other pipes is set by comparing it with that of the "A" pipes. To tune a flue pipe, they move the metal slide that increases or decreases the pipe's "speaking length." To tune a reed pipe, the tuner alters the length of the brass reed. A day or more may be needed to do this because most organs have hundreds of pipes.

Pipe-organ repairers locate problems, repair or replace worn parts, and clean pipes. Repairers also assemble organs onsite in churches and auditoriums, following manufacturer's blueprints. They use hand and power tools to install and connect the air chest, blowers, air ducts, pipes, and other components. They may work in teams and be assisted by helpers. A job takes several weeks or even months, depending on the size of the organ.

Violin repairers adjust and repair bowed instruments, such as violins, violas, and cellos, using a variety of handtools. They find defects by inspecting and playing instruments. They remove cracked or broken sections, repair or replace defective parts, and restring instru-

ments. They also fill in scratches with putty, sand rough spots, and apply paint or varnish.

Guitar repairers inspect and play the instrument to determine defects. They remove and replace levels using handtools, and fit wood and metal replacement parts. They reassemble and string the guitars.

Brass and woodwind instruments include trumpets, cornets, french horns, trombones, tubas, clarinets, flutes, saxophones, oboes, and bassoons. Brass and wind instrument repairers clean, adjust, and repair these instruments. They move mechanical parts or play scales to find defects. They may unscrew and remove rod pins, keys, and pistons, and remove soldered parts using gas torches. They repair dents in metal instruments using mallets or burnishing tools. They fill cracks in wood instruments by inserting pinning wire and covering them with filler and also replace worn pads and corks.

Percussion instrument repairers work on drums, cymbals, and xylophones. In order to repair a drum, they remove drum tension rod screws and rods by hand or using a drum key. They cut new drumheads from animal skin, stretch the skin over rimhoops and tuck it around and under the hoop using hand-tucking tools. They may operate a drill press or hand power drill to drill holes at the inside end of cracks in cymbals, gongs, or similar instruments, to prevent their advance, and cut out sections around cracks using shears or grinding wheels. They also replace xylophone bars and wheels.

Working Conditions

The work of musical instrument repairers and tuners is relatively safe, although they may suffer small cuts and bruises. Most brass, woodwind, percussion, and string instrument repairers work in repair shops or music stores. Piano and organ repairers and tuners usually work on instruments in homes, schools, and churches and may spend several hours a day driving. Salaried repairers and tuners work out of a shop or store; the self-employed generally work out of their homes.

Employment

Musical instrument repairers and tuners held about 8,700 jobs in 1990. Most worked on pianos. About half were self-employed. Eight of ten salaried repairers and tuners worked in music stores. Most of the rest worked in repair shops or for musical instrument manufacturers.

Training, Other Qualifications, and Advancement

Employers prefer people with post-high school training in music repair technology. Some musical instrument repairers and tuners



Violin repairers find defects by inspecting and playing the instruments.

learn their trade on the job. However, on-the-job training is difficult to find. A few music stores, large repair shops, and self-employed technicians hire inexperienced people as trainees, who may also sell instruments, clean up, and do other routine work. Trainees tune and repair instruments under the supervision of experienced workers. Usually 2 to 5 years of training and practice are needed to become fully qualified.

A small number of technical schools and colleges offer courses in piano technology and brass, woodwind, string, and electronic musical instrument repair. A few music repair schools offer 1- or 2-year courses. There are also home-study (correspondence school) courses in piano technology. Graduates of these courses generally refine their skills by working for a time with an experienced tuner or technician.

Music courses help develop the student's ear for tonal quality. The ability to play an instrument is helpful. Knowledge of woodworking is useful for repairing instruments made of wood.

Repairers and tuners need good hearing, mechanical aptitude, and manual dexterity. For those dealing directly with customers, a neat appearance and a pleasant, cooperative manner are important.

Musical instrument repairers keep up with developments in their fields by studying trade magazines and manufacturers' service manuals. The Piano Technicians Guild helps its members improve their skills through training conducted at local chapter meetings and at regional and national seminars. Guild members also can take a series of tests to earn the title Registered Piano Tuner-Technician. Repairers and technicians who work for large dealers or repair shops can advance to supervisory positions or go into business for themselves.

Job Outlook

Employment of musical instrument repairers and tuners is expected to show little or no change through the year 2005. The number of students playing musical instruments is expected to grow only slowly, as is the number of people employed as musicians.

Replacement needs will be high because many repairers and tuners are near retirement age. However, training is difficult to get because there are only a few schools, and few experienced workers are willing to take on apprentices. Therefore, opportunities for those who do get training should be excellent. In fact, unless training opportunities expand, the number of people employed as tuners and repairers could decline.

Earnings

According to the limited information available, repairers and tuners employed by retail music stores averaged about \$20,000 in 1990. Self-employed repairers and tuners averaged almost \$40,000.

Related Occupations

Musical instrument repairers need mechanical aptitude and manual dexterity. Electronic home entertainment equipment repairers, vending machine servicers and repairers, home appliance and power tool repairers, and computer and office machine repairers all require similar talents.

Sources of Additional Information

Details about job opportunities may be available from local music instrument dealers and repair shops.

For general information about piano technicians and a list of schools offering courses in piano technology, write to:

✉ Piano Technicians Guild, 9140 Ward Pky., Kansas City, MO 64114.

For general information on musical instrument repair, write to:

✉ National Association of Professional Band Instrument Repair Technicians (NAPBIRT), P.O. Box 51, Normal, IL 61761.

Vending Machine Servicers and Repairers

(D.O.T. 319.464-014 and 639.281-014)

Nature of the Work

Coin-operated vending machines are a familiar sight. These machines dispense many types of refreshments, from a cold soft drink to a hot

meal. Vending machine servicers and repairers install, service, and stock these machines and keep them in good working order.

Servicers make sure machines operate correctly. When checking complicated electrical and electronic machines, such as beverage dispensers, they make sure that the machines mix drinks properly and that refrigeration and heating units work correctly. On the relatively simple gravity-operated machines, servicers check handles, springs, plungers, and merchandise chutes. They also test coin and change-making mechanisms. When installing the machines, they make the necessary water and electrical connections and recheck the machines for proper operation. They also repair microwave ovens used to heat food dispensed from machines.

If a machine breaks down, repairers inspect it for obvious problems, such as loose electrical wires, malfunctions of the coin mechanism, and leaks. If the problem cannot be readily located, they may refer to troubleshooting manuals and wiring diagrams and use testing devices such as electrical circuit testers to find defective parts. Repairers may fix faulty parts at the site, but they often install replacements and take broken parts to the company shop for repair. When servicing electronic machines, repairers may only have to replace a circuit board or other component.

Preventive maintenance—avoiding trouble before it starts—is a major job of these workers. For example, they periodically clean refrigeration condensers, lubricate mechanical parts, and adjust machines to perform properly.

In repair and maintenance work, repairers use pipe cutters, soldering guns, wrenches, screwdrivers, and electronic testing devices. In the repair shop, they may use power tools, such as grinding wheels, saws, and drills as well as voltmeters, ohmmeters, oscilloscopes, and other testing equipment.

Because many vending machines dispense food, these workers must comply with State and local public health and sanitation standards. They also must comply with local plumbing and electrical codes.

Vending machine servicers and repairers also do clerical work, such as filing reports, preparing repair cost estimates, and ordering parts. Those employed by small companies may fill machines on a regular basis. These combination servicers-repairers stock machines, collect money, fill coin and currency changers, and keep daily records of merchandise distributed. However, many of the new computerized machines will minimize some of the paperwork that a servicer performs, such as keeping daily records of merchandise distributed.

Working Conditions

Some servicers and repairers work in company repair shops, others work in the field, but many do both. Because vending machines can be operated around the clock, repairers often work at night and on weekends and holidays.

Vending machine repair shops generally are quiet, well lighted, and have adequate work space. However, when servicing machines on location, the work may be done where pedestrian traffic is heavy, such as in a busy supermarket. Repair work is relatively safe, although repairers and servicers are subject to hazards such as electrical shocks and cuts from sharp tools and metal objects. They also must know and follow safety procedures, especially when lifting heavy objects and working with electricity and radiation from microwave ovens.

Employment

Vending machine servicers and repairers held about 26,000 jobs in 1990. Most repairers work for vending companies that sell food and other items through machines. Others work for soft drink bottling companies that have their own coin-operated machines. Some work for companies that own video games, pin-ball machines, juke boxes, and similar types of amusement equipment. Although vending machine servicers and repairers are employed throughout the country, most are located in areas with large populations where there are many coin and vending machines.

Training, Other Qualifications, and Advancement

Some vending machine repairers enter the occupation as general shop helpers or route drivers, where they learn informally on the job by



Vending machine servicers and repairers test coin- and change-making mechanisms.

observing, working with, and receiving instruction from experienced repairers. However, employers prefer trainees to have post-high school training in electronics. Trainees do simple jobs such as cleaning or painting machines. They then learn to rebuild machines—removing defective parts, repairing, adjusting, and testing the machines. Next, they accompany an experienced repairer on service calls, and then go out on their own. This learning process takes from 6 months to 3 years, depending on the individual's abilities, previous education, types of machines, and the quality of instruction.

Many beginners are high school graduates, but employers may not require a diploma. High school or vocational school courses in electricity, refrigeration, and machine repair help beginners to qualify for entry jobs. Some vocational high schools and junior colleges offer 1- to 2-year training programs in basic electronics for vending machine servicers and repairers.

The National Automatic Merchandising Association has established an apprenticeship program. Apprentices receive 144 hours of home-study instruction in subjects such as basic electricity and electronics, blueprint reading, customer relations, and safety. The apprenticeship program also lasts from 6 months to 3 years; at the end of the program, the employee can earn certification by passing performance and written tests.

To learn about new machines, repairers and servicers sometimes attend manufacturer-sponsored training sessions, which may last from a few days to several weeks.

Both trainees and experienced workers may take evening courses in basic electricity, electronics, microwave, refrigeration, and other related subjects.

Employers require applicants to demonstrate mechanical ability, either through their work experience or by scoring well on mechanical aptitude tests. Because vending machine servicers and repairers

sometimes handle thousands of dollars in merchandise and cash, employers want applicants who have a record of honesty and respect for the law. The ability to deal tactfully with people also is important. A commercial driver's license and a good driving record are essential for most vending machine repairer jobs.

Skilled servicers and repairers may be promoted to supervisory jobs.

Job Outlook

Employment of vending machine servicers and repairers is expected to show little or no change through the year 2005. More vending machines are likely to be installed in industrial plants, hospitals, stores, and other business establishments to meet the public demand for vending machine items. In addition, the range of products and services dispensed by machine also can be expected to increase. However, improvements in technology should reduce breakdowns, so the employment of repairers will not grow. Some job openings will arise as experienced workers transfer to other occupations or leave the labor force.

Persons with some background in electronics should have the best job prospects because electronic components increasingly are being used in vending machines. If firms cannot find trained or experienced workers, they are likely to train qualified route drivers or hire inexperienced people who have acquired some mechanical, electrical, or electronic aptitude by taking high school or vocational courses.

Earnings

According to a survey conducted by the National Automatic Merchandising Association, the average hourly wage rate for vending machine servicers and repairers was \$11 in 1990. The range was from \$7 to \$15, depending on the size of the firm and the region of the country.

Most vending machine repairers work 8 hours a day, 5 days a week, and receive premium pay for overtime. Some union contracts stipulate higher pay for nightwork and for emergency repair jobs on weekends and holidays.

Some vending machine repairers and servicers are members of the International Brotherhood of Teamsters.

Related Occupations

Other workers who repair equipment with electrical and electronic components include bowling-pin-machine mechanics, home appliance and power tool repairers, laundry machine repairers, maintenance mechanics, computer and office machine repairers, and sewing machine repairers.

Sources of Additional Information

Further information on job opportunities in this field can be obtained from local vending machine firms and local offices of the State employment service. For general information and a list of schools offering courses in vending machine repair, write to:

☛ National Automatic Merchandising Association, 20 N. Wacker Dr., Chicago, IL 60606.