

their own tools, and many experienced workers have thousands of dollars invested in them. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment; but individual workers ordinarily accumulate handtools with experience.

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

Job Outlook

Employment of diesel service technicians and mechanics is expected to increase about as fast as the average for all occupations through the year 2010. Besides openings resulting from employment growth, opportunities will be created by the need to replace workers who retire or transfer to other occupations.

Employment of diesel service technicians and mechanics is expected to grow as freight transportation by truck increases. Additional trucks will be needed to keep pace with the increasing volume of freight shipped nationwide. Trucks also serve as intermediaries for other forms of transportation, such as rail and air. Due to the greater durability and economy of the diesel engine relative to the gasoline engine, buses and trucks of all sizes are expected to be increasingly powered by diesels. In addition, diesel service technicians will be needed to maintain and repair the growing number of schoolbuses in operation.

Careers as diesel service technicians attract many because of relatively high wages and the challenge of skilled repair work. Opportunities should be good for persons who complete formal training in diesel mechanics at community and junior colleges and vocational and technical schools. Applicants without formal training may face stiffer competition for entry-level jobs.

Most persons entering this occupation can expect steady work, because changes in economic conditions have little effect on the diesel repair business. During a financial downturn, however, some employers may be reluctant to hire new workers.

Earnings

Median hourly earnings of bus and truck mechanics and diesel engine specialists, including incentive pay, were \$15.55 in 2000. The middle 50 percent earned between \$12.33 and \$19.30 an hour. The lowest 10 percent earned less than \$9.88, and the highest 10 percent earned more than \$22.63 an hour. Median hourly earnings in the industries employing the largest numbers of bus and truck mechanics and diesel engine specialists in 2000 were as follows:

Local government	\$17.93
Motor vehicles, parts, and supplies	15.48
Automotive repair shops	14.74
Trucking and courier services, except air	14.65
Elementary and secondary schools	14.63

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

The majority of service technicians work a standard 40-hour week, although some work longer hours, particularly if they are self-employed. A growing number of shops have expanded their hours to better perform repairs and routine service when needed, or as a convenience to customers. Those employed by truck and bus firms providing service around the clock may work evenings, nights,

and weekends. These technicians usually receive a higher rate of pay for working non-traditional hours.

Many diesel service technicians and mechanics are members of labor unions, including the International Association of Machinists and Aerospace Workers; the Amalgamated Transit Union; the International Union, United Automobile, Aerospace and Agricultural Implement Workers of America; the Transport Workers Union of America; the Sheet Metal Workers' International Association; and the International Brotherhood of Teamsters.

Related Occupations

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

Sources of Additional Information

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

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

► Detroit Diesel, Personnel Director, MS B39, 13400 West Outer Dr., Detroit, MI 48239.

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

► ASE, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: <http://www.asecert.org>

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

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

► National Automotive Technicians Education Foundation, 13505 Dulles Technology Dr., Herndon, VA 20171-3421. Internet: <http://www.natef.org>

For a directory of public training programs for diesel service technicians and mechanics, contact:

► SkillsUSA-VICA, P.O. Box 3000, 14001 James Monroe Hwy., Leesburg, VA 22075. Internet: <http://www.skillsusa.org>

Heavy Vehicle and Mobile Equipment Service Technicians and Mechanics

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

Significant Points

- Opportunities should be good for persons with formal postsecondary training in diesel or heavy equipment mechanics, especially if they also have training in basic electronics and hydraulics.
- This occupation offers relatively high wages and the challenge of skilled repair work.
- Skill in using computerized diagnostic equipment is becoming more important.

Nature of the Work

Heavy vehicles and mobile equipment are indispensable to many industrial activities, from construction to railroads. Various types of equipment move materials, till land, lift beams, and dig earth to pave the way for development and production. *Heavy vehicle and mobile equipment service technicians and mechanics* repair and maintain engines and hydraulic, transmission, and electrical systems powering farm equipment, cranes, bulldozers, and railcars. (For more detailed information on service technicians specializing in diesel engines, see the statement on diesel service technicians and mechanics elsewhere in the *Handbook*.)

Service technicians perform routine maintenance checks on diesel engines and fuel, brake, and transmission systems to ensure peak performance, safety, and longevity of the equipment. Maintenance checks and comments from equipment operators usually alert technicians to problems. With many types of modern heavy and mobile equipment, technicians can plug hand-held diagnostic computers into onboard computers to diagnose any component needing adjustment or repair. After locating the problem, these technicians rely on their training and experience to use the best possible technique to solve the problem. If necessary, they may partially dismantle the component to examine parts for damage or excessive wear. Then, using hand-held tools, they repair, replace, clean, and lubricate parts, as necessary. In some cases, technicians calibrate systems by typing codes into the onboard computer. After reassembling the component and testing it for safety, they put it back into the equipment and return the equipment to the field.

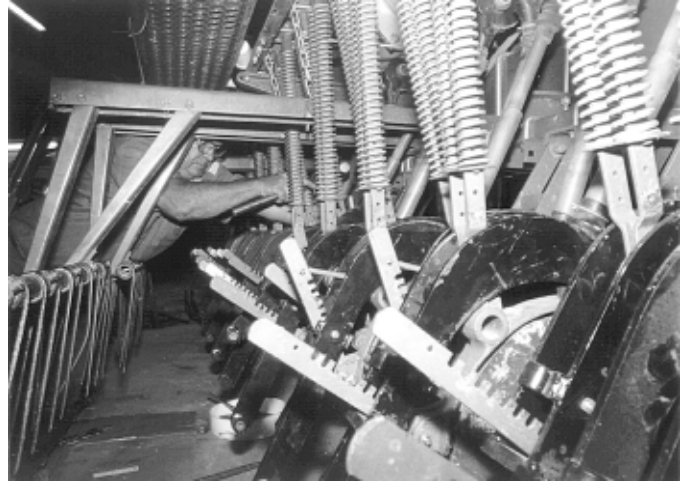
Many types of heavy and mobile equipment use hydraulics to raise and lower movable parts, such as scoops, shovels, log forks, and scraper blades. When hydraulic components malfunction, technicians examine them for hydraulic fluid leaks, ruptured hoses, or worn gaskets on fluid reservoirs. Occasionally,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

In addition to routine maintenance checks, service technicians perform a variety of other repairs. They diagnose electrical problems and adjust or replace defective components. They also disassemble and repair undercarriages and track assemblies. Occasionally, technicians weld broken equipment frames and structural parts, using electric or gas welders.

It is common for technicians in large shops to specialize in one or two types of repair. For example, a shop may have individual specialists in major engine repair, transmission work, electrical systems, and suspension or brake systems. The technology used in heavy equipment is becoming more sophisticated with the increased use of electronic and computer-controlled components. Training in electronics is essential for these technicians to make engine adjustments and diagnose problems. Training in the use of hand-held computers also is necessary, because computers help technicians diagnose problems and adjust component functions.

Service technicians use a variety of tools in their work. They use power tools, such as pneumatic wrenches to remove bolts quickly, machine tools like lathes and grinding machines to rebuild brakes, welding and flame-cutting equipment to remove and repair exhaust systems, and jacks and hoists to lift and move large parts. They also use common handtools—screwdrivers, pliers, and wrenches—to work on small parts and to get at hard-to-reach places. Service technicians may use a variety of computerized testing equipment to pinpoint and analyze malfunctions in electrical systems and other essential systems. For example, they use tachometers and dynamometers to locate engine malfunctions. Service technicians also use ohmmeters, ammeters, and voltmeters when working on electrical systems.

Mobile heavy equipment mechanics and service technicians keep construction and surface mining equipment such as bulldozers, cranes,



Due to the growing complexity of farm equipment, farmers increasingly turn to specialists for service and repairs.

crawlers, draglines, graders, excavators, and other equipment in working order. They typically work for equipment wholesale distribution and leasing firms, large construction and mining companies, local and Federal governments, or other organizations operating and maintaining heavy machinery and equipment fleets. Service technicians employed by the Federal Government may work on tanks and other armored equipment.

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

Farm equipment mechanics work mostly on equipment brought into the shop for repair and adjustment. During planting and harvesting seasons, they may travel to farms to make emergency repairs to minimize delays in farm operations.

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

Working Conditions

Service technicians usually work indoors, although many make repairs at the work site. Technicians often lift heavy parts and tools, handle greasy and dirty parts, and stand or lie in awkward positions, to repair vehicles and equipment. Minor cuts, burns, and bruises are common; but serious accidents are normally avoided when the shop is kept clean and orderly and safety practices are observed. Technicians usually work in well-lighted, heated, and ventilated areas. However, some shops are drafty and noisy. Many employers provide uniforms, locker rooms, and shower facilities.

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

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

The hours of work for 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 slow winter months, however, mechanics may work fewer than 40 hours a week.

Employment

Heavy vehicle and mobile equipment service technicians and mechanics held about 185,000 jobs in 2000. About 130,000 were mobile heavy equipment mechanics; 41,000 were farm equipment mechanics; and 14,000 were railcar repairers. More than 40 percent were employed by heavy and mobile equipment dealers and distributors. About 11 percent were employed by Federal, State, and local governments; and nearly 9 percent worked for construction contractors. Other service technicians worked for agricultural production and services, mine operators, public utilities, or heavy equipment rental and leasing companies. Still others repaired equipment for machinery manufacturers, airlines, railroads, steel mills, or oil and gas field companies. Less than 4 percent of service technicians were self-employed.

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

Training, Other Qualifications, and Advancement

Although many persons qualify for service technician jobs through years of on-the-job training, most employers prefer that applicants complete a formal diesel or heavy equipment mechanic training program after graduating from high school. They seek persons with mechanical aptitude who are knowledgeable about the fundamentals of diesel engines, transmissions, electrical systems, and hydraulics. Additionally, the constant change in equipment technology makes it necessary for technicians to be flexible and have the capacity to learn new skills quickly.

Many community colleges and vocational schools offer programs in diesel technology. Some tailor programs to heavy equipment mechanics. These programs educate the student in the basics of analysis and diagnostic techniques, electronics, and hydraulics. The increased use of electronics and computers makes training in the fundamentals of electronics essential for new heavy and mobile equipment mechanics. Some 1- to 2-year programs lead to a certificate of completion, whereas others lead to an associate degree in diesel or heavy equipment mechanics. These programs provide a foundation in the components of diesel and heavy equipment technology. These programs also enable trainee technicians to advance more rapidly to the journey, or experienced worker, level.

A combination of formal and on-the-job training prepares trainee technicians with the knowledge to efficiently service and repair equipment handled by a shop. Most beginners perform routine service tasks and make minor repairs, after a few months' experience. They advance to harder jobs, as they prove their ability and competence. After trainees master the repair and service of diesel engines, they learn to work on related components, such as brakes, transmissions, and electrical systems. Generally, a service technician with at least 3 to 4 years of on-the-job experience is accepted as fully qualified.

Many employers send trainee technicians to training sessions conducted by heavy equipment manufacturers. 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 the manufacturer's equipment, such as diesel engines, transmissions, axles, and 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. When appropriate, experienced technicians attend training sessions to gain familiarity with new technology or equipment.

High school courses in automobile repair, physics, chemistry, and mathematics provide a strong foundation for a career as a service technician or mechanic. It is also essential for technicians to be able to read and interpret service manuals to keep abreast of engineering changes. Experience working on diesel engines and heavy equipment acquired in the Armed Forces also is valuable.

Voluntary certification by the National Institute for Automotive Service Excellence (ASE) is recognized as the standard of achievement for heavy and mobile equipment diesel service technicians. Technicians may be certified as a Master Heavy-Duty Diesel Technician or in 1 or more of 6 different areas of heavy-duty equipment repair: Brakes, gasoline engines, diesel engines, drive trains, electrical systems, and suspension and steering. For certification in each area, technicians must pass a written examination and have at least 2 years' 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's experience. To remain certified, technicians must retest every 5 years. This ensures that service technicians keep up with changing technology. However, there are currently no certification programs for other heavy vehicle and mobile equipment repair specialties.

The most important work possessions of technicians are their handtools. Service technicians typically buy their own handtools, and many experienced technicians have thousands of dollars invested in them. Employers typically furnish expensive power tools, computerized engine analyzers, and other diagnostic equipment; but handtools are normally accumulated with experience.

Experienced technicians may advance to field service jobs, where they have a greater opportunity to tackle problems independently and earn additional pay. Technicians with leadership ability may become shop supervisors or service managers. Some technicians open their own repair shops or invest in a franchise.

Job Outlook

Opportunities for heavy vehicle and mobile equipment service technicians and mechanics should 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 these jobs.

Employment of heavy vehicle and mobile equipment service technicians and mechanics is expected to grow slower than the average for all occupations through the year 2010. Most job openings will arise from the need to replace experienced repairers who retire. Employers report difficulty finding candidates with formal postsecondary training to fill available service technician positions because many young people with mechanic training prefer to take jobs as automotive service technicians, diesel service technicians, or industrial machinery repairers—jobs that offer relatively higher earnings and a wider variety of locations in which to work.

Increasing numbers of service technicians will be required to support growth in the construction industry, equipment dealers, and rental and leasing companies. Because of the nature of construction activity, demand for service technicians follows the Nation's economic cycle. As the economy expands, construction activity increases, resulting in the use of more mobile heavy equipment. More equipment is needed to grade construction sites, excavate

basements, and lay water and sewer lines, increasing the need for periodic service and repair. In addition, the construction and repair of highways and bridges also requires more technicians to service equipment. Also, as equipment becomes more complex, repairs increasingly must be made by specially trained technicians. Job openings for farm equipment mechanics and railcar repairers are mostly expected to arise due to replacement needs.

Construction and mining are particularly sensitive to changes in the level of economic activity; therefore, heavy and mobile equipment may be idled during downturns. In addition, winter is traditionally the slow season for construction and farming activity, particularly in cold regions. Few technicians may be needed during periods when equipment is used less; however, employers usually try to retain experienced workers. Employers may be reluctant to hire inexperienced workers during slow periods though.

Earnings

Median hourly earnings of mobile heavy equipment mechanics were \$16.32 in 2000. The middle 50 percent earned between \$13.32 and \$19.86. The lowest 10 percent earned less than \$10.93, and the highest 10 percent earned more than \$23.29. Median hourly earnings in the industries employing the largest numbers of mobile heavy equipment mechanics in 2000 were as follows:

Federal Government	\$18.67
Local government	17.09
Machinery, equipment, and supplies	16.05
Miscellaneous equipment rental and leasing	15.95
Heavy construction, except highway	15.54

Median hourly earnings of farm equipment mechanics were \$12.38 in 2000. The middle 50 percent earned between \$9.99 and \$15.29. The lowest 10 percent earned less than \$8.15, and the highest 10 percent earned more than \$18.23.

Median hourly earnings of railcar repairers were \$16.19 in 2000. The middle 50 percent earned between \$12.31 and \$19.34. The lowest 10 percent earned less than \$9.78, and the highest 10 percent earned more than \$21.19.

About one-fourth of all service technicians and mechanics are members of unions including the International Association of Machinists and Aerospace Workers, the International Union of Operating Engineers, and the International Brotherhood of Teamsters.

Related Occupations

Workers in related repair occupations include aircraft and avionics equipment mechanics and service technicians; automotive service technicians and mechanics; diesel service technicians and mechanics; heating, air-conditioning, and refrigeration mechanics and installers; and small engine mechanics.

Sources of Additional Information

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

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

- ▶ The Equipment Maintenance Counsel, P.O. Box 1368, Glenwood Springs, CO 81602. Internet: <http://www.equipment.org>
- ▶ Specialized Carriers and Rigging Association, 2750 Prosperity Ave., Suite 620, Fairfax, VA 22031-4312.

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

http://www.aednet.org/aed_foundation

For a directory of public training programs in heavy and mobile equipment mechanics, contact:

- ▶ SkillsUSA-VICA, P.O. Box 3000, 1401 James Monroe Hwy., Leesburg, VA 22075. Internet: <http://www.skillsusa.org>

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

- ▶ National Automotive Technician Education Foundation (NATEF), 13505 Dulles Technology Dr., Herndon, VA 20171-3421. Internet:

<http://www.natef.org>

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

- ▶ ASE, 101 Blue Seal Dr. SE., Suite 101, Leesburg, VA 20175. Internet: <http://www.asecert.org>

Small Engine Mechanics

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

Significant Points

- Employment is expected to grow slowly, but persons with formal mechanic training should enjoy good job prospects.
- Because the use of motorcycles, motorboats, and outdoor power equipment is seasonal in many areas, mechanics may service other types of equipment or work reduced hours in the winter.

Nature of the Work

Though smaller, engines powering motorcycles, motorboats, and outdoor power equipment share many characteristics with their larger counterparts, including breakdowns. Small engine mechanics repair and service power equipment ranging from racing motorcycles to chain saws.

Small engines, like large engines, require periodic service to minimize the chance of breakdowns and to keep them operating at peak performance. During routine equipment maintenance, mechanics follow a checklist including the inspection and cleaning of brakes, electrical systems, fuel injection systems, plugs, carburetors, and other parts. Following inspection, mechanics usually repair or adjust parts that do not work properly, or replace unfixable parts. Routine maintenance is normally a major part of the mechanic's work.

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

In larger repair shops, mechanics may use special computerized diagnostic testing equipment as a preliminary tool in analyzing equipment. These computers provide a systematic performance report of various components to compare them to normal ratings. After pinpointing the problem, the mechanic makes the needed adjustments, repairs, or replacements. Some jobs require minor adjustments or the replacement of a single item, such as a carburetor or fuel pump. In contrast, a complete engine overhaul requires a number of hours to disassemble the engine and replace worn valves, pistons, bearings, and other internal parts. Some highly skilled