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Employment Opportunities for Diesel-Engine Mechanics

Bulletin No. 813

[Reprinted from the MONTHLY LABOR REVIEW, February 1945]

For sale by the Superintendent of Documents, U. S. Government Printing Office
Washington 25, D. C. - Price 5 cents

Letter of Transmittal

UNITED STATES DEPARTMENT OF LABOR,
BUREAU OF LABOR STATISTICS,
Washington, D. C., February 28, 1945.

The SECRETARY OF LABOR:

I have the honor to transmit herewith a report on employment opportunities for Diesel-engine mechanics. This is the first in a series of occupational studies prepared in the Bureau's Occupational Outlook Division for use in vocational counseling of veterans, young people in schools, and others considering the choice of an occupation. This study was prepared by Frank Dischel under the supervision of Richard H. Lewis.

A. F. HINRICHS, *Acting Commissioner.*

Hon. FRANCES PERKINS,
Secretary of Labor.

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Summary

The post-war demand for mechanics to service Diesel engines can be adequately supplied from the relatively large number of experienced engine mechanics who will be available. The value of Diesel training for persons without mechanical experience is therefore definitely limited. Experienced mechanics considering transferring to Diesel maintenance, and mechanics already employed by firms using or servicing such engines, may in some instances profit by brief training courses to become familiar with the special characteristics of these engines.

These are the chief conclusions drawn from an analysis of the post-war labor market for Diesel mechanics, despite the rising trend of sales of the engines in pre-war years and the favorable prospects for a continued expansion of their utilization in the post-war period. Although its importance is increasing, the Diesel engine now constitutes and will probably continue to represent only a small proportion of total engines in use. Because of its general similarity to other internal-combustion engines, mechanics experienced in maintaining other types of engines can transfer their skills to its servicing with relatively little difficulty.

Companies replacing other types of engines with Diesel engines have usually met their maintenance requirements by shifting mechanics already employed in servicing the displaced engines, rather than by hiring Diesel specialists. This employment policy is often reinforced by the seniority provisions of labor contracts. In the situations in which entirely new job openings result from the extension of Diesel-engine use, mechanics experienced on other engines have generally been preferred over inexperienced job applicants who have Diesel training.

Nature and Importance of the Occupation

In recent years the Diesel engine has been considered by many to represent one of the outstanding new fields of employment opportunity opened by technical innovations. The relatively rapid expansion in the sales of Diesel engines during the decade of the 1930's and their adoption for new uses, such as with tractors, in trucks and in busses, encouraged this view. Advertisements by schools offering

training stimulated interest in the vocational opportunities that would be created by the increasingly wide acceptance of Diesel power. The importance of these engines during the war, as measured by the heavy requirements of the armed forces, has caused a renewed interest in the post-war prospects for jobs in the Diesel field.

Information on the job openings that would be created by post-war expansion in the use of these engines is needed by young people without experience who are considering the value of this special training in improving their employment opportunities, by mechanics who wish to supplement their experience through courses in Diesel maintenance, and by men who have been trained as Diesel mechanics by the Army and Navy and who may want to adapt their wartime experience to a peacetime vocation.

It is the purpose of this article to provide information leading to a balanced judgment about employment opportunities for Diesel mechanics. This information is based on interviews with manufacturers and users of these engines and with training-school officials, as well as on an examination of the vocational and technical literature in the field.

In maintaining and repairing a Diesel engine, the mechanic performs such duties as diagnosing trouble, disassembling the engine, replacing or repairing defective parts, reassembling the engine, and adjusting the fuel and air valves. The function of this mechanic is similar to that of other engine mechanics, and Diesel-engine maintenance is generally regarded as a specialized branch of general mechanical work rather than as a separate and distinct occupation. Diesel mechanics do not design or engage in the manufacture of the engine; manufacturing occupations correspond to those found in the production of other engines, and in metalworking and assembly operations generally.

The term, "Diesel engineer," has been frequently used rather loosely in vocational literature to refer sometimes to professional engineers and sometimes to mechanics. The first Diesel engines were almost exclusively of the heavy stationary and marine type and the latter use of the term "Diesel engineer" was carried over from the practice of referring to maintenance men in power plants and on ships as "engineers."

Diesel engineering, at the professional level, cannot be considered to be a distinct occupation from the standpoint of either formal educational requirements or practical specialization. The basic required technical knowledge is that of the mechanical engineer. Engineering colleges, for example, do not offer a degree in Diesel engineering, although they may provide some courses in its principles to mechanical-engineering students. Professional Diesel engineers can probably be counted in the hundreds and are found primarily in the manufacturing rather than the maintenance fields. The manufacture of Diesel engines requires the usual specialization of mechanical engineering skills, including designers, research engineers, production engineers, and installation engineers. As a result, the occupation of Diesel engineering, in its restricted professional sense, can be included both logically and practically under the broader occupational title of mechanical engineer. This study considers only the Diesel mechanic.

Diesel mechanics are employed in a wide range of industries in which Diesel engines are used. Some of the more important sources of employment are ships and boats, public-utility and municipal electric-power plants, stationary power plants in buildings and in many manufacturing industries, logging, petroleum production, railroads, and companies using or servicing Diesel busses, trucks, tractors, construction machines, and earth-moving machinery.

Future needs for men who can service and repair Diesel engines depend on the extent of the wider use of this engine in various industries. To evaluate the prospects for increased Diesel utilization requires an understanding of the characteristics of the engine and recent trends in its introduction into important fields of use.

Characteristics of the Diesel Engine

The Diesel engine has been able to compete successfully with existing carburetor and steam engines for certain types of mechanical motive power because of its technical characteristics. It is an internal-combustion engine, similar in structure to the gasoline (or carburetor) engine. Both engines have similar stationary and working parts, including crankcases, cylinders, cylinder blocks and heads, exhaust manifolds and water-cooling systems with their associated pumps, radiators, and circulation jackets.[1] It is especially important to recognize this similarity in structure, since one of the most important factors in determining the opportunities for those with Diesel training is the ability of mechanics familiar with other engines to transfer their skill to this type of engine.

The essential difference between the carburetor engine and the Diesel engine, from the point of view of the mechanic, lies in their different methods of ignition. The Diesel engine has no electric ignition system and carburetor but has instead an oil-injector system and fuel pumps, with which the mechanic must be familiar.

It can be operated more economically than other engines, in many uses, because of its relatively more efficient utilization of fuel. This and certain other technical advantages are offset by its higher initial cost and greater weight per horsepower compared with the carburetor engine. It also lacks the flexibility required for passenger automobiles and is very noisy. These technical characteristics have made possible great expansions of its use in some fields, but have limited its use in others.

Prospects for Expansion in Use of Diesel Engines

Employment opportunities in Diesel-engine maintenance occur in the industries which use or service this type of engine. For this reason it is important to measure the relative rate of introduction of the Diesel engine into its various fields of use, as well as the total growth in its production.

[1] For a description of the structure of the Diesel engine see General Motors Corporation pamphlet, Diesel—the Modern Power, published in 1941.

Much of the optimism concerning employment opportunities for Diesel mechanics resulted from the wider use of the engines during the decade before the war and their adaptation to new uses. Examination of the following tabulation[2] shows the rapid recovery of Diesel-engine production from the effects of the depression, and an expansion well beyond previous high levels.

	Number of units	*Total rated horsepower*	*Value*
1929	3, 588	485, 327	$26, 798, 914
1931	1, 473	264, 037	11, 853, 820
1933	1, 144	139, 331	5, 153, 734
1935	6, 703	920, 261	17, 004, 187
1937	13, 814	1, 448, 857	41, 266, 449
1939	19, 263	1, 910, 627	45, 527, 826

By 1935, the number of units produced, as well as their total rated horsepower, exceeded the previous peak output of 1929. From 1933 to 1939 the number of units produced annually expanded 17 times, the aggregate rated horsepower 14 times, and the total value nearly 9 times. During the decade there was a reduction in the average size of the units produced, as measured by horsepower, and the average price per horsepower was reduced by more than half. These changes in character of output were caused mainly by the introduction of the engine for new uses. Sales of Diesel engines had consisted almost exclusively of marine and stationary engines until the early 1930's, when they began to be utilized in tractors, construction machinery, and locomotives, which use smaller engines. By 1939 the production of Diesel engines other than stationary and marine accounted for over half of the units and about 43 percent of the total horsepower. This does not include the engines made by tractor and locomotive manufacturers for installation in their products.

Diesel-engine production not only increased absolutely, but also made relative gains compared with carburetor engines (other than for motor vehicles) and steam engines and turbines. Diesel-engine production, as shown in the accompanying table, constituted 5.3 percent of the aggregate rated horsepower of internal-combustion engines and steam engines produced for sale as such in 1929, and 20.9 percent in 1939. However, the total production of engines included in this comparison is only a small fraction of the production of carburetor engines for passenger and commercial cars. There were 3,534,831 motor vehicles produced in 1939, including a very small number of Diesel-powered trucks and busses, while only 19,263 Diesel-engine units were made in independent engine plants (where the greater part of their production takes place). In addition, 478,935 carburetor engines were produced for other purposes, including 141,154 marine engines and 32,663 tractor engines.[3] Although Diesel-engine production has shown a marked relative as well as an absolute increase since 1929, it has begun to enter the market for motor-vehicle engines only in trucks and busses, and in these only to a small extent.

[2] Data are from the Census of Manufactures. They exclude all aircraft and motor-vehicle engines and engines made for installation in Diesel-electric locomotives, ships, boats, or tractors, when the engines in the locomotives, etc., are built by the same establishment.

[3] Census of Manufactures, 1939.

During the war a tremendous increase in Diesel-engine production has taken place, to meet the requirements of the armed forces. The total for 1943 has been estimated at 25,000,000 horsepower, as compared with less than 2,000,000 horsepower produced in 1939. The wartime output has exceeded the aggregate horsepower produced from the beginning of manufacture in this country through 1941. The greater part of the wartime production has gone directly to the armed forces, with the Navy taking the largest share. These engines have been used so extensively in such vessels as submarines, destroyers, patrol boats, and landing boats that the Diesel horsepower operated by the Navy is greater than its total steam horsepower. The Army has used Diesels in some of its tanks and heavy trucks, and both services have relied upon them to power the construction and earth-moving equipment which has been so important during the war.

Distribution of Engine Production by Type of Engine, 1929 and 1939[1]

Type of engine	Rated horsepower			
	1929		1939	
	Total	Percent	Total	Percent
All types	9, 204, 390	100. 0	9, 160, 880	100. 0
Diesel engines [2]	485, 327	5. 3	1, 910, 627	20. 9
Carburetor engines (excluding those used in motor vehicles)[2]	5, 321, 280	57. 8	5, 912, 333	64. 5
Steam engines and turbines [3]	3, 397, 783	36. 9	1, 337, 920	14. 6

[1] Census of Manufactures.
[2] Data for Diesel engines and carburetor engines exclude all motor-vehicle and aircraft engines, as well as engines made for installation in locomotives, ships, boats, or tractors, when the engines are made by the establishment building the locomotives, etc.
[3] Data for steam engines and steam turbines exclude production of locomotives and turbo-generators, and steam engines made for installation as parts of ships, blowers, pumps, etc., when the engines are made by the establishment building the ships, etc.

The post-war prospects for Diesel-engine sales, after war contracts have been terminated, depend upon the ability of the manufacturers to compete in the normal peacetime markets for engines. The high production levels of the war have made possible the development of mass-production methods and have stimulated technical improvements which may aid the competitive position of the Diesel engine.

Before the war this type of engine had been used in many different industrial fields, but until recently was particularly important as a source of stationary and marine power. The following tabulation shows the distribution of installed Diesel horsepower at the end of 1941 by type of use. The categories listed have been grouped under the kind of Diesel engine typically utilized by each.

	Rated horsepower (thousands)[1]	Percent
All types	19, 122	100. 0
Automotive	7, 630	39. 8
Tractors and contractors' machinery, including tanks	6, 247	32. 6
Trucks	955	5. 0
Busses	428	2. 2
Stationary	6, 594	34. 6
General industry	5, 138	26. 9
Public utility	526	2. 8
Municipal light and water	930	4. 9
Marine, including U. S. Navy	3, 841	20. 1
Railroads	1, 057	5. 5

[1] Data are from Diesel Power, January 1942.

The magnitude of post-war sales will depend upon the success of Diesel manufacturers in maintaining and extending their previous gains in the marine and power fields and developing further their market for locomotive- and automotive-type engines, including those for trucks, busses, tractors, and construction and farm machinery. Diesel engines will be utilized extensively in ships and boats, particularly in the medium- and small-size vessels.

The use of Diesel and Diesel-electric locomotives by the railroads will undoubtedly continue to expand. By 1943 over 2,000 Diesel locomotives were being operated by class I railroads, most of which had been purchased since 1937. Their relatively minor place in this field is indicated by the fact that more than 40,000 steam locomotives are also in service. Railroads have used the greatest number of their Diesel locomotives for switching, and they may largely supersede steam locomotives in this function. Many lines have been operating the widely publicized Diesel-electric streamlined passenger trains, and in the past few years Diesel locomotives have been successfully introduced into freight service.

In recent years a large proportion of the tractors and construction machinery produced have been powered by Diesel engines, and it is probable that they will continue to dominate this field in the post-war period.

The automotive field constitutes by far the greatest market for engines. Diesel trucks and busses are now in use, but they are still a very small proportion of the total. There are good prospects for expansion in the truck and bus field, however, particularly in the heavier vehicles, and especially if technical improvements reduce the present disadvantages of Diesels for this type of use. It is considered unlikely that Diesel engines will be used in passenger cars in the predictable future.

Job opportunities for Diesel mechanics are related to the number of Diesel engines in use. There were at least 100,000 units in service at the end of 1939. More recent data on the number of units produced are not available, but statistics on the rated horsepower of engines produced since 1939 for nonmilitary use suggest that the number of units in service may now be at least 50 percent higher than in 1939. The post-war period may see a substantial increase over prewar levels in the utilization of these engines if some of the sales potentialities listed above are realized and if many of the Diesel engines constructed during the war are used for peacetime purposes. Under these conditions the number in use should more than double the 1939 total within a few years after the war, and it will probably continue to increase at a rapid rate.

Opportunities for Diesel Mechanics

The wider use of Diesel engines in the marine, electric-power, railroad, and automotive fields after the war will result in an increased need for maintenance. However, this greater demand will not require a corresponding increase in the supply of newly trained Diesel mechanics, because of the ease with which mechanics familiar with other types of engines can transfer their skill to the maintenance of Diesel engines.

Employment practices among the industries using these engines largely determine the number of new job openings for Diesel mechanics as the engines are introduced and the need for their servicing arises. Large electric power stations, for example, generally employ supervisory stationary engineers with long practical experience who are directly responsible for the operation, maintenance, and repair of engines, and mechanics are usually placed under their immediate supervision. When a Diesel engine replaces another engine, the stationary engineer must apply his experience and previous knowledge to the new engine and then retrain the mechanics under his supervision.

Officers in charge of the operation and maintenance of the engines on ships are also called engineers, and they must be licensed by the U. S. Bureau of Marine Inspection and Navigation in peacetime and by the U. S. Coast Guard during the war. Their duties are somewhat broader than those of the stationary engineer because they are responsible for the operation and maintenance of all of the mechanical and electrical equipment on a ship. In the requirements for engineers' licenses, experience in the engine department of ships weighs very heavily, and a written examination must also be passed. A person with Diesel training but without engine-department experience on ships is not sufficiently qualified for even the lowest grade of licensed engineer, even though the requirements have been reduced during the war. Separate licenses are provided for engineers on steam and Diesel ships, and an engineer on a steam vessel cannot obtain a license for a Diesel (motor) vessel until he has acquired experience in the engine department of a Diesel ship. This requirement has been waived during the war, for third assistant engineers, and steam and Diesel experience are interchangeable for this, the lowest grade of licensed engineer.

The adoption of Diesel engines by railroads usually involves a readjustment by their experienced mechanics rather than the hiring of new personnel. The explanation was made, during an interview with an official of a large railroad company, that the seniority rules of their labor contract required that the mechanics employed in the maintenance of steam locomotives be assigned to Diesel engines before new workers are hired. Since the mechanics on this railroad had undergone an apprenticeship of 4 years and usually had long practical experience, they were considered able to repair a Diesel engine with little formal supervision or retraining.

More recently, employment opportunities for Diesel mechanics have appeared in the servicing of motor vehicles. The experience of a large bus company, with 40 percent of its busses powered by Diesels, may be cited as one example of employment practices in the automotive field. The manager of the maintenance department reported that all the mechanics who had been hired had only gasoline-engine experience, even though a large number of busses with Diesel engines had been serviced for several years. When Diesel engines were originally introduced, the bus company selected several foremen and superior mechanics and sent them to a Diesel training school for 2 months. These trainees then served as leadmen in training other mechanics. Mechanics with Diesel training or experience had not been hired recently, simply because none had been available on account of the wartime shortage of skilled engine mechanics. It is significant that the company was able to make its adjustment to Diesel-engine busses by depending primarily on the skill of its gasoline mechanics.

It is evident that the wider use of Diesel engines has generally resulted in the retraining and adaptation of the skills of engine mechanics who were already employed rather than in their technological displacement. Experience or training in servicing Diesel engines may improve the competitive position of an engine mechanic in the labor market, but length of experience, seniority, and all-round mechanical ability will continue to be the more important considerations even if Diesel engines should replace other forms of motive power.

The supply of qualified Diesel mechanics has been augmented by the large number of servicemen who have received Diesel training during the war. The Navy established a special rating for Diesel mechanics, known as "motor machinist's mate," in January 1942. On September 1, 1944, there were 70,364 motor machinist's mates, including 54,900 who had been trained as Diesel mechanics since the start of the war. The Army also trained 5,086 enlisted men as Diesel mechanics during a similar period. The Navy has trained mechanics to service marine Diesel engines, while the Army has generally trained Diesel mechanics to maintain tank and truck engines.

No data are available as to the number of experienced Diesel mechanics and the number of Diesel-school graduates. The number of these mechanics employed cannot be easily determined, since many of their employers' records do not show a separate occupation for them and many also work on other engines. Although no statistics are available, there is evidence that the number of resident Diesel-school students has been very small during the war.

However, if past practices are followed by employers, most of the job openings created by the wider use of Diesel engines will be filled

by mechanics employed in repairing other engines. The 1940 Census of Population reported 949,658 persons experienced as mechanics and repairmen, represented by 441,845 automobile, 28,384 airplane, and 43,998 railroad mechanics and repairmen, as well as by 435,431 other mechanics and repairmen. While the number of engine mechanics, as distinct from other types of mechanics and repairmen, cannot be specifically determined, most of the 514,227 automobile, airplane, and railroad mechanics and repairmen were probably engine mechanics, and many engine mechanics can be found among the 435,431 other mechanics and repairmen. This large reservoir of men, capable of learning to maintain and repair Diesels with relatively little additional training because of their previous experience, is the greatest single factor in the potential supply of Diesel mechanics.

The relative position of Diesel engines as a source of demand for repairmen is indicated by the fact that only about 100,000 Diesel engines were in use by the end of 1939, as compared to 31,000,000 registered passenger cars and motor trucks using carburetor engines. Although, as suggested above, the number of Diesel engines to be serviced may double the 1939 total within a few years after the war and continue to grow, it will still represent only a small fraction of the number of other types of engines in use.

The practice of retraining mechanics experienced on other engines to service Diesel engines, before new workers are engaged, and the increased supply of Diesel mechanics trained in the armed forces make the potential supply of Diesel mechanics after the war more than sufficient to meet any demand that may reasonably be expected. As a result, the value of Diesel training for persons without experience in engine maintenance would seem to be definitely limited. Experienced mechanics who desire to transfer to Diesel maintenance, and mechanics already employed by companies using or servicing Diesels, may find brief training courses useful in learning about some of the specialized components of the Diesel, such as the oil injector and fuel pump.

Training for Diesel Maintenance

In cases in which it has been decided that training would aid in obtaining or holding a job in Diesel maintenance, the training course should be carefully selected. There are no generally recognized standards for Diesel training, and in any event the scope of the instruction would depend upon the previous mechanical knowledge of the student. Privately operated trade schools offering Diesel training have often provided inadequate facilities and instruction. Before enrolling in a privately operated trade school, the prospective student may be able to obtain information on the quality of the instruction offered, from the superintendent of schools or the director of vocational training in the locality in which the school operates.

Courses in Diesel mechanics are taught in a number of public vocational and trade schools operated by local school boards. Generally this training is given as a part of regularly conducted training in auto mechanics. Special courses in maintenance can frequently be made available by vocational schools for employed adults who require Diesel training in connection with their daily employment.

Information on opportunities for training in this field may be obtained from the local superintendent of schools or the local director of vocational education.

Correspondence courses seem to be of little practical value to the person without mechanical experience, although they may be helpful to the experienced engine mechanic if he is able to learn from textual materials without the direct personal guidance of an instructor.

Two complete although accelerated training programs for Diesel mechanics were conducted by the Army and Navy. The Army program involved 12 weeks of training as an automobile mechanic and an additional 4 weeks of specific Diesel training, for a total of 800 hours of study. The Navy has required an 8-week preliminary engineering course and a 5-week elementary Diesel course, followed by 4 to 8 weeks of advanced Diesel-engine training, or a total of 850 to 1,050 hours of study. These training programs were designed to be complete courses of study, suitable for students with little practical experience, the specific Diesel-engine training being viewed either as part of the broader training of a competent engine mechanic or as an extension of previous training as an auto- or marine-engine mechanic.

These military training programs were designed for a specific purpose, the supplying of qualified Diesel maintenance men to the armed forces—and are interesting as an illustration rather than as a model for a civilian course of instruction. In peacetime mechanical training the scope and content of the course of study selected should be consistent with the background and needs of the individual student.

U. S. GOVERNMENT PRINTING OFFICE: 1948