

# DIESEL PLANT OPERATIONS HANDBOOK

CLIVE T. JONES

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While the text of this book takes on masculine gender in many cases for convenience, there is no intent on the part of the author to slight or ignore women, whose role in engineering and plant management has seen tremendous growth in recent years.

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*This work largely owes its creation to John P. Brydon, who generated the seed of an idea, and to Laurence F. Jonson, who provided a rain of encouragement.*

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# PREFACE

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The *Diesel Plant Operations Handbook* has been prepared for the day-to-day reference of the personnel employed in the running of diesel generating plants. Used as intended, the Handbook is a valuable practical guide for the proper operation of any diesel-powered generation complex.

The author has been engaged in the operation, maintenance, and overhaul of diesel power plant main and auxiliary machinery for many years and has drawn upon his considerable experience in providing a Handbook that will assist all of those personnel charged with the responsibility of running a safe, efficient, and economical facility.

The Handbook is also particularly suitable for either the familiarization or training of plant staff at any level or vocation. All references to any particular components are generic in nature so that the entire contents of the Handbook have a direct relevance to any plant where the Handbook is consulted.

The 48 chapters of the Handbook cover the functions of the principal engine components and develop in the operator an early awareness of a machine in difficulty. The Handbook discusses in some considerable detail the five systems upon which all internal combustion engines rely, i.e., air, fuel, exhaust, cooling, and lubrication. Maintenance and overhaul affairs are examined, and suggestions are made throughout the Handbook that will improve the efficiency of the plant in many spheres in a cost-effective manner.

The Handbook will serve the attentive reader as a buffer between the all-too-often inadequate operator's manual provided by the manufacturer and the shop repair manual.

*Clive T. Jones*

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# ACKNOWLEDGMENTS

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In the preparation of this Handbook numerous publications were consulted, which included:

Diesel Engine Manufacturers' Association, *Standard Practices for Stationary Diesel and Gas Engines*, New York, 1977.

Lister, Eugene C., *Electric Circuits and Machines*, McGraw-Hill, Inc., New York, 1960.

Odberg, Eric and F. D. Jones, *Machinery Handbook*, The Industrial Press, New York, 1964.

Sothorn, J. W. M., *Marine Diesel Oil Engines*, vols. I and II, James Munro, Glasgow, 1952.

Westinghouse Electric Corp., Apparatus Repair Division, *Westinghouse Maintenance Hints*, Pittsburgh, 1965.

Wilbur, C. T., and D. A. Wright, eds., *Pounders Marine Diesel Engines*, Butterworth & Co. Ltd., Kent, United Kingdom, 1984.

Williams, D. S. D., *Oil Engine Manual*, Temple Press, London, 1950.

Numerous guidebooks, bulletins, manuals, parts books, and instructional material were also utilized, particularly those issued by Caterpillar Inc., Peoria, Illinois, and their agent in Vancouver, British Columbia, Finning Tractor Ltd.; Electromotive Division of General Motors of La Grange, Illinois, and their Canadian agent, Mid-West Power Products of Winnipeg, Manitoba; Cummins Engine Company, Columbus, Ohio, and their agent in Western Canada, Alberta Governor Ltd., Edmonton, Alberta; and Maintenance Lubrication Services Ltd., Oil Analysts, Edmonton, Alberta.

Reference was also made to the publications of the Waukesha Engine Co., Mirrlees-Blackstone Ltd., GEC-Ruston Ltd., Lucas-CAV, and others.



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# CHAPTER 1

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## INTRODUCTION

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### 1.1 THE PURPOSES OF THIS HANDBOOK

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This handbook is intended to bridge the gap between the information given in the various operator's manuals and the shop manuals supplied by the equipment manufacturers and thereby help the power plant personnel, particularly the operators, to carry out their duties in a more effective manner. The work done by the operators can be divided into three main activities:

1. Operating the generating plant machinery in the most economic manner possible and appropriately to the prevailing load
2. Maintaining a continuous watch over the entire plant and safeguarding the plant against damage or deterioration
3. Performing the day-to-day maintenance duties that are prescribed by the owner and are in keeping with safe working practices

Diesel power plants have tremendous variations in purpose, equipment, capacity, manning, and management. In discussing the various aspects of operation and upkeep, the terms *operator*, *mechanic*, *planner*, *superintendent*, and *owner* are used frequently. In many instances, however, the operator may also perform the functions of mechanic, planner, and superintendent. Conversely, in larger plants several persons may be assigned to only one of the duties and in almost all plants there is always a certain amount of overlap of functions. The handbook should be read with those variations in mind.

If a diesel-powered generating plant is to operate continuously, reliably, and economically, certain standards of performance must be established by the owner and demanded of both the operators and the equipment. The standards of performance implied in this book are not hard to follow; they are merely statements of what must be done in any diesel plant if the consumer is to get value for his money, if the owner is to get a fair return on his investment, and if the employee is to give service worthy of his wage. On the other hand, the performance standards outlined here are by no means complete, and they never can be, even for a particular plant.

It will be necessary for the owner and the plant superintendent to maintain a constant pressure on the plant personnel to work to the best possible standard of performance and maintain it consistently. The diesel generating plant that has no standard of performance by which to abide will not be able to provide constant and predictably good service.

Another intention of this handbook is to provide a yardstick by which an en-

gine operator can judge his abilities and his progress in learning about his occupation. The book can also be a teaching guide for the plant superintendent. The owner will benefit greatly by hiring the best possible grade of operator, because virtually all the unpredictable engine expenses in manned plants are caused by shortcomings in operator performance. In turn, those shortcomings are caused by lack of training and background experience.

A further intention of the handbook is to effect an improvement in the diesel plant operator's professionalism. In far too many instances, stationary diesel plant operating personnel have been regarded as short-term employees who possess only limited skills, are transient, and are unworthy of much attention in the way of training. It is hoped that this handbook will assist the diesel plant operator in expanding his general knowledge of sound power plant operating practice and thereby encourage him, while expanding his experience, to remain in the industry.

No engine manufacturer produces bad engines, but many engines are unsuccessful and are condemned by their owners, users, or operators as bad because, in truth, they were improperly selected, applied, operated, or maintained. It is quite understandable that any person who is associated with diesel engine operating or upkeep work should form his own opinions on the merits of various engines. As time goes by and a person's experience broadens, that opinion becomes very useful. But no matter what attitudes toward a particular make or model of engine they may have, the operator, the mechanic, and the superintendent can only base their engine care activities on the premise that all of the engines and equipment they are required to work on is suitable for its duty. They must never knowingly evade giving the machinery under their control their best possible attention at all times.

## 1.2 OPERATOR EDUCATION

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The operator's ability to perform effectively will be in direct proportion to the training and experience that he brings to the job or is able to acquire. Diesel engine operating is a respectable and responsible occupation, and it is hoped that this handbook will contribute something to the trade.

To operate a diesel generating plant successfully, a knowledge of purpose and expected performance of the plant under various conditions is necessary, and so is an understanding of the part played by the many components. By its very nature, a plant operator's job is lonely. For that reason, an operator, once his basic and often all too brief training is complete, will learn nothing more about his job unless he takes the trouble to teach himself. The operator who is prepared to learn more about the nature and operation of the equipment that surrounds him will find other people such as station superintendents and journeymen more than willing to supply further instruction.

Operators should be encouraged to read on shift. Anything may be read as long as it is directly related to the job. Operator's manuals, parts books, procedure manuals, safety codes, *original equipment manufacturer's* (OEM) instruction books, training guides, job-oriented textbooks, and similar literature are provided by the owners, suppliers, and technical schools. If little material is available, it is not unreasonable for the operator to request it. By continuous reference to this reading matter, an operator can give himself a large amount of necessary education. He will find that the more he studies, the more interesting and satisfying his job will become.

Unfortunately, OEM-supplied manuals usually contain only the rudimentary

elements of running and servicing the engine, whereas the shop manuals deal only with the rebuilding of the engine or its individual components. Generally, none of these manuals provide much in the way of diagnostic assistance, trouble recognition, or fault avoidance.

Modern engines have many exact and carefully calculated adjustments that are necessary for efficient, smooth, and trouble-free operation. It is therefore essential that any operating adjustment or setting work shall be carried out by properly trained personnel who must use the relevant instruction manual.

There is simply no way a person, even with the best memory in the world, can remember the sequences, clearances, torque values, pressures, temperatures, and all the other vital information for handling an engine. Without there being a continuous reference to the OEM manuals during repair, maintenance, or operation, one may expect starting, running, and upkeep problems. There is a proverb in the engine world that “disregarded manuals and broken engines lie together in the same junk heap.”

At least four basic books are essential for engine upkeep: operator’s manual, the shop manual, the parts book, and the workbook. The first three are supplied by the OEM, and the fourth is supplied by the owner. They must, naturally, be available to both the operator and the mechanic at all times. In the event of loss or disintegration, their replacement is necessary. For engines of 750 kW at 720 rpm and larger, test sheets also are usually available. Occasionally, some or all of the four basic books will be found combined within one cover.

Any newly hired mechanic or operator will check out the presence of the four basic books as an early priority in his new duties. It is his duty to ask for them if they are not available. It must be understood by all personnel that no matter how many copies of these publications appear to be available, they always remain the property of the engine owner—past, present, or future. Although all manuals and other information sources must be properly looked after, nobody on the plant staff is entitled to the exclusive custody of any particular document. All teaching, guiding, and specifying material must be visible to all those who have good reason to use it.

### **1.3 CLOTHING**

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Simply as an elementary form of personal protection anyone occupied within the power plant should observe some basic clothing rules.

1. All power plant personnel should wear some kind of headgear. If the plant regulations require their use, hard hats or bump caps, must be worn. In the absence of such regulations, a cap at least should be worn. A person with longer hair must consider using a hair net also.
2. A long-sleeved garment should be worn so that the arms are fully covered.
3. Hard-toed boots or shoes are recommended, but in no case should rubber-soled footwear be permitted. Jogging shoes and Wellington boots are particularly dangerous.
4. Gloves are regarded as dangerous and as inhibiting the proper performance of operator and journeyman duties. They should be used only when handling very hot or very cold materials or tools. Hands inside gloves are very poor sensors, and they adversely affect an operator’s judgment of conditions.

5. Hearing protection and safety glasses must be used if plant regulations demand them, and the use of both is highly recommended in all plants on a voluntary basis.
6. Further, and purely in the interest of personal safety, it is prudent that rings (both finger and ear), wristwatches, necklaces, bracelets, and neckties should be left at home.

Any of the owner's rules regarding attire, protection or safety apply equally to any power plant visitor.

#### **1.4 OEM DEFINITION**

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The term *OEM* will frequently appear in the text of this handbook; it includes the engine builder, the alternator manufacturer, or any of the companies that provide switchgear, governors, fuel injection apparatus, or any other equipment incorporated in the final product as purchased. The OEMs provide their own service bulletins, specification sheets, parts books, instruction manuals, and other guidance information.



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## CHAPTER 2

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# THE OPERATOR

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### 2.1 OPERATOR IN CHARGE

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At any diesel power plant there can be only one person in charge of generator operations. That person, known as the *operator in charge* may carry out his duties alone or as one of several persons under that authority of a station superintendent. Whatever the command structure, the person acting as the operator in charge is responsible for the safe and proper starting, running, and stopping of the generator sets.

Under ordinary circumstances, the operator goes about his duties in a routine manner; he is the person trained and assigned to handle the generating equipment and its auxiliaries. The occasion may arise, however, when the operator is not sufficiently experienced to handle an emergency. If there is an outage or some other form of breakdown, it is quite common practice for the station superintendent, electricians, mechanics, or other personnel to attend the plant and make their assistance available. In those circumstances, it must be well understood by all concerned that, no matter who helps out, the operator remains in charge of operations unless he is relieved by the superintendent. If that occurs, the superintendent must tell the others who is then the operator-in-charge.

The occasion may also arise when more than one shift operator is at the plant during an emergency situation. Unless the station superintendent has stated otherwise, the operator in charge is the operator assigned to the shift within the current time frame.

The operator in charge is responsible for the proper and safe conduct of plant generating operations. All workmen performing any task within the environs of the plant must defer to the operator. They should not open any cubicle, remove any floor plates, commence welding, or carry out any other work that may infringe on the operator's normal activity or the plant's power-producing capability without clearly advising the operator of their intentions and obtaining formal clearance. Following such advice, it is the operator's duty to see that the necessary and appropriate flags, tags, or other warnings are applied in accordance with standard safety rules and practices.

At the time of shift change, the incoming operator must be fully briefed by the outgoing operator on any ongoing changes or alterations that have occurred during the preceding shift that may impede the normal operation of the next shift. The operator in charge must be aware of all plant visitors, whatever their rank or business, and he should acquaint them with the site safety regulations applying to such visitors.

Although the primary function of the operator in charge is to produce safe,