SELECTION, OPERATION, INSPECTION & MAINTENANCE
OF
DIESEL ENGINES

OISD-STD-127
First Edition, October, 2010

Prepared by

FUNCTIONAL COMMITTEE FOR
REVISION OF STANDARDS ON ROTARY EQUIPMENT

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Preamble

Indian petroleum industry is the energy lifeline of the nation and its continuous performance is essential for sovereignty and prosperity of the country. As the industry essentially deals with inherently inflammable substances throughout its value chain – upstream, midstream and downstream – Safety is of paramount importance to this industry as only safe performance at all times can ensure optimum ROI of these national assets and resources including sustainability.

While statutory organizations were in place all along to oversee safety aspects of Indian petroleum industry, Oil Industry Safety Directorate (OISD) was set up in 1986 Ministry of Petroleum and Natural Gas, Government of India as a knowledge centre for formulation of constantly updated world-scale standards for design, layout and operation of various equipment, facility and activities involved in this industry. Moreover, OISD was also given responsibility of monitoring implementation status of these standards through safety audits.

In more than 25 years of its existence, OISD has developed a rigorous, multi-layer, iterative and participative process of development of standards – starting with research by in-house experts and iterating through seeking & validating inputs from all stake-holders – operators, designers, national level knowledge authorities and public at large – with a feedback loop of constant updation based on ground level experience obtained through audits, incident analysis and environment scanning.

The participative process followed in standard formulation has resulted in excellent level of compliance by the industry culminating in a safer environment in the industry. OISD – except in the Upstream Petroleum Sector – is still a regulatory (and not a statutory) body but that has not affected implementation of the OISD standards. It also goes to prove the old adage that self-regulation is the best regulation. The quality and relevance of OISD standards had been further endorsed by their adoption in various statutory rules of the land.

Petroleum industry in India is significantly globalized at present in terms of technology content requiring its operation to keep pace with the relevant world scale standards & practices. This matches the OISD philosophy of continuous improvement keeping pace with the global developments in its target environment. To this end, OISD keeps track of changes through participation as member in large number of International and national level Knowledge Organizations – both in the field of standard development and implementation & monitoring in addition to updation of internal knowledge base through continuous research and application surveillance, thereby ensuring that this OISD Standard, along with all other extant ones, remains relevant, updated and effective on a real time basis in the applicable areas.

Together we strive to achieve NIL incidents in the entire Hydrocarbon Value Chain. This, besides other issues, calls for total engagement from all levels of the stake holder organizations, which we, at OISD, fervently look forward to.

Jai Hind!!!

Executive Director
Oil Industry Safety Directorate
FOREWORD

The Oil Industry in India is more than 100 years old. As such a variety of practices are in vogue because of collaboration/association with different foreign companies and governments. Earlier, standardisation in design philosophies, selection, operating and maintenance practices at a national level were hardly in existence. This, coupled with feedback from some serious accidents that occurred in India and abroad, emphasised the need for the industry to review the existing state of art in designing, selecting, operating and maintaining oil and gas installations.

With this in view, the then Ministry of Petroleum and Natural Gas in 1986 constituted a Safety Council assisted by Oil Industry Safety Directorate (OISD) staffed from within the industry in formulating and implementing a series of self-regulatory measures aimed at removing obsolescence, standardising and upgrading the existing standards to ensure safer operations. Accordingly OISD constituted a number of functional committees comprising of experts nominated from the industry to draw up standards and guidelines on various subjects.

The present standard on “Selection, Operation, and Inspection & Maintenance of Diesel Engines” has been prepared by the “Functional Committee on Revision of Standards for Rotary Equipment”. This committee felt that the existing OISD-STD-121 titled “Inspection of Turbines and Diesel Engines” should be bifurcated into two standards namely “Selection, Operation, Inspection and Maintenance of Steam & Gas Turbines” and “Selection, Operation, Inspection & Maintenance of Diesel Engines”. Present document is one of them titled “Selection, Operation, and Inspection & Maintenance of Diesel Engines.”

This document is based on the accumulated knowledge and experience of industry members and the various national and international codes and practices, is meant to be used as a supplement and not as a replacement for existing codes standards and manufacturer’s recommendations. It is hoped that the provision of this standard, if implemented objectively, may go a long way to improve the safety and reduce accidents in the Oil and Gas Industry. The users of this document are cautioned that no standard can be a substitute for a responsible and experienced engineer. Suggestions are invited from the users after it is put into practice to improve the standard further. Suggestions for amendment, if any, should be addressed to:

The Coordinator
Committee for Revision of Standards On Rotary Equipment
Oil Industry Safety Directorate
8th Floor, OIDB Bhavan, Plot No. 2, Sector – 73, Noida – 201301 (U.P.)

This standard in no way supersedes the statutory regulations of CCE, Factory Inspectorate or any other statutory body which must be followed as applicable.
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These documents are intended only to supplement and not to replace the prevailing statutory requirements.
## Functional Committee for Revision of Standards on Rotary Equipment

### List of Members

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SELECTION, OPERATION, INSPECTION & MAINTENANCE OF DIESEL ENGINES

1.0 INTRODUCTION

A diesel engine is an internal combustion engine which operates using the diesel cycle, named after Dr. Rudolph Diesel. The defining feature of the diesel engine is the use of compression ignition to burn the fuel, which is injected into the combustion chamber during the final stage of compression. This is in contrast to a petrol engine, which uses the Otto cycle, in which a fuel/air mixture is ignited by a spark plug. The diesel engines are used in vast majority as prime movers for fire water pumps, air compressors, power and emergency generators in Hydrocarbon Industry.

Hence the proper selection, safe operation, inspection and maintenance of diesel engine is very critical. This document has been prepared, considering the importance of this equipment in the overall safety of the industry.

2.0 SCOPE

This standard specifies the minimum requirements in selection, installation, commissioning, operation, inspection & maintenance of diesel engines in hydrocarbon industry, both offshore & onshore.

3.0 DEFINITIONS

3.1 Governor: It provides the engine with the feedback mechanism to change speed as needed and to maintain a speed once reached. A governor is essentially a speed-sensitive device, designed to maintain a constant engine speed regardless of load variation.

3.2 Fuel Injectors: Each cylinder has a fuel injector designed to meter and inject fuel into the cylinder at the proper instant.

3.3 Shall: Indicates mandatory requirement

3.4 Should: Indicates recommendatory requirement.

For Diesel Engine operational terminology, please refer Annexure -4 & major components of diesel engine are detailed in Annexure -5.

4.0 SELECTION OF DIESEL ENGINES

The selected engine shall conform to international standard like ISO 3046 / proven vendor standards. In addition, the following factors shall be considered for selection of diesel engines:

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4.1 Selection criterion for Diesel Engines shall include:-
   
a) Focus on the parameters that can result in unsafe condition.
b) Fire Hazard.
c) Health and environmental concerns.
d) Provision in the basic design that shall prevent occurrence of unsafe conditions.

4.2 Equipment shall be selected from the manufacturer’s standard range of products. Prototype equipment shall not be considered.

4.3 The following safety and environment factors shall be given consideration while selecting the diesel engines:-

a) **Emission Controls**
   Emission control of nitrogen and carbon oxides and un-burnt hydrocarbons in the engine exhaust shall meet the applicable statutory requirements.
   
   All other fugitive emissions such as from crankcase breather shall be suitably controlled.

b) **Temperature**
   
   Engine surfaces with temperature in excess of 70°C shall be screened to avoid personnel contact and burn.
   
   The screening shall ensure that the discharge from a crankcase breather and any other leak from the lubrication or fuel systems do not reach any hot surface with a temperature greater than the auto ignition temperature of lubricating oil or fuel.

c) **Noise Control**
   
   The selected engine shall have noise control equipment to meet the maximum allowable sound level as per applicable legislation / statutes.

d) **Corrosion Protection**
   
   All carbon steel piping, silencer etc subject to exhaust temperatures and exposed to the atmosphere shall be properly protected against corrosion.

e) **Fuel Quality**
   
   The diesel engine manufacturer shall advise the maximum allowable quantity and size of solids and water in the fuel for safe engine operation. Proper filters/ separators/ coalescer shall be used for achieving the fuel quality.

f) **Engine Cooling**
   
   The water cooled engine shall have provision for addition of scale and corrosion inhibitors. The cooling system shall be provided with an expansion tank, level indicator and pressure relief valve. Low coolant level and high coolant temperature shall generate alarm and shall not allow diesel engine start up.

g) **Over speed Protection**
   
   The engine shall be fitted with an over speed protection device. The device shall give alarm /high high alarm / trip the engine depending upon the engine

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application. Engine used for emergency services like fire water pump operation shall have alarm. The over speed tripping device shall be manual reset type only.

h) Vibration

Proper care shall be taken to limit the engine vibrations transmitted to the foundation or surroundings. Suitable anti-vibration pad may be used if required between base plate and supporting structure.

i) Coupling Guard

All moving parts shall be protected from human contact by suitable guards. All such guard shall be non sparking type.

j) Crankcase Explosion Relief

Engine having a crank case volume of over 0.6 m³ shall be provided with crankcase explosion relief devices. Dipstick and / or caps shall be effectively secured against ejection following crankcase explosion. The crankcase breather shall be as small as possible and located to minimize air inrush into crankcase following an explosion.

k) Instrumentation and Controls

The engine shall be supplied with monitoring and protection instruments. The monitoring and protection functions shall include the following as minimum:-

   i) Low lubricating oil pressure
   ii) High cooling water temperature
   iii) Low cooling water level
   iv) Engine over speed.

Detailed instrumentation and controls shall be as per Annexure-1. For Diesel Engine protections, please refer Annexure -3.

5.0 COMMISSIONING, OPERATION & MONITORING of DIESEL ENGINES

Procedures shall be in place to ensure that diesel engines are commissioned, operated and monitored so as to prevent failures, resulting in unsafe conditions.

5.1 Commissioning

This shall include the first time commissioning of the diesel engine system as well as the re-commissioning after repairs. Detailed check lists shall be prepared to cover:-

   a. Installation checks
   b. Pre start up checks
   c. Start up checks

Typical check list for start up is as per Annexure-2.

5.2 Operation & Monitoring

The operation and monitoring procedures shall include the following:-

   a. Ensuring proper operation of equipment as recommended by the OEM/ relevant standards..
b. Engine exhaust shall be routed to a safe location.

c. Engine RPM monitoring.

d. Ensuring proper functioning of the auxiliary systems by noting suitable parameters like:-

i) Cooling water level

ii) Cooling water temperature

iii) Fuel tank level

iv) Air inlet filter DP

v) Lubrication oil level

vi) Oil pressure

vii) Exhaust temperature etc.

e. Visual inspection for any leakage from engine fuel system, lubrication oil system and cooling water system. Notice for any abnormal sound.

f. Proper display boards detailing the precautions to be observed in handling the equipment including its safe start-up and shut down procedure shall be displayed prominently near the equipment.

6.0  INSPECTION SCHEDULES FOR MAINTENANCE

System should be in place for periodic inspection. Schedules shall be finalized based on OEM recommendation. The inspection schedules shall mainly include:

6.1  Weekly Inspection

The following checks shall be done weekly:-

i) Walk around inspection for any leakages

ii) Check for fuel level in fuel tank and fuel valve position

iii) Check service meter and note

iv) Drain water from water separator

v) Check for coolant level in coolant tank

vi) Check lube oil level in crank case

vii) Check battery electrolyte level in batteries

viii) Check for belt tension

ix) Check hoses and clamp condition

x) Check engine mounts for any damages

6.2  250 running hours inspections

The following checks shall be carried out after every 250 hours:-

i) Check condition of oil and change if required

ii) Check the fuel filter elements for metal particles clean it or replace if required.

iii) Check for lubrication oil filter elements for holes and tears, gaskets and ‘O’ rings for damage and replace if required.

iv) Coolant PH value. Change corrosion resistor element if PH value is below normal range of 8.5-10.5.

v) Belts; New belts will stretch within one hour of use. These shall be readjusted.

vi) Fan hub and drives.

vii) Throttle linkage

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6.3 1500 running hours / 2 years (which-ever is earlier) inspection

The following checks shall be done after 1500 hours/ 2 years whichever is earlier:-

i) All maintenance checks mentioned in the 250 hours maintenance schedule shall be repeated.

ii) Thermostat operation. It should start opening and closing fully within the range prescribed by the manufacturer.

iii) Fan hub and drive. Mounting bolts and bearing endplay shall be checked.

iv) Water pump, i.e. check the impeller and bearings.

v) Turbocharger oil leaks.

vi) Exhaust and inlet manifold nuts and cap screws.

vii) Vibration damper for eccentricity

6.4 4000 running hours / 3 years (which-ever is earlier) inspection

The following checks shall be done :-

i) All the checks mentioned in 1500 hours maintenance schedule shall be repeated.

ii) Turbocharger bearings, impeller and diffuser check and float.

iii) Crankshaft end float. If in excess of recommended limit take corrective action.

6.5 8000 running hours / 5 years (which-ever is earlier) inspection

i) Repeat all the checks mentioned in the 4000 hours schedule.

ii) Carry out complete overhauling of the engine carrying out the following checks:
   a) Check crank shaft-main bearing journals, bearings, big end bearing journals and big end bearings. Check connecting rod, piston and piston rings
   b) Check all valves
   c) Check cam shaft and drive gears
   d) Overhaul lube oil pump.

iii) Calibrate fuel injectors & timing device

7.0 PART WISE INSPECTION

7.1 Cylinder head valves

The following shall be checked:

i) Valves seats and, if required, carry out grinding.

ii) Valve guides, if required, replace it.

iii) Valve rocker shafts and bushes; if worn out or distorted replace the same.

iv) Check valve spring stiffness.

7.2 Cylinder block

Cylinder liner bores be checked for wear. Measure the ovality of the cylinder liner. If it is not within the manufacturer's recommendation, replace the same. Check piston and piston rings. While replacing liners, replace piston and piston rings also.

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7.3 Connecting rods

Check connecting rods for distortion. Gudgeon pin bushes are to be renewed along with the pistons during major overhaul.

7.4 Crankshaft

Main and connecting rod journals shall be measured and ground to the next under size if found necessary. After grinding, use new under-size bearings. Check end-float. Check bearing clearance, replace if necessary. Check bedding and locking arrangement.

7.5 Fuel injection system

The fuel pump shall be inspected and overhauled.

7.6 Cam Shafts

The following shall be checked:
  i) Cam wear and tear.
  ii) Journals and bushings
  iii) Cam shafts shall be checked for straightness.

7.7 Cooling systems

The following inspection shall be carried out:
  i) Inspect radiators for leaks.
  ii) Inspect radiator hoses.
  iii) Open heat exchangers, clean the tubes and pressure test the same.
  iv) In case of tube leakages beyond 10 per cent of the number of tubes, the tube bundle shall be replaced.

7.8 Chassis overhaul

  i) The chassis shall be checked for distortion.
  ii) All spring hanger brackets shall be checked for wear.
  iii) It shall be ensured that spring check cambering are done as recommended by the manufacturer.

8.0 FAILURE ANALYSIS

i) Failure of diesel engine shall be analyzed thoroughly.
ii) Root cause shall be established for each premature failure and necessary corrective action shall be implemented to improve the engine reliability.
iii) Root cause analysis shall be carried out as per the OISD-RP 126.

9.0 CHANGE MANAGEMENT

a) Change management systems shall be in place as per OISD-RP- 126.

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b) Changes in the Process and Equipment related parameters or any related System shall be properly reviewed by all concerned and approved by designated authority and suitably documented.

10.0 DOCUMENTATION

Following documents shall be maintained:-

a) Installation & Test Plan
b) Standard Maintenance Procedure
c) Equipment Failure History
d) Failure Analysis Report
11.0 REFERENCES

This Standard shall be read in conjunction with the following standards, codes & publications:-

i) OISD-RP-126 (Specific maintenance practices for rotating equipment)
ii) ISO 3046 (Reciprocating internal combustion engines – Performance)
iii) EEMUA 107 (Recommendations for the protection of Diesel engines for use in Zone 2 hazardous areas issued by The Engineering Equipment & Materials User Association London U.K.)
iv) Troubleshooting and repairing of diesel engines by Paul K. Dempsey.
Annexure-1

ENGINE MONITORING AND PROTECTION INSTRUMENTATION

This is a comprehensive list of instrumentation & protections and is intended to cover all types of installation. It requisite instrumentation, alarms and shutdowns shall be selected depending upon specific site requirements. The minimum essential instruments are indicated with an asterisk. Whether an indicator is local or on the control panel will be dictated by the site specific requirements.
## MONITORING AND PROTECTION INSTRUMENTATION

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<td>HH*</td>
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<td></td>
<td></td>
<td>L</td>
<td>LL</td>
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<tr>
<td>Hours run</td>
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<tr>
<td>Turbocharger speed</td>
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<td>H</td>
<td>HH</td>
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<td></td>
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<td>L</td>
<td>LL</td>
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<tr>
<td>Engine vibration</td>
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<tr>
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</tr>
<tr>
<td>Lube oil sump</td>
<td>X*</td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Coolant</td>
<td>X*</td>
<td>L</td>
<td>LL</td>
</tr>
<tr>
<td>Air filter oil bath</td>
<td>X*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Fuel day tank</td>
<td>X*</td>
<td>H</td>
<td>L</td>
</tr>
<tr>
<td><strong>ELECTRICAL/INSTRUMENTS</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mains power</td>
<td>X*</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Battery voltage</td>
<td>X*</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Battery charger on</td>
<td>X*</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Instrument power</td>
<td>X*</td>
<td>L</td>
<td></td>
</tr>
<tr>
<td>Instrument pneumatic pressure</td>
<td>X*</td>
<td>L</td>
<td></td>
</tr>
</tbody>
</table>

* Indicates essential indication and ESD functions.

(1) One per cylinder head for combustion diagnostics.
(2) Sensing points on each cylinder block.
(3) Start permissive.
X Indicates a requirement.
H Indicates alarm on high warning.
L Indicates alarm on low warning.
HH Indicates shutdown on high overshoot.
LL Indicates shutdown on low undershoot.
**Annexure 2**

**DIESEL ENGINE START-UP CHECK LIST**

This checklist should be used to validate the completion of diesel engine start-up procedure. A check-list should be completed for each diesel engine.

**Diesel Engine environment and services**

- Pre commissioning work & checklist complete
- Surroundings clean & clear from obstruction
- Lighting / heating, etc., systems operational

Observations……………………………………………………………………

**Safety Checks**

- Ensure starting is inhibited until start-up is required
- Set clean and fully assembled
- No loose materials near set
- Air ducts clear and clean
- Access & egress routes unobstructed & labeled
- Control & maintenance positions unobstructed
- Room secure – no unauthorized access
- Personnel warned of start-up process

**Cooling System**

- Cooling water pipe work checked for leaks
- Cooling water pump belts & guards checked for security / slipping
- Coolant heater operational if provided
- Cooling water is with added scale and corrosion inhibitors check
- Cooling water level & valves open
- Fans, pumps and controls checked
- Secondary cooling system checked
- Record dosing chemical & concentration..............................

**Diesel Fuel System**

- Bulk storage facility
- Isolating valves correctly positioned
- Transfer pump & controls operational
### Pipeline / tank heating system operational
- [ ]

### Fill point alarm operational
- [ ]

### Leaks check
- [ ]

### Storage facility secure
- [ ]

### Day tank isolating and solenoid valves checked
- [ ]

### Tank filled
- [ ]

### Spillage containment & alarms operational
- [ ]

### Transfer pump operational
- [ ]

### Leak check
- [ ]

### Fire valves & release tested and operational
- [ ]

---

### Fire alarm / suppression system

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fire alarm / suppression system operational</td>
<td>[ ]</td>
</tr>
<tr>
<td>Suppression system lock-off operational</td>
<td>[ ]</td>
</tr>
<tr>
<td>Operator instructed in fire system operation</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

### Lubrication system

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine oil pan filled to correct level</td>
<td>[ ]</td>
</tr>
<tr>
<td>Oil make up system operational</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

### Starting system

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery starting</td>
<td>[ ]</td>
</tr>
<tr>
<td>Batteries installed, filled and connected</td>
<td>[ ]</td>
</tr>
<tr>
<td>Battery charger commissioned</td>
<td>[ ]</td>
</tr>
<tr>
<td>Isolating valves correctly positioned</td>
<td>[ ]</td>
</tr>
<tr>
<td>Condensate drained</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

### Exhaust system

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check security of pipe work &amp; muffler</td>
<td>[ ]</td>
</tr>
<tr>
<td>Check cowl and/or rain cap are operational</td>
<td>[ ]</td>
</tr>
<tr>
<td>Check water drain pipe work and valves correct</td>
<td>[ ]</td>
</tr>
<tr>
<td>Leak check</td>
<td>[ ]</td>
</tr>
<tr>
<td>Check for exhaust gas recirculation</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

### Ventilation & attenuation

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Check louvers are clear and operational</td>
<td>[ ]</td>
</tr>
<tr>
<td>Forced ventilation system operational if applicable</td>
<td>[ ]</td>
</tr>
<tr>
<td>Check for hot air recirculation</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

### Initial start-up

<table>
<thead>
<tr>
<th>Task</th>
<th>Status</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual start-up, idle &amp; full speed checks complete</td>
<td>[ ]</td>
</tr>
</tbody>
</table>

---

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Local stop / emergency stop control checked
Remote start / stop / emergency stop checked

Checklist completed by ........................................
Date ........................................................................

Annexure-3

Diesel Engine Protections

A diesel engine is designed with protection systems to alert the operators of abnormal conditions and to prevent the engine from destroying itself.

Over-speed Device - Because a diesel Engine is not self-speed-limiting, a failure in the governor, injection system, or sudden loss of load could cause the diesel Engine to over speed. An over speed condition is extremely dangerous because engine failure is usually catastrophic and can possibly cause the engine to fly apart.

An over speed device, usually some type of mechanical flyweight, will act to cut off fuel to the engine and alarm at a certain preset rpm. This is usually accomplished by isolating the governor from its oil supply, causing it to travel to the no-fuel position, or it can override the governor and directly trip the fuel rack to the no-fuel position.

Water Jacket - Water-cooled engines can overheat if the cooling water system fails to remove excess heat. Removal of the excess heat prevents the engine from seizing due to excessive expansion of the components under a high temperature condition. The cooling water jacket is commonly where the sensor for the cooling water system is located.

The water jacket temperature sensors provide early warning of abnormal engine temperature, usually an alarm function only. The set point is set such that if the condition is corrected in a timely manner, significant engine damage will be avoided. But continued engine operation at the alarm temperature or higher temperatures will lead to engine damage.

Exhaust In a diesel engine, exhaust temperatures are very important and can temperatures -provide a vast amount of information regarding the operation of the engine. High exhaust temperature can indicate an overloading of the engine or possible poor performance due to inadequate scavenging (the cooling effect) in the engine. Extended operation with high exhaust temperatures can result in damage to the exhaust valves, piston, and cylinders. The exhaust temperature usually provides only an alarm function.

Low lube Oil: Low oil pressure or loss of oil pressure can destroy an engine in short pressure -order. Therefore, most medium to larger engines will stop upon low or loss of oil pressure. Loss of oil pressure can result in the engine seizing due to lack of lubrication. Engines with mechanical-hydraulic governors will also stop due to the lack of oil to the governor.

The oil pressure sensor usually stops the engine. The oil pressure sensors on larger engines usually have two low pressure set points. One set point provides early warning of abnormal oil pressure, an alarm function only. The second set point can be set to shutdown the engine before permanent damage is done.

High Crankcase: High Crankcase pressure is usually caused by excessive blow-by (gas pressure - pressure in the cylinder blowing by the piston rings and into the crankcase). The high pressure

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condition indicates the engine is in poor condition. The high crankcase pressure is usually used only as an alarm function.

Annexure-4

DIESEL ENGINE OPERATIONAL TERMINOLOGY

The following are some of the most commonly used terms in operation of a diesel engine.

Bore and Stroke

Bore and stroke are terms used to define the size of an engine. As previously stated, bore refers to the diameter of the engine’s cylinder, and stroke refers to the distance the piston travels from the top of the cylinder to the bottom. The highest point of travel by the piston is called top dead center (TDC), and the lowest point of travel is called bottom dead center (BDC). There are 180° of travel between TDC and BDC, or one stroke.

Engine Displacement

Engine displacement is one of the terms used to compare one engine to another. Displacement refers to the total volume displaced by all the pistons during one stroke. The displacement is usually given in cubic inches or liters. To calculate the displacement of an engine, the volume of one cylinder must be determined (volume of a cylinder = (\(\pi r^2\)h where \(h\) = the stroke). The volume of one cylinder is multiplied by the number of cylinders to obtain the total engine displacement.

Degree of Crankshaft Rotation

All events that occur in an engine are related to the location of the piston. Because the piston is connected to the crankshaft, any location of the piston corresponds directly to a specific number of degrees of crankshaft rotation. Location of the crank can then be stated as XX degrees before or XX degrees after top or bottom dead center.

Firing Order

Firing order refers to the order in which each of the cylinders in a multicylinder engine fires (power stroke). For example, a four cylinder engine’s firing order could be 1-4-3-2. This means that the number 1 cylinder fires, then the number 4 cylinder fires, then the number 3 cylinder fires, and so on. Engines are designed so that the power strokes are as uniform as possible, that is, as the crankshaft rotates a certain number of degrees, one of the cylinders will go through a power stroke. This reduces vibration and allows the power generated by the engine to be applied to the load in a smoother fashion than if they were all to fire at once or in odd multiples.
MAJOR COMPONENTS OF A DIESEL ENGINE

Figure 1 shows a typical cross section of a medium-sized, four-stroke, supercharged, diesel engine with inlet ports and exhaust valves. Figure 2 provides a cross section of a similarly sized V-type diesel engine.
Figure-2

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