

Specification for Diesel Engines

Revision history

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Acknowledgements

This IOGP Specification was prepared by a Joint Industry Programme 33 Standardization of Equipment Specifications for Procurement organized by IOGP with support by the World Economic Forum (WEF).

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Foreword

This specification was prepared under Joint Industry Programme 33 (JIP33) "Standardization of Equipment Specifications for Procurement" organized by the International Oil & Gas Producers Association (IOGP) with the support from the World Economic Forum (WEF). Companies from the IOGP membership participated in developing this specification to leverage and improve industry level standardization globally in the oil and gas sector. The work has developed a minimized set of supplementary requirements for procurement, with life cycle cost in mind, resulting in a common and jointly agreed specification, building on recognized industry and international standards.

Recent trends in oil and gas projects have demonstrated substantial budget and schedule overruns. The Oil and Gas Community within the World Economic Forum (WEF) has implemented a Capital Project Complexity (CPC) initiative which seeks to drive a structural reduction in upstream project costs with a focus on industry-wide, non-competitive collaboration and standardization. The CPC vision is to standardize specifications for global procurement for equipment and packages. JIP33 provides the oil and gas sector with the opportunity to move from internally to externally focused standardization initiatives and provide step change benefits in the sector's capital projects performance.

This specification has been developed in consultation with a broad user and supplier base to realize benefits from standardization and achieve significant project and schedule cost reductions.

The JIP33 work groups performed their activities in accordance with IOGP's Competition Law Guidelines (November 2020).

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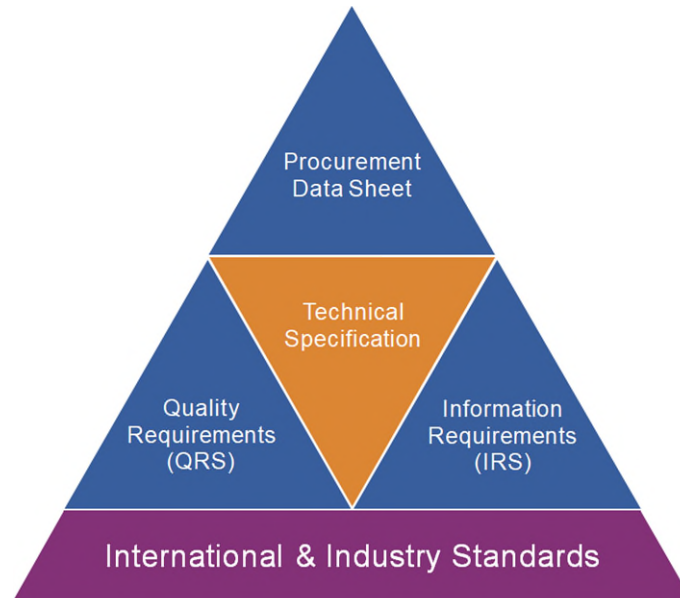
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Introduction

The purpose of this specification is to define a minimum common set of requirements for the procurement of diesel engines for application in the petroleum and natural gas industries.

This specification follows a common document structure comprising the four documents as shown below, which together with the purchase order define the overall technical specification for procurement.



JIP33 Specification for Procurement Documents Technical Specification

This specification is to be applied in conjunction with the supporting procurement data sheet, information requirements specification (IRS) and quality requirements specification (QRS) as follows.

IOGP S-711: Specification for Diesel Engines

This specification defines the technical requirements for the supply of the equipment.

IOGP S-711D: Procurement Data Sheet for Diesel Engines

The procurement data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The procurement data sheet may also include fields for supplier provided information attributes subject to purchaser's technical evaluation. Additional purchaser supplied documents may also be incorporated or referenced in the procurement data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-711L: Information Requirements for Diesel Engines

The IRS defines the information requirements, including contents, format, timing and purpose to be provided by the supplier. It may also define specific conditions which invoke information requirements.

IOGP S-711Q: Quality Requirements for Diesel Engines

The QRS defines quality management system requirements and the proposed extent of purchaser conformity assessment activities for the scope of supply. Purchaser conformity assessment activities are defined through the selection of one of four generic conformity assessment system (CAS) levels on the basis of evaluation of the associated service and supply chain risks. The applicable CAS level is specified by the purchaser in the data sheet or in the purchase order.

The terminology used within this specification and the supporting procurement data sheet, IRS and QRS is in accordance with ISO/IEC Directives, Part 2.

The procurement data sheet and IRS are published as editable documents for the purchaser to specify application specific requirements. The specification and QRS are fixed documents.

The order of precedence (highest authority listed first) of the documents shall be:

- a) regulatory requirements;
- b) contract documentation (e.g. purchase order);
- c) purchaser defined requirements (procurement data sheet, IRS, QRS);
- d) this specification.

1 Scope

This specification covers the design, manufacture, inspection and testing requirements for four-stroke industrial diesel engines in offshore and onshore oil and gas applications.

This specification contains general requirements which should be applied along with the specific requirements contained in the individual package specifications.

The requirements in this specification are intended for use with the following applications:

- a) power generation:
 - emergency generator packages;
 - diesel-electric generator for firewater pump packages;
 - main, stand-by, and essential power generation.
- b) mechanical drive:
 - firewater pump packages;
 - prime mover for rotating equipment;
 - drivers for offshore pedestal and land based cranes.

2 Normative references

The following publications are referred to in this document, the procurement data sheet (S-711D) or the IRS (S-711L) in such a way that some or all of their content constitutes requirements of this specification. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ASME BPVC, Section VIII, Division 1, *Rules for Construction of Pressure Vessels*

ASME BPVC, Section VIII, Division 2, *Alternative Rules - Rules for Construction of Pressure Vessels*

ASME PTC 17, *Reciprocating Internal-Combustion Engines*

ASTM D975, *Standard Specification for Diesel Fuel*

BS 2869, *Fuel oils for agricultural, domestic and industrial engines and boilers*

DIN 51601, *Liquid fuels; Diesel fuel; minimum requirements*

EN 1834-1, *Reciprocating internal combustion engines - Safety requirements for design and construction of engines for use in potentially explosives atmospheres - Part 1: Group II Engines for use in flammable gas and vapour atmospheres*

EN 13445, *Unfired pressure vessels*

IEC 60079 (all parts), *Explosive atmospheres*

ISO 3046-4, *Reciprocating internal combustion engines — Performance — Part 4: Speed governing*

ISO 3046-5, *Reciprocating internal combustion engines — Performance — Part 5: Torsional vibrations*

ISO 3046-6, *Reciprocating internal combustion engines — Performance — Part 6: Overspeed protection*

ISO 8178, *Reciprocating internal combustion engines — Exhaust emission measurement*

ISO 10816-6, *Mechanical vibration — Evaluation of machine vibration by measurements on non-rotating parts — Part 6: Reciprocating machines with power ratings above 100 kW*

ISO 12944-2, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 2: Classification of environments*

ISO 12944-5, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 5: Protective paint systems*

ISO 12944-6, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 6: Laboratory performance test methods*

ISO 12944-9, *Paints and varnishes — Corrosion protection of steel structures by protective paint systems — Part 9: Protective paint systems and laboratory performance test methods for offshore and related structures*

ISO 15550, *Internal combustion engines — Determination and method for the measurement of engine power — General requirements*

ISO 16890-1, *Air filters for general ventilation — Part 1: Technical specifications, requirements and classification system based upon particulate matter efficiency (ePM)*

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*

NFPA 70, *National Electrical Code*

3 Terms and definitions

3.1

hazardous area

area in which an explosive atmosphere is present, or may be expected to be present, in quantities such as to require special precautions for the construction, installation and use of equipment

[Source IEC 60079-0:2017, 3.2]

3.2

safety critical service

where unavailability of equipment may cause an unsafe situation leading to potential for personnel injury or fatality, damage to the environment and loss or severe damage to property

4 General requirements

The diesel engine, including all auxiliaries, shall be designed for a minimum service life of 20 years.

NOTE This requirement is a design criterion. Service or duty severity, maloperation, or improper maintenance can result in the machine failing to meet this criterion.

5 Technical requirements

5.1 Engine design

5.1.1 Direction of rotation

The direction of rotation of the diesel engine shall be permanently marked on the engine in a visible location at the drive end of the engine.

5.1.2 Crankcase ventilation system

5.1.2.1

Diesel engines shall have a crankcase breather.

5.1.2.2

The diesel engine crankcase breather outlet shall be flanged at the skid edge if not routed to the engine air intake.

5.1.3 Engine barring device

The barring device shall be interlocked with the diesel engine starting system.

5.1.4 Mechanical handling

Components over 25 kg (55 lb) and requiring onsite removal for maintenance shall have lifting lugs or provisions for lifting eyebolts.

5.1.5 Personnel protection

Surfaces exceeding 60 °C (140 °F) in areas that are accessible during operation and for inspection shall have personnel protection.

5.2 Starting system

5.2.1 General

5.2.1.1

Starting systems shall be rated for handling three consecutive cranking cycles, each of 15 seconds of cranking and 15 seconds of rest, without recharging the battery or pressurizing the air vessel or hydraulic oil accumulator.

5.2.1.2

Diesel engines in safety critical services shall have two independent starting systems.

5.2.1.3

Diesel engines that have two independent starting systems shall have an automatic changeover device.

5.2.1.4

If the engine fails to start after a complete cycle of cranking attempts, the starting sequence shall be aborted with a "failure to start" indication in the engine control panel or the unit control panel.

5.2.2 Electric starting system

5.2.2.1

Batteries located in a compartment shall be ventilated.

5.2.2.2

The battery charger shall be a solid state type with current limiting features to match battery characteristics.

5.2.2.3

The battery charger shall have an incoming circuit breaker.

5.2.2.4

The battery charger shall have output surge protection.

5.2.3 Pneumatic starting system

5.2.3.1

Diesel engine mounted air starter motors shall have control and overpressure protection.

5.2.3.2

Direct injection starting systems shall have double check valves between the air source and the engine.

5.2.4 Hydraulic starting system

5.2.4.1

If a hydraulic starting system is the only means of starting, the hydraulic oil pump shall be driven by an electric motor.

5.2.4.2

Hydraulic oil pumps shall be sized to recharge accumulators within 15 minutes.

5.3 Air inlet and exhaust system

5.3.1 Air inlet system

5.3.1.1

Pre-filters shall be rated for a filtration efficiency class of ISO ePM10 50 % or higher, in accordance with ISO 16890-1.

5.3.1.2

Diesel engine air filters shall have a service indicator.

5.3.1.3

Two-stage air filters shall have differential pressure indicators.

5.3.1.4

Charge air coolers shall have a condensate draining feature.

5.3.1.5

Diesel engines with air inlet ducting shall have an expansion bellow.

5.3.2 Exhaust

5.3.2.1

Diesel engine exhausts shall have exhaust silencers.

5.3.2.2

The exhaust silencer of diesel engines in an enclosure or container shall be outside the enclosure or container.

5.3.2.3

The diesel engine exhaust shall have an expansion bellow.

5.4 Engine fuel system

Main filters and pre-filters shall have individual local differential pressure indicators.

5.5 Engine lubrication system

5.5.1

Lubrication oil filters shall have a differential pressure indicator.

5.5.2

The oil side pressure of the lubrication oil cooler shall be higher than the water side pressure.

5.6 Engine cooling system

5.6.1

Radiators or external air coolers shall be designed for 110 % of the heat load at the maximum engine power, at maximum ambient design temperature.

5.6.2

Water-cooled heat exchangers shall be designed for 110 % of the maximum heat load at the maximum cooling medium inlet temperature.

5.6.3

Radiator cooler fans located on the diesel engine baseplate shall be driven from the engine drive shaft through direct drive, V-belt drive or toothed belt drive.

5.6.4

Radiator cooler fans located separately from the diesel engine baseplate shall be electric motor driven through a V-belt drive or flexible coupling.

5.6.5

The cooling system shall have a high point vent.

5.6.6

The cooling system shall have a low point drain.

5.6.7

Expansion tanks shall have a sight glass or level gauge.

5.6.8

Expansion tanks of diesel engines in safety critical or unattended services shall have a level transmitter.

5.7 Vibration and rotor dynamics

5.7.1

Data and vibration calculation for torsional analysis shall be in accordance with ISO 3046-5.

5.7.2

Vibration points, direction and limits shall be in accordance with ISO 10816-6.

5.8 Control, monitoring and protection

5.8.1 Engine control panel

5.8.1.1

Overspeed trip and emergency stop shall have a hardwired signal interface.

5.8.1.2

The diesel engine control panel shall have a communication interface or hardware interface.

5.8.2 Overspeed and emergency shutdown

5.8.2.1

Diesel engines shall have two independent speed sensors for shutdown of the engine (1 out of 2).

5.8.2.2

Overspeed protection shall be in accordance with ISO 3046-6.

5.8.2.3

The overspeed trip set point shall be 110 % of the rated speed.

5.8.2.4

The diesel engine control panel shall have provision for manual reset following an overspeed trip or emergency shutdown, prior to re-start.

5.8.2.5

The air inlet shut-off valve, where provided, shall be latched in the "closed" position following an emergency shutdown (ESD) or overspeed trip.

5.8.2.6

Air inlet shut-off valves shall have a local manual reset.

5.8.2.7

For diesel engines provided with a post lubrication system, the post lubrication system cycle shall be bypassed on receipt of an emergency shutdown signal.

5.8.3 Alarms and trips

5.8.3.1

Diesel engines shall have monitoring, alarm and trip functions in accordance with Table 1.

5.8.3.2

Diesel engines in safety critical services, while in "auto" or "remote" operation, trip interlocks with the exception of overspeed trip and manual stop shall be bypassed.

Table 1 — Monitoring, alarm and trip functions

Condition	Indication	Alarm	Trip
Engine speed (H, HH)	X	X	X
Engine vibration (H, HH)	X	X	X
Lube oil supply temperature (H, HH)	X	X	X
Lube oil supply pressure (L, LL)	X	X	X
Lube oil filter differential pressure (H)	X	X ^a	
Lube oil sump level (L, LL)	X	X	X
Jacket water temperature (H, HH)	X	X	X
Expansion tank level (L)	X	X	
Inlet air filter differential pressure (H)	X	X ^a	
Temperature of the charge-air downstream of the cooler (H)	X	X ^a	
Main fuel filter differential pressure (H)	X	X ^a	
Fuel pre-filter differential pressure across (H)	X	X ^a	
Day tank fuel level (L)	X	X	
Engine service-hours meter	X		
Radiator cooler fan vibration high (H)	X	X	
Manual stop (HH)	X		X
Abort of engine starting	X		
^a Continuous operation only			

5.9 Speed governors

Speed governors shall be in accordance with ISO 3046-4.

5.10 Coupling and guard

5.10.1

Coupling adapters shall not be used for crank shafts with an integrally forged shaft end for flywheel assembly.

5.10.2

The coupling and the coupling to shaft juncture (if applicable) shall be based on the torsional analysis with a minimum service factor specified by the supplier of the coupling.

5.10.3

Couplings and flywheels shall have guards.

5.11 Mounting plate

5.11.1

The diesel engine sub-baseplate shall have four lifting lugs designed for a single-point lift.

5.11.2

The diesel engine sub-baseplate shall be fabricated from structural steel with continuous welding.

5.11.3 Mounting plate finish

5.11.3.1

Mounting plates shall be flat and parallel to within 0,15 mm/m (0,002 in/ft).

5.11.3.2

Mounting plate surface finish shall be Ra 3,2 µm (125 µin).

5.11.4

Machinery mounting plates shall extend at least 25 mm (1 in) beyond the outer three sides of the equipment feet.

5.11.5

Shim plates for alignment shall be 300 series stainless steel.

5.11.6 Baseplate drip rim

5.11.6.1

Baseplates shall have a drip rim.

5.11.6.2

Baseplate drip rims shall be continuously welded.

5.11.6.3

The drip rim shall have a drain connection.

5.12 Hazardous area requirements

5.12.1

Diesel engines and auxiliaries installed in a hazardous area shall comply with the requirements of EN 1834-1 or NFPA 37.

5.12.2

The maximum surface temperature shall be based on peak engine power at the operating conditions in accordance with EN 1834-1.

5.12.3

Insulation used to reduce surface temperature shall be impermeable.

5.12.4

Radiator fan blades shall be made of non-sparking material.

5.12.5

Crankcases shall have an explosion relief device with a flame arrestor.

5.12.6

Coupling guards shall be made of non-sparking material.

5.12.7

The diesel engine exhaust shall have a spark arrestor.

6 Materials and coatings

6.1

Cast iron, carbon steel and low alloy steel external surfaces shall be coated.

6.2

Coating systems for outdoor applications in offshore and coastal environments with atmospheric corrosion category CX, defined by ISO 12944-2, shall be in accordance with ISO 12944-9.

6.3

High durability coating systems in accordance with ISO 12944-5 shall be applied for environments with atmospheric corrosivity category C3, C4 and C5 defined by ISO 12944-2.

6.4

Coatings for environments with atmospheric corrosion category C3, C4 and C5 defined by ISO 12944-2 shall be qualified in accordance with ISO 12944-6.

7 Inspection, testing and preparation for shipment

7.1 General

7.1.1

Auxiliary pressure containing equipment shall be hydrostatically tested.

7.1.2

Exhaust emissions shall be tested in accordance with ISO 8178.

7.2 Mechanical and performance test

7.2.1

Performance testing shall be in accordance with ISO 15550 or ASME PTC 17.

7.2.2

Mechanical overspeed devices shall be tested at the specified trip speed.

7.3 Preparation for shipment

7.3.1

The diesel engine shall be preserved for outdoor storage for a period of six months.

7.3.2

Exposed machined and unpainted surfaces, except for corrosion resistant materials, shall be coated with a rust preventive.

7.3.3

Flanged openings shall be provided with protective covers, sealed and made of weatherproof material.

7.3.4

Threaded openings shall have a steel cap or plug.

7.3.5

Lifting points, weight and centre of gravity shall be identified on the equipment.

Bibliography

ISO 2710, *Reciprocating internal combustion engines — Vocabulary*

ISO 3046, *Reciprocating internal combustion engines — Performance*

ISO 5011, *Inlet air cleaning equipment for international combustion engines and compressors — Performance testing*

ISO 6798, *Reciprocating internal combustion engines — Measurement of emitted airborne noise — Engineering method and survey method*

ISO 7967, *Reciprocating internal combustion engines — Vocabulary of components and systems*

ISO 14396, *Reciprocating internal combustion engines — Determination and method for the measurement of engine power — Additional requirements for exhaust emission tests in accordance with ISO 8178*

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