International Association of Oil & Gas Producers

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Specification for Diesel Generator Package

JIP33
JOINT INDUSTRY PROGRAMME

Revision history

VERSION	DATE	PURPOSE
0.1	September 2020	Issued for Public Review

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).

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 2014).

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Introduction

The purpose of this specification is to define a minimum common set of specification requirements for the procurement of a diesel generator package 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
Supplementary Technical Specification

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

IOGP S-714: Specification for Diesel Generator Package

This specification is written as a set of minimum requirements for the procurement of a diesel generator package. The terminology used within this specification is in accordance with ISO/IEC Directives, Part 2.

IOGP S-714D: Data Sheet for Diesel Generator Package

The data sheet defines application specific requirements, attributes and options specified by the purchaser for the supply of equipment to the technical specification. The 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 data sheet to define scope and technical requirements for enquiry and purchase of the equipment.

IOGP S-714Q: Quality Requirements for Diesel Generator Package

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.

IOGP S-714L: Information Requirements for Diesel Generator Package

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.

This specification enables the user to invoke other JIP33 supporting specifications via defined options in the data sheet (S-714D). These are set to 'off' by default to reflect manufacturer's standard for an industrialized supply. When the supporting specification options are invoked they only apply to the respective technical requirements specification and associated data sheet. These options do not apply to the information and quality requirements components of the supporting specifications. Information and quality requirements are covered entirely within the package level IRS (IOGP S-714L) and QRS (IOGP S-714Q) of this specification.

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

The 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 (data sheet, QRS, IRS);

d) this specification.

1 Scope

This specification provides requirements for the design, materials, fabrication, inspection, testing, documentation and preparation for shipment of diesel generator packages with rated power up to 3,5 MVA at less than 1 000 V 3-phase.

Generator requirements cover designs according to both IEC and North American standards. Diesel engine requirements are covered in IOGP S-711.

This specification excludes portable generator sets for temporary services.

2 Normative References

ANSI C84.1, *Electric Power Systems and Equipment — Voltage Ratings (60 Hz)*

ANSI/ISA-S5.1, *Instrumentation Symbols and Identification*

ANSI S12.12, *Method for the Determination of Sound Power Levels of Noise Sources Using Sound Intensity*

API MPMS, *Manual of Petroleum Measurement Standards*

API Recommended Practice 14F, *Recommended Practice for Design, Installation, and Maintenance of Electrical Systems for Fixed and Floating Offshore Petroleum Facilities for Unclassified and Class I, Division 1, and Division 2 Locations*

API Recommended Practice 551, *Process Measurement*

API Recommended Practice 686, *Recommended Practice for Machinery Installation and Installation Design*

API Standard 546, *Brushless Synchronous Machines - 500 kVA and Larger*

ASME B16.5, *Pipe Flanges and Flanged Fittings NPS ½ Through NPS 24 Metric/Inch Standard*

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*

ASME B36.19M, *Stainless Steel Pipe*

ASME BPVC, Section IX, *Welding and Brazing Qualifications*

ASME PTC 17, *Performance test code- Reciprocating internal combustion engines*

ASME PTC 19.3 TW, *Thermowells*

ASNT SNT-TC-1A, *Personnel Qualification and Certification in Nondestructive Testing*

ASTM A269/A269M, *Standard Specification for Seamless and Welded Austenitic Stainless Steel Tubing for General Service*

ASTM E230/E230M, *Standard Specification for Temperature-Electromotive Force (emf) Tables for Standardized Thermocouples*

ASTM E608/E608M, *Standard Specification for Mineral-Insulated, Metal-Sheathed Base Metal Thermocouples*

ASTM E1137/E1137M, *Standard Specification for Industrial Platinum Resistance Thermometers*

AWS D1.1, *Structural welding - Steel*

EN 50288-7, *Multi-element metallic cables used in analogue and digital communication and control - Part 7: Sectional specification for instrumentation and control cables*

EN 50289-4-17, *Communication cables - Specifications for test methods - Part 4-17: Test methods for UV resistance evaluation of the sheath of electrical and optical fibre cable*

IEC 60034, *Rotating electrical machines*

IEC 60034-22, *Rotating electrical machines – Part 22: AC generators for reciprocating internal combustion (RIC) engine driven generating sets*

IEC 60038, *IEC standard voltages*

IEC 60072-1, *Dimensions and Output Series for Rotating Electrical Machines*

IEC 60072-2, *Dimensions and output series for rotating electrical machines - Part 2: Frame numbers 355 to 1000 and flange numbers 1180 to 2360*

IEC 60073, *Basic and safety principles for man-machine marking and identification – principles for indicators and actuators*

IEC 60079, *Explosive Atmospheres*

IEC/IEEE 60079-30, *Explosive atmospheres - Part 30: Electrical resistance trace heating*

IEC 60092, *Electrical installations in ships*

IEC 60092-350, *Electrical installations in ships - Part 350: General construction and test methods of power, control and instrumentation cables for shipboard and offshore applications*

IEC 60092-360, *Electrical installations in ships - Part 360: Insulating and sheathing materials for shipboard and offshore units, power, control, instrumentation and telecommunication cables*

IEC 60092-376, *Electrical installations in ships - Part 376: Cables for control and instrumentation circuits 150/250 V (300 V)*

IEC 60196, *IEC standard frequencies*

IEC 60204-1, *Safety of machinery - Electrical equipment of machines - Part 1: General requirements*

IEC 60331, *Tests for electric cables under fire conditions*

IEC 60332, *Tests on Electrical and Optical Fiber Cables Under Fire Conditions*

IEC 60364-4-44, *Low-voltage electrical installations - Part 4-44: Protection for safety - Protection against voltage disturbances and electromagnetic disturbances*

IEC 60364-5-54, *Low-voltage electrical installations - Part 5-54: Selection and erection of electrical equipment - Earthing arrangements and protective conductors*

IEC 60502, *Power Cables with Extruded Insulation and Their Accessories*

IEC 60529, *Degree of protection provided by enclosures (IP Code)*

IEC 60584-1, *Thermocouples – Part 1: EMF specifications and tolerances*

IEC 60751, *Industrial platinum resistance thermometers and platinum temperature sensors*

IEC 60947-2, *Low-voltage switchgear and controlgear - Part 2: Circuit-breakers*

IEC 60947-5-1, *Low-voltage switch gear and control gear*

IEC 61000, *Electromagnetic compatibility (EMC)*

IEC 61439-1, *Low-voltage switchgear and controlgear assemblies – Part 1: General rules*

IEC 61508, *Functional safety of electrical/electronic/programmable electronic safety-related systems*

IEC 61515, *Mineral insulated metal-sheathed thermocouple cables and thermocouples*

IEC 61537, *Cable management - Cable tray systems and cable ladder systems*

IEC 61892, *Mobile and fixed offshore units - Electrical installations*

IEC 61892-3, *Mobile and fixed offshore units - Electrical installations - Part 3: Equipment*

IEC 61892-4, *Mobile and Fixed Offshore Units - Electrical Installations - Part 4: Cables*

IEC 62395, *Electrical resistance trace heating systems for industrial and commercial applications*

IEC 62443, *Security for industrial automation and control systems*

IEEE 48, *IEEE Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5 kV through 765 kV or Extruded Insulation Rated 2.5 kV through 500 kV*

IEEE 115, *Guide for Test Procedures for Synchronous Machines Including Acceptance and Performance Testing and Parameter Determination for Dynamic Analysis*

IEEE 515, *Standard for the Testing, Design, Installation, and Maintenance of Electrical Resistance Trace Heating for Industrial Applications*

IEEE 1580, *Recommended Practice for Marine Cable for Use on Shipboard and Fixed or Floating Facilities*

IOGP S-703, *Supplementary Specification to IEC 60034-1 Low Voltage Three Phase Cage Induction Motors*

IOGP S-705, *Supplementary Specification to API Recommended Practice 582 Welding Guidelines for Welding of Pressure Containing Equipment and Piping*

IOGP S-711, *Diesel Engines*

IOGP S-715, *Supplementary Specification to NORSOK M-501 Coating and Painting for Offshore, Marine, Coastal and Subsea Environments*

IOGP S-717, *Supplementary Specification to ISO 15664 Noise Emitting Equipment*

IOGP S-719, *Supplementary Specification to NFPA 750 Water Mist Fire Protection Systems*

IOGP S-730, *Supplementary Specification to API Standard 526 Flanged Steel Pressure-relief Valves*

ISO 3511, *Process measurement control functions and instrumentation*

ISO 3741, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for reverberation test rooms*

ISO 3743, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for small, movable sources in reverberant fields*

ISO 3744, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering methods for an essentially free field over a reflecting plane*

ISO 3745, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Precision methods for anechoic rooms and hemi-anechoic rooms*

ISO 3747, *Acoustics - Determination of sound power levels and sound energy levels of noise sources using sound pressure - Engineering/survey methods for use* in situ *in a reverberant environment*

ISO 3834-2, *Quality requirements for fusion welding of metallic materials - Part 2: Comprehensive quality requirements*

ISO 3834-3, *Quality requirements for fusion welding of metallic materials - Part 3: Standard quality requirements*

ISO 5167, *Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full*

ISO/TS 7849, *Acoustics - Determination of airborne sound power levels emitted by machinery using vibration measurement*

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

ISO 8528-2, *Reciprocating internal combustion engine driven alternating current generating sets - Part 2: Engines*

ISO 8528-5, *Reciprocating internal combustion engine driven alternating current generating sets*

ISO 8528-9, *Reciprocating internal combustion engine driven alternating current generating sets - Part 9: Measurement and evaluation of mechanical vibrations*

ISO 9606, *Qualification testing of welders - Fusion welding*

ISO 9614 series, *Acoustics - Determination of sound power levels of noise sources using sound intensity*

ISO 9712, *Non-destructive testing - Qualification and certification of NDT personnel*

ISO 11200 series, *Acoustics - Noise emitted by machinery and equipment - Guidelines for the use of basic standards for the determination of emission sound pressure levels at a work station and at other specified positions*

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

ISO 12944-4, *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 4: Types of surface and surface preparation*

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 12944-7, *Paints and varnishes - Corrosion protection of steel structures by protective paint systems - Part 7: Execution and supervision of paint work*

ISO 13702, *Petroleum and natural gas industries — Control and mitigation of fires and explosions on offshore production installations — Requirements and guidelines*

ISO 14731:2019, *Welding coordination - Tasks and responsibilities*

ISO 14732, *Welding personnel – Qualification testing of welding operators and weld setters for mechanized and automatic welding of metallic materials*

ISO/TR 15377, *Measurement of fluid flow by means of pressure-differential devices - Guidelines for the specification of orifice plates, nozzles and Venturi tubes beyond the scope of ISO 5167*

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

ISO 15614, *Specification and qualification of welding procedures for metallic materials - Welding procedure test*

ISO 15667, *Acoustics - Guidelines for noise control by enclosures and cabins*

ISO/IEC 17020, *Conformity assessment - Requirements for the operation of various types of bodies performing inspection*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

ISO 19901-5, *Petroleum and natural gas industries - Specific requirements for offshore structures - Part 5: Weight control during engineering and construction*

ISO 21940-11, *Mechanical vibration - Rotor balancing - Part 11: Procedures and tolerances for rotors with rigid behaviour*

NAMUR NE 43, *Standardisation of the Signal Level for the Failure Information of Digital Transmitters*

NEMA 250, *Enclosures for Electrical Equipment (1000 Volts Maximum)*

NEMA MG-1, *Motors and Generators*

NEMA VE 1, *Metal Cable Tray Systems*

NFPA 70, *National Electrical Code*

SAE J 342, *Spark arrester test procedure for large size engines*

SAE J 350, *Spark arrester test procedure for medium size engines*

SAE J 997, *Spark arrester test carbon*

UL 508A, *Standard for Safety Industrial Control Panels*

UL 845, *Motor Control Centers*

UL 1309, *Standard for Marine Shipboard Cable*

UL 1569, *Standard for Metal-Clad Cables*

UL 1685, *Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*

UL 2196, *Standard for Tests for Fire Resistive Cables*

UL 2225, *Standard for Cables and Cable-Fittings For Use In Hazardous (Classified) Locations*

UL 2250, *Standard for Instrumentation Tray Cable*

UL 2556, *Wire and Cable Test Methods*

3 Terms and Definitions

3.1 Terms and definitions

3.1.1
black start
where the stored energy system has the capability to start the prime mover without using energy from another source

[SOURCE: NFPA 110:2019, 3.3.2]

3.1.2
listed
equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose

3.1.3
P3 type package
type of package which is controlled and monitored by industrial controllers installed in a unit control panel having data link and hard wired interfaces signals to facility control systems

3.1.4
process piping
assemblies of piping components used to convey or distribute fluid flows (excluding engine exhausts)

3.1.5
safe
secure from liability to harm, injury, danger or risk

3.2 Acronyms, Abbreviations, and Symbols

AC	alternating current
ASNT	American Society for Nondestructive Testing
ATEX	ATmosphere EXplosibles (equipment for potentially explosive atmospheres)
CE	"Conformité Européenne" (French for European Conformity)
CSWIP	Certification Scheme for Welding Inspection Personnel
CWI	Certified Welding Inspector
DC	direct current
FAT	factory acceptance test
FPSO	floating production storage and offloading facility
HMI	human machine interface
IP	ingress protection (rating code)
IWE	International Welding Engineer

IWI-S	International Welding Inspector Standard Level
IWT	International Welding Technologist
LED	light emitting diode
NDE	non destructive examination
PPE	personnel protective equipment
PQR	procedure qualification record
PWHT	post weld heat treatment
WPS	welding procedure qualification

4 Package description

4.1 Function and performance

4.1.1 Function

4.1.1.1

The diesel generator package shall supply electric power to power distribution system for emergency or essential services in the event of loss of main generators.

4.1.1.2

Diesel generators shall be designed for a black start.

4.1.1.3

The diesel generator package shall be built for unattended operation upon receiving the signal "To Start" from a local or remote location.

4.1.2 Performance

4.1.2.1

The diesel generator package shall deliver the net output at the generator terminals for the following requirements in accordance with ISO 8528:

- mode of operation - continuous operation at varying load;
- parallel operation with main power generators;
- power rating category - prime power.

4.1.2.2

Torsional and lateral natural frequencies of the complete engine-generator system (including couplings) shall not be within 10 % of any operating shaft speed.

4.1.2.3

Diesel generators in emergency service shall accept nominal load within 25 seconds from initiation of a "To Start" command.

4.1.2.4

The generator shall be capable of supplying a sustained overload of 10 % for one hour every 12 hours.

4.2 Project specific data

4.2.1

The diesel generator package and the components within shall be certified, based on the project requirements applicable in the area of installation, according to:

- European Standards - ATEX and CE;
- North American Standards - CSA, UL or FM;
- IEC standards - IECEx.

5 Discipline requirements

5.1 Mechanical

5.1.1

The diesel engine shall be in accordance with IOGP S-711.

5.1.2

Secondary starting systems shall automatically take over in case of failure of the primary starting system.

5.1.3 Engine control, monitoring and protection

5.1.3.1

Diesel generator package shall have the provisions for local monitoring and control.

5.1.3.2

Electronic governors shall conform to ISO 8528-5, Table 4, governor class G3.

5.1.3.3

Electronic governors shall be proportional integral differential type according to ISO 8528-2.

5.1.4

Removable guards of spark-resistant material shall be arranged around moving shafts, fans and auxiliary drives.

5.1.5 Acoustic enclosure

5.1.5.1

The diesel generator enclosure shall have removable panels for removing the generator and diesel engine for maintenance.

5.1.5.2

The diesel generator enclosure shall be in accordance with the fire integrity criteria for emergency generators according to ISO 13702, Table C.6.

5.1.5.3

Mechanically induced ventilation shall be sized to control temperature inside the enclosure within the site rated temperature for equipment design.

5.1.5.4

Fire dampers installed in the acoustic enclosure inlet and outlet shall close upon receiving a signal from the fire and gas protection system of the facility.

5.1.5.5

Tie-in connections shall be flanged and located at enclosure skid edge.

5.1.5.6

Normal and emergency lighting shall be provided inside the enclosure.

5.1.6 Fire protection system

5.1.6.1

A dedicated fire extinguishing system shall be provided for the protection of the diesel generator package.

5.1.6.2

Water mist fire protection systems shall be in accordance with IOGP S-719.

5.1.6.3

Water mist fire protection systems shall be cylinder based.

5.1.6.4

Water mist fire protection systems shall be provided with 100 % redundant propellant gas and water cylinder system.

5.1.6.5

The release of fire suppressant shall be activated from the facility fire and gas system upon fire and gas detection within the enclosure.

5.1.6.6

The fire and gas detectors within enclosure shall be interfaced with facility fire and gas system and generator control panel through a dedicated fire and gas junction box.

5.2 HSE in design

5.2.1 Noise control

5.2.1.1

Equipment exceeding the specified sound pressure level threshold shall comply with IOGP S-717.

5.2.1.2

Noise acceptance tests shall be performed in accordance with ISO 3741, ISO 3743, ISO 3744, ISO 3745, ISO 3747, ISO 7849, ISO 9614 series, ISO 11200 series or ANSI S12.12.

5.2.2 Local environment

5.2.2.1

The design of the diesel generator package shall incorporate secondary containment of liquids and eliminate or minimize the venting of vapors.

5.2.3 Reliability

5.2.3.1

The diesel generator package shall be designed for a service life of at least 20 years.

5.3 Human factors engineering

5.3.1 Access

5.3.1.1 Means of access

5.3.1.1.1

Access from grade or designated access platform shall be provided for locations intended for personnel to occupy during operations, inspections, servicing, readings and maintenance.

5.3.1.1.2

Fixed or permanent means of access to machinery and equipment shall be in the following order of preference:

1. access directly from floor or deck;
2. ramps or stairs;
3. fixed ladders.

Note Refer to Figure 1 for examples of means of access.

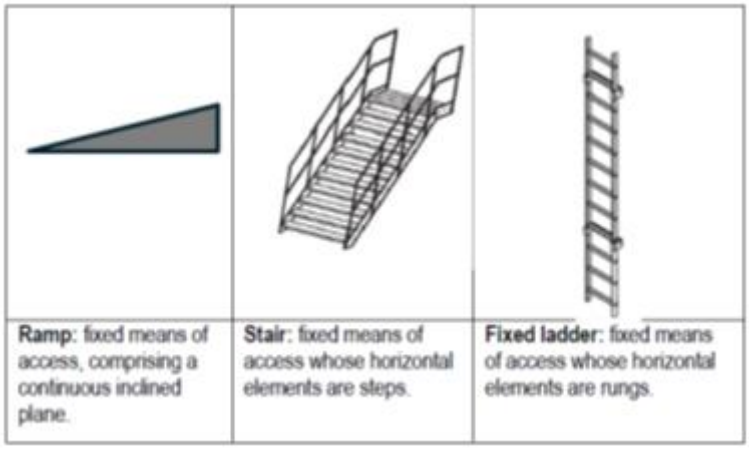

Figure 1 – Fixed or permanent means of access

5.3.1.1.3

Temporary access shall be designed to ensure recommended ergonomic body postures and space for tools and equipment.

5.3.1.1.4

Areas designated for temporary access shall be designed to:

- accommodate ancillary access equipment;
- accommodate operator, tools and consumable;
- avoid crush points and lines of fire hazards during use (including mounting, dismounting and transportation).

5.3.1.1.5

Dimensions of the following items shall be according to regulatory and specified requirements:

- ramps;
- stairs;
- fixed ladders;
- railing (handrails, guardrails, stair rails);
- walkways;
- working platforms.

5.3.1.2 Guard-rails, handrails, safety gates, toe-boards and kick-plates

5.3.1.2.1

Walkways, decks, working platforms, stairs and stepladders shall be equipped with railings according to regulatory and specified requirements to avoid injuries from falling to the level below.

5.3.1.2.2

Handrails, guardrails and stair rails shall be in accordance with regulatory and specified requirements.

5.3.1.2.3

Toe plates, kick plates and toe boards shall be included in the guardrail system.

5.3.1.2.4

Self-closing safety gates meeting regulatory and specified requirements shall be installed at the top of all ladders.

Note Refer to Figure 2 for an example.

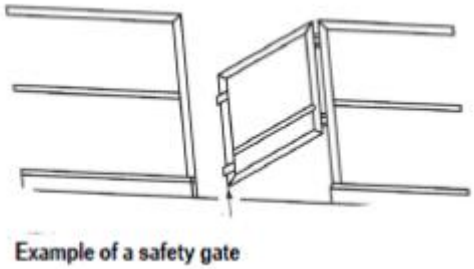

Figure 2 – Safety gate

5.3.1.2.5

Self-closing safety gates shall open away from the ladder and onto the platform or deck.

5.3.1.2.6

Safety gates shall be double bar gravity self-closing swing type.

5.3.1.2.7

Handrails and top rails shall be smooth with unobstructed finger clearance.

5.3.1.3 Walkways and access ways

5.3.1.3.1

Access ways or walkways shall be sized based on regulatory and specified requirements.

5.3.1.3.2

Equipment, piping, valves, tubing, drains, instruments, detectors, beacons and other items shall not protrude into walkways, access ways or transportation volumes.

5.3.1.3.3

Work areas, walkways and escape routes shall have anti-slip properties in accordance with regulatory and specified requirements.

5.3.1.4 Workspace

5.3.1.4.1

Workspace in accordance with regulatory and specified requirements shall be provided.

5.3.1.4.2

Required space for the use of tools, equipment, safety equipment and removal of components shall be taken into consideration.

5.3.1.4.3

Work activities shall be performed in a good ergonomic working body posture.

5.3.1.4.4

Work activities shall be performed when standing, seated when not able to stand and kneeling when work does not allow for sitting.

5.3.1.4.5

Cable trays, lighting fixtures, tubing, tubing supports and other elements shall be installed to provide head clearance as required by regulatory and specified requirements.

5.3.1.4.6

Field run items (e.g. cable trays, lighting fixtures, tubing and tubing supports) shall be installed so as not to obstruct or restrict access to equipment and machinery components.

5.3.1.5 Access to equipment and instruments

5.3.1.5.1

Installation height of valves, instruments, displays, switches, push buttons, junction boxes, detectors and other points of operator interactions shall be according to regulatory and specified requirements.

5.3.1.5.2

Visual displays, including gauges and level glasses, shall be located and orientated to allow accurate reading in all lighting conditions when standing on the floor or a working platform.

5.3.1.5.3

Safe distance between moving machinery parts and fixed objects shall be provided as defined by regulatory and specified requirements to prevent injury to human body parts.

5.3.1.5.4

Workspace around flanges for maintenance, inspection and removal of flange bolts or studs shall be provided so the work can be done with a good ergonomic body posture as defined by regulatory and specified requirements.

5.3.1.5.5

Pipe flanges, tubing and fittings shall be accessible for maintenance with space for the necessary tools.

5.3.1.5.6

Pipe flanges, tubing and fittings shall be accessible for maintenance without the need for dismantling of the equipment.

5.3.1.6 Doors and hatches

5.3.1.6.1

Access hatches and manway openings shall be sized according to regulatory and specified requirements to accommodate personnel entry and to allow internal components to pass through without cutting or welding.

5.3.1.6.2

Unobstructed access space shall be provided in front of hatches and manways sized in accordance with regulatory and specified requirements.

5.3.1.6.3

Handholes shall be sized in accordance with regulatory and specified requirements to accommodate the passage of the largest anticipated tools plus the hand and arm of the user in the posture expected.

5.3.1.6.4

It shall be possible to secure doors and hatches in open positions.

5.3.1.6.5

Doors shall be sized according to regulatory and specified requirements and the movement of personnel and materials.

5.3.1.6.6

The opening force of doors shall be in accordance with regulatory and specified requirements to eliminate excessive forces which may cause musculo-skeletal disorders or ergonomic strain.

5.3.1.6.7

Hinged doors leading to outdoor areas shall be provided with a damping mechanism.

5.3.2 Controls and displays

5.3.2.1

Controls and displays shall be arranged to mimic the spatial arrangement of the equipment to which they are related in the facility or package.

5.3.2.2

Human-machine interfaces shall be designed according to regulatory and specified requirements.

5.3.2.3

Instruments, control panels, push-buttons, displays, remote valve operation stations, emergency stops and other controls shall be installed in accordance with regulatory and specified requirements.

5.3.3 Adaption for cleaning

5.3.3.1

Accessible drains shall be provided for lines and equipment where fluids will be removed or where necessary for isolation.

5.3.3.2

Floors, walls and equipment surfaces shall facilitate cleaning and maintenance.

5.3.3.3

Equipment, instruments, panels, cable trays, tubing and piping connections shall be placed on skids, integrated vertical supports or structures to keep egresses, walkways and operating and maintenance areas clear for cleaning.

5.3.4 Material handling

5.3.4.1

There shall be space to locate, deploy, operate and monitor lifting and transportation gear from all required positions and in all required body postures for equipment that requires lifting.

5.3.4.2

Transportation ways and paths for materials handling shall be free of protrusion, thresholds and steps.

5.3.4.3

Equipment design shall provide for unobstructed maintenance volumes for equipment component removal.

5.3.4.4

Dropped object protection shall be provided for equipment in designated lifting areas.

5.3.4.5

Lifting space for equipment shall accommodate the height, width and weight of the largest component or consumable that may be lifted.

5.3.4.6

Lifting space for equipment shall accommodate the delivery, setup and use of the lifting device.

5.3.4.7

Lifting space for equipment shall accommodate the required work postures for the required number of personnel to construct the lifting equipment and perform lifting tasks in accordance with egress and walkway requirements.

5.3.4.8

Mechanical handling solutions shall be designed so that the removal of equipment or components can be completed with minimal disturbance to the rest of the package.

5.3.5 Hot and cold surfaces

5.3.5.1

Personnel shall be protected from contact with hot and cold surfaces in accordance with regulatory and specified requirements.

5.3.5.2

Guarding, spacing or insulation head clearance shall be in accordance with up to the regulatory or specified requirements to avoid burns and frostbite.

5.3.6 Indoor climate

5.3.6.1

Indoor areas shall maintain a temperature, relative humidity and air changes per hour in accordance with regulatory and specified requirements for the content type and occupancy.

5.3.7 Outdoor operation and weather protection

5.3.7.1

An evaluation of necessary weather protection suited for the installation site shall be conducted to include considerations for rain, hail, sleet, snow, ice, flood water, high environmentally induced temperatures, low environmentally induced temperatures and high wind speeds.

5.3.7.2

Modifications to weather protection based on weather impacts shall be implemented by agreement based on regulatory and specified requirements.

5.3.7.3

Sun shields and high luminance outdoor-type displays shall be used when displays and control panels are to be used in direct sunlight.

5.3.7.4

Handles, switches, handwheels, valve levers and other items requiring hand grasping shall accommodate the users hand and required PPE.

5.3.8 Illumination

5.3.8.1

Emergency escape lighting shall be in accordance with regulatory and specified requirements.

5.3.8.2

Permanent lighting of minimum 200 Lux inside the enclosure shall be included.

5.3.9 Hazardous substances

5.3.9.1

Work processes, technical controls and organizational controls shall be designed, maintained and operated to eliminate or minimize exposure to hazardous chemical compounds.

5.3.9.2

Hazardous chemicals shall be eliminated or replaced by less hazardous chemicals where elimination or substitution does not change the process.

5.3.9.3

Exhaust outlets and vents emitting hazardous fumes shall be routed away from areas where personnel could be exposed in accordance with regulatory and specified requirements.

5.3.9.4

Dedicated hoses and connections to chemical storage tanks shall use color coding, connection keying, unique leak-free connectors or other industry standard methods in accordance with regulatory and specified requirements to prevent human errors during transfers.

5.3.10 Additional requirements for enclosed packages

5.3.10.1

Accessways, walkways and workspaces in alignment with regulatory and specified requirements shall be provided inside enclosures that are not removable to allow for access and egress, the use of appropriate body postures for tasks and the use of materials handling equipment.

5.3.10.2

Doors or removable panels shall be provided on the container or enclosure to perform maintenance, inspection and operation.

5.3.10.3

Equipment to be dismantled for maintenance or inspection shall include provisions for lifting and transport of component in the equipment design, e.g. hoist, in accordance with regulatory and specified requirements.

5.3.10.4

Windows shall be included in enclosure doors and panels when all of the following apply:

- the noise inside the enclosure is higher than allowed by regulation or specified standards;
- there are instruments inside the enclosure to be read.

5.3.10.5

Enclosure windows shall comply with specified fire and blast requirements.

5.3.10.6

When access to the roof of the enclosure is required for operation, maintenance and inspections, a fixed vertical means of access, guardrails and toe-plates shall be provided in alignment with regulator and specified requirements.

5.3.10.7

Stairs shall be in accordance with regulatory and specified requirements.

5.3.10.8

Head clearance shall be provided for walking and working surfaces in accordance with regulatory and specified requirements.

5.4 Material technology

5.4.1 General

Material selection shall be in accordance with ISO 21457.

5.4.2 Fabrication

5.4.2.1 Structural welding

Welding of base plate and structural supports shall be in accordance with the specified design code.

5.4.2.2 Welding

5.4.2.2.1 Welding management requirements

5.4.2.2.1.1

Welding shall be performed under a weld quality management system complying to the applicable part of ISO 3834 specified in Table 1 or equivalent requirements in the specified fabrication code (e.g. ASME B31.3 Appendix Q or ASME VIII Appendix 10).

Table 1 – Quality assurance level requirements for welding

Fabrication of	Applicable part of ISO 3834	Welding coordinator qualification requirements
Piping and pressure containing equipment	ISO 3834-2	As specified in ISO 14731:2019, 6.2.2
Primary structure (major load-bearing structures with severe consequences of failure)	ISO 3834-2	As specified in ISO 14731:2019, 6.2.2
Any other welding associated with the package	ISO 3834-3	As specified in ISO 14731:2019, 6.2.3
Notes Welding coordinators holding IWE certification is considered to satisfy the requirements of ISO 14731:2019, 6.2.2. Welding coordinators holding IWT certification is considered to satisfy the requirements of ISO 14731:2019, 6.2.3. Engineers or technologists holding equivalent technical qualifications/certifications and/or relevant experience may also be acceptable.		

5.4.2.2.2 Welding procedure specifications

5.4.2.2.2.1

Welding procedures for piping, pressure containing equipment and attachments welded thereto shall be qualified in accordance with IOGP S-705.

5.4.2.2.2.2

Welding procedures for structures shall be qualified by a PQR in accordance with the applicable structural design code and AWS D1.1 or the applicable parts of ISO 15614.

5.4.2.2.2.3

Welding procedures for any other welding associated with the package shall be qualified by a PQR in accordance with the applicable code, ASME BPVC, Section IX or the applicable parts of ISO 15614.

5.4.2.2.2.4

Additional welding procedure qualification requirements shall be in accordance with the data sheet.

5.4.2.2.2.5

WPSs shall be issued directly to the welder or posted on a notice board adjacent to the welding activity.

5.4.2.2.2.6

WPSs shall be translated from the contract language to a language understood by the welder or welding operator.

5.4.2.2.3 Welder and welding operator qualification

5.4.2.2.3.1

Welders and tack welders shall be qualified in accordance with applicable parts of ISO 9606, ASME BPVC, Section IX or the applicable design and fabrication code.

5.4.2.2.3.2

Welding operators shall be qualified in accordance with ISO 14732, ASME BPVC, Section IX or the applicable design and fabrication code.

5.4.2.2.3.3

Additional welder or welding operator qualification requirements shall be in accordance with the data sheet.

5.4.2.2.4 Welding inspector qualification

Welding inspectors shall hold a current level 2 or equivalent certification from a recognized scheme, such as AWS-CWI, CSWIP 3.1, CWB-Level 2, or IWI-S.

5.4.2.2.5 Welding Coordinator Qualification

5.4.2.2.5.1

Welding coordinators shall be qualified in accordance with Table 1.

5.4.2.2.5.2

The tasks and responsibilities of the welding coordinator shall be in accordance with ISO 14731.

5.4.2.2.6 Test laboratories

Test laboratories for mechanical, chemical and corrosion testing shall have a certified laboratory system in compliance with ISO/IEC 17025 for the test methods employed.

5.4.2.2.7 Non-destructive testing quality system

The final NDE of welds shall be performed by an organization or part-organization operating a documented quality management system in compliance with ISO/IEC 17020 or ASME equivalent.

5.4.2.2.8 Inspection and non-destructive testing personnel

5.4.2.2.8.1

NDE personnel shall be certified in accordance with ISO 9712 or ASNT as specified in the data sheet.

5.4.2.2.8.2

NDE personnel shall not perform tasks that exceed their certification level as defined by ISO 9712 or ASNT qualification.

5.4.2.2.9 Production parameter monitoring

5.4.2.2.9.1

The recording frequency of production parameter monitoring shall be in accordance with the data sheet, but not less than the first weld per WPS and the first weld by a welder or welding operator.

5.4.2.2.9.2

Production parameter monitoring records shall be traceable to a specific welder, WPS and production weld.

5.4.2.2.9.3

Production parameter monitoring records shall verify correct fit-up and root pass penetration for single sided welds where full penetration is required, including weldolets and attachment welds.

5.4.2.2.9.4

Production parameter monitoring records shall detail the actual preheat and interpass temperature, consumables, welding parameters and resulting heat input.

5.4.2.2.9.5

Production parameter monitoring records shall be endorsed by the welding coordinator or welding inspector.

5.4.2.2.10 Weld Repair Rates

Repair rates of individual welders and welding operators shall be recorded.

5.4.2.2.11 Weld history records

Records shall be produced that show the WPS, joint type and size, welder or welding operator, date and time of welding, PWHT and NDE as a minimum for each weld.

5.4.2.2.12 Calibration of welding and measuring equipment

Welding and parameter-measuring/recording equipment shall be calibrated at least every 12 months or more often if required by the equipment manufacturer's recommendations.

5.4.3 Protective coatings

5.4.3.1

Painting and coating of equipment and piping for onshore (excluding marine coastal) applications in an environment with atmospheric corrosivity category C1 to C3 (low to medium corrosivity to ISO 12944-2) shall be selected and qualified in accordance with ISO 12944-5 and ISO 12944-6.

5.4.3.2

Painting and coating of equipment and piping for offshore and marine coastal applications and submerged coating shall be in accordance with IOGP S-715.

5.4.3.3

Surface preparation for onshore applications shall be in accordance with ISO 12944-4.

5.4.3.4

Execution and supervision of coating application for onshore applications shall be in accordance with ISO 12944-7 and the qualified coating system procedure specification.

5.4.4 Insulation

5.4.4.1 Enclosure insulation

5.4.4.1.1

The selection of insulation materials for enclosures and cabins shall be in accordance with ISO 15667.

5.4.4.2.1

Insulation shall be removable.

5.4.4.2.2

Insulated surfaces shall be coated in accordance with IOGP S-715.

5.4.4.2.3

Perforated guards or screens shall be used for personnel protection for surface temperatures up to 150 °C (300 °F).

5.5 Piping and layout

5.5.1 General

5.5.1.1

Process piping shall be designed, fabricated and tested in accordance with the specified piping design code.

5.5.2 Specifications

5.5.2.1

Process piping shall be selected from the sizes listed within ASME B36.10M and ASME B36.19M.

5.5.2.2

Process piping shall be equal to or greater than NPS ½.

5.5.2.3

NPS 1¼, 2½, 3½ and 5 shall not be used for process piping.

5.5.2.4

Process piping shall have a wall thickness equal to or greater than the schedules specified in Table 2.

Table 2 – Minimum process piping wall thickness

Pipe NPS	Minimum Schedule For Carbon Steel Process Piping	Minimum Schedule For Corrosion Resistant Alloy Process Piping
½	160	40S
¾	160	40S
1	160	10S
1½	XS / 80	10S
2	XS / 80	10S
3	STD / 40	10S
4	STD / 40	10S
6	STD / 40	10S
8	STD / 40	10S
10	20	10S
12	20	10S
14	20	10S
16	20	10S
18	20	10S
20	STD / 20	10S
22	STD / 20	10S
24	STD / 20	10S

5.5.2.5

Process piping mechanical joints shall use ASME B16.5 flanges.

5.5.2.6

Gaskets and sealing rings of process piping flanges opened or dismantled prior to delivery shall be replaced with new.

5.5.2.7

Hydraulic hoses, expansion joints and flexible couplings shall not be used in process piping.

5.5.2.8

Tubing shall not be used for process piping.

5.5.3 Valves

5.5.3.1

All valves in process piping shall be in accordance with the specified piping design code.

5.5.3.2

Valve stems shall not be mounted below the horizontal, except for gate valves in a pressure relief system.

5.5.3.3

Check valves shall not be installed with flow in the vertical down position.

5.5.3.4

Lift check valves shall be installed with the flow horizontal and bonnet in the vertical up position.

5.5.4 Piping bolting

5.5.4.1

Bolting and nuts for flanges in process piping shall be in accordance with the recommendations in ASME B16.5, including minimum bolt length requirements.

5.5.5 Piping design and layout

5.5.5.1 Layout

5.5.5.1.1

Package components shall not overhang the package baseframe.

5.5.5.1.2

Process piping shall be designed to provide isolation for safe maintenance of all items.

5.5.5.1.3

Process piping vents and drains shall be provided for filling, testing, start-up, operation and maintenance requirements.

5.5.5.1.4

Process piping shall be designed to avoid vapor pockets.

5.5.5.1.5

Process piping (including any in-line components) shall be designed so that insulation can be installed and removed without affecting adjacent pipes and insulation.

5.5.5.2 Flange layout

5.5.5.2.1

Flanges shall be located wherever process piping components need to be separated to facilitate expected maintenance or expected replacement of parts.

5.5.5.2.2

Removable process piping spools shall not incorporate piping branches or instrument connections.

5.5.5.2.3

Flanges in process piping shall be located so that potential leaks of hot or flammable fluids cannot fall on to access ways or walkways.

5.5.5.3 Pressure protection systems

5.5.5.3.1

Pressure relief devices shall be designed so that they cannot be isolated from any part of the system they are protecting.

5.5.5.3.2

Gate valves in pressure relief systems shall be installed with their stem in a horizontal or downward orientation.

5.5.6 Piping stress

5.5.6.1

The package shall be designed to withstand the specified maximum allowable loads at all equipment and piping interfaces.

5.5.6.2

Process piping stress design shall consider all loads that the piping may experience during its design life, including:

- transportation;
- start-up;

- operation;
- maintenance;
- environmental.

5.5.6.3

Process piping shall be designed to avoid failure due to fatigue within its design life.

5.5.6.4

Process piping flanges shall be designed to avoid overstress and leaking during all operating conditions.

5.5.7 Piping supports

5.5.7.1

Process pipe supports shall be designed to withstand the loads that the piping may experience during its design life, including:

- transportation;
- start-up;
- operation;
- maintenance;
- environmental.

5.5.7.2

Process piping shall be anchored locally to external interfaces.

5.5.7.3

Support components welded to process piping shall be the same or equivalent material grade as the pipe itself.

5.5.7.4

Dissimilar metals shall have an insulating barrier between the process piping and supports.

5.5.7.5

Small bore process piping branches at risk of vibration shall be braced back to the header pipe in two perpendicular directions.

5.5.7.6

Hollow process pipe support sections shall have ends sealed with closure plates and vent holes sealed after welding.

5.6 Structural

5.6.1 Design code

5.6.1.1

Design of package structural and lifting equipment shall be in accordance with the specified design code and standard.

5.6.2 Calculations

5.6.2.1

The structure shall satisfy the design condition criteria during normal operation with the following load conditions:

- in-place with permanent and variable functional loads combined with environmental loads;
- testing of equipment, e.g. hydrotest with partial wind;
- Impact loads, e.g. 20 % of design load for machinery.

5.6.2.2

The structure shall satisfy the serviceability criteria governing normal operation of the structure.

5.6.2.3

The structure shall satisfy the abnormal and extraordinary design conditions, combining the blast and environmental loads with permanent and variable functional loads.

5.6.2.4

The structural integrity during abnormal and extraordinary load effects (e.g. fire, explosion or vehicular impact) may be verified by applying plastic design methods.

5.6.2.5

The package structure, including lifting and tie down points shall satisfy the design condition criteria during transport operations, combining the following loads:

- package permanent loads;
- tie down forces;
- transport accelerations in all directions;
- environmental loads;
- Lifting loads based on lifting configuration.

5.6.3 Design loads

5.6.3.1

Operational design calculations shall include the following specified loads:

- wind;
- snow;
- ice;
- earthquake.

5.6.3.2

For floating installations, operational design calculations shall include the specified wave induced acceleration loads.

5.6.3.3

For floating installations, fatigue design calculations shall include actions induced by the specified wave accelerations.

5.6.3.4

Accidental design calculations shall include the following specified platform and sub-area location specific loads:

- blast over pressure;
- blast drag pressure;
- fire.

5.6.3.5

For fixed installations, the specified platform and sub-area location specific earthquake loads shall be used in operational and accidental design calculations.

5.6.3.6

The specified platform and sub-area location specific sea transportation wind loads shall be used in the sea transportation design calculations.

5.6.3.7

Package design shall include additional special loading conditions specified in the data sheet.

5.6.3.8

Equipment and sea fastenings shall be designed in accordance with the transport acceleration loads.

5.6.3.9

Design calculations shall include the following loads:

- dead loads (including permanently attached appurtenances);
- live loads (walkway, equipment content).

5.6.4 Base frame (skid)

5.6.4.1 General

5.6.4.1.1

For offshore applications, base-frames shall be designed with a maximum of four support points and analyzed with pinned boundary conditions.

5.6.4.1.2

Baseframe welding shall be continuous welds.

5.6.4.1.3

Baseframes shall be supplied with engineered tie down points for use in any of the temporary phases the package might encounter from engineering works to the installation site.

5.6.4.1.4

Areas on baseframes that are inaccessible for coating or inspection shall be boxed in and seal welded.

5.6.4.2 Equipment > 1 000 kg (2 200 lb)

5.6.4.2.1

For packages and equipment > 1 000 kg (2 200 lb), baseframe support points shall be bolted to a support plate as detailed in Figure 3, Figure 4, Figure 5 and Figure 6.

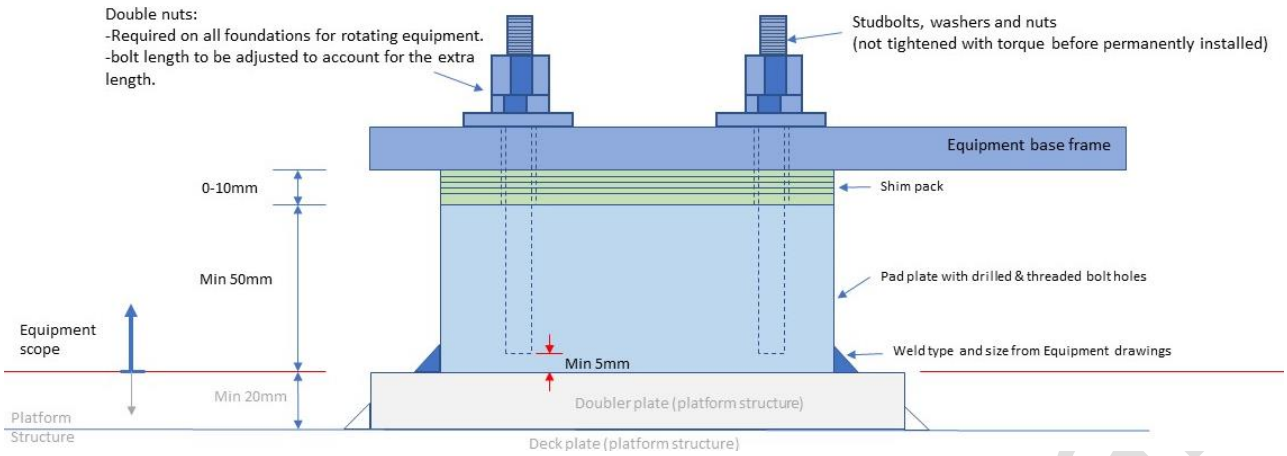

Figure 3 – Foundation for equipment ≥ 1 000 kg (2 200 lb) operational weight, interface design and responsibilities, double securing nut

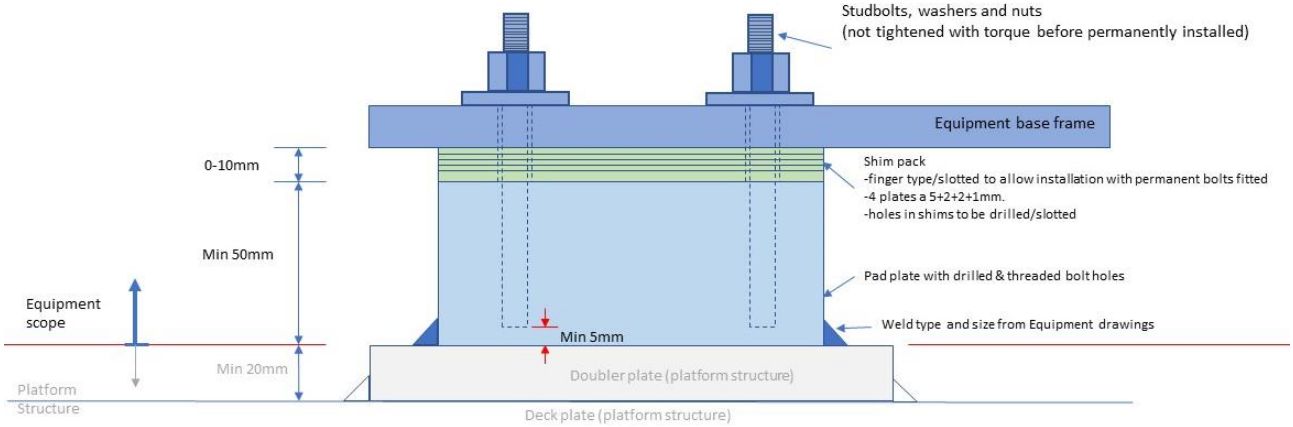

Figure 4 – Foundation for equipment ≥ 1 000 kg (2 200 lb) operational weight, interface design and responsibilities, single securing nut

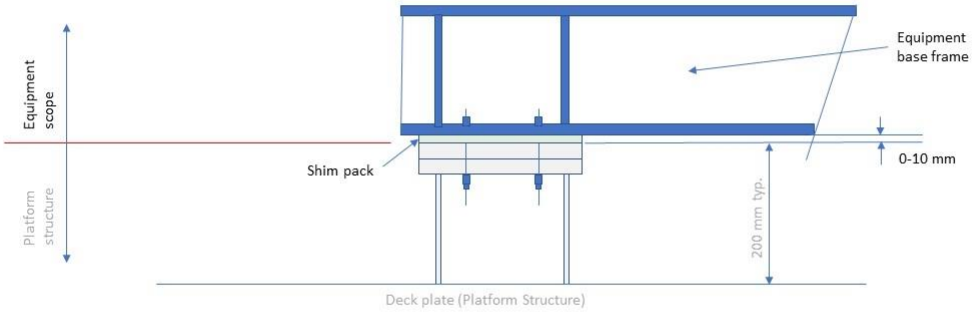

Figure 5 – Foundation for equipment ≥ 1 000 kg (2 200 lb) operational weight, elevated support, interface design and responsibilities

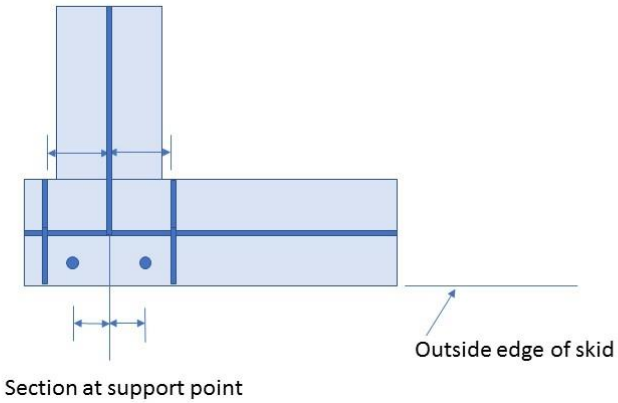

Figure 6 – Foundation for equipment ≥ 1 000 kg (2 200 lb) operational weight, section at support point showing bolt positions at support

5.6.4.2.2

The package or equipment support pad plate, as detailed in Figure 3 and Figure 4, shall be 316L stainless steel.

5.6.4.2.3

Shim packs for each package or equipment support, as detailed in Figure 3, Figure 4, Figure 5 and Figure 6, shall be 316 stainless steel.

5.6.4.2.4

Shim packs shall not be included on the general arrangement drawing or in the 3D model of the equipment.

5.6.4.2.5

Bolts for each equipment or package shall be as specified in the data sheet.

5.6.4.2.6

Nuts and washers for each equipment or package shall be a certified nut and washer type compatible with the specified foundation bolt type.

5.6.4.2.7

Hot dip galvanized nuts and washers for each package or equipment support shall be provided as detailed in Figure 3, Figure 4, Figure 5 and Figure 6.

5.7.4.2.8

A vibration secure combination of bolts, washers and nuts shall be provided for equipment including turbine or motors >200 kW (268 hp).

5.6.4.2.9

Anchoring bolts at support points shall be located on the outside face of the package skid.

5.6.4.2.10

Baseplate design, fabrication and mounting details for attachment to concrete foundation shall be in accordance with API RP 686.

5.6.5 Noise enclosure requirements

5.6.5.1

Noise enclosures shall be supported on the package baseframe.

5.6.6 Rotating equipment noise requirements

5.6.6.1

Rotating equipment and packages shall have anti vibration mounts fitted between the skid support points and the supporting deck structure.

5.6.7 Lifting arrangements

5.6.7.1 Lifting arrangements

5.6.7.1.1

Lifting equipment shall be certified by a competent enterprise approved by local authorities.

5.6.7.1.2

Lifting equipment and rigging arrangement shall be designed such that a single point lift can be performed safely, keeping the package horizontal.

5.6.7.2 Padeyes and lifting lugs

5.6.7.2.1

Lifting lug and padeye sizes internally on the package shall be selected from the following size list, per the governing lifting arrangement: 1, 3, 6, and 10 metric tonnes.

5.6.7.2.2

Lifting lugs and padeyes shall be welded to the supporting structure.

5.6.7.2.3

Where tension loading is perpendicular to the plate or section thickness, lifting lug and padeye welded connections to the supporting structure shall be inspected for lamellar tearing over the weld length and 50 mm on each side, as detailed in Figure 7.

NOTE Not required if the supporting material is of Z (through thickness) quality.

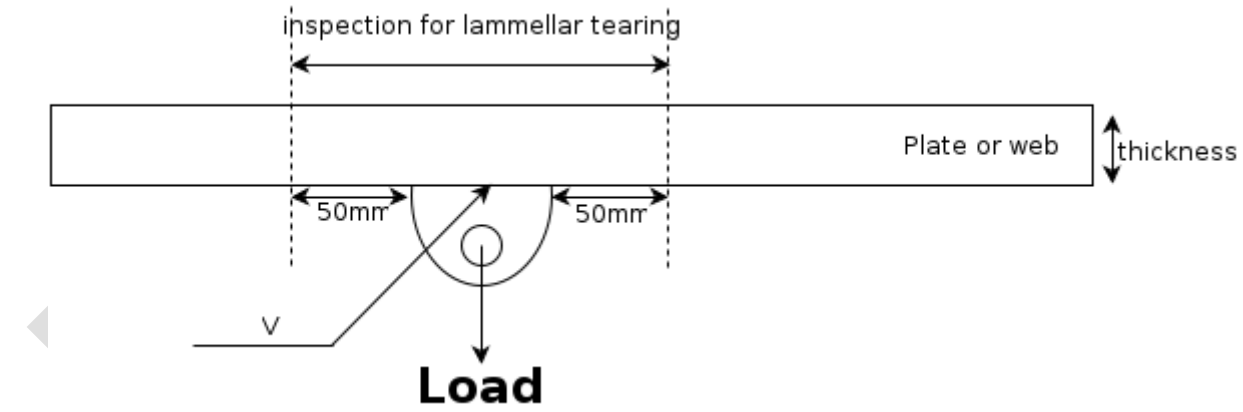

Figure 7 – Padeye and lifting lug NDT

5.6.7.3 Runway beams and monorails

5.6.7.3.1

Lifting monorail and runway beam sizes internally on the package shall be 1 t, 3 t, 6 t, or 10 t SWL (safe working load metric tonnes).

5.6.7.3.2

Monorail and runway beams shall be welded to the supporting structure.

5.6.7.3.3

Where tension loading is perpendicular to the plate or section thickness, runway beam and monorail welded connections to the supporting structure shall be inspected for laminar tearing over the weld length and 50 mm on each side, as detailed in Figure 8.

NOTE Not required if the supporting material is of Z (through thickness) quality.

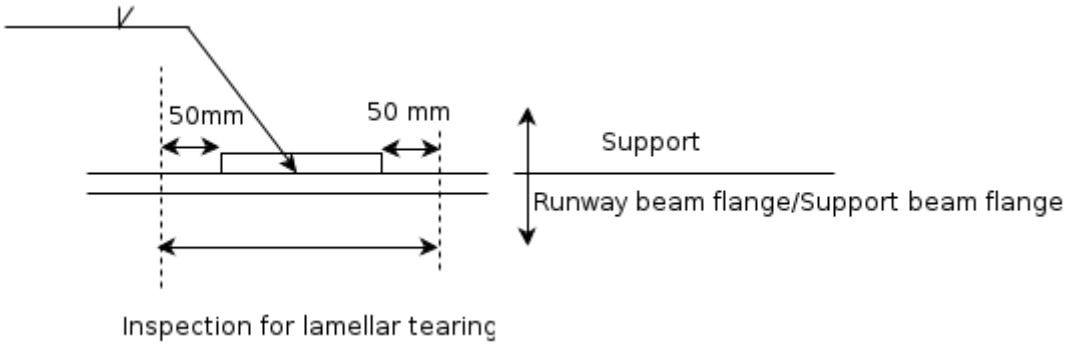

Figure 8 - Runway beam and monorail NDT

5.6.8 Grafting

5.6.8.1

Non-plated baseframe or deck areas accessible to personnel shall be covered with a grating surface.

5.6.8.2

Steel grating shall be hot dip galvanized.

5.6.8.3

Steel grating shall be serrated bar type with edging bars around the perimeter and cut-outs.

5.6.8.4

Grating shall be designed to prevent a 20 mm steel ball from falling through the grated deck.

5.6.8.5

Grating shall not be used as a mounting surface for equipment support.

5.6.8.6

Grating shall be removable.

5.6.8.7

Grating joints shall occur at supporting beams.

5.6.8.8

Grating panels shall have a minimum of four fixings per panel or per square meter.

5.6.8.9

Grating fixing shall be by stainless steel threaded stud bolts drilled and tapped or shot into the supporting structure with stainless steel fixing plates.

5.6.8.10

GRP grating on access areas shall be used where safety requirements are met regarding exposure to hydrocarbons, chemicals, solar radiation and weather.

5.6.8.11

Grating shall have panels spanning in the same direction.

5.6.8.12

Steel grating shall be used where safety requirements are not met regarding exposure to hydrocarbons, chemicals, solar radiation and weather or in laydown areas for equipment removal or maintenance.

5.6.9 Requirements to attachments

5.6.9.1

Outfitting items attached to brackets, foundation pads and doubler plates shall be of the same or equivalent material.

5.6.9.2

Attachments shall be fully and continuously welded to the structure.

5.7 Electrical

5.7.1 Site electrical supply

5.7.1.1

Electrical equipment shall be rated for the specified short-circuit level.

5.7.1.2

For IEC standard projects, packaged electrical equipment voltages shall be in accordance with IEC 60038.

5.7.1.3

For North American standard projects, packaged electrical equipment voltages shall be in accordance with ANSI C84.1.

5.7.1.4

For IEC standard projects, electrical equipment operating frequencies shall be in accordance with IEC 60196.

5.7.1.5

For North American standard projects, electrical equipment operating frequencies shall be in accordance with ANSI C84.1.

5.7.2 Emergency stops

5.7.2.1

Emergency push buttons shall be mushroom head type, twist to reset and shrouded.

5.7.2.2

For IEC standard projects, emergency push buttons shall be in accordance with IEC 60204-1 and IEC 60947-5-1.

5.7.3 Electric heat tracing

5.7.3.1

Electric trace heating for freeze protection in hazardous (classified) areas shall be in accordance with IEC/IEEE 60079-30.

5.7.3.2

For IEC standard projects, electric trace heating for freeze protection in non-hazardous areas shall be in accordance with IEC 62395.

5.7.3.3

For North American standard projects, electric trace heating for freeze protection in non-hazardous areas shall be in accordance with IEEE 515.

5.7.3.4

Trace heating cables shall be self-limiting tape type.

5.7.3.5

Where a package distribution board is provided, each trace heating circuit shall be protected with:

- either 2 pole MCBs or 2 pole RCBOs;
- 30 mA earth (ground)-fault protection (RCBO, RCD, GFCI).

5.7.4 Lighting

5.7.4.1

Average illumination level of lighting installations shall be a minimum of 200 lux (19 fc) measured at floor level.

5.7.4.2

Average illumination level for emergency lighting shall be a minimum of 60 lux (6 fc) measured at floor level.

Note Emergency lighting is not escape lighting.

5.7.4.3

Lamps shall be LED type with integral electronic drivers.

5.7.5 Electric motors

5.7.5.1

For IEC standard projects, three phase induction motors shall be in accordance with IEC 60034.

5.7.5.2

For North American standard projects, three phase induction motors shall be in accordance with NEMA MG-1.

5.7.5.3

For IEC standard projects, DC starter motors shall be in accordance with IEC 60034.

5.7.5.4

For North American standard projects, DC starter motors shall be in accordance with NEMA MG-1.

5.7.6 Switchgear and controlgear

5.7.6.1

For IEC standard projects, low voltage switchgear and controlgear for generator auxiliaries shall be in accordance with IEC 61439-1.

5.7.6.2

For North American standard projects, low voltage switchgear shall be in accordance with UL 845.

5.7.6.3

The generator circuit breaker, where provided, shall be in accordance with IEC 60947-2.

5.7.7 Generator

5.7.7.1

For IEC standard projects, generators shall be designed and manufactured in accordance with IEC 60034.

5.7.7.2

For IEC standard projects, generator frame dimensions shall be in accordance with IEC 60072-1 or IEC 60072-2.

5.7.7.3

For offshore IEC standard projects, generators shall comply with IEC 61892.

5.7.7.4

For IEC standard projects, generators supplying power to FPSO topside equipment shall be in accordance with IEC 60092.

5.7.7.5

For North American standard projects, generators shall be in accordance with API 546.

5.7.7.6

Generator windings shall be brought out in to a terminal box to form a neutral point.

5.7.7.7

Generator windings shall be insulated using the vacuum pressure impregnation technique.

5.7.7.8

Generator rotors shall be balanced in accordance with ISO 21940-11, Table 1, balance quality grade G 2.5.

5.7.7.9

Temperature detectors shall be embedded in the hot spots of the winding with the wires taken out to a dedicated junction box.

5.7.7.10

Generator bearings shall be replaceable without dismantling any part of the generator.

5.7.7.11

Self-lubricating bearings shall be used.

5.7.7.12

The generator bearings shall have Pt 100 type resistance temperature detectors on each bearing, wired to a separate terminal box.

5.7.7.13

Generator bearings subject to shaft voltages greater than 300 mV shall be protected from damage at the non-drive end.

5.7.7.14

Where sleeve bearings are used limited end float couplings are required.

5.7.7.15

A removable copper link between the earth/ground terminal and the neutral terminal in the main terminal box shall be provided.

5.7.7.16

A droop current transformer shall be provided.

5.7.8 Excitation

5.7.8.1

The exciter shall be an AC brushless type with a rotating diode bridge, full wave, solid state rectifier.

5.7.8.2

The power supply for the exciter field shall be provided from a separate, shaft mounted permanent magnet generator.

5.7.8.3

The excitation system shall share reactive load, when operating in parallel.

5.7.8.4

The rated excitation current shall be 110 % of the required excitation current for the rated output of the generator.

5.7.8.5

The excitation system shall be designed to provide field forcing.

5.7.8.6

The excitation voltage shall be rated at 110 % of the rotor voltage for the specified output of the generator.

5.7.8.7

The generator shall be capable of maintaining 300 % of its rated current output for a minimum of three seconds while feeding any type of short-circuit at its terminals.

5.7.8.8

The exciter shall have an auxiliary monitoring unit.

5.7.9 Automatic voltage regulator

5.7.9.1

For IEC standard projects, automatic voltage regulation shall be in accordance with IEC 60034-22.

5.7.9.2

For offshore IEC standard projects, voltage regulation shall be in accordance with the limits of IEC 61892-3.

5.7.9.3

Duty and standby digital automatic voltage regulators, with stepless automatic changeover, shall be provided in the generator control panel.

5.7.9.4

Automatic voltage regulators shall be provided with a precision voltage adjuster.

5.7.9.5

Automatic voltage regulators shall have an auto/manual control facility, mounted on the generator control panel.

5.7.9.6

Automatic voltage regulators shall be equipped with frequency dependent constant voltage and adjustable slope (voltage/frequency) facilities.

5.7.9.7

Upon failure of the automatic voltage regulator, the voltage regulation shall switch over to manual control .

5.7.10 Battery charger

5.7.10.1

The battery charger shall restore the battery to 80 % charge within ten hours following discharge.

5.7.10.2

The rectifier shall be at least six pulse.

5.7.10.3

The battery charger shall be a solid state type with current limiting features to match battery characteristics and protect equipment from load side short circuits.

5.7.10.4

The battery charger shall be rated to continuously supply 100 % of the rated load, including charging and output load, under the most severe variation of AC supply input over the battery voltage range.

5.7.10.5

The battery charger shall have automatic voltage regulation, with DC bus voltage between no load and full load maintained to within ±1 % of the supply voltage and frequency range.

5.7.10.6

The battery charger shall have temperature compensation.

5.7.10.7

The battery charger shall have automatic protection against reversal of current.

5.7.10.8

The battery charger shall have a start up (walk in) gradually picking up the DC standing load and battery recharge loads.

5.7.10.9

The battery charge shall have an incoming circuit breaker which will also act as an isolator.

5.7.10.10

The battery charger shall have output surge protection.

5.7.10.11

The output circuit breaker shall be two pole.

5.7.10.12

Dual battery chargers shall operate in parallel and load share mode.

5.7.10.13

Where two battery chargers are provided, failure of one battery charger shall not affect the second battery charger or the battery.

5.7.10.14

The battery charger shall have an HMI on the front panel.

5.7.10.15

The battery charger shall have a set of alarms and indications in accordance with Table 3.

Table 3 – Battery charger alarms and trips

Description	Alarm	Trip
Positive Earth/Ground fault	X	
Negative Earth/Ground fault	X	
Charger failure [a]	X	X
Low DC voltage	X	
High DC voltage	X	X
Over-current	X	
Common	X	
Cooling fan failure (for forced ventilated units)	X	
AC input failure	X	
Charger Over-temperature [a, b]	X	X
Battery Over-temperature [a, b]	X	
Output breaker open	X	

Key:
X - required
Footnotes:
[a] Alarms shall be local to the battery charger and battery.
[b] Over temperature trips shall be time delayed.

5.7.10.16

The battery voltage and current shall be measured with an analogue voltmeter and ammeter.

5.7.10.17

The battery shall have a lockable battery isolator with provision for remote tripping.

5.8 Instrumentation and control

5.8.1 Package control and integration

5.8.1.1 General

5.8.1.1.1

Package integration with control system shall be categorized as P3 Type.

5.8.1.1.2

Executive interfaces between the unit control panel and the facility fire and gas system shall be hardwired.

5.8.1.1.3

Instrumentation and control systems for outside the diesel engine block shall meet all the requirements of this specification.

5.8.1.1.4

Hard wired interface signals between the package control system and facility control and safety system shall be galvanically isolated.

5.8.1.1.5

Package enclosures and air ducts shall be supplied with fire and gas detectors.

5.8.1.1.6

Communication between the generator control panel and facility control systems shall be through a data link.

5.8.1.1.7

Measurements, event and alarm logs shall be available in the remote control system through a data link.

5.8.1.1.8

Data link failure shall not trip the equipment.

5.8.1.1.9

Protocol parameters required for data exchange with the facility control system shall be proposed/configured by package system supplier.

5.8.1.1.10

The current revision of the programming, application and system management software shall be supplied and registered in the name of the end user.

5.8.1.1.11

Each incoming electrical supply to electrical panels shall have an isolation switch on the outside of the panel with provision for padlocking in the 'OFF' position.

5.8.1.2 Generator control panel

5.8.1.2.1 General

5.8.1.2.1.1

Bolts, screws and fasteners shall be 316 stainless steel.

5.8.1.2.1.2

Internal and external components of the generator control panel shall be identified with a label.

5.8.1.2.1.3

The generator control panel alarms shall be visual and audible.

5.8.1.2.1.4

Engine fail-to-start shall be indicated locally on the generator control panel.

5.8.1.2.1.5

Input/output cards shall be provided with 10 % spare input/output (I/O) channels.

5.8.1.2.1.6

Electrical protection relays and controls in the generator control panel shall be time synchronized with the facility control system.

5.8.1.2.1.7

Protection relays shall retain data after the loss of the power supply.

5.8.1.2.1.8

An obsolescence management plan in accordance with an industry recognized system (e.g. IEC 62402) shall be provided for control system components.

5.8.1.2.1.9

For IEC standard projects, the generator control panel shall be in accordance with IEC 60204-1.

5.8.1.2.1.10

For North American standard projects, the generator control panel shall be in accordance with UL 508A.

5.8.1.2.1.11

The generator control panel shall have an HMI.

5.8.1.2.2 Wiring

5.8.1.2.2.1

Panel wiring and cable ways shall be flame retardant, low smoke with zero halogen emission.

5.8.1.2.2.2

Multi strand, 1,0 mm² (16 AWG) wire/conductor or above shall be used for instrument signal wiring within the generator control panel.

5.8.1.2.2.3

Wires or cables connected to terminals shall be identified by permanent cable sleeves.

5.8.1.2.2.4

Terminals shall accept instrument and control interface cables conductor sizes up to 2,5 mm² (12 AWG).

5.8.1.2.2.5

Separate terminal rails or terminations for intrinsically safe, non-intrinsically safe and power (based on voltage level) shall be provided.

5.8.1.2.2.6

Intrinsically safe, non intrinsically safe and different voltage level wires or cables shall run separately.

5.8.1.2.2.7

The color of intrinsically safe terminals shall be blue.

5.8.1.2.2.8

One wire shall be terminated per terminal.

5.8.1.2.2.9

Spare pairs and cores of multi conductor cable shall be numbered and terminated to the terminals.

5.8.1.2.2.10

The generator control panel shall be provided with earth bars for electrical power, instrument reference earth and intrinsically safe earth.

5.8.1.2.2.12

Instrument and intrinsically safe earth bars shall be electrically isolated from panel metal work.

5.8.1.2.2.13

Earth/ground bars shall have two earthing/grounding termination points at extreme ends for earthing/grounding the panel.

5.8.1.2.2.14

10 % spare terminals shall be provided.

5.8.1.2.2.15

The generator control panel shall supply AC power to the generator auxiliaries.

5.8.1.2.2.16

The generator control panel shall supply the DC power distribution to the generator auxiliaries.

5.8.1.2.3 Cable ways

5.8.1.2.3.1

Empty cable ways for routing the purchaser's cables shall be provided.

5.8.1.2.3.2

Cable ways shall be covered.

5.8.1.2.3.3

Cable ways shall be flame retardant, low smoke with zero halogen emission.

5.8.1.2.4 Operation and control functions

5.8.1.2.4.1

The generator control panel shall have meters on the front panel.

5.8.1.2.4.2

Manual synchronizing equipment with check synchronizer and dead bus override shall be provided.

5.8.1.2.4.3

An automatic synchronizing system shall be provided.

5.8.1.2.4.4

The generator control panel shall have an Automatic/Manual synchronizing selector switch.

5.8.1.2.4.5

A selector switch shall be provided to select the incoming supply for synchronization where there is more than one source.

5.8.1.2.4.6

An automatic power factor controller shall be provided.

5.8.1.2.4.7

The generator control panel selector switch shall have a "Test Mode" position.

5.8.1.2.4.8

The generator control panel shall have an Automatic/Manual starting mode selector switch.

5.8.1.2.4.9

The generator set shall have a black start override lockable switch.

5.8.1.2.4.10

Automatic load sharing shall be provided for continued parallel operation of the generator in droop mode.

5.8.1.2.4.11

The generator control panel shall have a local emergency stop button on the front panel.

5.8.1.2.4.12

Electrical panel anti-condensation heaters shall be provided with a pad-lockable means of isolation on the package.

5.8.1.3 Indications and alarms

5.8.1.3.1

Protection relays shall be digital type with communication capabilities.

5.8.1.3.2

The generator status, alarm, trip and shutdown requirements shall be in accordance with Table 4.

Table 4 – Generator status, alarm, trip and shutdown

Description	Status	Alarm	Trip	Trip Disabled for Emergency Operation
Overcurrent - voltage restraint (51V)			X	
Overcurrent (51)			X	
Stator earth/ground fault [a] (51G)			X [c]	
Undervoltage (27)		X	X	X
Over voltage (59)		X	X [c]	X
Under frequency (81U)		X	X	X
Over frequency (81O)		X	X [c]	X
Reverse power [b] (32)			X [c]	X
Negative phase sequence (46)			X	
Loss of excitation (40)			X	
Stator winding temperature high (49S)		X	X	X
Diode failure (58)		X	X	X
Diode Monitoring		X		
Rotor earth/ground fault (64)			X [c]	
Bearing temperature high (49B)		X	X [c]	X
Local Emergency Shutdown			X [c]	

Description	Status	Alarm	Trip	Trip Disabled for Emergency Operation
Remote Emergency Shutdown			X [c]	
Automatic voltage regulator failure		X		
Cooler water leakage (air to water)		X		
Cooler generator air outlet high temperature		X		
Control panel common alarm (including control/trip supply failure)		X		
Lock out general		X		
Generator circuit breaker 'OPEN' [d]	X			
Generator circuit breaker 'CLOSED' [d]	X			
Control/trip supply 'ON' [d]	X			
For acoustic enclosures: [e]				
Enclosure doors(s) open		X		
Ventilation air flow low			X [c]	X
Ventilation air temperature high			X [c]	X
Fire (heat) detection			X [c]	X
Inhibition of carbon dioxide extinguishing system		X		

Key:

X - required

Footnotes:

[a] Where a restricted earth/ground fault relay is used for generator differential protection the separate stator earth/ground relay may be omitted.
[b] Only where there is a parallel operation with public grid or other generator sets.
[c] Shutdown of engine required in addition to generator trip.
[d] Status indication required on each application.
[e] Mandatory functions.

Note Device numbers are as per IEEE/ANSI C37.2 - Standard for Electrical Power System Device Function Numbers, Acronyms and Contact Designations (which can be used in IEC standard projects).

5.8.1.3.3

The following fuel system alarms and shutdown shall be repeated in the generator control panel:

- High level;
- Low level;
- Low Low level;
- Low Low level shutdown.

5.8.1.3.4

Signals and alarms shall be repeated in the generator control panel from:

- engine control panel;
- battery charging system;

- fuel system;
- field instruments.

5.8.1.3.5

The engine control panel signals and alarms shall be repeated in the generator control panel in accordance with Table 5.

Table 5 – Engine monitoring and protection

Function	Indication	Alarm	Shutdown
General			
Engine Speed	X [1]	H, L	HH [1]
Hours run	X [1]		
Turbocharger speed	X	H, L	
Engine vibration	X		
Cylinder head vibration [2]	X		
Turbocharger vibration	X	H	
Fan vibration	X	H	
Start sequence	X		
Start sequence fail	X	X	
Controls fail	X	X	
Mode of operation	X		
Crankshaft key-phaser	X		
Temperature			
Lube oil to engine	X [1]	H, L [4]	
Lube oil to cooler	X	H	
Lube oil from cooler	X	H, L	
Coolant to engine	X	H, L	
Coolant from engine [3]	X [1]	H	
Air inlet manifold exhaust, each cylinder	X		
Exhaust turbocharger inlet	X	H, L	
Exhaust turbocharger outlet	X		
Main bearings	X		
Big end bearings	X		
Turbocharger bearings	X		
Pressure			
Lube oil	X [1]	L	
Coolant	X	L	

Function	Indication	Alarm	Shutdown
Air inlet manifold	X		
Exhaust to turbocharger	X		
Starting air	X [1]	L	
Hydraulic start accumulator	X [1]	L	
Differential Pressure			
Lube oil filter	X [1]	H	
Air filter	X [1]	H	
Level			
Lube oil sump	X [1]	L	
Coolant	X [1]	L	
Air filter oil bath	X [1]		
Fuel day tank	X [1]	H, L	
Electrical and Instruments			
Mains power	X [1]		
Battery voltage	X [1]	L	
Battery charger on	X [1]	L	
Instrument power	X [1]	L	
Instrument pneumatic pressure	X [1]	L	

Key

X - required
H - alarm on high warning
L - alarm on low warning
HH - shutdown on high overshoot

Notes

[1] Essential indications and emergency shutdown system functions.
[2] One per cylinder head for combustion diagnostics.
[3] Sensitive points on each cylinder block.
[4] Start permissive.

5.8.1.3.6

The generator control panel shall have a lamp test button.

5.8.1.3.7

Control and indication lamps shall be LED and color coded in accordance with IEC 60073.

5.8.1.4 Digital security

5.8.1.4.1

Digital security of hardware and software shall be in accordance with IEC 62443.

5.8.1.4.2

Risk and vulnerability assessment (RVA) reports shall define the hardware and software supplied and the vulnerabilities of the supplied hardware and software.

5.8.1.4.3

Hardware and software control systems shall be subject to hardening based on cyber security documentation.

5.8.2 Instrumentation design

5.8.2.1 General

5.8.2.1.1

Process measurement systems design and selection shall be in accordance with API RP 551.

5.8.2.1.2

The PID, graphic symbols, codes and identification of tags shall be in accordance with ANSI/ISA-S5.1.

5.8.2.1.3

Discrete input and output signals connected to the fire and gas system shall be line monitored.

5.8.2.1.4

Cable entries to instruments shall be M20 x 1,5 mm ISO or ½ NPT.

5.8.2.1.5

Where instruments do not have a cable entry size of M20 x 1,5 mm ISO or ½ NPT, Ex certified adaptors shall be used.

5.8.2.1.6

Each instrument shall have its own individual process tapping, not shared with any other instrument.

5.8.2.1.7

Field instruments shall be two-wire, 24 V DC loop powered with signal transmission that conforms to NAMUR NE 43.

5.8.2.1.8

Where two-wire instruments are not available, instruments may be separately powered (four-wire).

5.8.2.1.9

Process measurement signals connected to the package control system and facility shutdown system shall be hard wired, 4-20 mA.

5.8.2.1.10

Instrument communication protocol shall be HART, Foundation Fieldbus, or Profibus.

5.8.2.1.11

Wireless instrumentation shall not be used in control, interlocks or safety applications.

5.8.2.1.12

Electronic transmitters shall be provided with an integral digital display.

5.8.2.1.13

The protective system, excluding switchgear, shall meet the following design criteria:

- contacts closed with systems energized for healthy running condition;
- contacts open with relay coils and solenoid valves de-energized for shutdown or alarm;
- fire and gas logic and release of fire extinguishing material to follow “energize to discharge” action.

5.8.2.1.14 SIS Trip Transmitters

Safety instrumented function transmitters shall be provided with a safety integrity level (SIL) certificate from an independent assessment body to establish conformance to IEC 61508.

5.8.2.1.15

Minimum instrument connection sizes and ratings shall be in accordance with Table 6.

Table 6 – Instrument process connection - minimum sizes and rating

Instrument type	Minimum size [a]	Minimum rating [b]
On pressure vessel		
Pressure transmitter/pressure gauge, with or without chemical seal [c]	DN 50 (NPS 2) flanged	Cl-300
Thermowell [d]	DN 40 (NPS 1 1/2) flanged	Cl-300
Safety relief valves	As per sizing, Flanged	Cl-300 (inlet) Cl-150 (outlet)
Level bridle [e]	DN 80 (NPS 3) flanged	Cl-300
Level gauge (magnetic) [f]	DN 50 (NPS 2) flanged	Cl-300
Level transmitters (DP cells with flanged seal and capillaries)	DN 50 (NPS 2) flanged	Cl-300
Guided wave radar or non-contacting radar	DN 80 (NPS 3) flanged	Cl-300
On piping / atmospheric tank		
Pressure transmitter/pressure gauge	DN 20 (NPS 3/4) flanged	Cl-150
Pressure transmitter, with chemical seal [c]	DN 50 (NPS 2) flanged	Cl-300
Orifice flanges (DP flow transmitter)	DN 25 (NPS 1) flanged	Cl-300
Orifice flanges (DP flow transmitter, chemical seal) [c]	DN 50 (NPS 2) flanged	Cl-300
Magnetic/ultrasonic flow meter [g]	Line size, flanged	Cl-150
Coriolis flow meter [g]	As per sizing, flanged	Cl-150

Instrument type	Minimum size [a]	Minimum rating [b]
Control valves [g]	As per sizing, flanged	Cl-300 up to DN 200 (NPS 8) Cl-150 > DN 200 (NPS 8)
On/off valves [g]	Line size, flanged	Cl-150
Thermowell [d, g]	DN 40 (NPS 1 1/2) flanged	Cl-300 on piping Cl-150 on atmospheric tanks
Safety relief valves	As per sizing, Flanged	Cl-300 (inlet) Cl-150 (outlet)
Level bridle [e]	DN 80 (NPS 3) flanged	Cl-300
Level gauge (magnetic) [f]	DN 50 (NPS 2) flanged	Cl-300
Level transmitters (DP cells with flanged seal and capillaries)	DN 50 (NPS 2) flanged	Cl-150
Guided wave radar or non-contacting radar	DN 80 (NPS 3) flanged	Cl-150

[a] Size is the minimum requirement. Actual size shall be determined during detailed design.

[b] Rating is the minimum requirements. If pipe rating is higher than the rating specified, pipe rating shall be used.

[c] For corrosive, toxic and sour service, chemical seals shall have the flushing ring seal welded to the diaphragm flange with vent and drain valve.

[d] Screwed thermowells shall not be used.

[e] Level bridle shall have separate vent and drain connections in addition to the instrument vent and drain connections.

[f] When multiple level gauges are used in a vessel or tank, intermittent support shall be provided.

[g] Flange rating shall be selected based on pressure/temperature rating of process fluid for the chosen material or pipe rating or minimum rating specified

in the table whichever is higher.

5.8.2.1.16

Package instruments shall have a first isolation valve with the exception of the following:

- guided wave radar (internal);
- cone type radar;
- ultrasonic flow meter;
- vortex flow meter;
- positive displacement meter;
- turbine flow meter;
- thermowell;
- tuning fork.

5.8.2.1.17

Wetted parts material of transmitters, gauges, valve manifolds, valves, regulators, flow elements, level chambers, float, interface flanges, thermowells and non-wetted parts e.g. diaphragm seal flanges, bolts, nuts, washers of instrument body shall be 316/316L stainless steel.

Note 1 Equipment manufacturer may specify alternative materials that meet equivalent performance and service compatibility;

Note 2 316/316L stainless steel should not be used for fluids operating in aqueous chloride environments at metal temperatures above 60 °C.

5.8.2.1.18

Wetted parts material of transmitters, gauges, valve manifolds, valves, regulators, flow elements, level chambers, float, interface flanges and thermowells for sea water applications shall be hastelloy or titanium.

5.8.2.1.19

Transmitters used in safety (shutdown) applications shall be provided with a hardware write protection (switch or jumper) or configurable password protection.

5.8.2.1.20

Transmitters shall be configured with the transmitter tag number, calibrated range and failure mode.

5.8.2.2 Pressure and differential pressure gauges and transmitters

5.8.2.2.1

Pressure and differential pressure gauge dial size shall be 100 mm (4 in).

5.8.2.2.2

Casing and movement for pressure and differential pressure gauges shall stainless steel, with back blowout protection.

5.8.2.2.3

The front glass of pressure and differential pressure gauges shall be double strength and shatter proof.

5.8.2.2.4

Pressure and differential pressure gauges shall be designed for 130 % of full scale range without affecting accuracy and 200 % of full scale range or maximum static pressure without rupture of components.

5.8.2.2.5

The display compartment of pressure and differential pressure gauges shall be liquid filled.

Note Fill fluid is determined by ambient and process temperatures.

5.8.2.2.6

Pressure and differential pressure gauges shall have 20 mm (½ NPT) male process connections.

5.8.2.2.7

Pressure transmitters shall meet the following criteria:

- 1,3 times the upper range value without sustaining damage, loss of measurement accuracy or without the need of re-calibration;
- 1,5 times the process design pressure without rupture of any component;
- full vacuum, for devices exposed to negative pressure or vacuum condition.

5.8.2.2.8

Differential pressure devices shall withstand a differential pressure equal to the maximum allowable working pressure with either side open to atmosphere.

5.8.2.2.9

Pressure transmitters shall be supplied with a two-valve manifold unless the application requires a remote diaphragm seal.

5.8.2.2.10

A tube and tube fitting at the two-valve manifold shall be provided for calibration.

5.8.2.2.11

Differential pressure transmitters shall be supplied with a five-valve manifold unless the application requires a remote diaphragm seal.

5.8.2.2.12

A tube and tube fitting at the five-valve manifold shall be provided for calibration.

5.8.2.2.13

Local differential pressure flow transmitter indicators shall display in flow engineering units.

5.8.2.2.14

Local differential pressure level transmitters indicators shall display in percentage (0 to 100 %) unit.

5.8.2.3 Temperature instruments

5.8.2.3.1

Temperature elements shall be resistance temperature detectors (Pt-100) or K type thermocouples.

Note Resistance temperature detectors may not be suitable for severe vibrating service.

5.8.2.3.2

Temperature elements shall be spring loaded and be connected to a head mounted enclosure or transmitter.

5.8.2.3.3

Resistance temperature detector sensors for process applications shall be three-wire type, with two measurement wires and one compensation wire.

5.8.2.3.4

For IEC standard projects, resistance tolerance classes for platinum resistance temperature detectors shall be in accordance with IEC 60751.

5.8.2.3.5

For North American standard projects, resistance tolerance classes for platinum resistance temperature detectors shall be in accordance with ASTM E1137/E1137M.

5.8.2.3.6

Resistance temperature detector elements shall be mineral insulated and have a 316 stainless steel outer sheath.

5.8.2.3.7

For IEC standard projects, sheathed thermocouples shall be fabricated in accordance with IEC 61515.

5.8.2.3.8

For North American standard projects, sheathed thermocouples shall be fabricated in accordance with ASTM E608/E608M.

5.8.2.3.9

For IEC standard projects, thermocouple tolerance classes shall be in accordance with IEC 60584-1.

5.8.2.3.10

For North American standard projects, thermocouple tolerance classes shall be in accordance with ASTM E230/E230M.

5.8.2.3.11

Temperature transmitters shall provide thermocouple sensors with automatic compensation for temperature variations at the cold junction.

5.8.2.3.12

Temperature transmitters shall provide thermocouple open circuit, loss of signal detection and burnout protection with optional upscale or downscale action.

5.8.2.3.13

Thermowells shall be machined from a forged bar.

5.8.2.3.14

Thermowell wake frequency calculations shall conform to ASME PTC 19.3 TW.

5.8.2.3.15

Flanged thermowells shall be from bar stock or welded with full penetration welds.

Note 1 Screwed thermowells (made from bar stock) can be considered, only if flanged thermowell pose restriction to install on lines smaller than 100 mm (4 NPS).

Note 2 Supplier to provide justification where thermowells cannot be installed due installation constraints in applications e.g. as machine monitoring.

5.8.2.3.16

Weld-in thermowells or thermowells made from pipe shall not be used.

5.8.2.3.17

Temperature gauges shall be a bimetallic thermometer equipped with zero adjustment facility.

Note Gas or liquid filled gauges may be used, only if bimetallic type is not suitable for the application.

5.8.2.3.18

Temperature instrument dial size shall be minimum 125 mm (5 in).

5.8.2.3.19

Temperature gauge enclosures shall be 316 stainless steel.

5.8.2.3.20

Temperature gauges shall be direct mounted with every-angle back connection.

5.8.2.3.21

Instrument stems shall be 6 mm (¼ in) diameter with a minimum length of 100 mm (4 in) and fitted with a ½ NPT male thread connection.

5.8.2.4 Flow instruments

5.8.2.4.1

For IEC standard projects, orifice plates shall conform to ISO 5167.

5.8.2.4.2

For North American standard projects, orifice plates shall conform to API MPMS, 14.3.2.

5.8.2.4.3

For IEC standard projects, conical, quadrant edge and eccentric orifice plates shall conform to ISO/TR 15377.

5.8.2.4.4

For North American standard projects, conical, quadrant edge and eccentric orifice plates shall conform to API MPMS, 14.3.2.

5.8.2.4.5

Electromagnetic flow meters shall be selected to meet the process fluid's conductivity.

5.8.2.4.6

Electromagnetic flow meter casing ground terminal shall be connected to earth.

5.8.2.4.7

Lined electromagnetic flow meters shall have a lining failure alarm.

5.8.2.4.8

Two ground rings shall be provided if there is a possibility of high intensity of electrical interference and based on the piping material.

5.8.2.5 Level instruments

5.8.2.5.1

Diesel tanks shall have magneto strictive level transmitters with level gauge.

5.8.2.5.2

Magnetic level chambers shall have a vent ball valve with plug at the top.

5.8.2.5.3

Magnetic level chambers shall have a drain ball valve with plug at the bottom.

5.8.2.5.4

Magnetic level chambers shall have a flange connection of full chamber diameter at the bottom.

5.8.2.6 Self actuated pressure regulators

5.8.2.6.1

Pressure regulator body and internal components shall withstand the maximum operating pressure in the fail position or piping design pressure, whichever is higher.

5.8.2.6.2

Pressure regulators shall be sized to control the droop or proportional offset by:

- 10 % during steady state conditions;
- 25 % during transient conditions.

5.8.2.7 Pressure relief valves

Pressure relief valves shall conform to IOGP S-730.

5.8.3 Instrument installation

5.8.3.1

Instruments and valves shall be installed as per the manufacturer's instructions and API RP 551.

5.8.3.2

Instrument mounting hardware shall be 316L stainless steel.

5.8.3.3

Instruments shall be installed on structural steel or on a stanchion (dedicated 2 in (50 NB) pipe stand only for installing instruments) where close coupled installation is not chosen.

Note Incorrect installations include:

- hand rail mounted;
- process/utility pipe mounted;
- cladding mounted.

Ensure isolation of carbon steel structure or stanchion from stainless steel instrument mounting accessories to avoid galvanic corrosion.

5.8.3.4

For IEC standard projects, orifice plates shall conform to ISO 5167.

5.8.3.5

For IEC standard projects, venturi upstream and downstream straight length shall conform to ISO 5167.

5.8.3.6

For North American standard projects, orifice plates shall conform to API MPMS, 14.3.2.

5.8.3.7

For North American standard projects, venturi upstream and downstream straight length shall conform to API MPMS, 14.3.2.

5.8.3.8

For flow meters, the upstream and downstream straight length shall comply with the manufacturer's recommendation.

5.8.3.9

Tubing and fittings shall be seamless.

5.8.3.10

For onshore applications, tubing and fittings shall be a minimum 316 stainless steel in accordance with ASTM A269/A269M.

5.8.3.11

For offshore applications tubing and fittings shall be TPU coated 316 stainless steel, 6Mo stainless steel or 25Cr duplex stainless steel in accordance with ASTM A269/A269M.

5.8.3.12

Heat tracing and insulation shall be provided for instrument impulse lines, dead legs on instruments and low pour point fluids, if clogging arises due to subfreezing temperatures.

5.8.3.13

Impulse lines shall be insulated to minimize the temperature effects.

5.9 Electrical and instrumentation design and installation

5.9.1 Hazardous (classified) area requirements

If specified, the package equipment shall be certified or listed by a notified body for the hazardous (classified) area classification in accordance with IEC 60079 or NRTL approved laboratories in conformance with NFPA 70, article 500 and article 505.

5.9.2 Ingress protection

5.9.2.1 Ingress protection for equipment.

Equipment shall have a minimum degree of ingress protection as specified in Table 7 in accordance with IEC 60529 or NEMA 250.

Table 7 – Ingress protection rating or NEMA rating

Equipment	Location	IP rating	NEMA rating
Electric motors (onshore)	External	IP55	NEMA 4
Electric motors (offshore and onshore wet tropical locations)	External	IP56	NEMA 4
Power Socket Outlets	External	IP66	NEMA 4X
Free standing or wall mounted cabinets and consoles	Internal	IP41	NEMA 3
Instrument control panel	External	IP66	NEMA 4X
Instrument control panel	Internal	IP66	NEMA 4
Field instruments	External	IP66	NEMA 4X
Inside a control panel with door open	Internal	IP21	NEMA 2
Junction boxes	External	IP66	NEMA 4X
Cable glands	External	IP66	NEMA 4X
Luminaires	External	IP56	NEMA 4X
Luminaires	Internal	IP56	NEMA 4X
Distribution Board	Internal	IP21	NEMA 3
Distribution board	External	IP56	NEMA 4X
Transformer	Internal	IP21	NEMA 3
Transformer	External	IP56	NEMA 4

5.9.3 Cables

5.9.3.1 General

5.9.3.1.1

Minimum cable bending radius shall not exceed manufacturers recommendations.

5.9.3.1.2

Multi-pair cables shall have 10 % spares.

5.9.3.1.3

Cables within the package boundary shall be labelled.

5.9.3.1.4

Instrument, power and control cables not routed in a conduit or other external means of protection shall be armoured.

5.9.3.1.5

For IEC standard projects, cables shall be flame retardant, low smoke, zero halogen and certified in accordance with IEC 60332.

5.9.3.1.6

For IEC standard projects cables shall be UV resistant in accordance with EN 50289-4-17.

5.9.3.1.7

For IEC standard projects, cables for emergency systems or systems that operate during fire emergencies shall be fire resistant in accordance with IEC 60331.

5.9.3.1.8

For North American standard projects cables for emergency systems or systems that operate during fire emergencies shall be fire resistant in accordance with UL 2196.

5.9.3.1.9

For North American standard projects, cables shall be flame retardant, low smoke and certified in accordance with UL 1685 and UL 2250.

5.9.3.1.10

For North American standard projects cables shall be UV resistant in accordance with UL 2556.

5.9.3.2 Power and control cables

5.9.3.2.1

For onshore IEC standard projects, power cables shall be in accordance with IEC 60502.

5.9.3.2.2

For offshore IEC standard projects, cables shall be in accordance with IEC 61892-4.

5.9.3.2.3

For offshore North American standard projects, cables shall be in accordance with UL 1309 and IEEE 1580.

5.9.3.2.4

For North American standard projects power and control wiring in cable trays shall be Type MC or TC rated cable in accordance with the NFPA 70.

5.9.3.2.5

For three phase, four-wire systems of electrical power, the neutral conductor shall equal phase conductor specification and size.

5.9.3.2.6

Power conductors of electrical cables and wiring shall be continuous without splice.

5.9.3.2.7

For North American standard projects, electrical cables in hazardous (classified) areas shall be in accordance with UL 2225.

5.9.3.3 Instrumentation cables

5.9.3.3.1

For offshore IEC standard projects, instrument cables shall be in accordance with, IEC 61892-4, IEC 60092-350, IEC 60092-360 and IEC 60092-376.

5.9.3.3.2

For offshore North American standard projects, instrument cables shall be in accordance with UL1569, UL 2225 and UL 2250.

5.9.3.3.3

For onshore IEC standard projects, instrument cables shall be in accordance with EN 50288-7.

5.9.3.3.4

For onshore North American standard projects, instrument cables shall be in accordance with UL 2225 and UL 2250.

5.9.3.3.5

The outer sheath color of intrinsically safe cables shall be blue.

5.9.3.3.6

The outer sheath color of non-intrinsically safe cables shall be as specified.

5.9.4 Cable glands

5.9.4.1

Where earth continuity of the cable armour and gland cannot be achieved, the necessary bonding shall be provided between armour and gland to an external earth connection.

5.9.4.2

Adaptors and reducers shall be made of the same material as the gland.

5.9.5 Cable support systems

5.9.5.1

For IEC standard projects, cable trays and cable ladders shall be in accordance with IEC 61537.

5.9.5.2

For North American standard projects, cable trays and cable ladders shall be in accordance with NEMA VE 1.

5.9.6 Cable segregation and spacing

Separate rack and tray systems shall be used for the following cables:

- cables with system voltages greater than 1 000 V AC;
- cables with system voltages less than 1 000 V AC;
- instrument intrinsically safe cable;
- instrument non intrinsically safe cable.

Note In congested areas, cable trays and ladders may have a physical barrier (separation plate) between intrinsically safe, non-intrinsically safe and fire and gas cables.

5.9.7 Junction boxes

5.9.7.1

Electrical junction boxes shall be segregated as defined below:

- HV power junction box;
- LV power junction box;
- control junction box.

5.9.7.2

Separate junction boxes shall be provided for the following types of system:

- intrinsically safe analogue/digital;
- non-intrinsically safe analogue/digital;
- fire and gas system;
- communication;
- instrument power.

5.9.7.3

Junction boxes shall be 316 stainless steel or glass reinforced plastic.

5.9.7.4

Junction boxes shall be fitted with internal or external earth or ground studs.

5.9.7.5

Terminals and end brackets shall be blue for intrinsically safe signals.

5.9.7.6

The color of terminals for non-intrinsically safe circuits shall be as specified.

5.9.7.7

Except for four-way junction boxes, cable entry shall be from the bottom.

5.9.7.8

Terminals shall be mounted on the DIN rail using end fixing plates and rail clamps.

5.9.7.9

Terminal blocks and individual terminals shall be permanently numbered.

5.9.7.10

Terminal blocks shall have a clearance of at least 100 mm on all sides.

5.9.7.11

Power terminals shall be raising screw clamp type.

5.9.7.12

One conductor shall be terminated per terminal.

5.9.7.13

Where conductor inter-connections are needed, metal links shall be used.

5.9.7.14

Power terminals shall be marked L1, L2, L3, N or PE/E using pre-marked plastic letters.

5.9.8 Cable transits

5.9.8.1

Cable transits shall be used to facilitate cable penetrations through walls, roofs and floors in pressurized enclosures.

5.9.8.2

Spare ways in transit frames shall be filled with blank filling blocks and 10 % spare ways shall be provided.

5.9.8.3

Transits shall be identified by labels located on either side of the penetrations.

5.9.8.4

Cable insert blocks shall be halogen free, non-flammable intumescent elastomeric polymer.

5.9.8.5

10 % filler block shall be provided.

5.9.8.6

Separate multi cable transit frames shall be provided for instrument and electrical cables.

5.9.9 Earthing and bonding

5.9.9.1

For offshore IEC standard projects, earthing or grounding installations shall be in accordance with IEC 61892.

5.9.9.2

For offshore North American standard projects, earthing or grounding installations shall be in accordance API 14F.

5.9.9.3

For IEC standard projects, the earth or ground design shall be in accordance with IEC 60364-4-44 and IEC 60364-5-54.

5.9.9.4

For North American projects the earth or ground design shall be in accordance with NFPA 70.

5.9.9.5

Package base frame shall have two M10, 316 stainless steel, earthing bosses, as a minimum, at diagonally opposed locations, with lugs, stud, flat washers, spring washer and nut.

5.9.9.6

Non-current carrying metallic equipment and enclosures shall be bonded to package steelwork.

5.9.9.7

Cable screens and drain wires shall be isolated within the instrument head, earthed/grounded at the control panel end only.

5.9.10 Terminations

5.9.10.1

For IEC standard projects, high voltage terminations shall be in accordance with IEC 60502.

5.9.10.2

For North American standard projects, high voltage terminations shall be in accordance with IEEE 48.

5.9.10.3

Spare cores, conductors, pairs and triads shall be terminated to spare terminals.

5.9.10.4

Spare power terminals shall be terminated at both ends to the PE-bar.

5.9.10.5

Instrument and telecom cable spare cores or conductors shall be left unconnected at the field end and connected to instrument earth (IE) in supply end/panel end only.

5.9.10.6

Low voltage power and control terminals shall be rated to a minimum of 600 V.

5.9.11 Electromagnetic compatibility

Electrical equipment and instrumentation shall comply with the electromagnetic compatibility requirements specified in IEC 61000.

6 Management requirements

6.1 Operability and maintainability

6.1.1 Operability

6.1.1.1

Attendance and follow up actions shall be carried out through the following safety studies:

- HAZOP;
- SIL (safety integrity level).

6.1.2 Maintainability

6.1.2.1

Data shall be provided for reliability, availability, and maintainability analysis of the diesel generator package and the facility.

6.2.1.1

String and mechanical run tests shall use contract equipment including all auxiliaries.

6.2.2 Hydrostatic tests

6.2.2.1

Hydro-static test pressure shall be maintained for at least one hour without visible leakage.

6.2.2.2

After testing new seals, gaskets and O-rings shall be used if disassembly and reassembly is required.

6.2.2.3 Fuel tank leak tests

The diesel engine fuel tank shall be leak tested before painting and use in run tests.

6.2.3.1 Generator tests

6.2.3.1

The generator shall be type tested.

6.2.3.2

The generator shall have routine tests performed on it including:

- visual and mechanical checks;
- measurement of ohmic resistances of stator winding (cold);
- measurement of short circuit impedance and load loss;
- no-load test, measurement of no load loss and current;
- check of ration and polarity of built in current transformers;
- sustained three phase short circuit tests;
- check of phase sequence, direction of rotation and terminal markings;
- dielectric routine tests, Insulation resistance test of stator winding;
- withstand voltage test of machine windings and accessories (temperature detectors, heaters);
- vibration measurement;
- over speed test;
- measurement of terminal voltage;
- noise level tests;
- verification of all protection devices;
- functional check of accessories and auxiliaries (e.g. temperature detectors in windings and bearings, vibration monitoring, heaters, leakage detectors, etc);
- check of rating plate, nameplate, additional markings and labels;
- check outputs from monitoring systems.

6.2.3.2 Diesel engine tests

6.2.3.2.1 General

6.2.3.2.1.1

Exhaust spark arresters shall be tested in accordance with SAE J 342 or SAE J 350, and SAE J 997.

6.2.3.2.1.2

Engine mounted pressure containing components and off-engine package auxiliaries pressure equipment parts shall be hydro tested.

6.2.3.2.1.3

Exhaust emissions shall be tested in accordance with ISO 8178.

6.2.3.2.2 Mechanical and performance test

6.2.3.2.2.1

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

6.2.3.2.2.2

Diesel engines shall be tested in accordance with ISO 15550 or ASME PTC 17.

6.2.3.3 Electric motor tests

6.2.3.3.1

Low voltage motors shall be tested in accordance with IOGP S-703.

6.2.3.4 Unit control panel tests

6.2.3.4.1

Instrumentation, fire control, and safety equipment shall be function tested to ensure operation conforms to the cause and effect chart.

6.2.3.4.2

A full simulated communication test (input and output signals) shall be carried out.

6.2.3.5 Factory acceptance test (FAT)

6.2.3.5.1

The diesel generator package, i.e. generator, diesel engine, controller and all ancillary items, shall be fully assembled, with all utilities connected, and given a full-load, four hour minimum complete unit test (FAT) at the manufacturer’s works.

6.2.3.5.2

Diesel generator package vibrations shall be recorded as part of the performance test.

6.2.3.5.3

Vibrations shall comply with the limits of ISO 8528-9, Table C.1.

6.2.3.5.4

The generator package shall have the following 'string tests' performed:

- Check of starting and run cycles;
- Engine run-in cycle;
- On-set lube oil and fuel system tests;
- Demonstration of control, synchronizing and load sharing;
- Sudden step load acceptance and rejection at 50 %, 75 % and 100 %;
- Frequency and voltage regulation of the generator set shall be verified against the requirements for the excitation system;
- Insulation tests shall be performed on the generator, exciter, space heaters, temperature detectors, control panel and skid cabling;
- Operation of all alarms, shutdowns, and safety devices for the engine, generator and auxiliary equipment;
- Functional test to verify operation of the generator, including the battery charger, engine control panel and generator control panel;
- Data transfer and communication tests.

6.2.4 Completion

6.2.4.1

Completion activities shall be documented by completion of the purchaser's standard forms either by direct on-line registration in the purchaser's completion system or by manual completion of the purchaser's forms.

6.2.4.2

A mechanical completions dossier shall be compiled containing a mechanical completion certificate, mechanical completion check record, mechanical completion status index and punch list register.

6.3.1 Tagging

6.3.1.1

The tags or markings shall be placed directly on or next to the equipment and facing the positions of normal access to the completed installation.

6.3.1.2

Equipment and components that are delivered as loose items shall have tag plates attached with stainless steel wire.

6.4.1 Nameplates

6.4.1.1

Each equipment item shall be supplied with manufacturer's standard nameplate size.

6.4.1.2

Equipment nameplates shall include:

- supplier's name;
- purchase order number;
- equipment tag number;
- service description;
- rating;
- weight (operating/empty);
- year of manufacture.

6.4.1.3

Instrument nameplates shall include:

- supplier's name;
- model;
- type;
- serial number;
- operating voltage;
- hazardous area certification markings;
- range;
- set point (where applicable);
- IP rating;
- size and rating.

6.4.1.4

Nameplates, rating plates and tag plates shall be 316L stainless steel.

6.4.1.5

Nameplates, rating plates and tag plates shall be affixed with 316L stainless steel rivets or screws.

6.4.1.6

Nameplate text shall be engraved and painted with lettering 5 mm or larger.

6.4.2 Weight control

6.4.2.1

Weight and centre of gravity data for offshore packages shall be in accordance with ISO 19901-5, weight control class A.

6.4.3 Special tools

6.4.3.1

Special tools shall be identified and supplied for assembly and maintenance of the equipment.

6.4.3.2

Special tools shall be marked or tagged to indicate the intended use.

6.4.4 Marking

6.4.4.1

Each package and each tagged equipment item shall have tag number marked on the equipment surface.

6.4.4.2

For insulated equipment the tag number shall also be painted on the external surface of the insulation or cladding.

6.4.4.3

Lettering size shall be proportional to the equipment size.

6.4.5 Packing and shipping

6.4.5.1

Open gland entries shall be fitted with temporary blanking plugs to maintain the ingress protection rating during transportation and storage.

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