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|  | <b>Venus project<br/>Namibia</b> |  |
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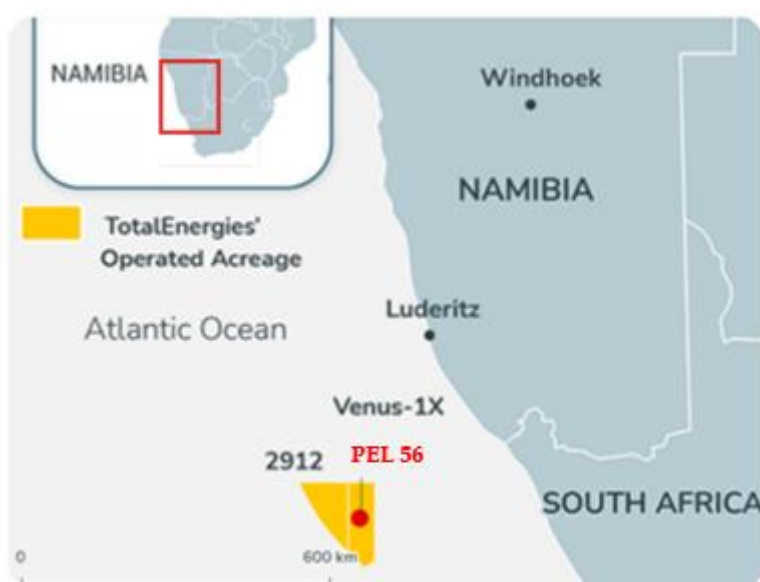
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## 1 INTRODUCTION

The Venus development PEL 56 (Block 2913B) is located in the deep offshore region of Namibia, North of the Namibia / South Africa border, at a water depth of approximately 3000 meters.

It is situated approximately 320km from the coast, 350km from the Luderitz harbour and 700km from Walvis Bay harbour.

The current working interests in the block are as follows: TotalEnergies (Operator), Qatar Energy, Impact and Namcor.



**Venus Location Map**

The development proposed is as follows:

- Recovery mechanism: full gas re-injection in the reservoir (no Water Injection),
- Wells: 38 subsea wells (19 Oil Producers & 19 Gas Injectors),
- Subsea system: Production through 2 conventional rings, Gas Injection through 2 flowlines, chemical injection and control through 2 main umbilicals,
- FPSO (Floating Production, Storage and Offloading): new built, spread moored, all electric, with an EPC (Engineering, Procurement & Construction) + O&M (Operation & Maintenance) contract,
- Oil offloading: tandem offloading from FPSO to DPST (Dynamic Positioning Shuttle Tanker), on site; then transshipment from DPST to conventional tanker, nearshore close to Walvis Bay harbour.

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## 2 PURPOSE OF THE DOCUMENT

This document defines the design, fabrication, inspection and testing requirements for the supply of essential diesel generators.

This equipment is derived by requirements from Classification Society's rules for FPSO and International maritime conventions so that Topsides design guidance/specifications generated in this Project shall not be applied to this equipment unless it is specifically written on this document.

## 3 REFERENCE DOCUMENTS

In principle, when a specific section or articles are referenced and intended to be applicable for the specific area, the remaining parts of the referenced document are not applicable to the design of equipment intended in this specification except the indicated/applicable section or articles.

### 3.1 Project Documents

|     |                       |                                                                          |
|-----|-----------------------|--------------------------------------------------------------------------|
| [1] | NA-101-20-F002-484008 | Specification for ECS (Electrical Control system)                        |
| [2] | NA-101-20-F002-489002 | Protection Schematic Diagram                                             |
| [3] | NA-101-22-F002-484009 | Specification – Generating units                                         |
| [4] | NA-101-22-F002-484013 | Specification - Alternator                                               |
| [5] | NA-101-22-F002-484012 | Electrical specification for packaged units                              |
| [6] | NA-101-20-F002-474107 | FPSO Specification – Cyber Security Requirements for System and Packages |
| [7] | NA-101-20-F002-474105 | Specification – Preliminary Obsolescence Management                      |

### 3.2 Codes and Standards

|      |                 |                                                                                                                              |
|------|-----------------|------------------------------------------------------------------------------------------------------------------------------|
| [8]  | SOLAS           | International Convention for the Safety of Life at Sea                                                                       |
| [9]  | BV rule - NR445 | Rules for the Classification of Offshore Units (July 2024)                                                                   |
| [10] | IMO MARPOL      | International Convention for the Prevention of Pollution from Ships, Annex VI                                                |
| [11] | ISO 3046-1      | Reciprocating internal combustion engines - Performance                                                                      |
| [12] | ISO 5167        | Measurement of fluid flow by means of pressure differential devices inserted in circular cross-section conduits running full |
| [13] | ISO 5168        | Measurement of fluid flow — Procedures for the evaluation of uncertainties                                                   |
| [14] | ISO 8217        | Specifications of marine fuels                                                                                               |
| [15] | ISO 19277       | Qualification testing and acceptance criteria for protective coating systems under insulation                                |
| [16] | IOGP S-563      | Material Data Sheets for Piping and Valve Components                                                                         |
| [17] | IOGP S-707      | Supplementary Specification to ISO 12490 Actuators for On-off Valves                                                         |
| [18] | IOGP S-715      | Supplementary Specification to NORSOK M-501 Coating and Painting for Offshore, Marine Coastal and Subsea Environments        |
| [19] | NORSOK M-004    | Piping and equipment insulation (2018)                                                                                       |
| [20] | NORSOK M501     | Surface protection and protective coating (2022)                                                                             |
| [21] | API STD 526     | Flanged Steel Pressure-relief Valves                                                                                         |
| [22] | API STD 527     | Seat Tightness of Pressure Relief Valves                                                                                     |
| [23] | API STD 551     | Process Measurement                                                                                                          |
| [24] | API STD 609     | Butterfly Valves: Double-flanged, Lug- and Wafer-type, and Butt-welding Ends                                                 |

|                                                     |                        |                      |                 |                                                  |                               |
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|      |                |                                                                                                                                                                         |
|------|----------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| [25] | API STD 2000   | Venting Atmospheric and Low-pressure Storage Tanks                                                                                                                      |
| [26] | API RP 576     | Inspection of Pressure-relieving Devices                                                                                                                                |
| [27] | ASME B16.5     | Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24, Metric/Inch Standard                                                                                         |
| [28] | ASME B16.34    | Valves--Flanged, Threaded, and Welding End                                                                                                                              |
| [29] | ASME PTC 19.3  | Temperature Measurement                                                                                                                                                 |
| [30] | ASTM D1599     | Standard Test Method for Resistance to Short-Time Hydraulic Pressure of Plastic Pipe, Tubing, and Fittings                                                              |
| [31] | IEEE 519       | IEEE Standard for Harmonic Control in Electric Power Systems                                                                                                            |
| [32] | IEC 60331      | Tests for electric cables under fire conditions                                                                                                                         |
| [33] | IEC 60332-3-22 | Tests on electric and optical fibre cables under fire conditions - Part 3-22: Test for vertical flame spread of vertically-mounted bunched wires or cables - Category A |
| [34] | IEC 60034      | Rotating electrical machines – ALL PARTS                                                                                                                                |
| [35] | IEC 60079-14   | Explosive atmospheres - Part 14: Electrical installation design, selection and installation of equipment, including initial inspection                                  |
| [36] | IEC 60584-1    | Thermocouples - Part 1: EMF specifications and tolerances                                                                                                               |
| [37] | IEC 60754-1    | Test on gases evolved during combustion of materials from cables - Part 1: Determination of the halogen acid gas content                                                |
| [38] | IEC 61034-2    | Measurement of smoke density of cables burning under defined conditions - Part 2: Test procedure and requirements                                                       |
| [39] | IEC 61511      | Functional safety - Safety instrumented systems for the process industry sector - ALL PARTS                                                                             |
| [40] | IEC 61892-7    | Mobile and fixed offshore units - Electrical installations - Part 7: Hazardous areas                                                                                    |
| [41] | IEC 62061      | Safety of machinery - Functional safety of safety-related control systems                                                                                               |
| [42] | IEC 62443-2-1  | Security for industrial automation and control systems - Part 2-1: Security program requirements for IACS asset owners                                                  |
| [43] | UL 1581        | Reference Standard for Electrical Wires, Cables, and Flexible Cords                                                                                                     |
|      |                |                                                                                                                                                                         |
|      |                |                                                                                                                                                                         |

## 4 DEFINITION AND ABBREVIATIONS

### 4.1 Definitions

|            |                                                     |
|------------|-----------------------------------------------------|
| Company    | TotalEnergies EP Namibia B.V.                       |
| Contractor | Hanwha Ocean Co., Ltd.                              |
| Project    | Venus Namibia Development Project                   |
| Vendor     | Supplier of the equipment intended in this document |

### 4.2 Abbreviations

|     |                            |
|-----|----------------------------|
| CCR | Central Control Room       |
| CFT | Call for Tender            |
| EDG | Essential Diesel Generator |



|                                                     |                        |                      |                 |                                                  |                               |
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|      |                                              |
|------|----------------------------------------------|
| ESD  | Emergency Shutdown                           |
| FAT  | Factory Acceptance Test                      |
| FEED | Front End Engineering and Design             |
| FGS  | Fire and Gas System                          |
| FPSO | Floating, Production, Storage and Offloading |
| HT   | High Temperature                             |
| ICSS | Integrated Control and Safety System         |
| IS   | Intrinsic Safety                             |
| LT   | Low Temperature                              |
| MS   | Machinery Space                              |
| PCS  | Process Control System                       |
| PDS  | Process Data Server                          |
| PSS  | Process Safety System                        |
| SII  | Industrial Information System                |
| SWL  | Safe Working Load                            |

## 5 LIST OF HOLDS

|          |                                                                                                                                                       |
|----------|-------------------------------------------------------------------------------------------------------------------------------------------------------|
| [HOLD 1] | Unit capacity of Essential Diesel Generators could be updated during detail engineering in accordance with Load Balance and Electrical Consumer List. |
| [HOLD 2] | FPSO Motion and Acceleration values might be further updated as per design progress.                                                                  |

## 6 RESPONSIBILITY

The Vendor shall assume unit responsibility for all equipment and all auxiliary systems included in the scope of order.



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## 7 SCOPE OF SUPPLY

### 7.1 Scope of Supply

#### 7.1.1 Main package

| Tag. no.                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                    | Q'ty     | Description                | RPM | Capacity                                                  | Remark         |
|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------|----------------------------|-----|-----------------------------------------------------------|----------------|
| 21-DG-0502-A/B/C                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            | Three(3) | Essential Diesel Generator | 720 | Engine: 7060 kW<br>Alternator: 6700 kW<br><b>(HOLD 1)</b> | 13.8 kV, 60 Hz |
| <p>The essential generator engine and alternator shall be mounted on a common bed plate and shall be installed on board by means of resilient supports.</p> <p>Accessories and fittings (per engine)</p> <ul style="list-style-type: none"> <li>2 off Turbocharger with cleaning provisions</li> <li>2 off Air cooler</li> <li>1 off Jacket cooling fresh water pump, engine driven</li> <li>1 off LO pump, engine driven</li> <li>1 off LO priming pump, electric motor driven</li> <li>1 off LO cooler with a thermostat valve</li> <li>1 off LO filter, manual duplex type</li> <li>1 off Governor</li> <li>1 off Tachometer</li> <li>1 off Cooling water shut-off valve for LO cooler &amp; air cooler</li> <li>Maintenance platform fitted on engine with ladders and handrails</li> <li>Set of resilient mountings</li> <li>Set of flexible hoses for all external connections</li> <li>Oil mist detector (above 300 mm bore or 2250 kW engines and above. In case of DNV, all engines)</li> <li>Local control panel or local starting box</li> <li>Engine control panel</li> <li>Others according to the engine manufacturer's standards.</li> </ul> |          |                            |     |                                                           |                |

#### 7.1.2 Certificate

Type Approval certificate issued by Classification Society to be provided by Vendor.

IMO NOx emission level Tier II EIAPP certificate issued by Classification Society and Engine record book to be provided by Vendor.

In case of flexible hoses for fuel oil, lube oil, cooling water and compressed air connections and/or expansion joint, it should be of a type approved by the Classification Society.

#### 7.1.3 Commissioning and start-up spares

Commissioning and start-up spares recommended by Vendor to be provided.

#### 7.1.4 Two year operation spares

Two year operation spares recommended by Vendor to be proposed **as option**.

|                                                     |                        |                      |                 |                                                  |                               |
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### 7.1.5 Capital spares

Capital spares recommended by Vendor to be proposed **as option**, but the following minimum requirement from Company shall be included;

| Essential/Emergency Generator                 | Per type of engine |
|-----------------------------------------------|--------------------|
| Piston, connecting rod, cylinder & crankshaft | 1                  |
| Starting unit                                 | 1                  |
| Journal & thrust bearing                      | 1 set              |
| Governor                                      | 1                  |

### 7.1.6 Special tools

Special tools necessary for installation and maintenance to be provided by Vendor.

### 7.1.7 Supervision at Contractor's yard and Offshore site

Unit rate and recommended period of supervision personnel at Contractor's yard and offshore site to be proposed by Vendor.

## 7.2 Exclusions

The following are excluded from the scope of Supplier.

- Equipment transportation and Un-loading at site or Contractor's yard
- Installation at site or Contractor's yard
- Electrical and Instrument cable between equipment skid and control/MCC room
- Commissioning and start-up work
- Initial filling

|                                                     |                        |                      |                 |                                                  |                               |
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## 8 BASIS OF DESIGN

### 8.1 CLASS notations

The Hull, machinery, equipment and outfits shall be constructed under the survey of Bureau Veritas (herein called the "Classification Society"), and shall have the following minimum notations.

#### 8.1.1 CLASS notation during transit to Namibia

During transit to Namibia, the FPSO shall have the following BV CLASS notation:

I ✕ HULL ✕ MACH,  
Offshore barge PERMANENT– Oil storage/ Oil production unit  
Transit – Specific route  
✕AUTO ✕ VeriSTAR-HULL ✕ ALM-MR  
INERTGAS LSA HEL ✕OHS ERS-H ERS-S  
Spectral fatigue  
INWATERSURVEY ETA Green Passport EU, CPS(COT), CPS (WBT) SUSTAINABILITY-1

#### 8.1.2 CLASS notation on SITE

On SITE, the FPSO shall have the following BV CLASS notation:

I ✕ HULL ✕ MACH  
Offshore barge PERMANENT - Oil storage/ Oil production unit  
NAMIBIA PEL 56 (Block 2913B) Area  
✕AUTO ✕ VeriSTAR-HULL ✕ POSA ✕ ALM-MR  
INERTGAS LSA HEL ✕OHS ERS-H ERS-S  
Spectral fatigue  
INWATERSURVEY ETA Green Passport EU, CPS(COT), CPS (WBT), SUSTAINABILITY-1

### 8.2 FPSO Motion and Acceleration

Equipment shall be designed to withstand FPSO motion and the resultant acceleration forces acting on equipment body.

- Any emergency and essential equipment: Designed and operate under the most extreme conditions (i.e. 100 year return period on site and 10 year return period during transit). Emergency equipment are also subject to SOLAS requirements which may be more stringent.
- All other process equipment: Operate under 10 year return period on site and designed to withstand 100 year return period on site and 10 year return period during transit.

Position of Essential Diesel Generator: AFT area, MS mid-level

*(HOLD 2, Data in below table is cited from NA-101-21-F002-223004 SEAKEEPING ANALYSIS REPORT and those values might be further updated as per design progress)*

|                                                        |                                                         |
|--------------------------------------------------------|---------------------------------------------------------|
| 10 year return period acceleration (m/s <sup>2</sup> ) | 100 year return period acceleration (m/s <sup>2</sup> ) |
|--------------------------------------------------------|---------------------------------------------------------|

|                                                     |                        |                      |                 |                                                  |                               |
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|              | AFT area | Midship | FWD area | AFT   | Midship | FWD   |
|--------------|----------|---------|----------|-------|---------|-------|
| LQ Top       | 1.999    | N/A     | N/A      | 2.323 | N/A     | N/A   |
| LQ mid-level | 1.839    | N/A     | N/A      | 2.152 | N/A     | N/A   |
| Main deck    | 1.59     | 1.373   | 2.293    | 1.797 | 1.614   | 2.685 |
| MS mid-level | 1.59     | 1.176   | 2.293    | 1.797 | 1.429   | 2.685 |
| Hull bottom  | 1.59     | 1.168   | 2.293    | 1.797 | 1.429   | 2.685 |

|              | 10 year return period acceleration (m/s <sup>2</sup> ) during Transit |         |          |
|--------------|-----------------------------------------------------------------------|---------|----------|
|              | AFT area                                                              | Midship | FWD area |
| LQ Top       | 3.54                                                                  | N/A     | N/A      |
| LQ mid-level | 3.259                                                                 | N/A     | N/A      |
| Main deck    | 2.826                                                                 | 2.211   | 3.216    |
| MS mid-level | 2.826                                                                 | 2.211   | 3.216    |
| Hull bottom  | 2.826                                                                 | 2.211   | 3.216    |

## 8.3 Diesel Engine

### 8.3.1 Particulars

|                   |                                                                     |
|-------------------|---------------------------------------------------------------------|
| No. of sets       | Three(3)                                                            |
| Type              | 4-stroke, trunk piston, V-type                                      |
| Rated output      | Approx. 7060 kW at 720 rpm ( <b>HOLD 1</b> )                        |
| Alternator output | Approx. 6700 kW ( <b>HOLD 1</b> )                                   |
| Starting          | By compressed air                                                   |
| Fuel              | MDO - grade DMZ (ISO 8217: 2017(E))<br>Viscosity 3 ~ 6 cSt at 40 °C |
| Lubrication       | Self-contained lubrication with wet oil sump                        |

The essential generator engines shall start/stop directly on MDO - grade DMZ.

The capacity of diesel generators in the machinery space shall be designed based on the following conditions of BV NR-445 Pt C, Ch1, Sec 2, 1.3.3:

- Total barometric pressure : 1,000 mbar
- Machinery space air temperature : 45 °C
- Relative humidity of air : 60 %
- SW temperature : 32 °C

|                                                     |                        |                      |                 |                                                  |                               |
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The power and fuel consumption of engines shall be determined in accordance with the following standard reference conditions specified in ISO 3046-1 (2002):

- Total barometric pressure : 1,000 mbar
- Ambient air temperature : 25 °C
- Relative humidity of air : 30 %
- Charge air coolant temperature : 25 °C

Exhaust gas NOx emissions from essential diesel generator engines shall comply with the IMO NOx limit Tier II.

### 8.3.2 Auxiliary system

Charging air cooler consists of:

- Thermometers each at inlet and outlet for both fluids
- Air vent valves for both fluids
- Drain valves for both fluids
- Chemical cleaning water connections with blind flange at FW side

Exhaust gas system consists of:

- Turbocharger with air filter
- Exhaust gas expansion joint with guide bar (after turbocharger)
- Water washing device with flexible hose (20 m), quick couplings, reducing valve, pressure gauge and drainage at turbine side
- Water washing device with hand injector or water can at blower side
- Exhaust gas outlet transition piece
- Silencer with spark arrester
- Insulation cover of galvanized steel plate for exhaust manifold

Cooling water system consists of:

- Cooling fresh water pump (engine driven HT pump)
- Automatic cooling water shut-off valve (attached on engine)
- Jacket cooling water temperature control valve of wax type (attached on engine)
- Jacket water preheating system

1 - Preheater of electric type fitted at each engine (engine inlet temperature: min. 60 °C)

Automatic temperature control for preheater

- Preheating control box: One (1) group panel for 2 engines (loose supply)
- One (1) stop valve, orifice (\*\* mm) & flexible hose for jacket cooling water air vent
- Complete internal piping work in case of totally enclosed alternator

\*\* To be recommended by Vendor.

Fuel oil system consists of:

|                                                     |                        |                      |                 |                                                  |                               |
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- FO safety filter (manual duplex type) with differential pressure switch
- FO leakage tank with high level alarm
- FO outlet pressure retaining valve

Lube oil system consists of:

- LO pump (engine driven)
- LO priming pump (engine mounted, continuous duty, motor driven)  
The electric motor shall be designed to operate without overload at lubrication oil viscosity of 1,000 cSt.
- Starter for LO priming pump (Wall mounting type) with
  - Under voltage release feature
  - One (1) group starter with flame-retardant partition wall between each starter
  - Individual power source for each starter
- LO filter (manual duplex type, engine mounted) with differential pressure switch
- LO cooler (engine mounted) with
  - Capacity based on continuous purification
  - Thermometers at inlet and outlet for both fluids
  - Air vent valves for both fluids
  - Drain valves for both fluids
  - Chemical cleaning water connections with blind flanges at freshwater side
- Thermostatic 3-way valve (wax type)
- Connections on sump tank to/from purifier
- Drain connection at sump tank
- LO centrifugal by-pass filter: 1 set/engine

Starting air system consists of:

- Starting air pressure reducing valve with safety valve, pressure gauge and strainer: 1 set/engine, if air motor starting (loose supply)
- Necessary accessories fitted on engine
- Starting air reservoir for engine (Contractor's scope of supply)
  - Capacity: According to Classification Society requirements
  - Pressure: 30 bar g.

Maintenance platforms fitted on engine with ladders and hand-rails

- The platforms shall be provided for convenient operation and maintenance of engine
- The platform service area should cover turbocharger as well as engine

### 8.3.3 Materials of Construction

The construction and materials of the essential generator engine shall be according to the engine manufacturer's standards in compliance with the requirements of the Classification Society.

|                                                     |                        |                      |                 |                                                  |                               |
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Pipes, valves, instruments(including gauges) etc. fitted on the engine by the engine manufacturer shall be in accordance with the engine manufacturer's standards.

### 8.3.4 Engine Control

Control class of Essential generator: P3 package (refer to 8.11.13)

All electric components on engine shall be designed with enclosure of min. IP44, unless otherwise specified.

All necessary sensors including cable connections to comply with the monitoring functions in below table and control equipment shall be supplied and integrated by Vendor, unless otherwise agreed upon.

Engine AUTOMATIC SHUT-DOWN at;

- ① Overspeed
- ② Oil mist concentration in crankcase (or engine bearing temperature monitors)
- ③ Lube oil inlet pressure, low-low

Engine READY-TO-START at:

- ① Turning bar/turning gear disengaged
- ② Engine lube oil primed

Local control panel or local starting box for start/ stop and safety system

- ① Power supply from:
  - AC 230V, 1 Ph, 60 Hz and DC 24V supply system
  - UPS in accordance with Classification Society requirement shall be provided by Vendor
- ② Components
  - 1 off Electric power converting system (AC 230V/DC 24V)
  - 1 off Automatic power changeover device
  - 1 off Start/stop push button for each engine
  - 1 off Control position changeover switch with lamps for each engine (remote-local-on engine)
  - 1 off Power source on-off switch with lamp
  - 1 off Engine ready to start indicator lamp
  - 1 off Printed circuit board for safety system for each engine
  - Necessary alarms and indicating lamps
- ③ External contact for remote control, alarm and indication for:
  - Start/stop control
  - Start failure alarm
  - Engine ready to start indication
  - Control position indication (remote - local - on engine)
  - Speed pick-up (low speed contact), 2 points for alarm and control
  - Engine shutdown individual alarm

|                                                     |                        |                      |                 |                                                  |                               |
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- Power failure alarm
- Engine running indication

④ Protection grade: According to the Classification Society requirements

Monitoring function table to be included

| Item                                                                                               |        |                | CCR        |       | Remarks                                                                                                                      |
|----------------------------------------------------------------------------------------------------|--------|----------------|------------|-------|------------------------------------------------------------------------------------------------------------------------------|
|                                                                                                    |        |                | Indication | Alarm |                                                                                                                              |
| Diesel Generator Engine                                                                            |        |                |            |       | *1. Engine start blocked<br><br>*2. One for each cylinder<br><br>*3. Engine shutdown<br><br>*4. Local indication is required |
| Jacket cooling fresh water                                                                         | Inlet  | Press.         | D *4       | L     |                                                                                                                              |
|                                                                                                    | Outlet | Temp.          | D *4       | H     |                                                                                                                              |
| Lube oil engine inlet                                                                              |        | Press.         | D *4       | L *3  |                                                                                                                              |
|                                                                                                    |        | Temp.          | D          | H     |                                                                                                                              |
| Lube oil sump tank                                                                                 |        | Level.         |            | L     |                                                                                                                              |
| Priming lube oil inlet                                                                             |        | Flow or Press. |            | L *1  |                                                                                                                              |
| Lube oil filter differential                                                                       |        | Press.         |            | H     |                                                                                                                              |
| Oil mist concentration in crankcase (or engine bearing temperature monitors or equivalent devices) |        |                |            | H *3  |                                                                                                                              |
| Fuel oil engine inlet                                                                              |        | Press.         | D *4       | L     |                                                                                                                              |
|                                                                                                    |        |                |            |       |                                                                                                                              |
| Fuel oil leakage tank                                                                              |        | Level.         |            | H     |                                                                                                                              |
| Fuel oil filter differential                                                                       |        | Press.         |            | H     |                                                                                                                              |
| Exhaust gas cylinder outlet                                                                        |        | Temp.          | D          | H *2  |                                                                                                                              |
| Starting air engine inlet                                                                          |        | Press.         |            | L     |                                                                                                                              |
| Engine start                                                                                       |        |                |            | F     |                                                                                                                              |
| Engine speed                                                                                       |        |                | *4         | H *3  |                                                                                                                              |
| Control system                                                                                     |        |                |            | F     |                                                                                                                              |

D: Display on CCR screen on demand, F: Failure alarm, H: High alarm, L: Low alarm

## 8.4 Alternator

The Alternator shall be designed in accordance with the following main data:

- Number of unit: Three(3)
- Rated output: 6700 kW (**HOLD 1**)
- Rated voltage: AC 13800V
- Frequency: 60 Hz
- Number of phase: Three(3)
- Power factor: 0.8 (lagging)
- Duty: Full load continuous (S1 type)
- Revolution: 720 rpm
- Excitation: Self excited, brushless
- Insulation: Class "F" with temperature rise class "B"
- Enclosure: IP44 (The installation space shall be protected by water-mist fire-fighting)



|                                                     |                        |                      |                 |                                                  |                               |
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- Type of bearing: End bracket type sleeve bearing
- Number of bearing: One, only at non-drive end
- Lubricating system: Manufacturer's standard
- Space heater: AC 230V, 1 phase
- Stator winding temp.: Two(2) embedded temp. sensors (one for working, the other for stand-by) for each phase

More information is given in NA-101-22-F002-484013 "Specification – Alternator".

## 8.5 Mechanical

### 8.5.1 Design Life

The equipment, piping, and vessels etc. shall be designed for minimum 30 years of continuous operation with normal inspection, maintenance and replacement of wearing parts. All static parts, such as support structures, piping and accessories, tanks and vessels, shall be designed without any need for replacement.

Service life shall be considered as starting at first oil at offshore site, however, the contribution of all the phases from FPSO float-out to first oil and decommissioning shall be considered.

### 8.5.2 Location of equipment

Essential Diesel Generators shall be located in indoor Machinery space; mechanically ventilated non-hazardous area.

### 8.5.3 Noise

During normal operation, noise from equipment shall not exceed 110 dB(A) at 1 meter distance from equipment surface.

### 8.5.4 Vibration

Vendor shall be responsible for any kinds of high vibration of the unit, exceeding the allowable vibration limit as follows:

- Engine block : 28.2 mm/s rms in all directions
- Alternator bearing : 18.0 mm/s rms in all directions

Vibration measurement results shall be submitted to Contractor with the shop test report.

Measured vibration levels at the shop test and on-board operation shall be below the vibration criteria as stated above.

The torsional vibration calculation for the diesel generator set shall be carried out by Vendor and shall be submitted to the Classification Society for approval.

One (1) copy of the approved calculation sheet shall be submitted to Contractor.

## 8.6 Structural, Painting

Lifting eye and proper handling space should be considered in equipment design to avoid manual handling of items weighing more than 25 kg.

|                                                     |                        |                      |                 |                                                  |                               |
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All lifting pad-eyes permanently attached to the structure shall be welded by full-penetration welds. Adjacent lift-load carrying welds in the supporting structure shall also be full-penetration welds.

All permanently installed lifting points with a SWL strictly above 3 tons shall be load test after installation to 150% of the SWL. For all permanently installed lifting points with a SWL equal to or less than 3 tons, no load test is required unless noted otherwise. All welds of permanently installed lifting points shall be 100% MPI and 100% UT before and after load test.

Painting of equipment shall be done in accordance with Vendor's standards, however, final colour should be approved by Contractor.

## 8.7 Blast pressure

Blast pressure is not applicable to equipment in Hull Machinery space.

Essential Diesel Generators shall be installed in Hull Machinery space.

## 8.8 Insulation and Corrosion Management

All equipment and piping under insulation located in the Hull, on Hull deck, and on Topsides shall be coated.

Thermal spray aluminium or organic coating could be used under thermal insulation. If organic coating systems are used, they shall be qualified according to ISO 19277.

Thermal spray aluminium shall be applied according to specification IOGP S-715v2020 and NORSOK M-501 rev 6.

The choice of the material for the thermal insulation shall comply with NORSOK M-004.

Thermal insulation material should not be used for Personnel protection. Personnel protection should be done with cages or specific insulation coating.

Supports in marine atmosphere shall be designed to prevent corrosion of the supported item.

Pipe support design shall be subject to Contractor approval.

Under thermal insulation, fasteners shall be either coated carbon steels or Corrosion Resistant Alloys.

## 8.9 Piping and Pressure vessels

Piping design and flange types within packaged equipment shall be designed in accordance with Vendor's standards, however, all interface flanges at battery limit shall be compatible with ASME B16.5 flange dimensions.

304 series austenitic stainless-steel bolting shall not be used in piping.

Valve and piping material shall be selected in accordance with Vendor's standards except piping and valves handling Topside process fluid of which material shall be subject to Contractor approval.

Sour service materials shall comply with IOGP DS-563 with suffix "S" option.

GRP piping requirements apply to all systems including all packages. Only GRE and GREV type GRP are acceptable materials.

Glass Fiber Reinforced Plastics (GRP) piping network shall conform to ISO 14692 parts 1 to 4 and ASME B31.3 chapter 7.

|                                                     |                        |                      |                 |                                                  |                               |
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Design of GRP system shall take into account the following:

- Surge and water hammer scenario
- Any damages that could be initiated from adjacent piping, support or nearby objects.
- Avoid air trap in firewater systems
- Adequate support and compatibility for valves.

All GRP material shall be qualified by performing a weeping/burst test in accordance with ASTM D1599. The corresponding weeping/burst tests pressure shall be at least the piping design pressure multiplied by the safety factor indicated in below table.

| Use case                                              | Safety Factor |
|-------------------------------------------------------|---------------|
| Line subject to vibration/ water hammer               | 6             |
| Buried lines                                          | Minimum 4     |
| Lines subject to vacuum                               | 6             |
| Lines not subject to Vibrations/ Water hammer/ Vacuum | 4             |

Connection type shall be bell and spigot conical/conical or cylindrical/conical. Connections can be adhesive bonded or laminate and shall fully resist thrust (tensile, thermal etc.) loads and forces.

Tightness and integrity test shall be performed on each system at 1.5 x Design Pressure. Test duration should be approved by Contractor.

All GRP piping with a diameter of 80 mm or above and with operating temperatures of 60°C or above shall be verified by a flexibility calculation using GRP Supplier material values (Supplier shall provide the minimum Allowable stress piping components and joints guaranteed for the supplied products including bonded or laminated joints in order to be implemented as input data within the piping stress calculation).

All personnel that assemble GRP piping shall be qualified. The term assembly is used to mean bonding taper-to-taper, or bonding taper to cylinder or assembly by manual lamination.

If flexible hose and/or expansion joint is required, it shall be of a type approved product as per Classification Society's requirements. Also, flexible hoses and expansion joints are to be complete with Class approved end fittings in accordance with manufacturer's specification.

Pressure vessels in packaged equipment shall be supplied in accordance with Vendor's standards, however, the design code should be notified to Contractor through Vendor's proposal document. If there is no cost impact, IOGP S-619 using ASME section VIII Division 1 or Division 2 is preferred.

## 8.10 Electrical

### 8.10.1 Electrical General Principle

Refer to the following Project documents:

- NA-101-20-F002-484008 "Specification for ECS (Electrical Control System)" [1]
- NA-101-20-F002-489002 "Protection Schematic Diagram" [2]
- NA-101-22-F002-484013 "Specification - Alternator" [4]

Load sharing between Turbo generators and Essential generator and between the Essential generators will be done by Power Management System provided by others.

Detailed interface shall be discussed during detail engineering.

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Refer to the relevant section of “Electrical specification for packaged units” (NA-101-22-F002-484012) [5] for details on the following features:

- Electric cables, cable trays/supports within package
- Emergency stop push button

### 8.10.2 Operating Voltage and Frequency

Electrical equipment shall operate during voltage fluctuations within the voltage tolerance defined as follows;

| Voltage            | Voltage Tolerances              | Frequency Tolerances         | Distributed Phase            | Neutral         | Neutral System                                                                         | Use/ Remarks                                                                                                                                                                               |
|--------------------|---------------------------------|------------------------------|------------------------------|-----------------|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 13.8 kV AC         | +6/-10%<br>(see <b>Note 2</b> ) | ± 5%<br>(see <b>Note 2</b> ) | 3-Ph – 3W                    | Not distributed | Isolated/Neutral earthing resistance. Earth fault current limited (typical 20A to 30A) | Normal/Essential distribution system:<br>- Power rated motors > 4MW<br>- Distribution transformers HV/HV, HV/LV                                                                            |
| 6600 V AC          | +6/-10%<br>(see <b>Note 2</b> ) | ± 5%<br>(see <b>Note 2</b> ) | 3-Ph – 3W                    | Not distributed | Isolated/Neutral earthing resistance. Earth fault current limited (typical 20A to 30A) | Normal/Essential distribution system:<br>- Power rated motors 500 kW < P ≤ 4MW                                                                                                             |
| 690 V AC           | +6/-10%<br>(see <b>Note 2</b> ) | ± 5%<br>(see <b>Note 2</b> ) | 3-Ph – 3W                    | Not distributed | Isolated/Neutral earthing resistance. Earth fault current limited (typically 266 mA)   | Normal/Essential distribution system:<br>- Power rated motors 100 kW < P ≤ 500 kW<br><br>Emergency distribution system:<br>All emergency loads (Motors and Feeders)                        |
| 400/230 V AC       | +6/-10%<br>(see <b>Note 2</b> ) | ± 5%<br>(see <b>Note 2</b> ) | 3-Ph+N – 4W                  | Distributed     | TN-S Neutral solidly bonded to earth                                                   | Essential distribution system for Galley and Laundry in Accommodations                                                                                                                     |
| 230 V AC<br>AC UPS | ± 1%                            | ± 1%                         | 3-Ph – 3W<br>or<br>1-Ph – 2W | Not distributed | Isolated Permanent Insulation Monitoring (PIM) required                                | - Instrumentation<br>Process control and Safety system,<br>- Telecom system,<br>Electrical control system,<br>- PA/GA system,<br>- Electrical control in Normal and Essential switchboards |
| 400/230 V AC       | +6/-10%                         | ± 5%                         | 3-PH+N – 4W                  | Distributed     | TN-S Neutral solidly bonded to earth                                                   | Normal/ Essential/ Emergency Lighting, Heating + Small power                                                                                                                               |
| 110 V DC           | ± 10%                           | N/A                          | Polarities +/-               | N/A             | Isolated Permanent                                                                     | Power supply for DC                                                                                                                                                                        |

|                                                     |                        |                      |                 |                                                  |                               |
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|         |       |     |                   |     |                                                         |                                                                                                                                                |
|---------|-------|-----|-------------------|-----|---------------------------------------------------------|------------------------------------------------------------------------------------------------------------------------------------------------|
| DC UPS  |       |     | 2W                |     | Insulation Monitoring (PIM) required                    | motors (see <b>Note 1</b> )                                                                                                                    |
| 24 V DC | ± 10% | N/A | Polarities +/- 2W | N/A | Isolated Permanent Insulation Monitoring (PIM) required | <ul style="list-style-type: none"> <li>- Electrical control in Emergency LV switchboard</li> <li>- EDG control panel NAVAIDS system</li> </ul> |

#### NOTES:

- 1) DC motors, such as emergency post-lube oil pumps or emergency fans, shall be defined by package vendor. Dedicated DC UPS to feed such equipment shall be supplied as part of the packaged unit. Battery set will be installed in the common battery room.
- 2) Transient variation for voltage can be up to ±20% - 1.5s and for frequency ±10% - 5s.

Emission levels of harmonics shall remain within the IEEE 519 limits in terms of both voltage and total harmonic distortion

### 8.10.3 Electric Motors

All motors shall be induction type designed and built as per IEC 60034 and suitable for area classification as appropriate, except for special motor.

Motors operating voltage shall be as follows:

| Frequency   | 60 Hz      |                     |                   |          |
|-------------|------------|---------------------|-------------------|----------|
| Power range | P ≤ 100 kW | 100 kW < P ≤ 500 kW | 500 kW < P ≤ 4 MW | P > 4 MW |
| Voltage     | 690 V      | 690 V               | 6600 V            | 13.8 kV  |

The motors shall be air cooled with a cooling design IC411, IC511 or IC611 as per IEC 60034-6.

HV motors and LV motors rated above 22 kW shall be provided with 230V anti-condensation heater.

LV Motor efficiency class should be rated IE3 according to IEC 60034-30, IE2 efficiency class may be used with Contractor approval.

HV motors above 1200 kW shall be protected with differential relay to detect internal fault.

### 8.10.4 Protection

| Equipment type                | Protection                                         | Equipment type                                                           | Protection                                                                                   |
|-------------------------------|----------------------------------------------------|--------------------------------------------------------------------------|----------------------------------------------------------------------------------------------|
| HV alternators                | Enclosed: IP23/IK08<br>Non-enclosed: IP55/IK08     | Lighting fixture (Luminaires, floodlight, beaconing, emergency lighting) | External areas: idem Zone 2 (Ex "db" or "db-eb" or "eb")<br>Living quarters: industrial type |
| HV electric motors            | Outdoors: IP55/IK08<br>Indoors/enclosed: IP23/IK08 | Distribution panel (lighting, small power, etc.)                         | IP55/IK08                                                                                    |
| VSD HV motor                  | Standard industrial                                | LV socket outlet                                                         | External areas: idem Zone 2 (Ex "db" or "db-eb")<br>Living quarters: industrial type         |
| LV alternator                 | Enclosed: IP23/IK08<br>Non-enclosed: IP55/IK08     | Heater                                                                   | IP55/IK08                                                                                    |
| LV electric motors P ≥ 100 kW | IP55/IK08                                          | Electric starter for diesel/gas engine                                   | Enclosed: IP23/IK08<br>Non-enclosed: IP55/IK08                                               |

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|-------------------------------------------|-------------------------------------------|-----------------------------|------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| LV electric motors<br>P < 100 kW          | IP55/IK08                                 | Junction box, Terminal box  | External areas: idem Zone 2 ( Ex "eb" or "db")<br>Living quarters: industrial type                                                                                                                                                 |
| VSD LV motor                              | Standard industrial                       | Control station Push button | External areas: idem Zone 2 (Ex "db-eb")<br>Living quarters: industrial type                                                                                                                                                       |
| VSD Frequency converter                   | Standard industrial                       | Trace heating               | Industrial type                                                                                                                                                                                                                    |
| Power transformers (Liquid immersed type) | Indoors: IP21/IK08<br>Outdoors: IP55/IK08 | Accumulator Batteries       | Protection against short circuits<br>Natural cooling<br>Indoor: On battery stand or in cabinet IP21/IK08 minimum<br>Outdoor: In Battery box with internal insulation (Global certification of box + battery box) IP23/IK08 minimum |
| HV connection                             | Indoors: IP21/IK08<br>Outdoors: IP55/IK08 | Package control panel       | Industrial type                                                                                                                                                                                                                    |
| LV connection                             | Indoors: IP21/IK08<br>Outdoors: IP55/IK08 | Solar array                 | Industrial type                                                                                                                                                                                                                    |
| Transformer protection relay              | Indoors: IP21/IK08<br>Outdoors: IP55/IK08 | Cable glands                | Industrial type for in accordance with the equipment type or protection                                                                                                                                                            |
| Power transformers (Dry type)             | Indoors: IP21/IK08<br>Outdoors: IP44/IK08 |                             |                                                                                                                                                                                                                                    |
| HV switchgear                             | IP55/IK08                                 |                             |                                                                                                                                                                                                                                    |
| LV switchgear                             | IP55/IK08                                 |                             |                                                                                                                                                                                                                                    |
|                                           |                                           |                             |                                                                                                                                                                                                                                    |

When the space is protected by water-mist fire-fighting, IP 54 shall be applied to the electrical equipment. If it is an indoor space, then IP 44 is acceptable instead of IP 54.

When electrical equipment is located on Hull open deck or indoor wet area, then IP56 shall be applied to the electrical equipment.

### 8.10.5 Electrical cables and cabling

All electrical cables shall be flaming retardant type to IEC 60332-3-22, Category A.

In addition to this requirement, electrical cables for special (vital safety) services shall also be fire resistant type to IEC 60331-21.

Indoor electrical cables for the living quarter areas and continuously, permanently and normally manned rooms/enclosures shall be Zero Halogen type.

Electrical cables running in hazardous areas in zone 1 & 2 shall be armoured.

Note: for instrumentation cables, refer to section 8.11.

## 8.11 Control and Instrumentation

### 8.11.1 Instrument General Principle

The use of on-off sensors (switches) for process and safety functions is not permitted. Threshold functions i.e. alarms and shutdowns used for safety functions (including process safety) shall be based on analogue signals.

|                                                     |                        |                      |                 |                                                  |                               |
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Safety and Process Control functions shall be performed by independent and autonomous sensors and final elements (including process connections); dual function is not permitted in order to avoid common-mode failures.

Invalidity detection shall be performed on all analogue I/Os. All digital outputs shall have a configurable failure position.

All instruments when not treated in fail safe configuration (e.g. Manual Call points (MAC), (Emergency) Shut-down, deluge pull handles/buttons...) shall be line monitored.

The input & output executive signals between package UCP and Safety systems (i.e. PSS, FGS, ESD system) shall be hardwired. For executive signal from UCP to ESD system or FGS that are linked to FPSO shutdown (i.e. ESD1, ESD2, SD2) shall be line monitored. Status information may pass via serial link.

Instruments shall be installed with vent and drain facilities as necessary. For hazardous and/or polluting fluids, the vent/drain of instruments shall be piped to the vent/drain networks.

Wireless instruments are not permitted for safety functions (PSS, ESD, FGS, HIPS, and UCP), time critical applications and any other critical safety functions.

An Instrument database is required to organize and manage the large amounts of instrument data required to be defined on a project.

The use of aluminium parts – even protected by special coating – shall be prohibited.

If hardwired digital input/output (DI/DO) interface with the ICSS is required, then ICSS shall provide wet contact for both DI and DO signals. Appropriate interposing relay should be installed in Vendor's panel or UCP to interface with the ICSS signals. For any signals related to safety-critical functions, such interposing relays shall be rated for SIL 3 compliance, in accordance with IEC 61508. Same principle shall be applied between UCP and MCC (UCP wet contact/ MCC dry contact with relay)

### 8.11.2 Field Instruments

When exposed to marine environment, instruments housings shall be SS 316 or SS 316L as a minimum.

Instruments wetted parts material shall be as a minimum AISI 316 or 316L unless the process fluid requires another material.

Tubing material shall be 316L for indoors, 904L for outdoors, and Monel 400 for indoor/outdoor corrosive fluid (sea water, chlorinated sea water, produced water etc.).

Tubing shall be supplied by the same manufacturer as the associated MP/HP fittings.

Tubing fittings shall be supplied by the same manufacturer for whole FPSO, including packages.

For outdoor field instruments, the enclosure "degree of protection" shall be IP65 as a minimum.

If the space is protected by water deluge system, for example cargo deck area, then IP66 shall be applied.

Signals within cables shall be segregated following their nature and magnitude:

- Analogue input & output and on/off input signals
- Low level signals (e.g. RTD, thermocouple)
- Frequency signals
- I.S. signals
- Instrument power supplies
- On/off output signals
- System cable (e.g. network cable).



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All instruments and microprocessor-based system shall meet emission and Radio Frequency Immunity (RFI) requirements as per IEC 61000-5.

Field devices which are part of a Safety Instrumented Function shall be certified suitable for SIL 2 applications as a minimum.

All pressure instrument connection shall be installed with a block and bleed valve assembly. The assembly shall be SS 316, including the trim.

For flow instruments, the following shall be applied:

- square edge orifice plate with concentric entrances,
- flanged type, in compliance with piping class requirements,
- minimum AISI 316,
- Calculations as per ISO 5167/5168.
- The beta ratio (d/D) shall be selected as follows: Between 0.10 and 0.75 as per ISO 5167 for square edged concentric type.

Differential Pressure type instrument is the preferred solution for level measurement and interface level measurement in vessels.

If Guided Wave Radars are used, additional spare flanges shall be provided on sides of the vessels for future DP type level transmitters.

Thermowells shall be designed and sized in conformity ASME PTC 19.3 TW 2016 calculations.

Tapered thermowells with round tip shall be selected.

Threaded thermowells are not allowed, not even using retaining welds.

The thermowell standard material shall be SS 316 or 316L.

Thermocouple classes and accuracy shall be in accordance with IEC 60584-1.

### 8.11.3 Instrument Cables and cable glands

As a minimum, instrument cables materials and construction shall limit the production of noxious gases and fumes in the event of fire as follows:

- Acid gas generation: HCl < 17% as per IEC 60754-1
- Cable light transmittance: 60% minimum as per IEC 61034-2.

All instrument cables routed, even partially, within the accommodation (LQ block) or any room/enclosure, which is permanently and normally manned, shall be low smoke, halogen free (sometimes called LSZH – low smoke zero halogen) as per IEC 61034.

Overall outer sheath shall be UV resistance as per UL 1581 art. 1200.

All instrument cables shall be flaming retardant type to IEC 60332-3-22, Category A. In addition to this requirement, instrument cables for special (vital safety) services shall also be fire resistant type to IEC 60331 defined as per “FPSO HSE Requirements”.

Instrument cables running in hazardous areas in zone 1 & 2 shall be armored.

Instrument cables glands for junction boxes and instruments shall be:

- Nickel plated brass or AISI 316 or 316L material.
- Compression type with double sealing, and armor clamping.



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- Certified for hazardous area in line with IECEx.
- Designed to withstand deluge.
- In addition, the gland and its associated instrument cable shall be selected to reduce the effects of “cold flow characteristics” as per IEC 60079-14.

#### 8.11.4 Junction Boxes

For outdoor installations,

- Junction boxes shall be made of GRP or AISI 316 with 316 screw fastenings.
- The minimum ingress protection degree for junction boxes and cable glands shall be of IP65. If the space is protected by water deluge system, for example cargo deck area, then IP66 shall be applied. All ballast system and bilge system junction boxes shall be IP68.
- Instrument cables entries shall be through the bottom via suitable cable glands certified zone 1. Entries for spare instrument cables shall be provided with certified plugs for use in zone 1.
- Instrument cables glands for junction boxes and instruments shall be nickel plated brass or AISI 316 material, compression type with double sealing, and armor clamping

For indoor non-hazardous area installations fitted at equipment, cable gland design, material and IP grade of junction box and cable gland shall be in accordance with Vendor's standards and Classification Society requirements.

#### 8.11.5 Control Valve

Butterfly valves shall not be used above ASME Class 600, In general Butterfly control valves are accepted for seawater, steam and chemical services in all sizes, when the available pressure drop is low, Butterfly control valves shall be designed to API STD 609.

Seat leakage classification shall be as per ANSI/FCI 70-2.

Screwed bonnets and union bonnets shall not be used, except for self-acting pressure regulators in non-hazardous applications.

#### 8.11.6 On/Off Actuated valves (ESDV, SDV and BDV) Control panels and Actuators

Actuators and accessories shall comply with IOGP S-707.

Single acting spring return actuators are required for all shutdown and blowdown valves.

Double acting actuators shall be used when valve shall remain in position in case of air failure, fail lock position.

Valves shall be equipped with both open and close position limit switches or position feedback transmitter in addition to the local visual valve position indicator (beacon).

On/off actuated valves shall be designed as normally energized.

There shall be no more than 2 solenoids per control panel.

Limit switches shall be proximity type (magnetic or inductive, e.g. Westlock magnum XT-90).

Manual override of the solenoid valve shall not be permitted.

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Actuators shall be sized to provide at least 130% of the required operating torque at any point of the valve stroke.

#### 8.11.7 Self-acting pressure regulators

Self-acting pressure regulating valves shall not be used as a substitution of, or complement to, overpressure protection by pressure safety relief valves or actuated on-off valves.

Direct-operated pressure regulators shall only be used for non-hazardous media such as instrument air and inert gases.

In case of flammable or toxic process media, venting to atmosphere is not allowed.

#### 8.11.8 Pressure Safety Valves, Rupture Discs

Safety relief valves shall be of conventional direct-acting angle pattern, spring loaded, pilot operated and high-capacity type:

- Conventional spring-loaded safety valves shall be used in services where there is no backpressure or where the constant backpressure does not exceed 10% of the set pressure.
- Balanced bellows safety valves shall be used for variable backpressures or for backpressures ranging from 10% to 50% of the set pressure or when the fluid is corrosive, toxic or fouling.
- Pilot operated valves shall be considered on services such as light gases at high set pressure, on clean gas in pulsating service, when the set point is less than 10% above the operating pressure or for very high capacities.

For conventional valves, the built-up backpressure shall not exceed 10% of the set pressure.

Test gags (sometimes known as transportation gags) shall not be used.

Bonnets and top plates for flanged pressure relief valves above NPS 1 inch shall be a bolted design with fully retained gaskets. Screwed bonnets and union bonnets are not permitted.

Sizes shall be identified in accordance with API STD 526 showing inlet size - orifice area - outlet size (e.g. 1D2, 2H3...).

Flanged PRVs shall meet the requirements of API STD 526, with the following additions:

Bonnets and top plates shall be the same material, or equivalent forged material, as the valve body.

Each safety relief valve shall be provided with a permanently engraved AISI 316L stainless steel nameplate.

Relief valves bodies shall be marked in accordance with ASME B16.34.

Basic requirements for inspection and maintenance of pressure relief devices shall comply with API RP 576.

Hydrostatic shell tests shall be executed for 100% of the supplied valves by the Supplier in accordance with ASME B16.34.

The test pressure application time and the leakage rate shall be in accordance with API STD 527.

#### 8.11.9 Fire and Gas Detectors

The detectors shall have the following characteristics:

- Analogue signal 0-22 mA covering normal operation (4-20 mA), fault and alarms

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- HART, if provided, fixed at factory and access to configuration for modifications forbidden Therefore, at site it is only be possible to read the measurement, configuration parameters and diagnostic information.
- Operating voltage: 24 VDC.
- Power for detectors by the FGS, package FGS or Addressable Fire Detection System as appropriate via the signal cable
- Immunity of detectors to solar interference (direct or reflected sunlight), heavy rain, fog, mist and steam.
- Physical or chemical filters before the sensors shall only be accepted if the sensors' sensitivity and detection speed are not altered.

#### 8.11.10 Instrument Cabinets Design

Outdoor instrument cabinets which are not certified for Zone 1 hazardous areas and not listed above shall as a minimum be certified for use in Zone 2 hazardous areas and shall subsequently be electrically isolated upon gas detection.

All cabinets shall be lockable for Cyber Security reasons.

IS terminals and wire ducts shall be clearly identifiable as IS, preferably blue.

#### 8.11.11 Instrumented Package

The package instrumentation, control systems and any associated components (switches, routers, etc.) which are subject to marine classification – typically within the hull and living quarters – shall be type approved by the project selected Classification Society.

Instruments which are part of a Safety Instrumented Function shall be certified minimum suitable for SIL 2 applications.

The SIL requirement shall apply to all parts of logic solver including controller, system software, I/O modules and FTA's, relays, etc. The recommendations of IEC 61511 shall be followed.

Dedicated sensors and final elements shall be used for safety and control functions in order to avoid common-mode failures.

In a similar manner, any on-skid valve (e.g. BDV) which requires a safety actuation by the plant SIS shall be equipped with a dedicated solenoid valve directly hardwired to PSS, ESD system or FGS.

The license of the application software shall be embedded in the installed program; the use of USB sticks containing the license and the like are not permitted as all USB ports are disabled for cyber security reasons and are also a potential cause of failure for automatic restart after power failure (i.e. the required auto restart during black start without the requirement for human intervention).

By default, the ICSS shall be the clock master for time synchronization of package UCPs.

The package Supplier shall provide and install the necessary hardware and/or input point to receive the time synchronization signal from ICSS.

All safety executive actions between the package UCP and PSS, FGS and ESD system shall be hardwired.

Communication links between UCP and the PCS shall use dedicated communication cards installed in the package PLC rack and in the PCS rack. This communication link shall be based on non-routable communication cards. By default, ModBus TCP/IP (maximum 2 packages per communication card).

Packages are normally operated in "remote" mode from the ICSS Operator workstations in the CCR, but the package shall always be capable to run in "local" mode using the UCP's HMI.

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In case of failure of the serial communication link between UCP and PCS, the package shall automatically switch over to "local" mode and be kept in operation under the control of its own control system.

All packages shall allow transfer of package data to the Process Data Server (PDS) unless project specifications define that for some specific non-critical systems, such data transfer is not required. Non transfer of data from a package to a PDS shall be subject to COMPANY approval.

Base case is to transfer data to the PDS through a PDS interface node.

PDS communication links with packages shall not require redundancy unless:

- The data storage and data availability of a particular package has been defined as critical. In this case, redundancy is required for the interface nodes as well.
- The PDS interface node itself is redundant.

Aspentech InMation Integrator shall be installed by COMPANY to provide unified data structure collecting real time and historical data from P3 packages.

PDS data acquisition node (PI Data Collector) shall be designed to receive data from the P3 Packages interfaced with PI–OPC interfaces on DMZ Layer 3.5. In addition, InMation Integration Interface shall be provided for the Packages' data using OPC server.

The OPC Server shall be capable of handling up to 240K data points from the ICSS and 500K data point from the Package UCPs, in addition to PI data communication.

The communication protocol shall be OPC-UA, which shall also be the preferred protocol for the PDS data link.

#### 8.11.12 Safety Integrity Level

The IEC 62061 or IEC 61511 methodology and requirements shall be used to assign the SIL, enabling the appropriate design of the package.

SIL verification calculations shall then be carried out for all safety instrumented functions (SIF).

#### 8.11.13 ICSS Functional analysis and standard functions

The Package Functional Analysis documents shall be developed by the P3 Package Equipment Vendor to describe with all relevant data and information the detailed functionalities of a specific P3 package.

The Package Functional Analysis shall primarily be used for configuring the package UCP.

For P1 and P2 packages, supplier shall provide control narratives for their equipment. These shall be part of input documents for the plant Functional Analysis to be used by the Functional Analysis Subcontractor.

The Package SUPPLIER shall provide a comprehensive Functional Analysis and description of the package. This shall express in detail all the controls, sequential phases, alarms, events and any additional information implemented in the package PLC.

#### 8.11.14 Cyber Security

Refer to NA-101-20-F002-474107 "FPSO Specification – Cyber Security Requirements for System and Packages" [6].

Industrial Information System (SII) shall have cyber security protection methods integrated into the design from the start and not just an "add-on" when the equipment is delivered.

Any system determined not to be part of the Industrial Information System domain shall automatically be part of the Enterprise Information System domain (SIE).

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The SII domain shall be subject to a cybersecurity risk assessment based on IEC 62443-2-1.

Systems defined as SP1 shall not communicate with any other SII system with different security profile except via hardwired signals.

Systems defined as SP2 and SP3 may communicate together via a dedicated interface network using non-routable communication cards. The use of IT equipment (i.e. servers, routers, switches, standard firewalls) in place of communications cards is not permitted. (A non-routable interface is an interface that cannot be accessed from another network (e.g. IP, MAC layer). A non-routable interface is typically based on point-to-point communication that use Vendor supported communication cards either Serial or TCP/IP or Ethernet).

Systems defined as SP3 shall have their own dedicated Engineering Workstation (EWS).

It shall not be possible to configure an SP3 system from any other system.

SII equipment shall use non-routable on internet IP address ranges as per RFC 1918.

Commercial Off-The-Shelf Software including the Operating System (OS) of any equipment shall be properly configured to minimize cyber risks by disabling all services not used.

Any hardware and software not required shall be disabled, includes at a minimum, Email, office applications, games, Bluetooth, wireless communications, etc.

#### 8.11.15 Obsolescence

Facilities are designed with an expected design life in the order of 30 years. It is not practical to achieve such a design life for electronic based equipment without the requirement for upgrading (revamping).

The control and instrumentation equipment scope shall be given specific attention to ensure all control and safety systems, components, software and individual elements can be maintained or replaced such that the original function and integrity of the whole production system can continue in an uninterrupted manner for the field life.

A project specific Obsolescence Management Plan shall be developed. It shall address all obsolescence requirements and data. The Obsolescence Management Plan shall consider the complete life cycle including:

- Design phase
- Project delivery phase
- Operation & maintenance phase

The Obsolescence Management Plan shall be further complemented during the detailed engineering stage by ICSS and Package Vendors and shall detail all aspects of equipment life cycle. Obsolescence database shall be part of OMP and required from Contractor/ ICSS Vendor from CFT stage up to commissioning stage.

#### 8.12 Hazardous Material

Inventory of Hazardous Material (IHM) shall be maintained as per Hong-Kong Ship Recycling Convention (2009). Company is requesting to include the two additional materials listed in EU-SRR type IHM to anticipate further update of Hong Kong Convention:

- ① Perfluoro octane sulfonic acid (PFOS) (As defined in EU-SRR Annex I: "perfluorooctane sulfonic acid" (PFOS) means perfluorooctane sulfonic acid and its derivatives) and,
- ② Brominated Flame Retardant (HBCDD) (Refer to EU-SRR Annex II)

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## 9 SITE CONDITIONS AND UTILITIES

### 9.1 Site conditions

|                        |                                           |
|------------------------|-------------------------------------------|
| Location               | Venus Well – Namibia PEL 56 (Block 2913B) |
| Altitude               | Sea level                                 |
| Climate                | Tropical – Semi Arid                      |
| Sea water temperature. | Max. 22.91 °C, Min. 14.49 °C              |
| Air temperature        | Max. 25.48 °C, Min. 9.45 °C               |
| Relative humidity      | Max. 97.82%, Min. 48.57%                  |

### 9.2 Utilities

|                     |                               |
|---------------------|-------------------------------|
| Cooling fresh water | 27 °C, 2~3 bar g.             |
| Nitrogen            | 7.3 bar g.                    |
| Instrument air      | 5~8.5 bar g. dew point -20 °C |

|                                                     |                        |                      |                 |                                                  |                               |
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## 10 INSPECTION AND TEST

### 10.1 Factory Acceptance Test

The essential generator engine shall be tested at the engine manufacturer's shop by using ISO 8217 MDO – grade DMZ (viscosity 3 ~ 6 cSt at 40 °C), and it shall be run coupled to the actual alternator and tested as follows:

- Starting test at no load
- Load tests

| Load (% MCR) | Duration                                      |
|--------------|-----------------------------------------------|
| 25           | Half an hour                                  |
| 50           | Half an hour                                  |
| 75           | Half an hour                                  |
| 100          | <b>Four(4) hours</b><br>(Project requirement) |
| 110          | Half an hour                                  |

- Engine protection device test (automatic shut-down)
- Governor test
- Parallel running test, if allowed in the shop testing facilities

### 10.2 Inspection and measurement

After the shop tests, the overhaul inspection shall be carried out in accordance with the engine manufacturer's standards, and the scope of the overhaul inspection shall be one(1) cylinder for the FPSO.

- Overhaul inspection for one (1) cylinder
- Crankshaft deflection check (hot & cold conditions)
- Bearing temperature measurement
- NOx emission measurement for exhaust gas, if required by IMO
- Vibration measurement of the generator set: 1 set/ship

Vibration measurement at shop test shall be carried out with the assembled condition of generator engine and alternator.

- Torsional vibration measurement of the generator set: 1 set/ship
- Sound level measurement
- Others shall be carried in accordance with the requirements of Classification Society.

### 10.3 Onboard Test

After essential diesel generators and necessary auxiliary machineries are installed on board, and relevant piping and wiring are fitted, these machines shall be operated and examined to see whether their functions are satisfactory.

Remote operation from CCR will be demonstrated to prove AUTO notation.