



**CONFIRMATION N. 6608**

**30.10.2007**

**Subject: Salalah Methanol Project**

### **TECHNICAL DESCRIPTION**

#### **NO. 3 DIESEL GENERATING SETS MODEL MT.3050**

The generating sets will be powered by MTU diesel engines which will be coupled to Stamford alternators. Each engine/alternator will be located inside a 45 ft high cube sound proof container.

#### **GENERATOR DUTY**

In accordance with the specification requirements the generators are continuous power C.O.P. rated. The C.O.P. load factor electrical output of the generator is 2000 kWe which is equal to 2500 KVA at 0.8 pf in accordance with C.O.P. in ISO 8528 (BS7698), or prime power P.R.P. rated with a load factor electrical output of the generator 2300 kWe which is equal to 2875 KVA at 0.8 pf.

The generator nominal frequency will be 50Hz with a nominal engine speed of 1500 rpm, the nominal voltage produced at the alternator will be 11,000 V. Each generator set is governed by a class A1 MTU MDEC electronic governor.

The reference conditions for achieving the stated duty are:

- 45 °C intake air temperature
- 100 m altitude above sea level

The generating sets are capable of providing full load under the following ambient condition:

- 45 °C intake air temperature
- 400 m altitude above sea level
- R.h. 100%

Each generating set is equipped by:

#### **MTU DIESEL ENGINE MODEL 20V4000G63L**

- 4 stroke
- Direct injection
- Turbocharged and inter-cooled
- 20 cylinders 'V' disposal – liquid cooled
- Bore 170 mm
- Stroke 210 mm
- Capacity 95.4 litres
- Compression ratio 16.5:1
- Rotation: anticlockwise viewed from flywheel side
- Piston speed at 1500 RPM: 10.5 m/sec
- Mean effective pressure: 23,9 bar



- Gross C.O.P. rating as per ISO 3046: 2100 kW at 1500 RPM, no overload admitted
- Gross P.R.P. rating as per ISO 3046: 2590 kW at 1500 RPM, with 10% overload admitted
- Fuel type: EN590: grade n.1d and n.2d according to ASTM D975-00 (with low calorific value of 9.700 Kcal/Kg)
- Specific fuel consumption at 100% load 193 gr/KWh
- MDEC electronic governor Class A1(injection pump)

### **STAMFORD ALTERNATOR MODEL HV 804 W**

- Nominal rating for continuous operation: 3470 KVA (@ 40 °C and H/H)
- Rating at project condition (45 °C and H/B): 2875 KVA
- Nominal voltage 11kV
- Rated power factor: 0.8
- Frequency: 50 Hz at 1500 RPM
- Double bearings construction form, according to IM1005
- Brushless excitation with PMG
- 4 Poles
- 6 Wires
- Efficiency at 100% @ 0.8pf = 96.4%: at 75% 0.8pf = 96.4%
- Short circuit current – 3 In for 10 seconds
- Insulation: class 'H'
- Over temperature to Class 'B'
- Self ventilated by internal fan
- IP 23 mechanical protection
- Air to air cooling
- Current transformers for paralleling facility
- Anti-condensation heater 230 V
- PT100 on windings
- PT100 on bearings
- Power factor regulator
- Diodes failure module (Revisione del 16.07.08)
- excitation loss module (Revisione del 16.07.08)

### **FUEL SYSTEM (GENERATOR ENCLOSURE)**

- Feed pump
- Fuel oil-water separator, static type complete with Racor type connecting parts
- Full flow filters with replaceable elements
- Electrically operated 24V shut down solenoid
- 700 litres daily service tank installed inside container

### **ENGINE COOLING SYSTEM**

- Tropical horizontal radiator with separate electric driven fans for jacket and aftercooler circuits
- Cooling radiators will be skid mounted for installation on genset container roof as a pre-assembled factory built unit. Low noise electric driven fans will be installed above the radiator cores pulling air through the radiator

- Electrical connection box IP55 - Aluminium alloy
- Protection snare / Painting carbon steel
- Venturi / Painting carbon steel



- Fans
  - Supporting legs 4mm galvanized steel
  - Side frame 3 mm galvanized steel
  - Intermediate plate 2 mm galvanized steel
  - Tube sheet 2 mm galvanized steel
  - Flanges DN80-PN16-UNI 2278 - Carbon steel
  - Flanges DN100-PN16-UNI 2278 - Carbon steel
  - Headers 3" (AC) - Carbon steel
  - Headers 4" (JW) - Carbon steel
  - Aluminium fins 0.13 mm
  - Exchange tubes
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- Engine driven centrifugal pump and water precirculating electric pumps
  - Thermostatic valves
  - Engine temperature transducers (one for jacket, one for aftercooler)
  - High water temperature alarm switch, two steps (high and high high shutdown)
  - Water immersion heater with thermostat
  - All pipe work, connections, valves and supports are included
  - Coolant includes for a corrosion inhibitor with a 40% mix of antifreeze and water
  - Low water level alarm/shut-down switch (one for jacket and one for AC)
  - Low water temperature switch (jacket circuit)
  - High vibrations alarm switch

#### **LUBRICATING SYSTEM**

- Oil/water pack type heat exchanger
- Centrifugal pump (engine driven)
- Oil pressure transducer
- Oil temperature transducer
- Pressure switch (two step) for low oil pressure alarm and low low oil pressure shut-down
- Manual pump for lube oil drain
- Min oil level switch
- High oil temperature switch
- Prelubricating pump
- Oil heater with thermostat

#### **COMPRESSED AIR STARTING SYSTEM**

- one motor driven compressor
- one electric driven compressor
- electric starter motor
- one bottle 500 litres, 30 bar
- safety pressure valves
- connection pipes and accessories

#### **ENGINE INTAKE AIR SYSTEM**

- Dry type air filters with replaceable elements
- Visual clogging indicator (with alarm switch)
- Turbochargers

#### **EXHAUST GAS SYSTEM – (INSTALLED WITHIN THE CONTAINER)**



- Exhaust gas silencer – MR Series installed within the container including spark arrestor

The MR silencers reduce noise by absorption and through resonance. The exhaust gas enters an expansion chamber covered with a sound absorbent material. This is protected by perforated metal sheet, and then a sound-proofing absorbent body. The outer casing is made of carbon steel. Noise reduction of 30 dBA is achieved by each silencer.

- Air cooled exhaust manifold
- Stainless steel flexible bellows
- System designed to achieve the noise criteria of 85 dBA @ 1m

### **ENGINE/ALTERNATOR COUPLING**

- The engine/alternator coupling is a highly flexible plug-in type coupling which creates a torsionally soft connection between an internal combustion engine and the alternator.

The highly flexible torque transmitting element is designed as a rubber disc which torsional strain twists, absorbing high torsional vibrations and any misalignments.

The inner diameter of the rubber disc element is vulcanized directly to a taper hub or to a metal sleeve. On its outside diameter the rubber disc is engaged into an internally toothed aluminium ring making a backlash free plug-in connection.

The flange dimensions of the coupling are according to SAE J 620 and DIN 6281 respectively. A bell housing is provided between engine and alternator.

### **GENERATOR MOUNTING**

- The engine and alternator are mounted on a structural steel sub-base sized to support the engine, alternator and the auxiliary systems to form a rigid frame. The sub-base is designed to support the equipment and maintain the correct alignment. The sub-base includes lifting eyes.
- The engine/alternator are mounted on anti-vibration mounts fixed to the steel sub-base.

### **GENERATOR AUTOMATIC CONTROL PANEL – WITHIN EACH GENERATOR CONTAINER WITHOUT POWER SECTION**

#### Operation sequence

The Control Panel allows to obtain a system that, a few seconds after a Mains failure, starts the engines, synchronizes the Gen Sets, closes their Circuit Breakers and permits the parallel between the Gen Sets.

Once achieved parallel running, the Control Panel gives consents for Mains / Gen Sets changeover (Changeover Switch not included in the supply) and connects the loads to the Gen Sets.

The automatic load sharing system allows the power to be equally supplied by the Gen Sets. After an adjustable delay, if the appropriate circuit is inserted (by selector switch), the Control Panel verifies the real requested electric power. In case it can be supplied by a single Gen Set, the Gen Set not selected as “master” will be deactivated.

In case of load increasing, the system allows the starting of the stand-by Gen Set, that automatically works again in parallel to the master Gen Set.



All the activation and deactivation delays, as well as the power thresholds levels, can be adjusted directly on the Gen Set control devices DST4601/PX.

When the Mains returns within normal limits, the system switches the power supplied from the Gen Sets to the Mains, opens the Gen Sets Circuit Breakers and stops the engines, after an adjustable cooling time delay.

#### Auxiliary services

Each Gen Set is equipped with the following auxiliary services:

- n. 1 Automatic Battery charger, 24 Vdc
- n. 1 Three-phase power supply for engine water pre-heating

#### Measuring instruments

Each Gen Set is equipped with the following digital instruments:

- n. 1 Digital control voltmeter: Phases R-S / S-T / T-R (\*)
- n. 1 Digital control ammeter: Phases R-S-T (\*)
- n. 1 Digital frequency meter for control of voltage frequency to Gen Set terminals (\*)
- n. 1 Gen Set hour counter (\*)
- n. 1 Gen Set start counter (\*)
- n. 1 Battery control digital voltmeter (\*)
- n. 1 Digital kilowattmeter for Gen Set power control (\*)
- n. 1 Digital power-factor meter for Gen Set reactive power control (\*)
- n. 1 Digital kVAmpere for the measure of the apparent power
- n. 1 Active power hour meter (\*)
- n. 1 Reactive power hour meter (\*)
- n. 1 Digital kilovarmeter for Gen Set reactive power control (\*)
- n. 1 Oil pressure gauge (\*)
- n. 1 Water thermometer (\*)
- n. 1 Fuel level gauge (\*)
- n. 1 Engine revolution counter (\*)
- n. 1 Synchronoscope (\*)
- n. 1 Bus Voltmeter (\*)
- n. 1 Bus Frequencymeter (\*)

(\*) Digital instruments incorporated into the microprocessor control board DST4601/PX.

All the measures of gen set voltage, current, active and reactive power, power factor, are visualized also on the single phases.

#### Controls

For each Gen Set the following controls are provided:

- Gen Set operation key selector switch: OFF/RESET –MANUAL – AUTOMATIC (\*)
- Engine manual start push button (\*)
- Engine manual stop push button (\*)
- Acoustic alarm silencing push button (\*)
- Generator circuit breaker control push button (enabled only when mode selector switch is on MANUAL) (\*)
- Switch for insertion of circuit depending on load request: 0 – INSERTED

(\*) Controls incorporated into the microprocessor control board DST4601PX.



The parallel section includes the following controls:

- Switch for Changeover control: MAINS – AUTOMATIC – 0 - GEN SETS
- Switch for load connection upon Main failure: IMMEDIATE – END PARALLEL.
- Emergency stop push button

### Optical signalings

For each Gen Set are provided the following status and failure light signalings, realized by a set of high efficiency light emitting diodes or by display:

- Status
  - Engine running
  - Generator live
  - Gen set circuit breaker closed
- Protections
  - Engine overcrank (shut down)
  - Low oil pressure (shut down)
  - Belt breakage
  - Discharge of battery (alarm)
  - High engine temperature (shut down)
  - Fuel reserve (alarm)
  - Fuel end (shut down)
  - High fuel level (alarm)
  - Overspeed (shut down)
  - Generator overload (shut down)
  - Reverse power (shut down)
  - Generator over voltage (shut down)
  - Generator under voltage (shut down)
  - Generator over frequency (shut down)
  - Generator under frequency (shut down)
  - Emergency stop (shut down)
- Operating conditions not reached (shut down)
- Gen Set parallel failed (shut down)
- Digital multifunction protection for: 51V/87/32/46/27/59/51G/26W/26B/26C/94D/81/40

### Main electronic devices

- n. 2 engine protection and control boards DST4601/PX (including Load sharing modules and Gen Sets active power governors).
- n. 2 Electronic card DiChron (including Synchronizer)

### Embedded functions

Real time clock calendar:

Hour, minute, second, day, month, year (leap year), day of week.

Operating without power for at least 2 days.

Gen-set operation can be enabled base on days of the week and time.

Test operation can be enabled base on days of the week and time.



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Date and time can be remotely adjusted by supervisor software.

Fast trend history log:

30 record of all measured value plus total powers measure (typical 30 last operating minutes).

Slow trend history log:

48 record of all measured value plus total powers measure (typical last operating day).

Event history log:

99 record of event. Relevant event connect to special 15 record of analogue measure.

Communication:

RS485 Serial communication, MODBUS RTU interface (for communication with PMS supplied by GS).

Maintenance warning:

Board issue a warning when the running hours before maintenance are elapsed.

Panel Temperature warning:

Board issue a warning when panel temperature are approaching a specified temperature

Gen-Set lock function:

Gen-Set operation can be remotely disabled. Unlocking requires the supplied password.

Internal Alarm Horn:

Internal Alarm Horn make easier panel assembling.

Other parameters are available in order to better adapt the control device for the several applications.

### Carpentry

The Control Panel is fitted into a single cubicle, comprising three sections, with the following features:

- Approximate sizes (Height) 2.100 x (Width) 1200 x (Depth) 600 mm.
- Standard painting, color RAL 7032.
- Cables incoming from the bottom.
- Cables connection on the front.
- Carpentry shape 2.

## **DISTRIBUTION PANEL FOR AUXILIARY SUPPLY**

**PORTABLE PC** loaded with all softwares related system



## **GENERATOR ACOUSTIC CONTAINER**

### General

Each of the generators is to be housed within an independent freestanding weatherproof acoustic container. Each container will be complete with:

- No. 1 generating set
- Cooling system with electric driven fan and horizontal radiator fitted on container's roof
- Control panel
- Ventilation system (with motorized louvres)
- Exhaust system
- Fire detection system and extinguishing system (NFPA FM200 with smoke detector & VV/IR)

### Material

The container is constructed from the following materials:

- Plate Fe 360 B (UNI EN 10025);
- Plate Fe PO02GZ275 (UNI EN 10142);
- Corner fittings ISO 1161
- Galvanised bolts
- Mineral wool (class 1 fire reaction)

### Dimensions:

(l x w x h mm) 13.600 x 2.438 x 3.000 mm.

### Acoustic performance

Open field - 85 dBA at 1 mt. distance

## **CONTAINER CONSTRUCTION**

### Base frame and floor

The base is made of cold-pressed steel sections and is based on a perimeter of side members in addition to a series of transoms and stringers.

The floor is made of an olive plate, 3+2 mm of thickness, which is welded above the structure. Located on the floor is the generator base, upon which the engine/alternator is installed.

### Roof Structure and Posts

The external profile is made up of cold-stamped steel plate. Located at the edges are 4 No corner fixings according to ISO template.

The roofing is made using fretted plate, 15/10 thickness. The pitch between the waves is equal to 200 mm with a height of 40 mm. All the edges are fully welded.

### Walls and Doors

#### Walls



The walls are made using fretted plate, 15/10 thickness. The pitch between the waves is equal to 200 mm with a height of 40 mm.

The four angle irons (edges) are made of stamped plate, 4 mm thickness, that has been welded both at the corner fittings and at the stringer.

#### Doors

Each container will be provided with access doors to the generator area and control panel area as indicated in our preliminary layout drawing. Each door will have the following characteristic:

- Double doors on the sides in case of intervention on the set (at least one shutter is equipped with a panic big handle, while the remaining doors have a pole fastener).
- A service door, equipped with vision porthole and pole fastener system.
- The doors are secured to the container walls through bolted hinges made of zinc plated steel. The hinge mechanism allows the doors to open outwards.
- The acoustic characteristics and weatherproofing are maintained by utilising the correct gaskets.

#### Walls and roof insulation

Prior to the application of the insulation the inner surfaces of the container are treated, this is not visible to the end user. The surfaces are degreased and then a epoxidic primer at 60 microns thick is applied.

To insulate the walls and roof, fibreglass insulation is applied at a density of 100 kg per cubic meter. This is then covered by fibrous and metallic protections (galvanized stretched sheet iron). The materials utilised have at least Class 1 fire integrity.

#### Painting (standard cycle)

On the visible inner surfaces

- Accurate degreasing
- Application of a layer of epoxidic primer, 60 micron thick
- Application of polyurethane enamel (RAL to be defined to meet with Clients requirement), 60 micron thick

On the external surfaces

- External treatment of the sheet carried out in automatic plant. The process is undertaken on all the container sides and bottom.
- Application of a layer of inorganic galvanizing material, 60 micron thick
- Application of a layer of epoxidic primer, 60 micron thick
- Finish with polyurethane enamel (RAL to be defined to meet with Clients requirement), 60 micron thick.

#### MISCELLANEOUS

##### Generator Control Panel

The generator control panel is located within a segregated room located within the generator container. The area is accessed directly from the outside through a dedicated door, which is complete with a glass viewing window. The separate access/segregated room allows the operator to interrogate the genset control panel without being exposed to the genset environment within the container.



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### Container Lighting & Power System

The fluorescent lighting and power system will consist of luminaries and power distribution system. All luminaries utilised will provide adequate lighting to 200 lux inside container and 300 lux in the control panel space and will comprise integral emergency luminaries (self contained battery lighting units to provide 50% of normal 200 lux illumination – 3 hr minimum with integral test facility).

A mains power supply will be required for general power, engine heaters, radiator fans and circulating pumps, a supply rating of 40 kW is required.

### Earthing Plant

All electric equipment and all the installed fittings will be routinely cross bonded to earth to comply with the requirements of BS7671.

Two earthing points will be provided for connection to the external earthing system.

## **N.1 FUEL TANK 45.000 LITRES CAPACITY, 24 hours running per each genset, single skin type, on supports, complete with:**

- visual level gauge (magnetic type)
- fuel level switches (for high and low level alarm on control panel)
- level transmitter for remote monitoring
- flame arrestor on vent
- fuel supply connection flanged with valve
- return connection flanged
- manhole
- overflow connection flanged
- filling connection flanged with check valve and isolation valve
- spare connection flanged, blinded

## **N.1 LOAD BANK**

Resistive load bank system

Load rated 700 Kw - 11 KV - 3 ph - 50 Hz (in two steps)

Fan motor 400 V - 3 ph - 50 Hz

Rated at 45°C. For static installation

## **N.1 NEUTRAL GROUNDING RESISTOR 400 A – 10 SEC.**

## **N.6 LOAD BREAK SWITCHES (n.3 for STG & n.3 for EDG)**