



Annex - A.2

Technical specification

(Engine, Alternator, Engine auxiliaries)

Engine Type : 23 x B32:40V16AH
Customer : Midland East Power Ltd
Customer Project : 150 MW HFO Power Plant
Reference : BP175028



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00.00 Bergen generating set

00.01	Number of Generating sets.....	23
	Engine type;4-stroke, turbocharged, intercooled.....	B32:40V16AH
	Maximum Continuous Engine Rating (MCR).....	7200 kWm
	Maximum Continuous Alternator Rating.....	7015 kWe
	Alternator Efficiency (IEC 600034 – 1).....	97.43 %
	Rated Output, electric (with cos phi =0.8)	8769 kVA
	Engine speed at MCR.....	750 rpm
	Number of cylinders.....	16
	Cylinder bore.....	320 mm
	Piston stroke.....	400mm
	Break mean effective pressure at MCR.....	22,4 bar
	Specific Fuel-oil consumption at MCR	175.8 g/kWbhr +5%
	Specific Lube-oil consumption at MCR	0.45 g/kWhe

Engine is designed for Nitrogen oxide emission, NOx: 2000 mg/Nm³ at 15% O₂.

Direction of rotation : Clockwise seen towards flywheel.

Ratings are according to ISO 3046/1. The following operating conditions will however apply without any derating (ISO ratings in brackets).

Altitude above sea level.....	Max. 100 m ASL
Turbocharger air suction temperature.....	max. + 35 °C (25°C)
Turbocharger air suction.....	min. + 5 °C
Charge air cooling water inlet temp.....	max. + 50 °C (25°C)
Relative humidity.....	98% (30%)

Specific Fuel-Oil Consumption measured at our test bed is given at 100% load, running on Fuel-oil according to ISO 8217, ie RMA, RMB, RMD RME or RMG with a lower heat value of 42.7 MJ/kg (Viscosity upto 180 cST at 50 Deg C) including two engine driven pumps (lubricating oil pump and jacket water cooling pump)

Specific lubricating oil consumption is for guidance only.

00.02 The Generating set specification is based on

Engine room :
Mode of start-up : Automatic
Mode of control : Automatic
Mode of synchronizing: Automatic

00.06 The Generating set(s) is to operate in parallel with the grid .



01.00 Scope of supply

Only components mentioned in this specification are included in Bergen Engines AS scope of supply.

Generating set(s) to be delivered, with the following equipment :

- 01.04 1 set **Turning Gear**, electrically operated, including starter and control unit.
- 01.05 23 set **Rigidly Mounted Diesel Engine(s)**. The supply includes foundation plates (& anchor bolts), blind flanges and couplings for all pipe connections. Flexible pipe connections are loose supplied..
- 01.06 23 set **Flexible Coupling(s)**, between Engine and Generator.
- 01.08 1 set **Pump** for adjustment and check of opening pressure, fuel oil injection nozzle.
- 01.09 1 set **Hydraulic Pump**, pneumatically operated, for tightening tool.
- 01.11 1 set **Special Tools** for the generating set and the turbocharger.
- 01.12 1 set **Light hand tools**, including tool bench.
- 01.13 1 set **Lifting And Transportation** equipment. Including required lifting straps, spreader beams, and bolts for single point lift for engine.
- 01.15 1 off Training, 10 days of operator staff during commissioning.



02.00 Starting and control air system

The DIESEL ENGINE type B is started with pressurized air, 30 bar, acting directly on the pistons in cylinder bank B of a BV-engine, or acting directly on all pistons of a B-in line engine.

In the engine control air system, dry and clean air of 7 bar is required for problem-free operation of oil mist detector, various solenoid valves and I/P-converters.

Equipment built on the engine:

02.01 **Starting air valve** prepared for remote control, and a push button for emergency start.

Control air system with oil mist detector and I/P- converters and various valves.



03.00 Charge Air System

System design requirements:

The ventilation fans shall be able to maintain an overpressure of about 5 mmWG in the engine room in all running conditions.

Filtration : 95% of particles exceeding 5 micron.

If the air intake is ducted directly on to the turbocharger, the total pressure loss in the system must not exceed 100 mmWG.

Equipment built on the engine:

- 03.01 The Diesel Engine is turbocharged and equipped with a two stage charge air cooler including integrated water separator.
- 03.02 The Turbocharger and the Charge Air Cooler is located at the Engine pump end.
- 03.03 **Turbocharger**, make ABB/Napier. With **air suction branch** to external air inlet pipe. The air suction branch angle to be decided by customer within 1 month after contract unless otherwise has been agreed.
- 03.04 The Turbocharger is equipped for water washing of the compressor and the turbine side.
- 03.08 **Pressure transmitter and temperature sensor**, for control equipment two-stage charge air cooler.

Equipment supplied, but not built on the engine:

- 03.13 46 off **Compensator(s)** for the charge air inlet pipe.



04.00 Exhaust system

System design requirements:

Back pressure: 300 mmWG, maximum

Equipment built on the engine:

04.01 **Exhaust Valves** in "Nimonic" with Deloro seat armouring. The valves are equipped with low mounted valve rotators.

Equipment supplied, but not built on the engine :

04.07 46 off **Expansion joint(s)** to fit the discharge pipe from turbocharger, including counter flange.



07.00 Heavy Fuel Oil System

The Engine is equipped for Heavy Fuel Oil Operation up to ISO-F- RM 180 cSt at 50 °C.

Start - stop can be done on Heavy Fuel Oil, but only for a short period of time, if engine is supposed to be stopped for a longer period of time engine shall be shut down after change over to diesel fuel operation.

Equipment built on the engine :

- 07.02 **Injection pumps**, one for each cylinder.
- 07.03 **Injection valve** including holder, cooled.
- 07.04 **High pressure pipes**, double tubed steel pipes with drain to a Pressure Sensor for leakage alarm.

Equipment supplied, but not built on the engine:

- 07.07 23 off **Cleaning system(s) 88HO** for the Fuel Injection Pumps. The control sleeves/racks are washed with diesel oil at regular intervals, to prevent sticking. Including air driven pump, solenoid valve and air filter. For 24 V DC supply.

The below listed coarse and fine filter are equipped for steam heating.

- 07.09 23 off **HFO Fine filter, 53 HO** duplex type with change over valve. Depth type filter cartridge, 7-10 micron nominal. Loose supplied.

08.00 Nozzle temperature control system

Equipment, built on the engine:

08.05 23 off **Nozzle temperature control module**, supplied loose.



9.00 Cooling water system

Jacket Cooling Water: Fresh water

Low Temperature Cooling Water: Fresh water

The cooling water systems are designed for the Engines maximum continuous rating (MCR). The jacket cooling water system is to provide cooling of :

the cylinders, the cylinder cover, the nozzle temperature control system and the charge air cooler.

The low temperature cooling water system is to provide cooling of :

the charge air cooler, the lub.oil cooler and when applicable the generator cooler.

Equipment built on the engine:

09.02 **Jacket Cooling Water Pump**, centrifugal type with flexible bellow on the suction pipe connection (not self priming).

The cooling water pump(s) has cast iron housing, cast iron impeller and stainless steel shaft.

Jacket Cooling Water Pipes on the Engine are made of carbon steel.

Low Temperature Cooling Water Pipes on the Engine are made of carbon steel.

Equipment supplied, but not built on the engine:

09.04 23 off **Jacket Cooling Water Pre-heater** electric type, incl. heating element , thermostat, **circulating pump** with electric motor and starter box for electric motor and heater.

09.08 23 off **Circulating Pump**, centrifugal type, electrically driven. For after-cooling of engine, auto starts at stop of Engine. Circulates the hot jacket cooling water for 15 min. in order to prevent boiling.

09.13 23 off **Thermostatic Valve** for jacket water recirculation with variable setting. Incl. PID controller. PID controller(s) to be mounted in engine room console.

09.14 23 off **Thermostatic FCV** for low temperature fresh water recirculation with PID Controller.



10.00 Lubricating oil system

The lub.oil system is based on higher capacity wet sump integrated in base frame.

Separation of lub. oil is required for engine operation with heavy fuel oil, a lubricating oil centrifuge is included for separation.

Equipment built on the generating set:

- 10.03 **Lub. Oil Pump**, gear pump for pressure lubrication of the Engine's main lub.oil system.
- 10.06 **By-Pass Filter**, centrifugal type, mounted at the Engine's pump end. MAKE: Glacier/ equivalent.
Lube oil Splash temperature Monitoring Equipment, Temperature sensors for measuring the temperature of lube oil splash from crankshaft.

Equipment supplied, but not built on:

- 10.05 23 off **Lub. Oil priming pump**, screw pump, electrically driven, for hot standby operation.
- 10.07 23 off **Backflush Lube oil filter**, centrifugal type, mounted at the Engine's pump end. MAKE: Boll & Kirsch / Glacier / Parker / equivalent.
- 10.09 23 off **Lubricating Oil Filter**, duplex type with change over valve. Depth type paper filter cartridge, 10-15 micron nominal.
- 10.17 23 off **Lubricating Oil Cooler(s)**, plate type heat exchanger. Plates in stainless steel, gaskets in nitrile rubber.
- 10.18 23 off **Lubricating Oil Thermostatic Valve**, with wax element.
- 10.33 23 off **Crank case ventilation filtering (oil mist eliminator) system..**



11.00 Instrumentation, Governing , Control and Monitoring

Instrumentation:

Instrumentation on engine is according to Bergen Engines AS recommendations and includes:

- Pressure sensors
- Temperature sensors
- Speed pickups
- Level/micro switches
- Oil mist detector
- Temperature pockets for thermometers

All sensors and/or switches mounted on the genset skid are identified with engraved stainless steel name plates. Pressure sensors are equipped with test cocks.

Governing:

11.08 23 off **Electronic motor management system**, make Woodward 723 plus.

Comprising the following control functions:

- Load
- Speed

Mounted in the Engine Control Cabinet. For paralleling with local or external grid.

Electro - hydraulic actuator for electronic governor



Control & monitoring:

11.11 23 off Engine control cabinet(s).

- The Control System is based on PLC, type Siemens S7-300 with main functions:
 -
 - Start, stop and loading sequences
 - Alarm and safety functions
 - Alarm logging
 - Monitoring of genset data
 - Interface to plant main control system
 - Interface to MCC

Graphical LCD Operator Panel and emergency stop are mounted in cabinet front, hour counter are mounted inside the cabinet.

System supply : 24 V DC +/-10%, 16 A

Enclosure : IP54

The control cabinet is to be mounted in the engine room adjacent to the generating set.

PID controls are controlled by PLC.

Cables to be installed at site by client.

The ECC is tested together with the gen-set at the test bed.

ECC's will be equipped with 24 V DC cooling fan.

Equipment for 24 V DC supply is not included



12.00 Generator

12.01 23 off Brushless Generator(s) acc to IEC-34.1, equipped as follows :

Make : ABB / Leroy Somer / Siemens / Equivalent

Type : AMG or as per Manufacturer selection

Construction : IM 1101 (B20). Two bearings.

Rating :

- **Active Power** : 7015 kW(e)
- **Output** : 8769 kVA
- **Cos phi** : 0,80
- **Generator Efficiency** : : 97.43 %
- **Voltage/Frequency** : 11 kV/ 50 Hz
- **Voltage Variation**: : designed with $\pm 5\%$ Variation
- **Frequency Variation**: : designed with $\pm 3\%$ Variation
- **Generator speed** : 750 rpm
- **Insulation Class** : : F
- **Temperature Rise** : : F

12.02 **Enclosure** : IP23

Equipment built on the generator:

12.03 **Anti-Condensation Heater**. 230V. Single phase.

12.04 **Air Cooled** with a rotor mounted fan.

12.05 **Sensors** in stator windings (2x3 Pt-100).

12.06 **Sensors** in the bearings. 1 per bearing.



12.09

TERMINAL BOX:

Location of Signal cable (Low Voltage) termination*, Non Driving end side of Generator

Location of Main cable (High Voltage) termination*, seen from engine: Left hand side.

Type of cable entry: Gland

Enclosure: IP54

Current transformers* (CT) starpoint side, triple core:

- Primary current: Nearest standard size according to generator current
- Secondary current: 1A 1A 1A
- Class: 0,5 5P10 5P10
- Burden: 20VA 20VA 20VA

Neutral point in terminal box: On isolated busbar

Neutral point isolated/earthed: Isolated

* NOTE! Location of Main cable termination, and type of current transformers, must be approved by client within 1 month after signed contract. Other alternatives on request at additional cost.

Equipment supplied, but not built on the generator:

12.10 23 off

AUTOMATIC VOLTAGE REGULATOR (AVR) AVR for mounting into the Generator Control Cabinet (GCC). AVR is designed for paralleling to the local bus (voltage regulation) and to grid (cosinus-phi regulation).



19.00 Documentation, technical calculations and testing

19.01 3 set **Installation instructions and drawings:**

DOCUMENTATION supplied by Bergen Engines AS:

1 set INSPECTION CERTIFICATE 3.1.B in acc. with EN 10204.

19.02 3 set **OPERATING INSTRUCTIONS** in English:

- **Service manual engine** (Section 1): Main Data, Manufacturing Data, Test Results, Instructions and Drawings for Operation, Maintenance and Ordering Spare Parts

- **Instructions for auxiliaries** (Section 2): Main dimensions Gen-set foundation and connections, P&I system Drawings, Operating Instructions Gen-set and AUXILIARIES.

- **Engine control system** (Section 3): Engine control cabinet, Cabling, Alarm list, Electrical equipment on engine, Governor.

Time of delivery for Operating Instructions are normally at the commissioning. Place of delivery and conditions of dispatch as for the Generating set(s) when nothing else is specified.

Drawings, Lists etc. are based on the following Standards:

- Instrumentation : ISA S 5.1 (ISO/TC10/Sc3)
- Piping-Fittings : NS 1710 (ISO/TC8N561)
- Hydraulics/Pneumatics: ISO/1219-1.2
- Electrical Circuits : NEN (IEC)

19.04 **Technical calculations.**

The Engine Plant is based on technical data received from the Purchaser.

The alternator specification must be approved by the Purchaser within 1 month after contract, but at least 5 months prior to delivery.

If the original data received from the Purchaser are altered, requiring new Torsional Vibration Calculations, the additional cost of these new calculations will be charged by the Purchaser.

19.05 **TESTING.**

Every Diesel Engine will be tested by Bergen Engines AS at the factory before delivery. The tests will be performed according to Bergen Engines AS standards as follows:

Customer : Midland East Power Ltd
Project Name : 150 MW HFO Power Plant
Reference : BP175028



Rolls-Royce

Starting up :

Inspection of equipment acc. to test order. Crankshaft deflection, cold Engine.

Running 25% load 1 hour.

Running 50% load 1 hour.

Running 75% load 1 hour.

Running 100% load ½ hour.

Adjustment:

Air and exhaust valves.

Fuel oil injection pumps.

Overspeed trip arrangement.

All sensors and switches.

Test run on MDO:

Running 100% load 2 hours.

Running 75% load ½ hour.

Running 50% load ½ hour.

Running 25% load ½ hour.

Inspections:

Crankshaft deflection, warm engine. One big end bearing shell.



20.00 Surface treatment - packing

20.00 Anti-corrosive treatment

The Engine Sump is filled with preservative oil, and drained after the Engine has been ticking over for 10 minutes.

All pipe ends and openings, except oil pipes, are sprayed with anti-corrosive. All machined surfaces are covered with a thin oily anti-corrosive for the storage and installation period.

All Tools and Spare Parts which can be affected by corrosion, are sprayed with anti-corrosive.

The preservation scheme is effective for 12 months after FAT. If storage is expected for longer periods the client must inform Bergen Engines AS before engine FAT.

Painting

The Generating set is cleaned and coated with a 50 micron alkaline painting type RAL 5012 (light-blue) after completed Factory Test.

Any alterations in painting specification have to be received by Bergen Engines AS at least 2 months prior to delivery date. Alterations may lead to price changes.

20.02 Packing

The Engine is covered with a Tarpaulin. All pipes and exhaust outlets are blinded.

Tools and Spare Parts are packed in Boxes made of plywood with steel framing. . Packing inside box are protected against water ingress.

Handling and care after arrival.

The Generating set must be stored indoors in a dry place,. The Tarpaulin Cover should not be removed before mounting.

The Generating set has to be cleaned before start-up.

The Engine must not be turned / cranked without oil supply to the bearings.



Technical specification

(Balance of Plant auxiliaries)

Engine Type : 23 x B32:40V16AH
Customer : Midland East Power Ltd
Customer Project : 150 MW HFO Power Plant
Reference : BP175028



Equipments and Functions Supplied

1. Compressed Air System

The Start air system shall consist of a module with electric motor driven reciprocating compressors (1 working + 1 standby), air receivers , control air module. (and the basic parameters of the system are as per table below)

The compressed air system shall consist of a module with electric motor driven reciprocating compressors (one working and one standby), , air filters and pre-filters.

The system shall be designed and regulated to maintain the required pressure and demands for Engine starting and control including a minimum of three (3) starts for the engines. The starting system shall be designed to recharge receiver tank within approximately 60 minutes from minimum to 30 bar pressure.

1.1.1 Start Air Compressor (1W+1S) : 2 Module per Plant

Compressor Capacity : 140 m³/hr FAD +/- 5%

At 1 Bar Barometric Pr.

Pressure Required : 30 Bar

Cut In : 22 Bar

Cut Out : 30 Bar

V – Belt Drive Provided With Belt Guard.

Motor : - TEFC Motor 3 – Phase / 415 V / 50 Hz.

1.1.2 Engine Starting Air Receiver :- 12 Nos (1 per 2 genset)

The Air receiver shall be designed as per ASME Sec VIII Div 1, and shall be hydro tested at 45 bar pressure. The receiver shall be mounted with standard fittings and valves.

The receiver shall be fabricated out of plate as per SA 516 Grade 60/70.

Air Receiver Capacity : 2000 litre

Working Pressure : 30 Bar

Design Pressure : 45 Bar

No of start per genset : 3 nos.

Design standard : ASME Sec VIII Div 1

1.2.1 Control & Instrument Air Compressor (1W+1S) : 2 set Plant

Compressor Capacity : 120 m³/hr FAD +/- 5%

At 1 Bar Barometric Pr.

Pressure Required : 7 Bar

Cut In : 5 Bar

Cut Out : 7 Bar

V – Belt Drive Provided With Belt Guard.

Motor : - TEFC Motor 3 – Phase / 415 V / 50 Hz.



1.2.2 Engine Control and Instrument Air Receiver :- 4 Nos per Plant

The Air receiver shall be designed as per ASME Sec VIII Div 1, and shall be hydro tested at 10.5 bar pressure. The receiver shall be mounted with standard fittings and valves.
The receiver shall be fabricated out of plate as per SA 516 Grade 60/70.

Air Receiver Capacity	: 1000 litre
Working Pressure	: 7 Bar
Design Pressure	: 10.5 Bar
Design standard	: ASME Sec VIII Div 1

2 Engine Fuel system

2.1 HFO Treatment system :- 1 set (2W+1S) 3x50% Capacity .

1 set per plant HFO treatment plant comprising fully automatic, self cleaning centrifuge of suitable for capacity of total 39 cu.m/hr, suitable for treatment of fuel of viscosity upto 180cst at 50°C, and density 0.99 at 15°C. Maintenance tools shall be supplied.

The heavy fuel oil treatment module removes solids and water from the heavy fuel oil. It is designed for continuous, automatic operation.

Each module comprises a centrifuge complete with pipe work, instrumentation and controls and a steam heater to raise the heavy fuel oil to the correct temperature for centrifuging. The heater is complete with a control system to monitor and regulate the temperature of the fuel oil required for separation.. The centrifuge is mounted on a common base frame, which includes a sludge tank, , and pneumatically operated diaphragm sludge pump. The centrifuge is fully automatic, with manual stop/start, and has self cleaning operation.

The centrifuge module is complete with drive motors, controls, cabling, and instrumentation including motor starters.

1 per plant Hydrophore Unit.

2.2 Fuel Feeding and Boosting System:-

2 per plant HFO Feeder Pump Module including:- Feeder pumps(1w+1st.by), filters, PRV and local alarms. The feeder pumps capacity shall be of suitable for 12 genset at 5 bar each. The Pump shall be screw type electric driven.

2 per plant LFO Feeder Pump including:- Feeder pumps (1w+1st.by), filters, PRV and local alarms. The feeder pumps capacity shall be of suitable for 12 genset at 5 bar each.

1 per engine HFO Booster Module including - booster pumps (1W), filters(s) including coarse and fine, de-gasing tank, viscometer, heaters, HFO



Flow meter and local alarms, fuel Change over and 3-way solenoid valve.

- 01 set per engine Emergency Fire Control Solenoid isolation Valve.
- 01 per engine Pressure regulating Valve

3.0 Lube Oil System :-

- 1 per engine **Lube oil centrifuge** with accessories. The lube oil centrifuge capacity shall be 2.2 m3/hr.

Centrifuge shall be solids discharging (self cleaning) total discharge type. The lubricating oil treatment oil module receives lubricating oil from the engine sump, treats the oil to remove solids and water, and returns the treated oil to the engine sump. It is designed for continuous, automatic operation.

Each centrifuge includes a suction pump complete with strainer to take oil from the engine sump and deliver it to the centrifuge.

The centrifuge is fully automatic with manual stop/start and timed self cleaning operation..

Note :

The above description may be altered depending upon vendor selection for supply such ancillary modules.

A Single 7 barg saturated steam supply and steam / condensate return system to be provided by customer to each lube oil centrifuge module.

- 2 per plant **Mobile transfer pump- Trolley Mounted.** The pump shall be 3 m3/hr at 2 bar capacity. Pump shall be screw type, electric driven.

- 1 per plant **Lube Oil Unloading Pump Module-** Stationary (1w+1st.by). The Pump capacity shall be 3 m3/hr at 4 bar each . The pump shall be screw type electric driven.

- 1 per plant **Lube Oil Transfer Pump Module-** Stationary (1w+1st.by). The Pump capacity shall be 3 m3/hr at 4 bar each . The pump shall be screw type electric driven.

4.0 Charge Air System :-

- 1 Set per engine **Intake air filter (s)**-Oil bath filters, designed to take 99% of particles down to 5 micron.
- 2 per engine **Intake air silencer (s)**-attenuation 25 dB (A).Intake Air Silencer shall be fabricated out of MS Plate (IS 2062) and shall have suitable fabricated flange ends to be connected to the Intake Air Ducting.



5.0 Plant Water & Engine Cooling Water System :-

1 set per engine LT water circulation pump - motor driven -Low temperature cooling pumps, electrical driven. One Duty / one standby automatic.

1 sets per engine Combined Radiators for HT & LT System (Detail to be submitted later), Each radiator cooler fan shall have sound level of 70 dB(A) \pm 3 dB(A) at 10m, designed for heavy duty, dusty environment (IP55 Enclosure for motor) and ambient temperature of 40 deg C. Radiator Support Structure shall be done by customer.

Support structure, hand rail, and ladder shall be in customer scope, BEAS will provide fabrication drawing.

6.0 Exhaust Gas System :-

1 per engine Exhaust gas silencer (s), reactive – absorption & industrial type, attenuation 35 dB(A). Exhaust Gas Silencer shall be fabricated out of SA 516 Grade 60/70 and shall have suitable fabricated flange ends to be connected to the Exhaust Gas Ducting.

1set per engine Expansion bellows -Material of construction of bellow and sleeves – AISI 321,Flanges (according to DIN 2501ND6) – IS 2062 Grade 2, End Connections ANSI B16.2, ASA 150.



1.0 Electro Control Package

01.01 23 off GEN-SET CONTROL CABINET (Gn):

The Genset Control Cabinet (Gn) is designed to be fully integrated with Engine Control Cabinet (ECC), and other cabinets within Bergen Engines scope of supply.

The Genset Control System is based on Synchronizing and protection unit and a Siemens S7, 1500 / equivalent series PLC.

Generator Protection Unit contains all Generator Protection functions :

- Reverse power(ANSI code 32R)
- Overvoltage (2 levels).....(ANSI code 59)
- Undervoltage (2 levels).....(ANSI code 27)
- Over frequency (2 levels).....(ANSI code 81O)
- Under frequency (2 levels).....(ANSI code 81U)
- Overload (2 levels).....(ANSI code 32)
- Current unbalance (1 level).....(ANSI code 46)
- Voltage asymmetry (1 level).....(ANSI code 46)
- Reactive power import (excitation loss) (1 level)..... (ANSI code 40 R)
- Reactive power export (over excitation) (1 level)..... (ANSI code 40)
- Short Circuit & Overcurrent (ANSI code 50, 51)
- Differential Protection (ANSI code 87G)
- Voltage dépendent over curent (ANSI code 51 V)
- Restricted Earth Fault (ANSI code 64R/87N)

01.02 - Differential protection relay (ANSI code 87G). (PURCHASER must supply CT according to BEAS specifications).

01.04 Multi Function Meter (VAMP 260) for accurate measuring and counting of produced energy and transducer output.

- kWh-counter class 0.5, including kVARh-counter class 1.0
- Display of kWh in WIN CC SCADA system, hourly basis.

01.06 Auto Synchronizing of Generator CB with Bus



Automatic Generator Controller (AGC- 4) / equivalent contains all necessary 3-phase measuring circuits, and presents all relevant electrical values and alarms on the AGC 4 Liquid Crystal (LC) display mounted in the cabinet door. AGC 4 contains synchronizing functions and protection:

- Reverse Power (ANSI code 32 R)
- Power Import/Export (ANSI code 40/40R)
- Circuit Breaker Failure (ANSI code 50BF)

Following measured and calculated values are available in AGC- 4 display:

- 01.06 Display on AGC 4 , Generator:
- Voltage (3-phase + N) (V)
 - Current (3-phase) (A)
 - Active power (kW)
 - Reactive power (kVAr)
 - Power factor (cos phi)
 - Frequency (Hz)
 - Busbar: Voltage (3-phase) (V) and Frequency (Hz)

- 01.07 Analog meters:
- In addition,,analog meters are available for the following genset values:
- Double volt meter, single phase (V)
 - Ampere meter, single phase (A)
 - Ampere meter for excitation current (A)
 - Double frequency meter (Hz)
 - Gen-set speed (rpm)
 - Synchroscope

- 01.08 Generator breaker position is available in a mimic diagram at the cabinet front.

- 01.09 Switches:
- Frequency.....: Lower / rise.
 - Voltage / power factor.....: Lower / rise.
 - Synchronisation.....: Manual / 0 / auto.
 - Generator breaker.....: Open.
 - Generator breaker.....: Manual close command.
 - Gen-set.....: Emergency stop.

- 01.10 Control functions:
- Interface and control of genset.
 - Interface and control of starters in MCC.

- Dead bus close of generator breaker

01.11 Automatic Voltage Regulator (AVR): Automatic Voltage Regulator (AVR) is delivered as part of the generator supply, and is mounted inside the Genset Control Cabinet.

2.0 Central alarm and monitoring system

The Central Alarm & Monitoring System is a WinCC system of Siemens (PC based HMI system) running under Windows NT.

The computer collects signals from all the PLCs in the system and communicates this to the operator through pictures and tables with plant variables and events.

The monitoring systems function is to collect data from the process, and present these data to the operator.

The monitoring system will also take care of the functions as data logging of alarms and events, printing of reports, trend monitoring of important parameters, alarm annunciation and acknowledge.

2.01 1 set WinCC Equipment:

- CPU with 22" colour monitor, Keyboard, Mouse, Communication card for PLC – 4 nos.
- CPU with Keyboard (Server), Mouse, Communication card for PLC – 2 nos.
- CPU with Keyboard (Engineering Station) Mouse, Communication card for PLC – 1 no.
- 42" colour Monitor with VGA Switch – 1 no.
- Printer (matrix A4/Laser) w/cable,
- Communication cable to PLC`s (max 100 meters cable included)
- Windows NT
- WinCC - Tags element configuration Licence

2.02 WinCC Functions:

- Trending of BEAS-selected parameters
- Alarm & Event logging
- Continuous printing of alarm states
- English language on HMI
- Process Control (ref. Genset and Grid chapter)
- Customised trending (details to be agreed)
- Customised logging (details to be agreed)
- Daily Plant data report in Excel format
- Remote monitoring and controls through VNC software for trouble shooting of PLC functionality (Required agreement from customer for internet access)

03.0 Grid Control Cabinet

03.01 3 off GRID CONTROL CABINET (U1):

Grid / Utility Control Cabinet (U1) is designed to be fully integrated with Generator control Cabinet (GCC) and other cabinets within Bergen Engines scope of supply.

Grid breaker Synchronisation:

Automatic synchronisation of grid breaker implemented in Grid Control Cabinet as an integrated function in the Parallel & Protection unit.

Manual synchronisation within specified limits is available from Grid Control Cabinet.

03.02 Parallel & Protection relay (AGC-4 Mains) with following inbuilt protection

- Vector / Phase shift monitoring (ANSI Code 78)
- df/dt ROCOF Monitoring (ANSI code 81RL)
- Reverse power (ANSI code 32R)
- Overvoltage (2 levels) (ANSI code 59)
- Under voltage (2 levels) (ANSI code 27)
- Over frequency (2 levels) (ANSI code 81O)
- Under frequency (2 levels) (ANSI code 81U)
- Overload (2 levels) (ANSI code 32)
- Current unbalance (1 level) (ANSI code 46)
- Voltage asymmetry (1 level) (ANSI code 46)
- Reactive power import (excitation loss) (1 level) (ANSI code 32R)
- Reactive power export (over excitation) (1 level) (ANSI code 32)
- Short circuit & over current (ANSI code 50, 51)

03.03 Measuring and monitoring:

The Paralleling and Protection Unit contains all necessary 3-phase measuring circuits, and presents all relevant electrical values and alarms on the display mounted in the cabinet door.

Following measured and calculated values are available in LC display:

Busbar:

- Voltage (3-phase + N) (V)
- Current (3-phase) (A)
- Active power (kW)
- Reactive power (kVAr)
- Power factor (cos phi)
- Frequency (Hz)
- Grid: Voltage (3-phase) (V) and Frequency (Hz)

03.04 Analog meters:

In addition, analog meters are available for the following grid values:

- Double volt meter, single phase (V)
- Double frequency meter (Hz)
- Ampere meter, single phase (A)
- KW meter
- Synchroscope



-Multi Function meter (PAC 4200) with Profibus

- kWh-counter class 0.2, including kVARh-counter class 1.0
- Display of kWh in WIN CC SCADA system, hourly basis.

03.05 Grid breaker position is available in a mimic diagram at the cabinet front.

03.06 Switches:

- Frequency / speed.....: Lower / raise
- Voltage / power factor.....: Lower / raise
- Synchronisation.....: Manual / 0 / auto
- Grid breaker.....: Manual close command
- Reactive power control (cos phi or kVAr) in grid connection point.
- Active power export/import control (kW) in grid connection point.
-

PURCHASER must install grid protection according to local rules and regulations.

PURCHASER grid protection must include:

- over/under voltage protection
- over/under frequency protection
- micro interruption protection (df/dt (ROCOF) or vector surge)

To assure selectivity between generator breaker and grid breaker, protection settings must assure tripping of grid breaker before generator protections are tripping the generator breaker.

4.0 Battery Cabinet

4.01 13 off BATTERY CABINET (B1): (12 for 23 Engines and 1 for 1 PCCP)

The battery cabinet (B1) is designed to be fully integrated with Bergen(BEAS) Engine Control Cabinet(ECC) and other cabinets within BEAS scope of supply.

The Battery Cabinet shall have a 415V 3Ph, 50Hz supply (Included in MCC if BEAS is the supplier of MCC).

One battery cabinet can supply power for 2 gen-sets.

Equipment:

2 x 40 amps, 24 V DC Battery Charger

2 sets of Batteries of 65AH each

2 x DC protection relays

1 battery charger of 24 V DC, 40 Amps, delivered DC supply to Cabinets and instrument per Genset,

1 voltmeter, 1 ampere-meter, 1 main switch 24 V, 40 A. Automatic fuses for equipment delivered by BEAS.

5.0 Power Control centre (PCC)

3 per Plant Power Control Centre (PCC) consists of metal enclosed, free-standing vertical sections containing non draw out cubicles with removable hinged doors. Power Control Centre (PCC) shall be supplied with one incoming breakers for power supply and outgoing feeders to Engine MCC, Radiator MCC, common auxiliary and Pump House MCC.

6.0 Pump House Auxiliaries MCC

1 per plant Panel(s) including all starters for fuel system, Lub oil system and other pumps and equipments installed in Tank farm Area. This includes start / stop / remote switch / indicators for SCADA system within Bergen Engines scope of supply.

ET 200s interfacing module of Siemens make for starters start/stop and status feedback signal to SCADA .

Load manager displaying electrical data.

7.0 Radiator MCC

1 per Engine Panel(s) including all starters and start / stop / remote switch / indicators for SCADA system within CONTRACTOR's scope of supply.

ET 200s interfacing module of Siemens make for starters start/stop and status feedback signal to SCADA.

Load Manager displaying electrical data.

8.0 Engine Motor Control Centre (EMCC)

8.01 1 per Engine MOTOR CONTROL CENTRE (MCC):

Panel(s) including all starters and start / stop / remote switch / indicators for consumers within Bergen Engines scope of supply.

The front door of the cabinet is equipped with a mode-selector switch (man - 0 - auto) and start/stop push buttons for each of the starters. There is also an indication light for running feedback for each of the starters.
All starters are foreseen for external emergency stop (potential free contact).

The supply to the MCC is PURCHASER scope of supply, and the nominal voltage is 415 V AC three phases, 50 Hz with neutral and PE.

Alarms, status signals and start/stop commands are fully integrated with our



alarm and control system.

ET 200s interfacing module of Siemens make for starters start/stop and status feedback signal to SCADA.

Load Manager displaying electrical data.

9.0 Plant Common Control Panel (PCCP)

1 per plant PCCP having common PLC for start/stop of Genset common auxiliaries and monitoring of all parameters, alarms and events. . Graphs of analogue values are also available and can hook up with the printer. PCCP can communicate with other PLCs for data transfer