TECHNICAL DIARY - Offshore

220MW Barge Mounted Power Plant
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<td>Steam Turbine De-aerating Condenser</td>
<td>80</td>
</tr>
</tbody>
</table>
Once Through Steam Generators also called OTSG are supplied by IST, Canada. These are the steam generators, which generate steam for power generation in steam turbine. The heat in the exhaust gases from Gas Turbines is transferred to feed water to generate steam at two pressures, HP & LP. The OTSG are drum less boilers having tube bundles where steam is generated. Feed water is supplied to OTSG through feed water pumps after treating the water in Condensate Polishing Unit. Suppling DM water to condenser hot well fulfils the additional makeup requirement. The exhaust gases after giving their heat to feed water are let off to atmosphere through stack. The OTSG has a dry running capability up to 560°C.

**General Specification:**

- **Manufacture**: INNOVATIVE STEAM TECHNOLOGIES
- **Type**: ONCE THROUGH STEAM GENERATOR
- **Make No.**: 
- **Number of boilers**: 4
- **Working Pr in psig / kg/cm2 (g)**: HP - 865 / 59.62 & LP - 68.3 / 4.71
- **Design pr in psig / kg/cm2 (g)**: HP - 953 / 65.71 & LP - 103 / 7.10
- **Hydraulic test pressure in psig / kg/cm2(g)**: HP - 1884 / 129.87 & LP - 384 / 26.47
- **Flue Gases**: Gas Turbine exhaust flue gas
- **Capacity in lb/hr / kg/hr.**: HP - 107600/48806.5 & LP - 35570/16134.28
- **Design dry running gas temperature**: 986 F
- **Maximum operating gas temperature**: 856 F
B. BARGE

The Function of Barge is to contain and deliver 1(one) combined cycle barge mounted floating power plant of nominal net capacity 220 MW, consisting of 4(four) Once Through Steam Generator (OSTG), 1(one) steam turbine generator (STG), 4(four) combustion gas turbine generators and auxiliary equipment condensers, chilling system for air intake and the remaining balance of plant. The basic design is to include the barge and the connections to the mooring system, together with the power plant equipment.

The Design data of the barge

a) Barge size (length x wide x depth) : 106m x 55.2m x 6m
b) Barge draft for towing : 2.4 m (Normal operation 3.4m)
c) Total barge weight : 13,900 tonnes
(barge itself including steam turbine hall, control building and above deck foundations: approximate 6,000 tonnes)

Stability

a) The barge is designed to comply with the intact stability regulation of US 46 CFR Chapter I, Section 174.015 for river and harbor service.
b) The barge is designed to comply with the one compartment damage stability regulations of US 46 CFR Chapter I, Section 172.065. The Barge shall comply with a wind heeling moment as defined in CFR Chapter I, Section 174.055
c) The Barge is designed to comply with IMO International Convention on Load Lines

Barge Access

Four(4) ramps are designed to access the barge from shore,
  one(1) main ramp 6m wide
  one(1) ramp 4.5m and
  two(2) auxiliary ramps 3.5m wide respectively.

Barge Ventilation

Below deck spaces are ventilated according to the recommended practices of SNAME T&R 4~16 “Calculation Merchant Ship Heating, Ventilation and Air Condition Design”.

Fans are sized to limit the temperature rise in the ventilated spaces to be less than 5°C and to provide sufficient ventilation air to ensure noxious fumes are below accepted occupational safety regulation levels.
C. CHILLERS

Chillers are used to cool Gas Turbine intake air and enhancing the output of each Gas Turbine by 7 to 10 MW approximately. The chillers operate on Vapour Compression Cycle. Chilled water is circulated through evaporator where it rejects heat to refrigerant HFC134a and become chilled. This chilled water again picks up heat from gas turbine intake air-cooling them. The boiled refrigerant is than compressor. The heat added to the refrigerant in evaporator and compressor is that rejected in condenser, cooled by sea water. The motor is hermetically sealed. Lube Oil and motor windings are cooled by refrigerant. Therefore heat from a low temperature source is rejected to high temperature source.

Design criteria

1) Site condition
   GT chiller coil required cooling capacity : 1200 USRT x 2 sets

2) GT chiller cooling coil design condition
   - Inlet air condition (Ambient) 37 ° DB / 75 % RH
   - Outlet air condition (GT inlet air) 7.22 ° DB / 95 % RH
   - GT inlet air flow rate 128.9 kg/s
   - Chilled water supply / return temp. 5 °c / 13.8 °c
   - Chilled water flow rate: 826 m³/h

Chilled water system consists with the following equipment,

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Name</th>
<th>Q'ty</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. GT-1</td>
<td>Combustion air chilling coil #1</td>
<td>1 set</td>
<td>100%</td>
</tr>
<tr>
<td>2. GT-2</td>
<td>Combustion air chilling coil #2</td>
<td>1 set</td>
<td>100%</td>
</tr>
<tr>
<td>3. CS-M-CH01-1A</td>
<td>Centrifugal Chiller #1A</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>4. CS-M-CH01-1B</td>
<td>Centrifugal Chiller #1B</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>5. CS-M-CH01-2A</td>
<td>Centrifugal Chiller #2A</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>6. CS-M-CH01-2B</td>
<td>Centrifugal Chiller #2B</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>7. CS-M-PP01-1A</td>
<td>Chilled water Circul. P/P #1A</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>8. CS-M-PP01-1B</td>
<td>Chilled water Circul. P/P #1B</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>9. CS-M-PP01-2A</td>
<td>Chilled water Circul. P/P #2A</td>
<td>1 set</td>
<td>50%</td>
</tr>
<tr>
<td>10. CS-M-PP01-2B</td>
<td>Chilled water Circul. P/P #2B</td>
<td>1 set</td>
<td>50%</td>
</tr>
</tbody>
</table>
### Details of Chiller:

#### Name Plate Details:

- **Type:** Centrifugal
- **Make:** Carrier, USA
- **Refrigerant Used:** R 134a
- **Quantity of Refrigerant charge:** 1270 Kg
- **No. of chillers:** 8
- **Capacity:** 1210 USRT each
- **Motor:** Hermetically Sealed
- **Rated Power:** 808 KW
- **Design Chilled water temperature:** 5°C
- **Delta T across evaporator:** 8.8°C
- **Chilled water flow rate:** 415.77 m³/hr
- **Design Sea water inlet temperature:** 29°C
- **Delta T across condenser:** 6 °C
- **Condenser sea water flow rate:** 739 m³/hr
- **No of tubes in evaporator:** 976
- **Evaporator tube diameter:** 19.05 mm
- **Evaporator heat transfer area:** 228 m²
- **Evaporator tube material:** Copper
- **Chilled water:** DM water
- **Evaporator fouling factor:** 0.00008806 m².deg.c/W
- **LMTD across evaporator:** 7.13
- **Evaporator approach:** > 1°C
- **No of tubes in condenser:** 1170
- **Condenser tube diameter:** 19.05 mm
- **Condenser heat transfer area:** 257 m²
- **Condenser tube material:** Titanium

---

<table>
<thead>
<tr>
<th>Equipment No.</th>
<th>Name</th>
<th>Q'ty</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>GT-3</td>
<td>Combustion air chilling coil #3</td>
<td>1 set</td>
</tr>
<tr>
<td>2.</td>
<td>GT-4</td>
<td>Combustion air chilling coil #4</td>
<td>1 set</td>
</tr>
<tr>
<td>3.</td>
<td>CS-M-CH01-3A</td>
<td>Centrifugal Chiller #3A</td>
<td>1 set</td>
</tr>
<tr>
<td>4.</td>
<td>CS-M-CH01-3B</td>
<td>Centrifugal Chiller #3B</td>
<td>1 set</td>
</tr>
<tr>
<td>5.</td>
<td>CS-M-CH01-4A</td>
<td>Centrifugal Chiller #4A</td>
<td>1 set</td>
</tr>
<tr>
<td>6.</td>
<td>CS-M-CH01-4B</td>
<td>Centrifugal Chiller #4B</td>
<td>1 set</td>
</tr>
<tr>
<td>7.</td>
<td>CS-M-PP01-3A</td>
<td>Chilled water Circul. P/P #3A</td>
<td>1 set</td>
</tr>
<tr>
<td>8.</td>
<td>CS-M-PP01-3B</td>
<td>Chilled water Circul. P/P #3B</td>
<td>1 set</td>
</tr>
<tr>
<td>9.</td>
<td>CS-M-PP01-4A</td>
<td>Chilled water Circul. P/P #4A</td>
<td>1 set</td>
</tr>
<tr>
<td>10.</td>
<td>CS-M-PP01-4B</td>
<td>Chilled water Circul. P/P #4B</td>
<td>1 set</td>
</tr>
</tbody>
</table>
Condenser fouling factor: 0.00008806 m².deg.c/W
LMTD across evaporator: 3.08
Condenser approach: 1 to 2 ºc
Coefficient of Performance (COP): 5.2
Energy Efficiency: 0.192
Main motor: 6,600 V, 50 Hz, and 3 Ph
Aux. Power: 415 V, 50 Hz, 3 Ph

D. AIR COMPRESSOR

The plant instrument air and service air requirement are met through screw type air compressors located in barge below deck compartments. There are 3 X 100 % compressors installed, having one instrument air receiver and one service air receiver. The instrument air is passes through 2 X 100 % desiccant type dryers which dries the air for use in instruments. The compressors are water cooled. To meets the equipment preservation air requirement and service air requirement we have a onshore air compressors which is run when the plant is under shutdown. The air is routed through the driers in barge to fulfil the requirement.

Specifications

Type                   rotary screw Oil free,
Make                   Water cooled screw type
Serial no              TS 1703
Manufacturer           Ingersoll Rand
Quantity               3 sets
Capacity               12.7Nm³/min
Pressure               8.64 bar g
Motor                  120.4 kw/set

Compressor package data
Capacity               18 m³/min
Rated operating pressure 8.5 bar g
Max discharge pressure  8.7 bar g
Gross mass             3250 Kg
Total package amperes   218/209
Voltage                380/415 V
Phase/hertz            3/50
Serial no              TS1701000126
E. GAS TURBINE

Gas Turbines are the main power generating units located on barge top deck. These are LM6000PC machines, which uses Natural Gas as fuel for continuous operation. These engines are aero derivative engines manufactured by GE. There are four GT each of 46.68 MW capacity. These machines are twin shaft engines. LP shaft is connected to generator at cold end through a reduction gear box. HP shaft is a freewheeling type shaft and its speed is proportional to load. LP shaft has LP compressor and LP turbine mounted on it. HP shaft has HP compressor and HP turbine mounted on it.

Inlet air to gas turbines are filtered in the filter house which has conical filters. Instrument air is used to clean the filters of dust accumulation. The air is then used for generator compartment pressurization, combustion and ventilation. The air is cooled by chilled water supplied from chillers pass through heat exchanger. The air than passes through drift eliminator and coalescer before going to engine after removing the moisture. The condensate generated in cooling process is used form DM water production in DM plant. The air energy is raised through compression and used for combustion. After expansion in turbine the exhaust gases are diverted to OTSG where its heat energy is utilized in generating steam. The turbine has water injection for Nox control.

Gas turbine lube oil system

A) Lube oil facility for gas turbine is installed on auxiliary package.

B) The system consists of four major sections.
   - Gas turbine lube oil unit
   - On-engine mounted supply and scavenge pump
   - Lube oil cooler unit
   - Air/oil separator module

Generator and gearbox lube oil system

The lube oil system consists of two major sections
   - Shaft driven main lube oil pump integrated on the reduction gearbox.
   - Lube oil module including electric motor driven lube oil pump, twin water-cooled lube oil coolers, filters, and lube oil tank.

Hydraulic starting system

The main component of the system is as follows:
   - Motor driven main hydraulic starting oil pump with hydraulic control
   - Motor driven clutch cooling oil pump
- High and low pressure regulating valves
- Hydraulic starting oil tank
- Supply and return filters
- Hydraulic starter
- Hydraulic starting oil cooler

**Air intake and exhaust gas system**
Gas turbine inlet air is drawn through this filter house, and is led to the gas turbine inlet through the air silencer and an inlet scroll assembly.

**Water washing system**
The main components consisting system are as follows:
- Solution and rinse water tank
- AC motor driven pump
- Water wash filter
- Off-line water wash spray manifold (on-engine)
- On-line water wash spray manifold (on-engine)

**Fire protection system**
The fire protection system consists of CO2 bottle skid, related valves, pipe and Instrumentation.
- The CO2 is supplied to two places as follows,
  - Gas turbine enclosure
  - Generator rear bearing enclosure

**Generator**
A) The generator uses open air-cooled, synchronous type, and totally enclosed type.
B) The generator will be able to handle all load situations in a satisfactory manner at both maximum and minimum ambient temperature. The generator consists of the following components:
   (1) Rotor
   (2) Stator
   (3) Exciter
   (4) Cooling system
   (5) Frame & enclosure.
General specification

GT Type Aero-derivative -LM 6000 PC
Make GE
Power 46,688 kw/GT
Revolution 3600 rpm

Compressor
Type : Axial
Stage : LPC-5 / HPC-14
Compression Ratio : LPC - 2.4:1 / HPC - 12.5:1

Combustor
No of combustor : 1 per GT
No of nozzle : 30/combustor
Combustor type : Annular Sequential
Ignition type : Electrical igniter

Inlet Air System

Make : Donaldson
Filter elements : Static Cylindrical and conical
No. Of elements : 224 pairs (2 * 16 columns * 7 rows)

Air Flow

<table>
<thead>
<tr>
<th></th>
<th>Initial clean sys.</th>
<th>Initial clean filter</th>
<th>pressure drop</th>
</tr>
</thead>
<tbody>
<tr>
<td>GT Combustion</td>
<td>130 kg/sec</td>
<td>93 mm W g</td>
<td>18.5 mm W g</td>
</tr>
<tr>
<td>GT Ventilation</td>
<td>25 kg/sec</td>
<td></td>
<td>57</td>
</tr>
<tr>
<td>Generator cooling</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>And ventilation</td>
<td>1390 cuM/min</td>
<td>42 mm W g</td>
<td>31.5 mm W g</td>
</tr>
<tr>
<td>Generator bearing</td>
<td>30 cu. M/min</td>
<td>50 mm W g</td>
<td></td>
</tr>
</tbody>
</table>

Filter efficiency:
- Sodium removal efficiency : 99.98%
- Chloride removal efficiency: 99.98%
- Moisture removal efficiency: 99.5% on 50 micro droplet

SPRINT System

The term “SPRINT” (SPRay INTercooling) is a technological advancement that has been developed by GE Industrial Aero Derivative Gas Turbines (GE-IAD) to enhance the output performance of the LM6000 Gas Turbine. The addition of GE”s proprietary Sprint technology increases the output by 9% at ISO and by more than 20% on 90° F (32°C) days. The effectiveness of the system becomes more pronounced as ambient temperatures rise.

The SPRINT system begins a mist injection process once the turbine reaches full load operation; no enhancement benefits are achieved at part load for either power augmentation or decreased heat rate.
The SPRINT cooling technology lowers the high-pressure compressor (HPC) inlet temperature (T2.5), which in turn effectively lowers the HPC compressor discharge temperature (T3).

ISO-International Standards Organization
- Ambient temperature 59 F (15 C)
- Barometric pressure 14.6% (101.4 kPa)
- Relative humidity 60%
- Elevation sea level
- Inlet and exhaust losses-none
- Emission controls-none

The system consists of two multi-nozzle inter stage mist injection systems
1) The low-pressure compressor (LPC) mist injection system consists of a single row of 23 nozzles located in the inlet of the LPC.
2) The high-pressure compressor (HPC) manifold is split into two (2) separate manifolds (inner / outer) consisting of two rows of 12 nozzles each for a combined total of 24 nozzles. The HPC manifolds are located in the compressor front frame support housing between the LPC and HPC.

Only one manifold will be operational at a given time. Which manifold is energized is dependent on the inlet air temperature. Inlet air temperatures of ≥ 48°F enables the LPC SOV valve to be opened when the system is enabled. When temperature drop below 48°F the LPC manifold will be de-energized and HPC manifold energized. If the temperature continues to drop, at 41°F both HPC and LPC will be de-energized. As temperatures increase from below 41°F the HPC manifold will be reenergized at 43°F increasing and at 50°F increasing the LPC manifold will be reenergized and HPC manifold de-energized.

Air extracted from the engine 8th stage HPC bleed air extraction port is utilized to atomize & pressurize the system By using the SPRINT spray inter-cooling system, the compressor pressure ratio can be increased and additional air can be directed through the compressor to increase the gas turbine characteristics

**Specifications**

- **Pump Type**: Vertical Multi Stage Centrifugal Pump
- **Material**: Stainless Steel
- **Catalogue No**: 3SVDK15SCP
- **Pressure**: PSI 360 max
- **Temperature**: 250 F Max
- **Manufacturer**: Goulds Pumps, ITT, G&L Services SSV
- **Flow Range**: 11 to 75 gpm
- **Pump Efficiency**: 65%
- **Motor Power**: 3/4 HP
Filter
Type: Duplex
Manufacturer: Indufil BV, Netherland
Year: 2007

Skid Mounted Equipment

Deminerlised water is supplied to the SPRINT system from DM plant. It is supplied at a rate of 10-gpm minimum to 30 gpm maximum and at pressures 0-65 psig. After interface connection, it flows through a Y-type strainer, a normally open ball valve to a centrifugal pump. The centrifugal pump is driven by motor rated at 10 HP. After the pump, the deminerlised water pressure is monitored by pressure switch LOW PSL-62227 which activates pressure alarm LOW PAL-62227 in the event the water pressure falls below 75 psig. Pressure gauge PI-62229 scaled 0-400 psig displays pump discharge pressure. The deminerlised water then flows through a flow meter, solenoid actuated block valve, and enters a duplex filter that filters the water to 20 microns absolute. Pressure differential switch HIGH PDSH-62233 monitors the differential pressure across the filters and activates an alarm should the differential pressure increase to 10 psid. Pressure differential indicator PDI-62232 provides a visual display of the differential pressure across the filter.

LPC SPRINT – 17 gpm (64 L/Min)
HPC SPRINT – 13 gpm (50 L/Min), 6.5 gpm (25 L/Min) per manifold

System Pressurization Air

Air for atomizing and pressurizing the SPRINT system is extracted from the 8th stage HPC at engine. The air is supplied at 630 scfm (18 SCMM) and 150 psia (1034 KPaG) through an orifice. The air flow is divided into two separate flow one for LP SPRINT and the other for HP SPRINT.

System purge air is used to purge deminerlized water from the system for approximately two minutes immediately after SPRINT shutdown. This is conducted to prevent corrosion and the possibility of ice formation. System purge air is provided from the customer’s connection at 80-120 psig, dry filtered to 5 microns absolute.

Fuel Injection System
Type: Gas Fuel System with Nox Injection

The LM6000 PC fuel system includes fuel manifolds, flexible fuel hoses, and 30 fuel Nozzles. The minimum temperature of the gas fuel supplied to the gas turbine shall be 50°F (27.8°C) greater than the saturated vapour temperature of the gas supply pressure. The temperature of the gas fuel should not exceed 300°F (148.8°C) at the gas manifold inlet.
F. STEAM TURBINE

Steam Turbine expands the steam generated from all the OTSG to generate power. HP and LP steam generated from all 4 OTSG by utilizing the heat in exhaust flue gases, is directed to common header. Steam from HP and LP headers are injected in the steam turbine through control valves. LP steam is injected at 29th stage of the turbine. The steam gets expanded over the reaction blades and after utilization of work is dumped into the axial flow deaerator cum condenser. The steam gets condensed in the condenser and feed water from condenser hot well is directed back to the OTSG through boiler feed pumps. Condensate polishing unit purifies the feed water before it enters the OTSG. Steam jet air ejector and vacuum pump are used to generate and maintain vacuum in the condenser. The two-pole Generator uses air cooling for the rotor winding and the stator winding. The losses in the remaining generator components, such as iron losses, windage losses, and stray losses, are also dissipated through air.

The AC exciter is provided to supply the field current to the rotor winding of the generator.

The brushless Exciter system is consists of three phase main exciter (AC exciter), Rotary Rectifier (R-RF), Pilot Exciter (permanent magnetic generator) and AVR (Automatic Voltage Regulator). The turbine is an axialflow, single casing construction with approx. 50% of reaction.

TURBINE BYPASS SYSTEM

There are four bypass stations in the Tanir Bavi (GEL, Kakinada) power plant. Two of them are HP bypass stations and other two LP bypass stations.

Each HP and LP bypass stations are connected to HP and LP steam line of two OTSG (once-through steam generator).

The bypass stations functions are described below.

Each bypass stations consisting of:

One steam shut off valve per bypass
One steam pressure control valve per bypass
One water injection control valve per bypass
One steam assisting/preheating per bypass

<table>
<thead>
<tr>
<th>HP steam by-pass valve</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Steam Pressure</td>
<td>60.0</td>
</tr>
<tr>
<td>Inlet Steam Temperature</td>
<td>419</td>
</tr>
<tr>
<td>Inlet Steam Flow</td>
<td>82.6</td>
</tr>
<tr>
<td>Outlet Steam Pressure</td>
<td>5.0</td>
</tr>
<tr>
<td>Outlet Steam Temperature</td>
<td>162</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>Feed water</td>
</tr>
</tbody>
</table>
### LP steam by-pass valve

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inlet Steam Pressure</td>
<td>5.8 bara</td>
</tr>
<tr>
<td>Inlet Steam Temperature</td>
<td>240 °C</td>
</tr>
<tr>
<td>Inlet Steam Flow</td>
<td>30.6 t/h</td>
</tr>
<tr>
<td>Outlet Steam Pressure</td>
<td>3.0 bar a</td>
</tr>
<tr>
<td>Outlet Steam Temperature</td>
<td>143 °C</td>
</tr>
<tr>
<td>Cooling Water</td>
<td>Feed water</td>
</tr>
</tbody>
</table>

### STEAM TURBINE GENERATOR

<table>
<thead>
<tr>
<th>1</th>
<th>Type</th>
<th>K 9 V</th>
</tr>
</thead>
<tbody>
<tr>
<td>a</td>
<td>Manufacturer</td>
<td>ABB generation</td>
</tr>
<tr>
<td>b</td>
<td>Type</td>
<td>GTL 1200 GC</td>
</tr>
<tr>
<td>c</td>
<td>Number of poles (Pair)</td>
<td>2(1)</td>
</tr>
<tr>
<td>d</td>
<td>Protection class</td>
<td>54</td>
</tr>
<tr>
<td>e</td>
<td>Characteristic generator curve no.</td>
<td>TT/1 , TT/4</td>
</tr>
<tr>
<td>f</td>
<td>Rated apparent power at design conditions</td>
<td>MVA 64.7</td>
</tr>
<tr>
<td>g</td>
<td>Rated power factor (lagging)</td>
<td>cos phi 0.85</td>
</tr>
<tr>
<td>h</td>
<td>Rated voltage</td>
<td>kV 11</td>
</tr>
<tr>
<td>i</td>
<td>Voltage variation range at full load</td>
<td>% +5 to -5</td>
</tr>
<tr>
<td>j</td>
<td>Rated current</td>
<td>A 3396</td>
</tr>
<tr>
<td>k</td>
<td>Rated frequency</td>
<td>Hz 50</td>
</tr>
<tr>
<td>l</td>
<td>Rated speed</td>
<td>rpm 3000</td>
</tr>
<tr>
<td>m</td>
<td>Efficiency at 100% base load and power factor 0.8</td>
<td>% 98.48</td>
</tr>
<tr>
<td>n</td>
<td>Stator winding - cooling medium</td>
<td>- Air</td>
</tr>
<tr>
<td>o</td>
<td>Max. outlet temperature of cooling medium</td>
<td>°C 80</td>
</tr>
<tr>
<td>p</td>
<td>Rotor winding - cooling medium</td>
<td>- Air</td>
</tr>
<tr>
<td>q</td>
<td>Max. outlet temperature of cooling medium</td>
<td>°C 85</td>
</tr>
<tr>
<td>r</td>
<td>Pressure of cooling medium</td>
<td>bar (g) -</td>
</tr>
<tr>
<td>s</td>
<td>Synchronous reactance saturated, Xq</td>
<td>%</td>
</tr>
</tbody>
</table>
G. FEEDWATER SYSTEM

The function of the feedwater system is to provide boiler feedwater to the followings;

Feeding of the HP and LP feedwater
Feeding feedwater to the attemperator sprays for the HP and LP by-pass system.

The feedwater system design flow is based on the heat balance for the MCR condition including spray water for Steam Turbine by-pass operation.

The HP/LP feedwater pumps are sized with 10% margin on head loss. **Boiler Feed Pump**

<table>
<thead>
<tr>
<th>Type</th>
<th>horizontal centrifugal pump</th>
</tr>
</thead>
<tbody>
<tr>
<td>Serial no</td>
<td>99042871</td>
</tr>
<tr>
<td>Number of pumps</td>
<td>6</td>
</tr>
<tr>
<td>Model no</td>
<td>80*65SS 14M</td>
</tr>
<tr>
<td>Capacity (HP/LP)</td>
<td>HP 54 M³/hr, LP 17 M³/hr</td>
</tr>
<tr>
<td>Speed</td>
<td>2980 rpm</td>
</tr>
<tr>
<td>Design temperature</td>
<td>41°C</td>
</tr>
<tr>
<td>Fluid handled</td>
<td>feed water</td>
</tr>
<tr>
<td>TDH(HP/LP)</td>
<td>957 M/ 267 M</td>
</tr>
<tr>
<td>Power(BHP)</td>
<td>206.85 Kw</td>
</tr>
<tr>
<td>HTP</td>
<td>152.48 bar g</td>
</tr>
<tr>
<td>Weight</td>
<td>5190 kg</td>
</tr>
<tr>
<td>Make</td>
<td>HYOSUNG-EBARA CO ltd</td>
</tr>
<tr>
<td>Oil</td>
<td>AWT-32</td>
</tr>
</tbody>
</table>

**Motor**

<table>
<thead>
<tr>
<th>Type</th>
<th>3D squirrel cage induction motor</th>
</tr>
</thead>
<tbody>
<tr>
<td>Frame</td>
<td>400</td>
</tr>
<tr>
<td>Power</td>
<td>240 Kw</td>
</tr>
<tr>
<td>Poles</td>
<td>2</td>
</tr>
<tr>
<td>Voltage</td>
<td>6600 V</td>
</tr>
<tr>
<td>Current</td>
<td>24.9 A</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Code letter</td>
<td>F</td>
</tr>
<tr>
<td>Rating</td>
<td>S1</td>
</tr>
<tr>
<td>Efficiency</td>
<td>93.5%</td>
</tr>
<tr>
<td>cos D</td>
<td>0.900</td>
</tr>
<tr>
<td>Insulation class</td>
<td>F</td>
</tr>
<tr>
<td>Amb temperature</td>
<td>50°C</td>
</tr>
<tr>
<td>Temp rise</td>
<td>70°C</td>
</tr>
<tr>
<td>Space heater</td>
<td>1D, 240 V, 238 W</td>
</tr>
<tr>
<td>Bearing (DE/NDE)</td>
<td>NU217MC4+6217C4</td>
</tr>
<tr>
<td>Total weight</td>
<td>2800 Kg</td>
</tr>
<tr>
<td>Serial no</td>
<td>00525RMHO28004</td>
</tr>
</tbody>
</table>
Technical Diary - Offshore

Manufacturing date 2000, 06
Make HYUNDAI

Ammonia/ Hydrazine dosing

**Ammonia solution tank**
Type vertical cylindrical
Capacity 300 L

**Hydrazine solution tank**
Type vertical cylindrical
Capacity 300 L

**Ammonia dosing pump**
Type metering pump
Capacity 5.0 L/hr @ 20.7 bar g
Make LIQUID DYNAMICS
M.A.W.P 3000 bar at 100°C
MIN.D. metal temp 20 F
Serial no 024477
Seal material E.MAX 170 F MIM -50 F
Membrane material E.MAX 170 F MIM -50 F
Recommended refill pressure 2400 Psi

**Agitator**
Model 8641-99
Power 0.25 HP
Voltage 240 V
FLA 2.4
INS class F
Enc TEFC
Frame 56C
Duty continuous
Speed 960 rpm
Frequency 50 Hz
SF 1.0
Max Ambient 50°C
Bearing 6023
### H. CLOSED COOLING WATER SYSTEM

The function of the circulating water system is to provide cooling water to the main condenser to condense turbine exhaust steam for reuse in the turbine cycle and to the closed cooling water coolers including G/T inlet air chillers to remove heat loads from various plant components.

### Technical data

#### A) Aux. C.W booster pump

**Motor**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>HK165SR259FB</td>
</tr>
<tr>
<td>Frame</td>
<td>160L</td>
</tr>
<tr>
<td>Duty</td>
<td>cont</td>
</tr>
<tr>
<td>Type</td>
<td>HK-50</td>
</tr>
<tr>
<td>Bearings(drive/opposite)</td>
<td>6309ZZC3/6309ZZC3</td>
</tr>
<tr>
<td>Enclosure</td>
<td>IP54</td>
</tr>
<tr>
<td>Code</td>
<td>G</td>
</tr>
<tr>
<td>Insulation class</td>
<td>F</td>
</tr>
<tr>
<td>S.F</td>
<td>1.0</td>
</tr>
<tr>
<td>Nema design</td>
<td>B</td>
</tr>
<tr>
<td>Power(KW/HP)</td>
<td>15/20</td>
</tr>
<tr>
<td>Poles</td>
<td>4</td>
</tr>
<tr>
<td>Voltage</td>
<td>415 V</td>
</tr>
<tr>
<td>Current</td>
<td>28.8A</td>
</tr>
<tr>
<td>Frequency</td>
<td>50 Hz</td>
</tr>
<tr>
<td>Nema nominal efficiency</td>
<td>88.5%</td>
</tr>
<tr>
<td>Speed</td>
<td>1465 rpm</td>
</tr>
<tr>
<td>Max ambient</td>
<td>50°C</td>
</tr>
<tr>
<td>Ref no</td>
<td>0F114083-002</td>
</tr>
<tr>
<td>Weight</td>
<td>143 Kg</td>
</tr>
<tr>
<td>Make</td>
<td>Pump</td>
</tr>
</tbody>
</table>

**Pump**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Type</td>
<td>horizontal centrifugal pump</td>
</tr>
<tr>
<td>Model no</td>
<td>HES 150-200</td>
</tr>
<tr>
<td>Serial no</td>
<td>9904243-1</td>
</tr>
<tr>
<td>Capacity</td>
<td>260 M³/hr</td>
</tr>
<tr>
<td>TDH</td>
<td>10 M</td>
</tr>
<tr>
<td>Speed</td>
<td>1450 rpm</td>
</tr>
<tr>
<td>Power</td>
<td>9.6 Kw</td>
</tr>
<tr>
<td>Design temperature</td>
<td>29°C</td>
</tr>
<tr>
<td>HTP</td>
<td>11.8 bar</td>
</tr>
<tr>
<td>Fluid handled</td>
<td>sea water</td>
</tr>
<tr>
<td>Total weight</td>
<td>323 Kg</td>
</tr>
<tr>
<td>Bearing</td>
<td>6307</td>
</tr>
<tr>
<td>Make</td>
<td>HYOSUNG-EBARA CO ltd</td>
</tr>
</tbody>
</table>
I. AUXILIARY COOLING WATER SYSTEM

The function of the closed cooling water system is to remove the waste heat from the components of various Plant equipment and rejects it through the CCW coolers.

Design Basis

The system is designed to remove heat from the components in a safe, reliable, and economical manner with minimal vibration and noise. There are separated two (2) closed cooling water systems for simple cycle operation and combined cycle operation.

The closed cooling water system continuously supplies demineralized (passivated) quality water as a cooling medium for the Plant equipment in the closed loop cooling system.

Cooling water is supplied to the following equipment.

A) Simple cycle cooling GT
   generator cooler GT lube
   oil coolers Hydraulic
   starting oil coolers
   Air compressor coolers

B) Combined cycle cooling
   Sampling cooler
   ST generator air cooler
   ST lube oil coolers
   Water box priming pump coolers

Technical data

A) Simple cycle closed cooling water pump

<table>
<thead>
<tr>
<th>Type</th>
<th>Horizontal, centrifugal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quantity</td>
<td>Two (2) set</td>
</tr>
<tr>
<td>Serial no</td>
<td>9904243-5</td>
</tr>
<tr>
<td>Capacity</td>
<td>510 m$^3$/hr</td>
</tr>
<tr>
<td>Speed</td>
<td>1485 rpm</td>
</tr>
<tr>
<td>Design temperature</td>
<td>40°C</td>
</tr>
<tr>
<td>Fluid handled</td>
<td>demineralized water</td>
</tr>
<tr>
<td>Model no</td>
<td>HES 200-330</td>
</tr>
</tbody>
</table>
**J. CONDENSATE POLISHING UNIT (CPU)**

The condensate polishing system treats OTSG feed water and provides feed water quality suitable for its use.

The CPU package consists of 2 x 100% condensate polishing vessels, 1x100%, back washing pump, and powdex coating system.

Condensate polishing system

1) Condensate polisher inlet quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Normal Quality</th>
<th>Startup or Inleakage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids, ppb</td>
<td>1000</td>
<td>2500 – 5000</td>
</tr>
<tr>
<td>TDS (Less NH₃), ppb</td>
<td>1000</td>
<td>2000</td>
</tr>
<tr>
<td>Reactive SiO₂, as SiO₂, ppb</td>
<td>&lt;100</td>
<td>100 – 500</td>
</tr>
<tr>
<td>Total Fe, as Fe, ppb</td>
<td>&lt;100</td>
<td>100 – 500</td>
</tr>
<tr>
<td>Total Ca, as Ca, ppb</td>
<td>&lt;50</td>
<td>50 – 100</td>
</tr>
<tr>
<td>Na, as Na, ppb</td>
<td>25</td>
<td>50</td>
</tr>
<tr>
<td>Cation Conductivity, ns/cm</td>
<td>3</td>
<td>3 – 5</td>
</tr>
<tr>
<td>PH</td>
<td>8 – 9.4</td>
<td>8 – 10</td>
</tr>
</tbody>
</table>

2) Condensate polisher outlet quality

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Startup or Inleakage</th>
<th>Normal Quality</th>
</tr>
</thead>
<tbody>
<tr>
<td>Suspended Solids, ppb</td>
<td>5</td>
<td>90% removal (2)</td>
</tr>
<tr>
<td>TDS (Less NH₃), ppb</td>
<td>25</td>
<td>90% removal up to pH 9.6</td>
</tr>
<tr>
<td>Reactive SiO₂, as SiO₂, ppb</td>
<td>10 (4)</td>
<td>90% removal up to pH 9.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or 20ppb whichever is greater</td>
</tr>
<tr>
<td>Total Fe, as Fe, ppb</td>
<td>5</td>
<td>90 % removal</td>
</tr>
<tr>
<td>Total Ca, as Ca, ppb</td>
<td>2</td>
<td>90% removal up to pH 9.6</td>
</tr>
<tr>
<td>Na, as Na, ppb</td>
<td>5 (4)</td>
<td>90% removal up to pH 9.6</td>
</tr>
<tr>
<td></td>
<td></td>
<td>or 10 ppb whichever is greater</td>
</tr>
<tr>
<td>Cation Conductivity, ns/cm</td>
<td>0.1</td>
<td>0.2</td>
</tr>
</tbody>
</table>
K. WASTE WATER SYSTEM

The function of waste water system is to collect oily wastewater and chemical wastewater, into the waste water drain tank separately.

The collected wastewater will be delivered to the oil separator or wastewater treatment system on-shore, which is supplied by others before effluent to discharge.

STG or GTG lube oil will be drained to the lube oil drain tank for inspection or maintenance.

**Design Basis**

Waste water characteristics.

<table>
<thead>
<tr>
<th>Description</th>
<th>Characteristic</th>
<th>Source</th>
<th>Collect tank capacity</th>
<th>Disposal</th>
</tr>
</thead>
<tbody>
<tr>
<td>Oily wastewater</td>
<td>Oily water</td>
<td>Equipment drainage</td>
<td>120m³</td>
<td>Oil separator</td>
</tr>
<tr>
<td>T/R drain wastewater</td>
<td>Oil or oily water</td>
<td>Transformer equipment</td>
<td>-</td>
<td>Oil separator</td>
</tr>
<tr>
<td>Chemical wastewater</td>
<td>Chemical</td>
<td>Equipment chemical cleaning</td>
<td>50m³</td>
<td>W/T plant</td>
</tr>
<tr>
<td>Lube oil drain wastewater</td>
<td>Lube Oil</td>
<td>Lube oil tank</td>
<td>12m³</td>
<td>Lube oil tank or disposal to on-shore</td>
</tr>
</tbody>
</table>

The oily waste water system included the following pumps **Oily waste water pumps:**

- Oily wastewater pump : 60m³/hr x 45m³ x 2 sets
tag no : ED-M-PP02-B
serial no : 6050
capacity : 60 cu.m/hr
speed : 1480 rpm
design temperature : 32°C
fluid handled : sea water
type : horizontal centrifugal
model no : GMC 100D
TDH : 32 m
Power : 8 Kw
Hydro test pressure : 3.8 bar g
Total weight : 272 Kg
Bearings : 6308/6308
Manufacturer : HYOSUNG EBARA CORPORATION
Year of manufacture : Sep 2000
L. PLANT ELECTRICAL SYSTEM

The plant generates power at 11KV and evacuates power to 220kV switchyard from each of generator step-up transformer on barge through overhead lines. There are three step up transformers

1. GST#1- 11KV/11KV/220KV -120MVA Three winding transformer
2. GST#2-11KV/11KV/220KV -120 MVA Three winding transformer
3. SST -11KV/220KV -70MVA Two winding transformer

GST is three winding transformer with input from two gas turbine generator at LV side (11KV) and output at HV side (220KV). SST is two winding transformer with input from steam turbine generator at 11KV side and output of 220KV at HV side.

Also the 11KV is stepped down to 6.6KV through Unit Auxiliary transformers UAT#1 and UAT#2 for the plant auxiliary power. 6.6KV is used for running the Boiler feeder pumps and chillers during plant operation and also stepped down to 415V through Auxiliary transformers AT#1, AT#2, AT#3 and AT#4 for the plant auxiliary.

Design Criteria

The system parameters for utility are detailed below

<table>
<thead>
<tr>
<th>System</th>
<th>Fault level</th>
<th>System Earthling</th>
</tr>
</thead>
<tbody>
<tr>
<td>220kV, 50Hz, 3ph, 3wire</td>
<td>31.5kA/1sec</td>
<td>Solid earthling (BIL;950kV)</td>
</tr>
<tr>
<td>11.0kV, 50Hz, 3ph, 3wire</td>
<td>50kA/3sec</td>
<td>Neutral earthed through NGTR(&lt;10A)</td>
</tr>
<tr>
<td>6.6kV, 50Hz, 3ph, 3wire</td>
<td>20kA/1sec</td>
<td>Low Resistance through NGR (1200A)</td>
</tr>
<tr>
<td>415V, 50Hz, 3ph, 4wire</td>
<td>50kA/1sec</td>
<td>Solid earthling</td>
</tr>
</tbody>
</table>

The system/equipment are designed as per the following:

<table>
<thead>
<tr>
<th>Motors/System</th>
<th>Voltage</th>
<th>System Earthing</th>
</tr>
</thead>
<tbody>
<tr>
<td>Motors above200kW</td>
<td>6.6kV</td>
<td>Low Resistance</td>
</tr>
<tr>
<td>Motors 1kW up to 200kW</td>
<td>415V</td>
<td>Solid</td>
</tr>
<tr>
<td>Motors below1KW</td>
<td>240V</td>
<td>Solid</td>
</tr>
<tr>
<td>Controls for MCC UPS supply Illumination</td>
<td>110VAC</td>
<td>Solid</td>
</tr>
<tr>
<td>System</td>
<td>240VAC</td>
<td>Earthed</td>
</tr>
<tr>
<td>Space heater for panel/motor 55kw &amp; above</td>
<td>240VAC</td>
<td>Solid</td>
</tr>
<tr>
<td>DC system</td>
<td>110VDC</td>
<td>Unearthed</td>
</tr>
</tbody>
</table>
M.V switchgear

M.V switchgear is composed of vacuum circuit breaker (VCB) for 6.6KV motors and power feeding to 415V common MCC and on-shore, control/metering instruments, integrated digital relays for protection, etc.

L.V switchgear is composed of four (4) common MCC, each of them having incoming air circuit breaker (ACB), MCCB for outgoing feeders, control/metering instruments, etc.

DC / UPS system

Battery backed D.C system consisted of redundant battery chargers and two battery banks are provided. For critical loads redundant feeders with auto-changeover scheme is provided. Some of the loads also require a secure A.C supply for its operation. For these loads, station DC fed inverter system, generally known as uninterrupted power supply (UPS) is provided for the followings:

- DCS
- Communication system
- Control, protection system etc.

Lighting system

Lighting system is designed to provide appropriate illumination for the plant in all times considering the nature of work to be carried out.

The power supply for lighting systems shall be derived from the following sources:

- Normal A.C system
- Emergency lighting system (DC)
- Battery backed exit lighting

Fluorescent lamps are used for offices, switchgear room, etc. High-pressure sodium vapor lamps & metal halide and LED lamps shall be used for high bay indoor area and outdoor area respectively as appropriate.

Grounding & lightning protection

The grounding & lightning system in general cover the followings;

- System neutral grounding
- Equipment grounding for personnel safety
- Lightning protection

All metallic, non-current carrying parts of all apparatus such as transformers, switchgear panels, control & protection panels, cable trays, crane rails, steel structures, etc. are bounded with grounding system.

Power supply to on-shore

For on-shore plant, the followings are provided from the barge:

- 6.6KV redundant feeders through interconnecting cable support
- 415V emergency power in redundant feeders through interconnecting cable support
Power Transformers GST 1 & GST 2

Rating : 3 phase / 120 MVA
Voltage : 220/11/11 KV
Capacity HV/LV1/LV2 : 120/60/60
Cooling : ONAN/ONAF
BIL (KVP) : 1050/75/75
Frequency : 50 HZ
Connection & Symbol : Star/Delta/Delta – Ynd11d11
Neutral Grounding : HV solidly grounded
Type of Conservator : Air Cell type (COPS)
Type of tank : Conventional type with bolted cover
Type of tap changer : Off Circuit tapping switch
Cooling Equipments : Radiator with fans
Type of bushing : HV – 245 KV OIP Condenser bushing  
LV 1 & LV 2 – 17.5 KV Porcelain bushing  
HV neutral – 36 KV porcelain bushing
No load loss : 90 KW
No load current : 1 %
Noise level : 85 dB
Load losses : 340 KW
Temperature rise : Oil – 35 deg.c & Winding – 45 deg.c
Voltage variation : + 5 to – 5 % of HV – Switch

Power Transformer SST

Rating : 3 phase / 70 MVA
Voltage : 220/11 KV
Capacity HV/LV : 70
Cooling : ONAN/ONAF
BIL (KVP) : 1050/75
Frequency : 50 HZ
Connection & Symbol : Star/Delta – Ynd11
Neutral Grounding : HV solidly grounded
Type of Conservator : Air Cell type (COPS)
Type of tank : Conventional type with bolted cover
Type of tap changer : Off Circuit tapping switch
Cooling Equipments : Radiator with fans
Type of bushing : HV – 245 KV OIP Condenser bushing  
LV – 17.5 KV Porcelain bushing  
HV neutral – 36 KV porcelain bushing
No load loss : 46 KW
No load current : 1 %
Noise level : 85 dB
Load losses : 260 KW
Temperature rise : Oil – 35 deg.c & Winding – 45 deg.c
Voltage variation : + 5 to – 5 % of HV – Switch

60
Unit Auxiliary Transformers UAT 1 & UAT 2

Rating : 3 phase / 18.5 MVA
Voltage : 11/6.9 KV
Capacity HV/LV : 18.5
Cooling : ONAN/ONAF
BIL (KVP) : 75/7.5
Frequency : 50 HZ
Connection & Symbol : Delta/Star – Dyn1
Neutral Grounding : LV through neutral grounding resistor
Type of Conservator : COPS
Type of tank : Conventional type with bolted cover
Type of tap changer : On load tap changer. Make – Easun-MR 2 X V III
\[350 \text{ D 10.19 In W, 19 position with MA 2 motor driven mechanism}\]
Cooling Equipments : Radiator with fans
Type of bushing : HV – 17.5 KV Porcelain bushing
LV – 17.5 KV Porcelain bushing
LV neutral – 17.5 KV porcelain bushing

No load loss : 15 KW
No load current : 1 %
Noise level : 85 dB
Load losses : 130 KW
Temperature rise : Oil – 55 deg.c & Winding – 60 deg.c
Voltage variation : + 10 to – 12.5 % of HV – OLTC

Auxiliary Transformers AT 1, AT 2, AT 3 & AT 4

Type : 3 phase / Cast resin moulded transformer
Rating : 2.5 MVA
Voltage HV/LV : 6.6/0.413 KV
Frequency : 50 HZ
Type of tap changer : No voltage tap link (+/- 2.5 % X 2)
Tap Voltage : F 6.93 / 6.765, R 6.6 / 6.434 / 6.27 KV
Winding Connection : Dyn11
Cooling method : AN
% Impedance : 10.7 (IEC tolerance)
Temperature rise : Primary winding – 70 deg.c
Secondary winding – 90 deg.c
Winding Insulation class : Primary Voltage – BIL 60 KV
Noise level : 70 dB
No load losses : 5.6 KW
Load Losses : 19 KW
## List of Onshore and Offshore AC Equipments

<table>
<thead>
<tr>
<th>Location</th>
<th>Total no</th>
<th>Each capacity</th>
<th>Total capacity in TR</th>
<th>Type</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>Barge control room</td>
<td>1</td>
<td>8</td>
<td>8</td>
<td>package</td>
<td>CARRIER</td>
</tr>
<tr>
<td>Rack room</td>
<td>2</td>
<td>8,11</td>
<td>19</td>
<td>package</td>
<td>CARRIER,BLUE STAR</td>
</tr>
<tr>
<td>Roof top</td>
<td>1</td>
<td>20</td>
<td>20</td>
<td>package</td>
<td>CARRIER</td>
</tr>
<tr>
<td>Remote i/o panel</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>ducting split</td>
<td>BLUE STAR</td>
</tr>
<tr>
<td>Pump house -PLC</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Switch yard</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Work shop building(mech)</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>DM plant</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Ware house</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Security building</td>
<td>6</td>
<td>2</td>
<td>12</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Energy meter room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>Nox panel</td>
<td>2</td>
<td>1.5</td>
<td>3</td>
<td>window</td>
<td>VOLTAS</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>29</strong></td>
<td></td>
<td><strong>94</strong></td>
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</table>
### Technical Diary - Offshore

<table>
<thead>
<tr>
<th>Location</th>
<th>Total no</th>
<th>Each capacity</th>
<th>Total capacity in TR</th>
<th>Type</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Barge I &amp; C room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>2 Gas skid</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>3 MCC room</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>4 6.6 kv room</td>
<td>3</td>
<td>2</td>
<td>6</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>5 O &amp; M building server room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>6 Naptha enclosures</td>
<td>4</td>
<td>2</td>
<td>8</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>7 Battery bank room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>8 Ware house office room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>9 DM plant office room</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td>10 Work shop (elec &amp; inst)</td>
<td>2</td>
<td>2</td>
<td>4</td>
<td>split</td>
<td>VOLTAS</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>18</strong></td>
<td></td>
<td><strong>36</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### O& M Building

<table>
<thead>
<tr>
<th>Location</th>
<th>Total no</th>
<th>Each capacity</th>
<th>Total capacity in TR</th>
<th>Type</th>
<th>Make</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 Ground floor</td>
<td>5</td>
<td>5.5</td>
<td>5.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>17</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>5.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>17</td>
<td>17</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td>2 1st floor</td>
<td>5</td>
<td>8.5</td>
<td>8.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>5.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.5</td>
<td>8.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>5.5</td>
<td>5.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td></td>
<td></td>
<td>8.5</td>
<td>8.5</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td>3 2nd floor</td>
<td>1</td>
<td>17</td>
<td>17</td>
<td>CENTRALIZED</td>
<td>CARRIER</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>98.5</strong></td>
<td></td>
<td><strong>98.5</strong></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
**M. BLACK START DG SET**

Black start DG set is a diesel engine driven generating unit. This is used for plant start up and auxiliary supply during grid failure leading to complete plant blank out. The unit is connected to 415 V CMCC 1 and supplies power to CMCC 1 and CMCC 2 through bus tie. There is a facility to extend power supply to onshore 415 V MCC for DM plant, Fuel Handling and plant lighting load.

<table>
<thead>
<tr>
<th>Rating</th>
<th>1500 KW, 415 V, 1500 rpm, 50 HZ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manufacturer</td>
<td>Mitsubishi</td>
</tr>
<tr>
<td><strong>Diesel Engine</strong></td>
<td></td>
</tr>
<tr>
<td>Model</td>
<td>S16R – PTA</td>
</tr>
<tr>
<td>Type</td>
<td>Four cycle, water cooled, turbo charged</td>
</tr>
<tr>
<td>Output</td>
<td>Standby 2131 HP</td>
</tr>
<tr>
<td>No of cylinders</td>
<td>V – 16 cylinders</td>
</tr>
<tr>
<td>Speed</td>
<td>1500 rpm</td>
</tr>
<tr>
<td>Bore x Stroke</td>
<td>170 mm X 180 mm</td>
</tr>
<tr>
<td>Displacement</td>
<td>65.37 litre</td>
</tr>
<tr>
<td>Compression ratio</td>
<td>14.0: 1</td>
</tr>
<tr>
<td>Break mean effective pr</td>
<td>20.2 Kg/cm²</td>
</tr>
<tr>
<td>Rotating direction</td>
<td>Counter clockwise (flywheel side)</td>
</tr>
</tbody>
</table>
Gas Turbine Control System

GE has provided many gas turbines to many customers with Simplex and Redundant gas turbine control systems which have been produced by Woodward.

Micro Net plus is the gas turbine control system which was supplied by GE. It is the latest in long line of electronic control system platform used to perform speed, load and process control for all types of prime movers. The standard Micro Net I/O modules are available to build up a custom control system for any type or any size of application.

The Micro Net plus control system is a flexible, state-of-the-art digital control System designed specifically for prime mover control applications such as:

- Gas Turbine control
- Steam Turbine control
- Hydro Turbine control
- Diesel and Gas Engine control

System Features

Micro Net control system consists of Hardware and software parts:

**Hardware parts:**
- Chassis and slots
- Power supply units
- Motorola CPU5200 Processor
- HMI (Human machine Interface)
- I/O modules and FTM’s (Field Termination Modules)
- Fibre-optic switch
- RIO – Remote I/O Panel
- LIO – Local I/O Panel

**Software Parts:**
- GAP – Graphical Application Program
- Watch windows
- Coder
- Application Manager
- Servlink OPC server
- Control Assistant
O. PLANT FIRE FIGHTING SYSTEM

The plant fire protection system consist of hydrant system, high velocity water spray system for transformers, fire detection and alarm system, CO2 fire fighting system for rack room and control room and portable extinguishers. The system is designed by M/S Agni Heavy Engineering Limited. Addressable Fire protection & detection system of Notifier is provided for entire Barge and semi addressable for remaining part of the Plant.

Emergency Fire Pump

Make : Kirloskar Brothers limited
Model : 6 UP4
Capacity : 273 m3/hr
Total head : 70 m WC
Shutoff head : 72 m WC
Power required at duty point : 76.57 KW
Efficiency : 70%
Recommended minimum flow : 100 m3/hr
NPSH required : 3.5 m
Type of cooling : Self cooling
Type of lubrication : Grease
Type of pump : Horizontal split casing centrifugal pump
No of stages : Single
Type of coupling : Spider coupling
Direction of rotation from driving end : Clockwise

Diesel engine
Manufacturer : Cummins India Limited
Type : Mechanical (Air less) direct injection, 4 Stroke cycle and cold starting type, Turbo Charged
Model : NT-495-F1
Design standard : BS:5514
No of cylinders : 4
RPM : 1500
BHP at rated rpm : 127 BHP
Engine starting details : 24 V electrical start
Fuel consumption : 25 litre / hr
Fuel consumption at 150 % of rated : 31 litre / hr
Type of cooling : Water cooled with heat exchanger
Fuel tank capacity : 200 litre
Battery : 4 X 12 V – 180 ah capacity
## P. START UP VACUUM SYSTEM

### Start-up Vacuum Pump
- **Manufacturer**: NASH KOREA
- **Type**: Liquid Ring
- **Quantity**: 1
- **Hogging capacity at 10 inch HgA**: 595 Sm³/hr
- **Evacuation volume**: 450 m³
- **Hogging suction pressure**: 254 mm HgA
- **Suction temperature**: 33 deg.c
- **BHP**: 42 KW
- **No of stage**: 1
- **Speed**: 590 rpm
- **Hogging time required to reduce suction pr from atmosphere pr to 254 mm HgA**: 20 min
- **Discharge pr**: Atmospheric
- **Material of construction –**
  - **Casing**: A48
  - **Shaft**: KSD 3752 SM45C (EQ. A576)
  - **Rotor**: A536
  - **Pump direction of rotation**: C.W from driver end
  - **No of bearings**: 2
  - **Type of bearing**: Roller
  - **Type of lubrication**: Grease
  - **Pump-Motor coupling**: Flexible
  - **Seal water requirement –**
    - **Flow**: 7.95 m³/hr
    - **Temperature**: 35 deg.c

### Moisture separator
- **Dimension**: O.D 390 mm X 1375 mm H
- **Material**: KSD 3503 (EQ. A283)

### Silencer
- **Size**: O.D 460 mm X 1830 mm H
- **Type**: Vertical
- **Material**: KSD 3503 (EQ. A283)

### Motor
- **Rating**: 45 KW
- **Poles**: 10 poles
- **Rotor Type**: Squirrel Cage
- **Enclosure**: Totally enclosed
- **Cooling method**: Fan cooled
- **Frequency**: 50 HZ
- **Phase**: 3
- **Insulation class**: F
- **Temperature rise at full load**: 90 deg.c
- **Voltage**: 415 V
- **No load current**: 75 A
Full load current 113 A  
Starting current 670 A  
Speed 590 rpm  
Efficiency –  
At 1/2 load 85 %  
At 3/4 load 87.5 %  
At full load 88 %  
Power Factor –  
At 1/2 load 54 %  
At 3/4 load 60 %  
At full load 63 %  

Q. STEAM TURBINE DEAERATING CONDENSER

Heat duty at rated condition 473800000 KJ/hr  
Heat duty at HP/HP bypass valve operation 669700000 KJ/hr  
Maximum dissolved oxygen content 7 ppb  
Condenser pressure 0.077 bara  
Condensate temperature 40.8 deg.c  
Manufacturer HHI  
Quantity 1  
Applied design code HEI  
Operating life 30 years  
Reference condition –  
Barometric pressure 1.004 bara  
Relative Humidity 75 %  
Ambient air temp 31 deg.c  
Cooling water temp (sea water) 29 deg.c  
Maximum makeup water 30 m3/hr  
Type Deaerating condenser  
Hotwell capacity –  
From normal level to low level 3 minutes  
From normal level to bottom 5 minutes  
No of passes 2  

Performance at rated condition  
LP turbine exhaust –  
Flow 225619 m3/hr  
Enthalpy 2266.7 KJ/Kg  
Gland steam condenser drain –  
Flow 245 Kg/hr  
Enthalpy 196.2 KJ/Kg  
Steam Jet air ejector drain –  
Flow 300 Kg.hr  
Enthalpy 193.5 KJ/Kg  
Condensate leaving condenser –  
Flow 226164 Kg/hr  
Enthalpy 170.8 KJ/Kg  
Temperature 40.8 deg.c
Pressure: 0.077 bara

Circulating water –

Inlet temperature: 29 deg.c
Temperature rise: 8 deg.c
Inlet pr: 2.2 bara
Flow: 14565 m3/hr
Specific gravity: 1.02
Head Loss: 4.5 m

Performance at 100 % bypass

HP bypass –
Flow: 194040 Kg/hr
Enthalpy: 2770.9 KJ/Kg
Temperature: 162 deg.c
Pressure: 5 bara

LP bypass –
Flow: 65812 Kg/hr
Enthalpy: 2745.3 KJ/Kg
Temperature: 143 deg.c
Pressure: 3 bara

Condenser neck spray from CEP outlet –
Flow: 5983 Kg/hr
Enthalpy: 191.2 KJ/Kg

Condensate leaving condenser –
Flow: 266236 Kg/hr
Enthalpy: 191.3 KJ/Kg
Temperature: 45.7 deg.c
Pressure: 0.0993 bara
Cooling water inlet temp: 29 deg.c
Cooling water outlet temp: 40.3 deg.c

Tubing
Diameter: 25.4 mm
Thickness mm (BWG): 0.5 (25), 0.7 (22)
Effective surface area: 5137 m2 (5292 m2)
No of tubes: 7852 (8088)
- 25 BWG: 7952
- 22 BWG: 136
Effective length: 8200 mm
Tube velocity: 2.2 m/s
Cleanliness factor: 0.9
Water box velocity (inlet): 1.964 m/s