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SECTION 1. DESIGN BASIS

1.1 GENERAL

This specification is intended to cover the specific requirements for design, furnishing, commissioning at site, on an EP + Comm. (Engineering, Procurement and Commissioning) basis for the MDU (Main Diesel Unit) with unit capacity of 1.4MW. All the unit will be installed in the individual 40 feet - container and 8 (eight) units are to be supplied for the containerized power plant having the generation capacity of about 11 MW with Heavy Fuel Oil (HFO) Firing.

1.2 INTRODUCTION OF THE PLANT

The power plant will containerized type and is to be designed by the Purchaser and Main Generating sets are to be designed and supplied by STX while other Balance of Plant (BOP) are to be designed, procured, supplied, installed, commissioned by the Purchaser. At the initial stage, the plant will consist of eight units of MDU with HFO firing for power generation of about 11MW and may be extended in accordance with power demand in the future.

1.3 DESIGN AND CONSTRUCTION

All design related to the power plant is based on simplicity and reliability. Repair and normal maintenance may be performed by means of general tools and special tools, to be supplied by supplier.

The equipment is designed to prevent from accidental contact with live or from dangerous parts and to minimize ingress of dust and dirt.
The equipment will be designed in accordance with the contract and Supplier's standards for modern design, engineering and production and all identical parts of the power plant are interchangeable.

1.4 UNITS AND LANGUAGE

The SI unit for measurement of weights, measures and dimensions will be used in all technical documents including drawings, but only pressure unit will be shown as "bar".
All technical documents including drawing, operating & maintenance manuals, caution plate and name plate will be written in English.

1.5 STANDARDS AND REGULATION

All materials, design, manufacturing, factory test and inspection of the equipment will be executed with the following standards.

- KS, Korean Industrial Standards
- JIS, Japanese Industrial Standards
- ISO, International Organization for Standardization
- IEC, Standards of International Electro technical Committees
- NEMA, National Electrical Manufacture's Association
- Supplier's Standards

1.6 MATERIALS AND WORKMANSHIP

Materials to be used for manufacturing the equipment will be of good quality under the strict quality control and free from defects and be suitable for the purpose.
The workmanship to be executed for manufacturing the equipment will be of significant grade and in accordance with the modern process.

1.7 PAINTINGS

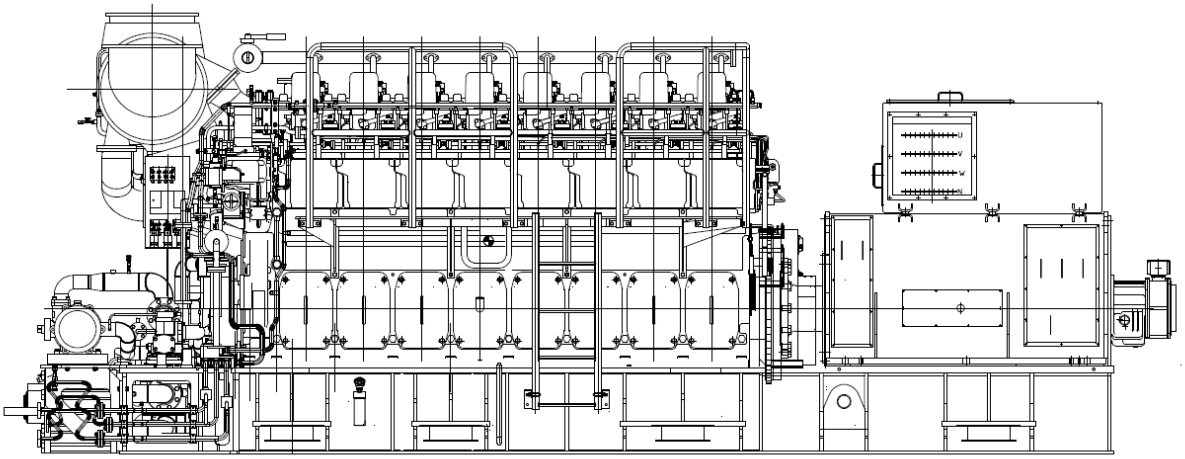
All casting surface will be coated with anticorrosive paint in accordance with supplier's standards. But some of specific part of Auxiliary equipment may be painted with manufacturer’s standard color.

The finished color of exterior surface for the equipment is as below.

- Generator sets	Munsell No. 2.5 G 7/2
- Auxiliary Equipment	Munsell No. 2.5 G 7/2
- Electrical Equipment	Munsell No. 5Y 7/1
- Exhaust Line	Silver Gray

SECTION 2. MAIN DIESEL UNIT (MDU) FOR POWER GENERATION

2.1 MDU DESIGN CONDITIONS



The above illustration shows STX engine and generator arrangement with direct coupling and to be installed on the common bed.

The power generation unit will be designed and constructed for the output 1,400KWe at each generator terminal at the following conditions(ISO condition) and the output will be limited as per site actual ambient temperature conditions;

- Ambient air temperature	25 °C
- Altitude	110 m above sea level (1000 mbar)
- Water temperature to charge air cooler	25 °C

2.1.1 Designed Fuel oil consumption and Generator output

This figure is based on PF 1.0 at shop test.

- 100 % load (1,415 kWe***)	208.0 g/kWe.h + 5% tolerance***
- 75 % load (1,059 kWe)	215.8 g/kWe.h + 5% tolerance (for reference)
- 50 % load (699 kWe)	241.5 g/kWe.h + 5% tolerance (for reference)

The specific fuel consumption is referred to the power at the generator terminal at above conditions with tolerances of +5% and with a fuel lower calorific value of 42,700 kJ/kg excluding leakage and/or treatment losses in the process.

Notes :

1) Performance values of generator output and fuel oil consumption marked by *** are to be guaranteed and confirmed through the shop test with load bank (1.0 Power factor) as a final acceptance test

2) Site performance data which are de-rated from the designed ones as per site conditions such as ambient temperature, altitude, cooling water temperature to charge air cooler and generator power factor are to be verified through the performance test at Site.

2.1.1.1 Fuel consumption calculation for ISO condition

Specific Fuel Oil Consumption

8L22HLX x 900 rpm 2012-03-20

LOAD	100%	75%	50%	REMARKS
Engine ISO power rating, kWm	1,480	1,110	740	
Engine SITE power rating, kWm	1,480	1,110	740	Amb. temp : 25 ℃
Generator terminal output, kWe	1,415	1,059	699	
SFOC, g/kWm.h	198.1	204.8	226.7	ISO Condition without tolerance + 5%
A. Site condition				
β : Adjustment factor of fuel consumptio	1.0000	1.0000	1.0000	
SFOC(A), g/kWm.h	198.1	204.8	226.7	SFOC(A) = SFOC x β
B. Built on Engine driven pump				
- F.O Feed pump (p1)	0.00	0.00	0.00	0.8 g/kWm.h
- L.O pump (p2)	0.00	0.00	0.00	0.8 g/kWm.h
- H.T cooling water pump (p3)	0.80	1.07	1.60	0.8 g/kWm.h
- L.T cooling water pump (P4)	0.00	0.00	0.00	N/A
P : Increase of specific fuel consumption	0.80	1.07	1.60	P = p1+p2+p3+p4
SFOC(B), g/kWm.h	198.9	205.8	228.3	SFOC(B) = SFOC(A) + P
C. Low calorific value				
- 42700/LCV = λ	1.00	1.00	1.00	LCV = 42700 kcal/kg
SFOC(C), g/kWm.h	198.9	205.8	228.3	SFOC(C) = SFOC(B) x λ
D. Genertor terminal				
- Generator efficiency (%), η	95.6	95.4	94.5	Expected
SFOC(D), g/kWe.h	208.0	215.8	241.5	SFOC(D) = SFOC(C) / η
E. Tolerance (to be guaranteed)				
- Tolerance (5%)	1.05	1.05	1.05	
SFOC(E), g/kWe.h	218.4	226.5	253.6	SFOC(E) = SFOC(D) x tolerance (5%)

2.1.1.2 Power calculation for ISO condition

ADJUSTMENT OF POWER AND FUEL OIL CONSUMPTION FOR AMBIENT CONDITIONS

1. Power Adjustment Factor

When the power at site is adjusted from the Niigata's Standard Conditions, adjust the power by using ISO formulae (refer ISO 3046-I), and then a final power adjustment power factor can be obtained by multiplying to the ISO based power adjustment factor ,

2. Calculation Method

Site conditions

Ambient temperature	Tx :	25	°C	298 K
Cooling water temperature at air cooler inlet	Tcx: :	25	°C	298 K
Altitude (above sea level)	Px :	110	m	750.137 mmHg

$Px = 760 \times (1 - 22.57 \times 10^{-6} \times H)^{5.255}$ H : Altitude (m)

2-1. Power Adjustment Factor at Site

Where;

$K = (Px/Pr)^m \times (Tr/Tx)^n \times (Tcr/Tcx)^q$

$= (Px/750)^{0.7} \times (298/Tx)^{1.2} \times (298/Tcx)^{1.0}$ = 1.0001

$\alpha = K - 0.7 \times (1 - K) \times (1/\eta_m - 1)$ = 1.0001

$A = 1.093 \times \alpha$ = 1.000

α : ISO base power adjustment factor
A : Final power adjustment factor
K : Ratio of indicated power
P : Barometric pressure (mmHg)
T : Absolute air temperature
Tc : Absolute charge air coolant temperature
η_m : Mechanical efficiency (= 0.9)

* Eng. Output (ISO)	1,480	kWm
* Eng. Output (Site)	1,480	kWm
* Gen. Efficiency	95.60	%
* Gen. Output	1,415	kWe
* Gen. Q'ty	8	Sets
* Gross power	11.32	Mwe
* SFOC (Site)	208.0	g/kWe.h

Subscript "r" means values under the standard reference conditions
Subscript "x" means values under the conditions being considered

Pr =	750 mmHg	
Tr =	298 K	(= 25 °C)
Tcr =	298 K	(= 25 °C)

2-2. Adjustment Factor of Fuel Consumption

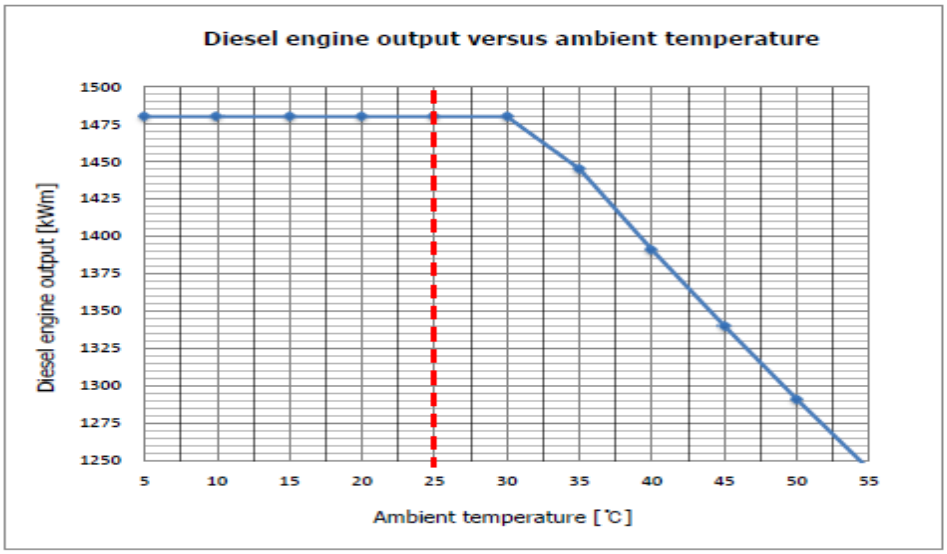
When the engine is operated under the site conditions different from ISO standard reference conditions, the specific fuel consumption shall be adjusted from that given on ISO base and recalculated with the following formulae.

$\beta = K/\alpha$ = 1.0000

β : Adjustment factor of fuel consumption

2.1.1.3 Derating curve as per site condition

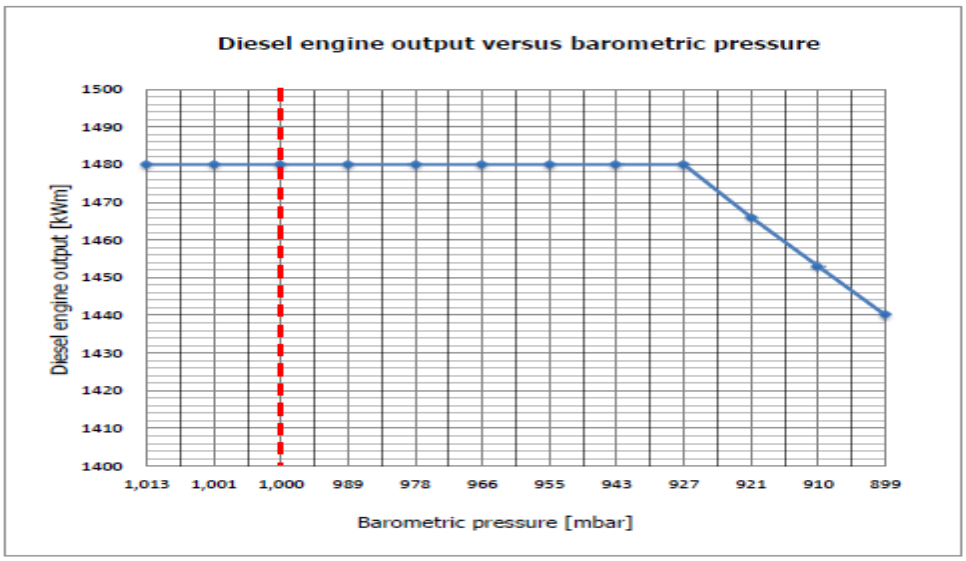
1. DIESEL ENGINE OUTPUT VERSUS AMBIENT TEMPERATURE



▶**NOTE**

1. The correction curve based on the following design condition present the engine output changes accroding to ambient temperature changes.
2. Design condition
   - Ambient temperature : According to ambient temperature changes
   - Barometric pressure : 1000 mbar
   - Cooling water to charge air cooler : ΔT = 10 ℃ (Temp. diff. btw. ambient & cooling water)
   - Engine load : 100 %

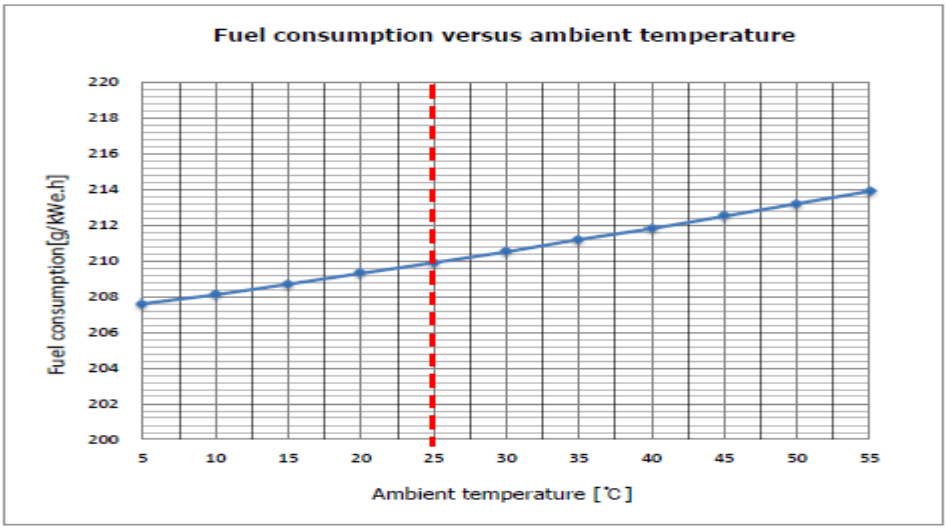
2. DIESEL ENGINE OUTPUT VERSUS BAROMETRIC PRESSURE



▶**NOTE**

1. The correction curve based on the following design condition present the engine output changes accroding to barometric pressure changes.
2. Design condition
   - Ambient temperature : 25 ℃
   - Barometric pressure : According to barometric pressure changes
   - Cooling water to charge air cooler : ΔT = 10 ℃ (Temp. diff. btw. ambient & cooling water)
   - Engine load : 100 %

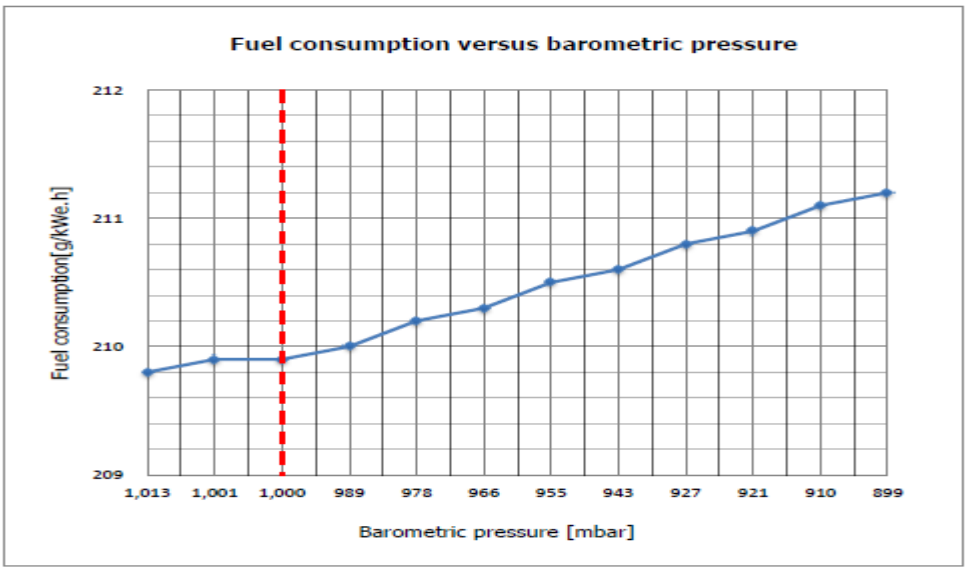
3. FUEL CONSUMPTION VERSUS AMBIENT TEMPERATURE



▶NOTE

1. The correction curve based on the following design condition present the fuel(HFO) consumption changes accroding to ambient temperature changes.
2. Design condition
   - Ambient temperature : According to ambient temperature changes
   - Barometric pressure : 1000 mbar
   - Cooling water to charge air cooler : ΔT = 10 ℃ (Temp. diff. btw. ambient & cooling water)
   - Engine load : 100 %
3. Tolerance of 5% was not included.

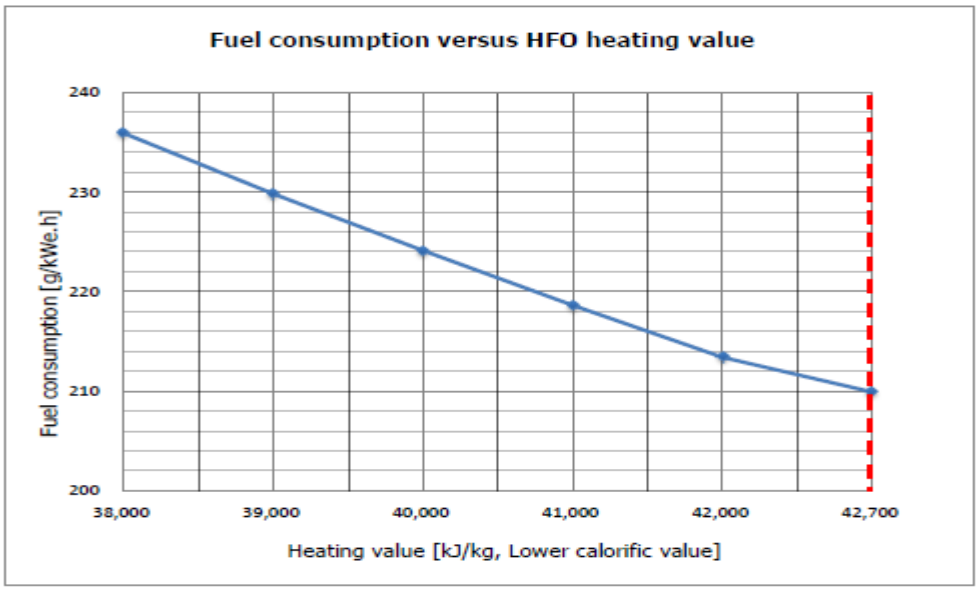
4. FUEL CONSUMPTION VERSUS BAROMETRIC PRESSURE



▶NOTE

1. The correction curve based on the following design condition present the fuel(HFO) consumption changes accroding to barometric pressure changes.
2. Design condition
   - Ambient temperature : 25 ℃
   - Barometric pressure : According to barometric pressure changes
   - Cooling water to charge air cooler : ΔT = 10 ℃ (Temp. diff. btw. ambient & cooling water)
   - Engine load : 100 %
3. Tolerance of 5% was not included.

5. FUEL CONSUMPTION VERSUS HFO HEATING VALUE



▶**NOTE**

1. The correction curve based on the following design condition present the fuel(HFO) consumption changes accroding to fuel heating value(Lower calorific value) changes.
2. Design condition
   - Ambient temperature : 25 ℃
   - Barometric pressure : 1000 mbar
   - Cooling water to charge air cooler : ΔT = 10 ℃ (Temp. diff. btw. ambient & cooling water)
   - Generator efficiency : 94.6 % at 100 % engine load
   - Engine load : 100 %
   - Fuel net calorific value (HFO) : According to fuel heating value changes
3. The fuel consumption was calculated as g/kWh at the generator terminal.
4. Tolerance of 5% was not included.

2.1.2 Lubricating oil consumption

The specific lube oil consumption is 1.0 g/ kWm·h + 10% tolerance at the rated output (1,400 kWe) after total running time of 500 ~ 700 hours of the Genset. This specific lube oil consumtion is based on the use of recommended lube oil, net consumption excluding leakage and treated losses. At the initial stage of operation of new genet, more lubricating oil than specified above may be consumed.

2.1.3 Limitation for Operating Medias

The engines are designed and developed for continuous operation on operation media as described below. Note, that those are extreme limits for STX engines. More detailed information about actually used operation media can be found under each system description in the O&M manual of the engine.

2.1.3.1 Fuel oil

The diesel engine is designed and developed for continuous operation using Diesel oil / Heavy Fuel Oil as a fuel in accordance with the following Fuel oil specifications.

1) Guidance value of Diesel Oil (DO)

Property	Unit	Guidance value
Viscosity at 38℃	cSt	2.0 ~ 5.8
Density at 15℃	kg/m^3	831 ~ 900
Flash point	℃	min. 50
Ash	wt %	max. 0.01
Sulphur	wt %	max. 0.4
Water	vol %	max. 0.01

2) Guidance value of Heavy Fuel Oil (HFO)

Property	Unit	Guidance value
Viscosity at 50℃	cSt	max. 700
Density at 15℃	kg/m^3	max. 991
Flash point	℃	min. 60
Carbon residue	wt %	max. 15
Asphalt	wt %	max. 10
Sulphur	wt %	max. 3.5
Water	vol %	max. 1.0
Ash	wt %	max. 0.15
Aluminium	ppm	zero
Vanadium	ppm	max. 300
Sodium	ppm	max. 20% of vanadium content

2.1.3.2 Lubricating oil

Only lubricants approved by STX are allowed to use.
The properties of lubricating oil (SAE40) must stay within the following limits.

Property	Unit	Guidance value
Viscosity at 40 ℃	cSt	max. 145
Viscosity at 100 ℃	cSt	max. 15
Total Base No.	mg KOH/g	20 ~ 30
Water	vol %	max. 0.3
Flash point	℃	min. 160

2.1.3.3 Cooling water

It is strongly recommended that treated water be used as cooling water within the following limits.

Property	Unit	Guidance value
PH at 20℃	PH	6 ~ 8.5 (max. 10)
Total hardness	ppm	0 ~ 100 as $CaCo_3$ (max. 80)
Chloride ion (Cl^-)	ppm	max. 100
Sulfate ion (SO_4^{2})	ppm	max. 150
Silicate (SiO_2)	ppm	max. 50
Chlorine	ppm	max. 10
Conductivity at 25℃	μS/cm	40 ~ 200 (max. 400)

2.2 ENGINE

2.2.1 Design

The proposed STX- Niigata 8L22HLX engine is four stroke, direct injected, turbocharged and intercooled design.
Engine shaft output corresponds to 100 % load of the engine at ISO 3046/I-1995(E) conditions.

The engine is designed for continuous heavy fuel duty and can be started and stopped on heavy fuel oil provided that the fuel is treated and heated to operating temperature.

2.2.2 Engine specification

■ Model	:	8L22HLX
■ Type	:	Vertical In-line 4-cycle diesel engines
■ Combustion System	:	Direct Injection
■ Number of cylinders	:	8
■ Cylinder bore	:	220 mm
■ Stroke	:	300 mm
■ Speed	:	900 rpm
■ Compression ratio	:	15.58
■ Rated piston speed	:	9.6 m/s
■ Maximum combustion pressure	:	20.4 Mpa
■ Direction of rotation	:	Clockwise viewing from flywheel end
■ Starting System	:	Air over piston
■ Cooling System	:	Fresh-water cooling
■ Lube oil system	:	Wet type common bed
■ Turning System	:	Ratchet handle system
■ Turbocharger system	:	Constant Pressure System

2.2.3 Mechanical auxiliary System for the Engine

The proper function of the DG-set is dependent on the mechanical auxiliary systems. The proposed systems have been optimised for the this particular plant. The function of the systems is to provide the engine with fuel, lubricating oil, starting air, cooling water and charge air at required quantity and quality as well as to dispose of exhaust gases in a proper manner.

2.2.3.1 Lube oil system

The lubricating oil is supplied through the treatment process and supply process in accordance with their requirement, after purifying, clean lube oil is supplied by engine driven pump from the sump tank.

The system includes the following items.

1) Lube oil pump
   - Q'ty : 1 / MDU
   - Capacity : $45m^3/h$ x 7.8 bar
   - Type : Engine driven

2) Lube oil priming pump
   - Q'ty : 1 / MDU
   - Capacity : 8.08 m^3/h x 3 bar
   - Type : Motor driven

3) Lube oil cooler
   - Q'ty : 1 / MDU
   - Type : Plate type

4) Temperature control valve
   - Q'ty : 1 / MDU
   - Type : Wax element 3-way type

5) Lube oil main filter
   - Q'ty : 1 / MDU
   - Type : Duplex manual type, abs. 10~15㎛

6) Lube oil pressure regulating vlave

- Q'ty	:	1 / MDU
- Capacity	:	50A

2.2.3.2 Cooling water system

The system is designed for cooling of cylinder jackets, air cooler and lube oil cooler. The H.T cooling water circuit is for cooling of cylinder jackets and the L.T cooling water circuit is for cooling of charge air cooler and lube oil cooler.

The system includes the following items.

1) H.T cooling water pump

- Q'ty	:	1 / MDU
- Capacity	:	54 m3/h x 3 bar
- Type	:	Engine driven

2) H.T thermostatic 3-way valve

- Q'ty	:	1 / MDU
- Type	:	Wax element type, DN 65

3) L.T cooling water pump

- Q'ty	:	1 / AEU
- Capacity	:	100 m3/h x 3 bar
- Type	:	Motor driven

4) Radiator

- Q'ty	:	1 / AEU
- Type	:	HT/LT combined type
- accessories	:	HT/LT expansion tank

2.1.3.3 Starting air and control air system

The engine is directly started by compressed air through starting air valve on each cylinder. A main starting valve is placed in the engine inlet line. As the starting solenoid valve is energized by the signal of engine starting, compressed air with pressure of 30 bar is delivered to starting mechanism of the engine through the pipeline of DN20.
A control air with the pressure of 9 bar is delivered to the control system through the pipeline of DN6

The system consists of following items.

1) Sol. valve panel
- Q'ty : 1 / MDU

2) Main starting valve & Y-strainer
- Q'ty : 1 / MDU

2.2.3.4 Intake & Exhaust gas system

The intake air is led into each cylinder through dry type air filter and through charge air cooler from atmosphere. The exhaust gas from each cylinder is gathered into exhaust gas manifold to drive turbocharger, and is discharged to atmosphere through vertical type of exhaust gas silencer.

The system consists of following items.

1) Intake air filter
- Q'ty : 1 / AEU
- Type : Dry type

2) Expansion joint(450A)
- Q'ty : 1 / MDU
- Type : T/C outlet

3) Transit piece
- Q'ty : 1 / MDU

4) Exhaust gas silencer(450A)

- Q'ty	:	1 / AEU
- Size	:	DN 450
- Type	:	25 dB(A) damp

2.3 GENERATOR

2.3.1 Design and construction

The generator will be provided with three-phase, brushless, self ventilating and drip proof design with self-regulating AC exciter by means of rotating rectifiers. And the generator will be suitable for continuous operation.

2.3.2 Technical data

■ Rating	:	1,750 kVA
■ Output	:	1,400 kW
■ Power factor	:	0.8 Lagging
■ Voltage	:	480 V
■ Current	:	2105.0 A
■ Frequency / speed	:	60 Hz / 900rpm
■ Poles	:	8 poles
■ Connection	:	3 phase, 4 wire
■ Insulation / Temp. Class	:	F/F
■ Enclosure	:	IP23
■ Bearings	:	Sleeve bearing
■ Standards	:	NEMA MG1, IEC 60034-1, IEC 60034-5, IEC 60034-6, ISO 8528

2.3.3 Mechanical Specification

2.3.3.1 Construction

The generators are rotating-field machines in which the cylindrical rotor carrying the D.C-excited field winding and the damper winding rotates inside the stator which carries the A.C output winding. The generators incorporate exciter and rotating rectifiers mounted on the shaft, which provide the excitation current for the main machine.

2.3.3.2 Degree of protection

The generator enclosure is designed to comply with degree of protection IP23 (IEC34-5)

2.3.3.3 Cooling

The cooling of the internally-ventilated generators is in accordance with EC34-6(IC01)
A fan at the drive end draws the cooling air axially through the machine.

2.3.3.4 Type of construction

B16 with insulated single sleeve bearings.

2.3.3.5 BEARING

Insulated Sleeve bearings.

2.3.3.6 LUBRICATION

Self lubrication

2.3.3.7 SPEED AND DIRECTION OF ROTATION

The nominal frequency is produced at the rated speed. Unless otherwise stated a speed rise of 5% when the load reduced from the rated value to zero will be assumed. Direction of rotation is counter clockwise (C.C.W) viewed from drive end.

2.3.3.8 MAIN TERMINAL BOX FOR HIGH VOLTAGE POWER

Degree of protection	:	IP54
4 leads wired out	:	U, V, W, N

Terminal box is located on the right side when viewed from drive end.

2.3.3.9 ANTI-CONDENSATION HEATER

Generator will be provided with AC 220V heater to prevent condensation when the machine is shut down. Heater will be arranged to provide even distribution of heat

2.3.10 OVERSPEED STRENGTH

The generator will be free from mechanical faults when operated at 120% of rated speed for 2 minutes under no load and non excited condition.

2.3.4 ELECTRICAL SPECIFICATION

2.3.4.1 INSULATION

Class F insulation is used as a standard feature for the generator.
This protects the winding against corrosive gas, vapor, dust and oil.

2.3.4.2 STATOR WINDING

The three phase stator winding is the double-layer type and star connection.
The four stator lead ends U, V, W,N and exciter pole connection＋F1 and －F2, are brought out to the cable Connection box.

2.3.4.3 ROTOR WINDING

The rotor winding is designed as a coil winding in the slots of the cylindrical rotor.
The generator is fitted with a damper winding, i.e. a cage of bars connected by rings, which lies in special slots in the rotor.

2.3.4.4 EXCITING SYSTEM

Self-exciting brushless system with rotary exciter mounted on the generator frame.

2.3.4.5 VOLTAGE ADJUSTMENT

The rated voltage can be adjusted with ± 10% at no-load and with ± 5% at full-load using mounting reference value setter when the power factor is between 0.8 and 1

2.3.4.6 STEADY-STATE VOLTAGE VARIATION

Throughout the range from no-load to rated load at rated power factor and rated speed with nominal excitation control system including an A.V.R., the voltage variation and steady condition is within ±1.0% of the rated voltage.

2.3.4.7 INSTANTANEOUS VOLTAGE VARIATION

With a load corresponding to 50%(power factor: less than 0.4) of rated current applied at rated voltage and frequency, the instantaneous voltage variation factor will be less than 20% and will be restored to +/-3% of the final voltage with 2 seconds.

2.1.3.4.8 EFFICIENCY

The efficiency allows for the total losses in the generator, including those of the field winding and excitation system. The values at rated output will be over 94.6% at 0.8 power factor.

2.3.4.9 TEMPERATURE RISE

Temperature rise at full load and rated power factor.

1) Stator coils : Not to exceed 105K by resistance method.

2) Rotor coils : Not to exceed 110K by resistance method.

Temperature rise is based on intake air not exceeding 40K and altitude 0 m above mean sea level 1013.3 mbar in accordance with IEC 60034-1

2.3.4.10 Voltage regulation

Voltage adjustment range with automatic voltage regulator in the range no-load to full load at the rated power factor during individual operation is ±5%.

For control of the reactive current at parallel operation the voltage drop between no-load to full load can be adjusted to ±5 % of the rated voltage under steady state conditions, and in automatic mode.

The generator, when driven at rated speed and when given the rated voltage on no-load under the control of excitation and voltage regulating system, is switched on to a symmetrical load which absorb 50 % of rated current at rated voltage, at a power factor between 0.4 and zero lagging

2.3.4.11 Accessories

Terminal box, enclosure IP54.

Generator terminal box will be provided with the main and auxiliary terminal points for connection of external cables.

AVR and exciter power supply unit will be installed at generator control panel

2.4 COMMON BED AND FOUNDATION BLOCK

The proposed STX-Niigata engine and generator are placed on a steel fabrication common bed which is mounted on the container foundation on a basis of elastic mounting. The common bed and associated foundation bolts will be supplied by STX.

2.5 GENSET COUPLING

The Genset will be directly coupled with engine flywheel and generator shaft flange. Single generator bearing will be applied.

2.6 ENCLOSURE

The CPP applies the compact design with a container type for the enclosure.

The Enclosure for MDU (Main Diesel Unit)

1) Enclosure for MDU
   - Q'ty : 1/MDU
   - Enclosure : 40 feet (with sound attenuator)
   - Chain block : for maintenance
   - Fire extinguisher : Portable
   - Miscellaneous
   - Module work

2) Enclosure for AEU
   - Q'ty : 1/AEU
   - Enclosure : 40 feet (with sound attenuator)
   - Chain block : for maintenance
   - Fire extinguisher : Portable
   - Miscellaneous
   - Module work

SECTION 3. ELECTRICAL SYSTEM FOR MDU

3.1 General

A Generator Breaker and a low voltage distribution panel are to be provided for MDU as follows:

3.2 Standards and Regulation

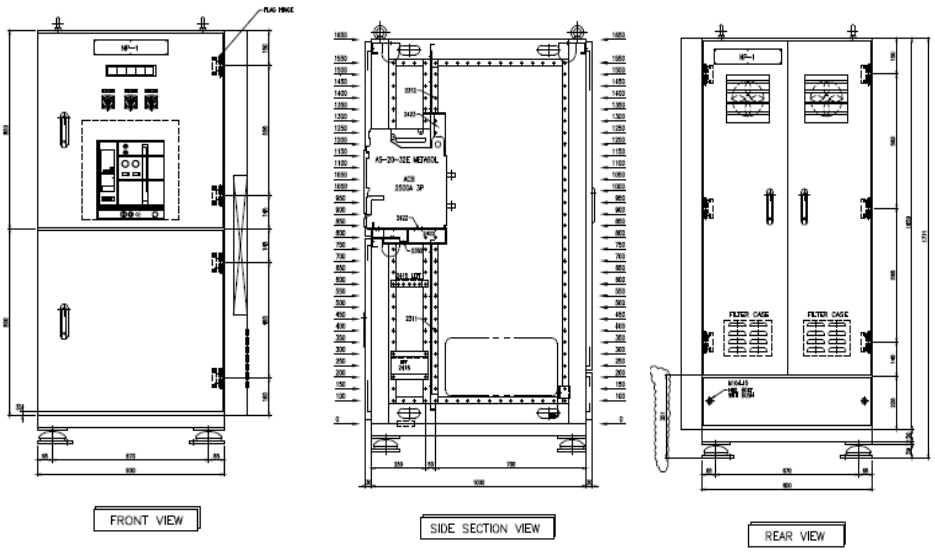
All materials, design, manufacturing, factory test and inspection of the equipment will be executed with the following standards.

- IEC, Standards of International Electro technical Committees
- NEMA, National Electrical Manufacturers Association
- ISO, International Organization for Standardization
- Manufacturer's Standards

3.3 Generator Breaker

- Type	:	Air Circuit Breaker (ACB)
- Rated voltage	:	690 V
- Rated current	:	2500 A
- Control voltage for ACB closing	:	DC24 V linked with AC 220V
- Control voltage for ACB trip	:	DC 24V

3.4 LV Distribution Panel



*. The control panel arrangement can be changed by design value.

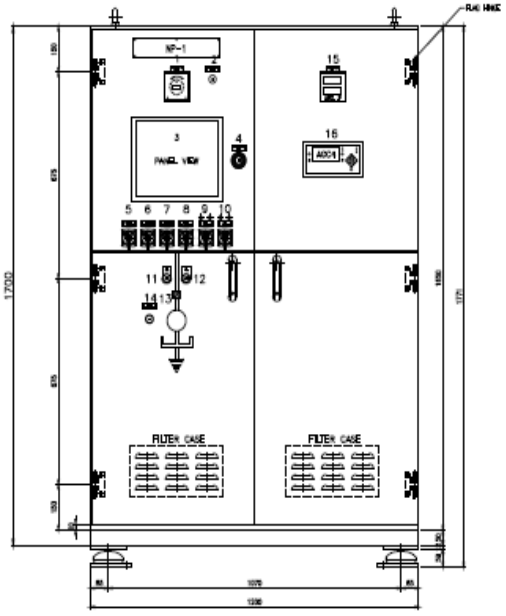
Electrical Data will be as follows:

ITEM	Value
Electrical Network Frequency	60 Hz ± 5%
L.V. Electrical Distribution Network(3ph)	480 VAC ± 10%
Control Voltage for Engine	24 VDC ± 10%, AC 220V
Control Source for MCC, actuator	24 VDC ± 10%
Solenoid Valve Voltage	24 dc± 10%

3.4 CONTROL AND MONITORING OF MDU

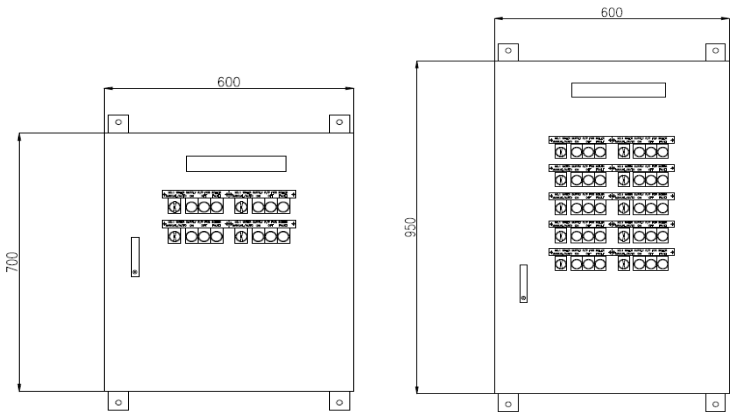
3.2.1 Engine/generator control panel

The Engine/Generator Control Panel will be designed to interface with Engine & Generator Local Panel and with other control panels.



FRONT VIEW

PANEL DOOR DESCRIPTION			
No	DESCRIPTION	DIMENSIONS	MARKER
1	SYNCHRO	96X96mm	ISKRA
2	SYNCHRO LAMP	25 ø / WITHE	
3	TOUCH PANEL VIEW	12.1"	PRO FACE (GP4601T)
4	EMERGENCY STOP (PBL)	22 ø / RED	TELEMECANIQUE
5	ENG. CONT. MODE SELECT (LOCAL/REMOTE)	53X53mm	YONGSUNG
6	FUEL OIL MODE SELECT (HFO/DO)	53X53mm	YONGSUNG
7	ENG. CONTROL SELECT (STOP/START)	53X53mm	YONGSUNG
8	GOV. CONTROL SW. (LOWER-RAISE)	53X53mm	YONGSUNG
9	AVR CONTROL SW. (LOWER-RAISE)	53X53mm	YONGSUNG
10	LOAD SHARING SW. (MENU-SEMI-AUTO)	53X53mm	YONGSUNG
11	VCB OPEN COMMAND SW. (PBL)	22 ø / GREEN	TELEMECANIQUE
12	VCB CLOSE COMMAND SW. (PBL)	22 ø / RED	TELEMECANIQUE
13	POSITION LAMP (INDICATOR)	22 ø / GREEN	TELEMECANIQUE
14	LOCKOUT RESET (PBL)	22 ø / RED	TELEMECANIQUE
15	DIGITAL METER FOR AUX. POWER	96X96mm	DEIF (MIB-7000)
16	GEN. PROTECTION RELAY(AGC)	115x220mm	DEIF (AGC 4)
19			



*. The control panel arrangement can be changed by design value.

1) The engine control system will consist of the following components.

- PLC for control and safety system

1-1) PLC function

The PLC performs the following function:

- Engine start/stop control
- HFO/DO change over control
- Engine lub oil Priming
- Monitoring (engine speed, temperatures, press and so on)

Alarm generation and control in conjunction with RCMS control and monitoring of engine.

1-2) Auxiliaries

- Touch screen (12.1")

1-3) Auxiliary control

Control and Monitoring via the communications network to the unit & common motor control Center PLC.

1-4) Local, manual and remote mode

Local, manual and remote mode is provided in Engine/Generator control system. Local and remote control will both be inhibited when the off position of the engine control switch is selected. Auto and manual mode is available in case of PF, Var, Load sharing control.

2) The generator Control & Protection system

- Protection relay with Electrical measuring
  - Type : 24V DC auxiliary supply
  - Function : 27, 32, 40, 46, 50, 51VR, 59, 81H/L, 51G
- Lockout relay
- Load sharing unit for kW & kVar
- Automatic voltage regulator
- Synchroscope with synchro check function

(Including Voltage and frequency display for bus and generator side synchro.)

- Lamp

2-1) Generator Monitoring

The followings can be monitored by Touch screens located in local and Central Engine/Generator control panel, Operator console in CCR and LDC.

- Stator winding temperature
- Bearing temperature
- MW, MVARS, MWH, MVARH
- Voltage and Ampere

3.2.2 Motor Control center (for MDU)

The motor control center will be designed to interface with Engine/generator control system and with Auxiliary equipments in the scope of STX's supply.

The panel will consist of the following components.

- Mold case circuit breaker
- Aux. relay
- Combination controller with PLC system
- The motor control center will be provided for feeding power to the auxiliary system of the MDU and for feeding control power required for MDU.
- Two power sources for this panel, one from step up transformer side of Generator breaker as a main source and the other from the common system from the Owner's LV distribution system as a back-up source are to be provided and automatic change over switch between these two source is to be provided.
- Also a small size of DC 24 V battery system with charger is to be provided for control power of MDU

SECTION 4. PERFORMANCE VALUES TO WITH SHOP INSPECTION AND TEST

4.2.1 Inspection

Material inspection and parts inspection will be performed in accordance with Supplier's standards. Inspection records for the key components will be submitted as specified in the document schedule. For major components such as engine frame, cylinder cover, and cylinder liner, etc., the hydraulic pressure test will be performed at 7 bar.

4.2.2 Shop Test

After the assembly is completed, the diesel engine will be tested at STX's factory in accordance with the standard program before shipment. Running test will be performed by STX under the witness of Buyer or his representatives. Test records will be submitted as specified in the document schedule.
Test program is ;

1) Measurement of crankshaft deflection
2) Starting test ;
   The consecutive start test will be carried out with a fully charged air receiver at 30 bar, and the number of times and the latest pressure of successful start will be recorded.

3) Load test ;
   The Gensets will be tested using Diesel oil under the following loads and duration of test program.

Load	Duration
25 %	30 min.
50 %	30 min.
75 %	30 min.
100 %	30 min.
110 %	30 min

4) Test of governor

5) Test of protection device

6) Inspection after shop test

After running test is completed, main components of diesel engine such as crankshaft, main bearings, con-rods, and cylinder liners are inspected through crankcase chambers without being dismantled.

7) Designed performance values of generator output of 1,415 kWe and fuel oil consumption of 208.0 g/kWe.h + 5% tolerance are to be guaranteed and are confirmed through the shop test as a final acceptance test.

4.2.3 Site Test

Upon completion of the installation, commissioning of the plant equipment, Site test required by the Puchaser will be carried out by Purchaser's operators under the technical advice, assistance and guidance of Supplier's technical supervisors from STX as follows:

4.2.3.1 No-Load Test

1) Check of installation
2) Check of engine & generator coupling and alignment
3) Test to prove correct operation of interlocks, alarm and tripping circuits
4) Rotational test on all motors delivered by STX
5) Safety device simulation check
6) Adjustment provided for the on-load test

4.2.3.2 On-Load Test

1) Final acceptance test will be performed under the same load (without overload) sequence as the shop test program, as far as the site load ranges within rate output.
2) Purchaser, at its own expense, will make all preparations for variable On-load test.
3) the performance values of generator output and fuel-oil consumption of which are compensated from the designed values are to be verified

SECTION 5. TOOLS AND SPARES

5.1 TOOLS

The following tools will be supplied for easy maintenance work at site.

- 1 lot of standard tools for diesel engine
- 1 lot of standard tools for electrical panel

5.2 SPARE PARTS

The Following spare parts will be supplied for the power plant operations.

5.2.1 Spare parts for power plant

- 1 lot of 2-years wearing spare parts for diesel engine
- 1 lot of commissioning spare parts
- 1 lot of generator spare parts
- 1 lot of Standard Spares for Electrical Panels and Aux. machinery

SECTION 6. OTHER SERVICE

6.1 DOCUMENT SCHEDULE

The following engineering will be performed together with document dispatch in relation to the execution of the project :

6.1.1 Basic Engineering Package

As a basic engineering package, five (5) sets of following documents will be released within eight(8) weeks after the date of Letter of Credit with down payment including all necessary site data and project design data are available.

- Technical specification for diesel power plant
- Outline drawings for equipment specified in scope of supply
- Spare part & Tool list
- Factory test and site test program

6.2 TRAINING

Supplier will provide training service to Buyer's supervisors or representatives for the diesel genset and its incorporated system related to the power plant according to the training program as specified in the contract, in order for easy understanding for smooth start-up, commissioning, operation and maintenance.

6.2.1 Training at STX factory

Supplier will provide the training service at STX factory according to the training program under the contract.

6.2.2 Training at site

The training will be carried out at site according to the standard training program under the contract.

6.3 COMPLETION OF WORK

On completion of work at site, following documents will be handed over.

5 sets of approval test records including;

- Final acceptance test run reports at site
- Daily reports of checking and supervision
- Correction reports
- Electronic documentation including autocad drawings

6.4 PROJECT MEETINGS

After the Contract is effective, both party's project handling teams will meet for discussion of the project procedure according to the following;

1) First Meeting after the supplier's receipt of the necessary project design data, including actual site conditions from the Buyer.
2) Second Meeting at Supplier's site after the Buyer's receipt of the Basic engineering package as specified.
3) Both parties are responsible for their own travel and lodging expenses for the meeting.

SECTION 7. ABBBREVIATION

- AC : Alternating Current
- ACB : Air Circuit Breaker
- Aux : Auxiliary
- AVR : Auto Voltage Regulator
- CCR : Center Control Room
- DC : Direct Current
- CPP : Containerized Power Plant
- cSt : Centistokes
- DO : Diesel Oil
- EP : Engineering, Procurement
- HFO : Heavy Fuel Oil
- IEC : International Electrical Committee
- ISO : International Organization for Standardization
- LDC : Load Distribution Center
- LV : Low Voltage
- MCC : Motor Control Center
- MDU : Main Diesel Unit
- O&M : Operation & Maintenance
- PF : Power Factor
- PH : Potential of Hydrogen
- PLC : Programmable Logic Controller
- ppm : parts per million
- RCMS : Remote Control Monitoring System
- SFOC : Specific Fuel Oil Consumption