TIChE Plant Design Competition Year 2021-2022

"Cold Energy Utilization from LNG"

1.Background and Motivation

Liquefied natural gas (LNG) is natural gas (predominantly Methane, CH_4, with some Ethane, C_2H_6) that has been cooled down to liquid at approximately -162 °C (-260 °F); form for ease and safety of non-pressurized storage or transport. When LNG changes its phase from Liquid to gas, the volume expands 600 times of original volume in the gaseous state. It is odorless, colorless, non-toxic and non-corrosive.

In Thailand, the energy demand will increase due to economic growth and an increasing population so LNG will be an energy resource to strengthen national energy security.

LNG is a cryogenic fluid having latent heat around 190 kWh of cold energy per ton under 100 barg. Typically, sea water is used as a heating medium to vaporize LNG from liquid to gas state for the regasification process in LNG terminal due to its low operating cost while the cold energy of LNG is wastefully discharged to the sea.

The propose of this study is to optimize and recover the cold energy to be a more environmentally friendly TERMINAL operation. One of the hardest problems in the recovery of cold energy is investment, commonly governed by financial break even.

2. Process and LNG plant basis of design

2.1 TERMINAL Capacity and Throughput

At TERMINAL, LNG is re-gasified by vaporizers for gas send-out and deliver to a PTT gas pipeline network through new send-out gas line (Operating pressure max. 86 barg).

Design capacity of LNG terminal is shown as below table.

	Phase I
Required Send-out Capacity	7.5 MMTPA (nominal) 9.0 MMTPA (peak rate)
Average hourly gas send-out rate (t/h)	856
Maximum hourly gas send-out rate (t/h)	1,028

The terminal is available for 24 hours/day and 365 days/year operation.

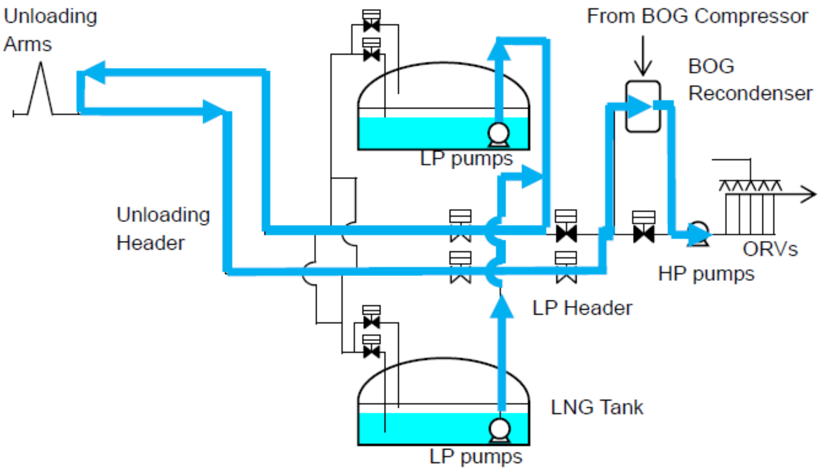
2.2 LNG Sources

LNG composition for process design is shown in the table below.

Table 4.5.1 LNG Composition

Composition (mol %)	Lean Case	Rich Case	High N_2 Case
CH_4	99.84	87.24	93.40
C_2H_6	0.01	8.45	3.90
C_3H_8	0.00	3.15	1.12
i- C_4H_{10}	0.00	1.11	0.58
n- C_4H_{10}	0.00	0.00	0.00
i- C_5H_{12}	0.00	0.05	0.00
n- C_5H_{12}	0.00	0.00	0.00
CO_2	0.00	0.00	0.00
N_2	0.15	0.00	1.00
Total	100.0	100.0	100.0
Molecular Weight	16.06	18.61	17.27
Density (kg/m^3) @ b.p. at 1 atm	424.7	469.5	451.9

2.3 Process Description



Simplified diagram of existing LNG terminal

2.3.1 LNG Storage Tank

2 Full containment type of LNG tanks with an inner shell of 9%Ni alloy steel and a pre-stressed concrete outer shell (including roof) is used to contain LNG. To avoid any risk of uncontrolled spill, all instrumentation and piping connections to the tank is routed through the tank roof.

2.3.2 LNG Off-loading

LNG is withdrawn from the LNG tanks by in-tank LNG pumps (LP Pumps) installed in the pump wells. All LNG pumped up by the LP LNG pumps is sent to suction of High-Pressure LNG pumps (HP Pumps). LNG is pressurized to the pressure higher than pipeline maximum operating pressure by HP pumps and then sent to the vaporizers.

2.3.3 LNG Regasification

Open rack vaporizers (ORV) are used to re-gasify LNG by using the heat from seawater. ORV operating pressure changes depending on the pipeline pressure which fluctuates in the range of 50-86 barg. Operating temperate of natural gas is within 15.6 - 48.6 deg. C.

Types of LNG vaporizers available in the market

(i) Open rack vaporizer (ORV)

In the Open Rack Vaporizer, seawater flows on the surface of panels with many heat exchanger tubes (star-fin tubes) to vaporize the internal LNG. Seawater used as a heat source.

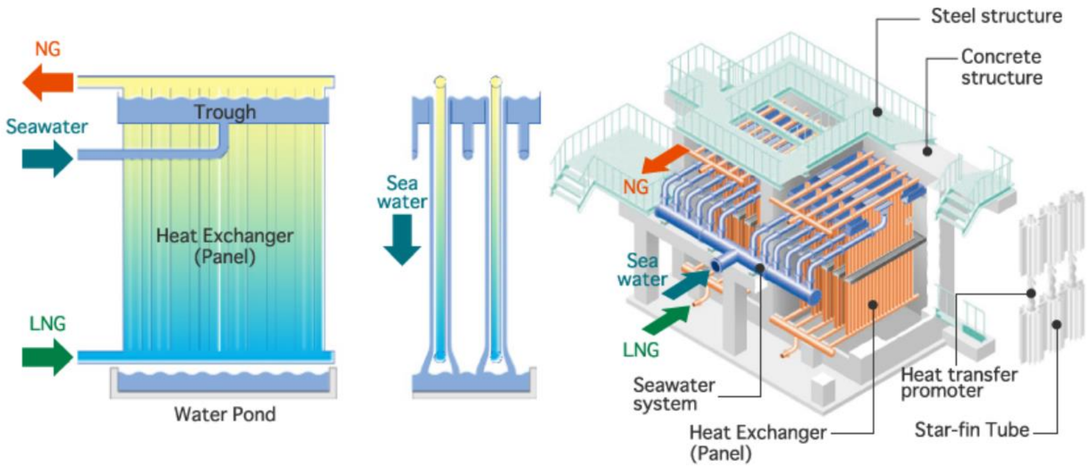
ORV is mainly composed of (1) Heat Exchanger, (2) Seawater system

a) Heat Exchanger (Panel)

Lining up several Aluminum heat exchanger tubes (called panel), flowing LNG inside the tubes, and LNG is to exchange heat with seawater that flows down outside of tubes and vaporized.

b) Seawater system

System for supplying seawater which works as heat source is consisted of seawater manifold, distribution pipe, and trough.



Configuration of Open rack vaporizer (ORV)

(ii) Intermediate Fluid Vaporizer (IFV)

The IFV is characterized by its unique concept of three heat exchangers and the use of intermediate fluid. Thanks to the use of intermediate fluid, the IFV is not subject to freezing and has a wider temperature range of the heating medium.

IFV is mainly composed of (1) E1: Intermediate Fluid Vaporizer, (2) E2: LNG Vaporizer, (3) E3: NG heater

a) E1: Intermediate Fluid Vaporizer

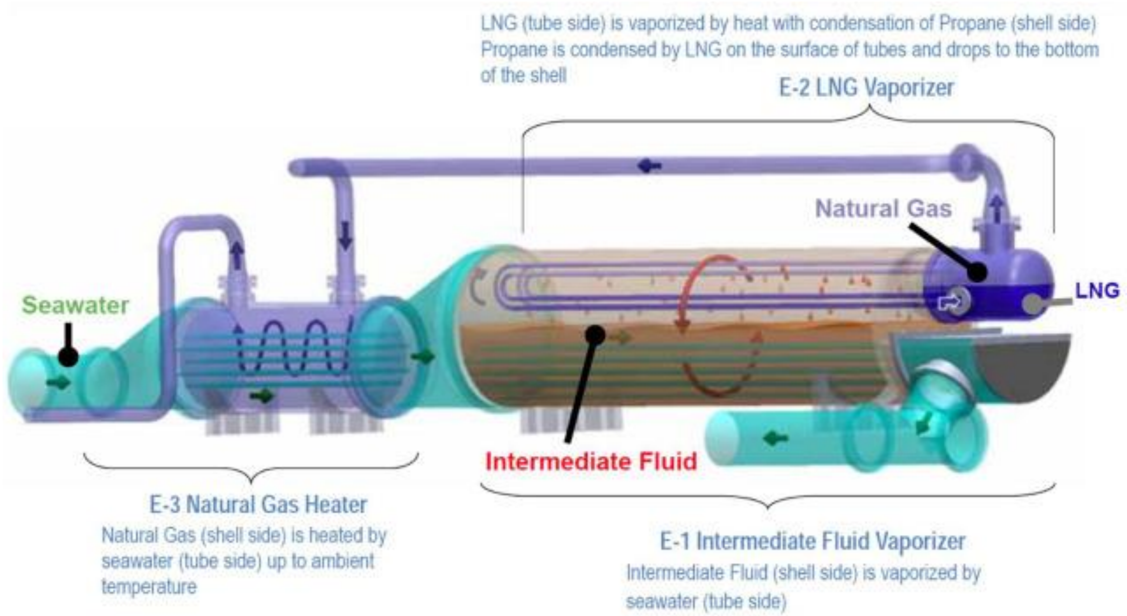
Intermediate fluid (shell side) is vaporized by seawater (tube side).

b) E2: LNG Vaporizer

LNG (tube side) is vaporized by the heat from the condensation of the intermediate fluid (shell side). Intermediate fluid is condensed by LNG on the surface of the tubes and dropped to the bottom of the shell.

c) E3: NG heater

LNG (shell side) is heated by seawater (tube side) up to an ambient temperature



Configuration of Intermediate Fluid Vaporizer (IFV)

(iii) LNG Ambient Air Vaporizer

LNG ambient vaporizers use the natural convection of air to vaporize liquefied gases. Finned aluminum tubes absorb heat from the air and transfer it to the product gas. A combination of proprietary fin tube profiles maximize heat transfer performance and optimize run times.

Configuration of LNG Ambient Air Vaporizer (AAV)

(iv) Submerged Combustion LNG Vaporizer (SCV)

The LNG is warmed by flowing through tube bundles that are submerged in a water bath which is heated by flue gases coming from natural gas fired burners. The submerged combustion burner emits hot exhaust gas that directly heats the water bath by bubbling through the water to an exhaust stack. The flue gas will be cooled below the dew point, the water from the combustion condenses out giving up its latent heat to the water bath.

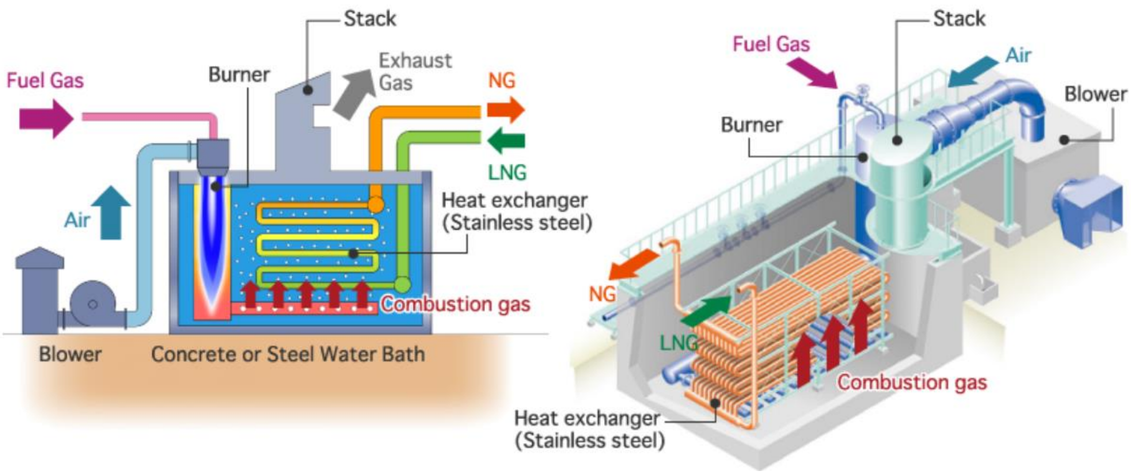
SCV is mainly composed of (1) Heat Exchanger, (2) Combustion system

a) Heat exchanger

Heat exchanger is composed of bundled stainless-steel tubes. Flowing LNG inside the tubes, LNG is vaporized exchanging heat from warmed water by combustion gas.

b) Combustion system

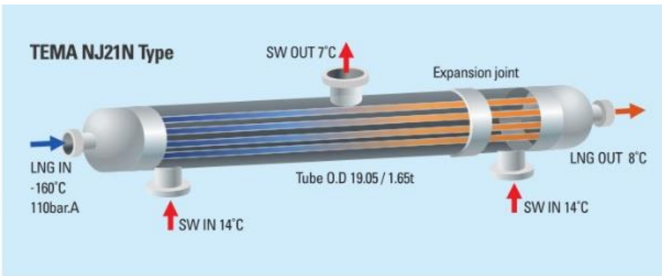
System for warming water bath by combustion gas produced at burner, composed of blower, burner, down comer, fuel gas piping, etc.



Configuration of Submerged Combustion LNG Vaporizer (SCV)

(v) Shell and Tube vaporizer (STV)

LNG that is being supplied from RV/FSRU (combination of LNG Tanker, Re-gasification facility and Gas unloading facility) by HP LNG Pump, is vaporized by HP Vaporizer. The seawater is utilized as a source of heat that vaporizes LNG.



Configuration of Shell and Tube vaporizer (STV)

(vi) Plate heat exchanger (Cold box)

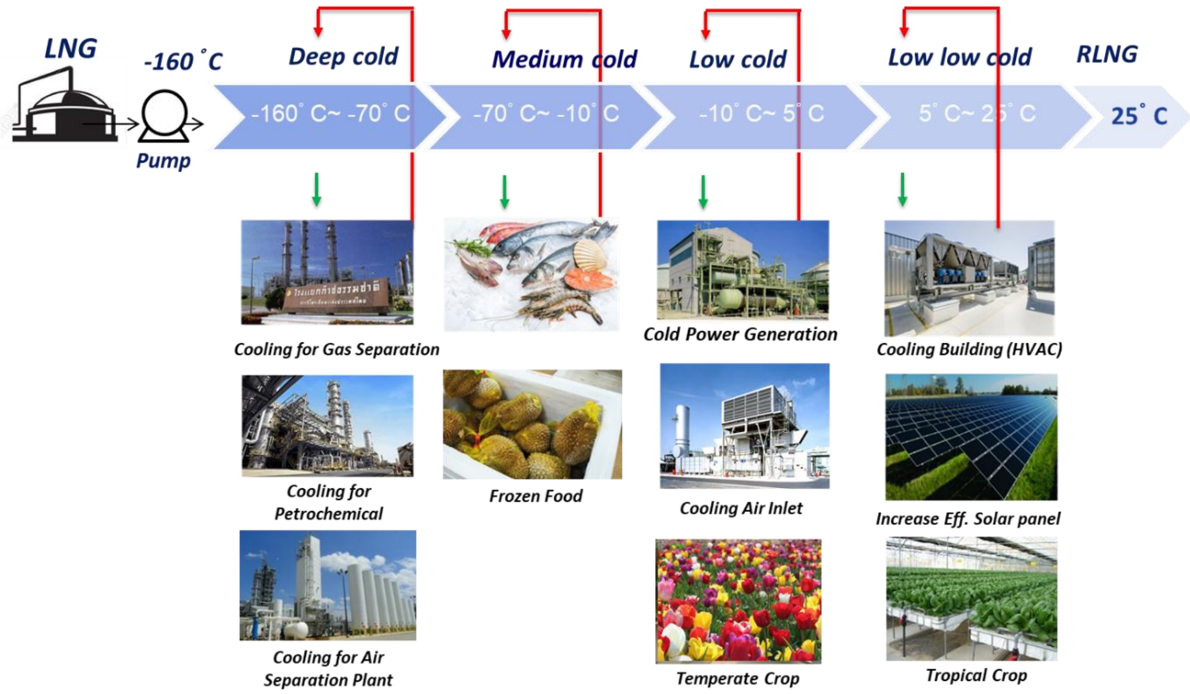
Cold box is a complete package of brazed aluminium heat exchanger contained in carbon steel of stainless steel casing with structural support, insulation containment, and protection for the internal equipment. Insulation work of heat exchanger and piping assembly can be easily done by perlite insulation and inside of cold box will be pressurized and purged by dry nitrogen gas.

Configuration of Plate heat exchanger

3. Project Objective

The objective is to perform a feasibility study including economic analyses of a new cold energy utilization plant in the Map Ta Phut Industrial Estate, Rayong. Your job is to define, analyze, evaluate, select, and design a valuable cold energy utilization process for LNG and related auxiliary facilities. An economic analysis report of the plant which you have designed is also required.

Typical cold energy utilization usage



Note: it is mandatory to design a cold energy utilization plant for medium cold and low cold applications

This is an open ended project. You need to incorporate all kinds of Chemical Engineering knowledges such as Thermodynamics, Plant Design, Unit Operations, Transport Phenomena, Process Control, HAZOP. You may utilize reliable outside information for the study. All assumptions made must be rational and be clearly stated. Its system configuration, pipe sizing, equipment unit capacity, way of control etc shall be determined by yourself. Any equipment, control devices, instrumentations etc that are necessary can be added as long as there is no information regarding in this document.

Your plant layout must be designed at areas as shown in the figure below

- 20 Rai area on west side of LNG terminal
  (The piping length from tie-in point up to battery limit is 460 m.)
- 60 m x 50 m area inside the LNG terminal
  (The piping length from tie-in point up to battery limit is 330 m.)

3.1 Design Requirements

The process design of plant takes full account of the following main aspects:

- Plant to be available for 24 hours/day and 365 days/year operation.
- Safety of operations with safeguard systems consists of Safety Instrumented System (SIS)

- Simple plant operations with automatic routines where relevant
- High plant efficiency by selecting state-of-the-art equipment and superior thermal insulation
- High plant availability by selecting proven equipment and appropriate sparing equipment
- "No Flaring" philosophy in normal operation
- Direct or indirect media for cold energy transferring to your plant to be also considered environmental and safety perspective.
  e.g. Direct transferring LNG to be limited in only industrial area which clearly define hazardous area in case of leakage. It might be not safe if it goes through residential and public areas.

3.2 Design Parameters

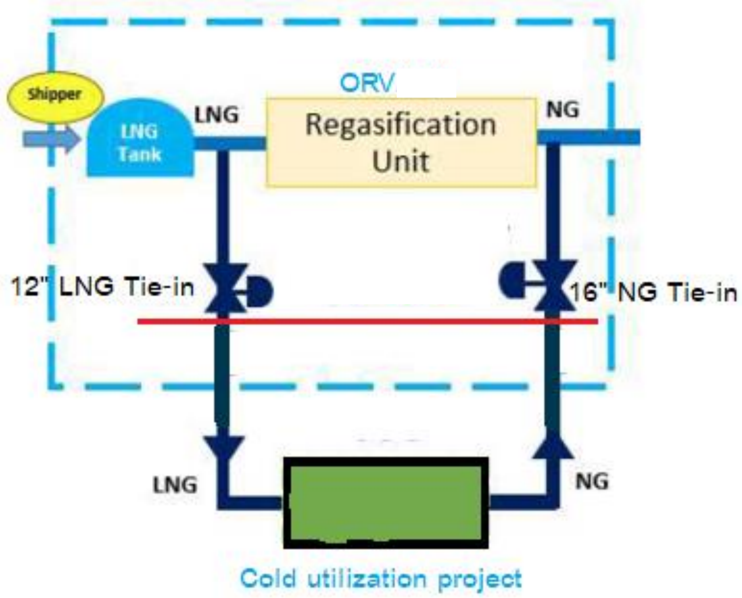
3.2.1 SI unit to be used for all design assumptions.

3.2.2 Your plant to be designed to utilize cold energy via using high pressure of LNG. LNG must be taken from High pressure LNG header and to return the natural gas in gas phase to High pressure NG header.

The conditions of supply LNG are shown below

High pressure (HP) LNG

- Supply high pressure of LNG 90.5 – 105.5 barg
- Supply LNG temperature -129.3 to -154.5 deg. C
- **Available of LNG flow which will be utilized cold energy utilization is 100 t/h**.
- Overall allowable pressure drop 10 bar (from HP LNG header and return to HP NG header)
- The returned temperature 15.6 - 48.9 deg C.
- Tie in point for HP LNG and HP NG header is 12 and 16 inches, respectively.
- The recommendation of velocity flow rate complied with API-14E.
  The limit of velocity in the pipe line as follows
  - Liquid 3 - 6 m/s
  - Gas 15 – 20 m/s



3.3.3 Your plant to be designed for a lifetime of 25 years. Automatic plant control system may be installed and complied with Thai regulations and international standards.

3.3.4 In consideration of economic analysis, the cost of LNG cold energy to be 20 Baht per ton of LNG when LNG is returned to existing terminal. LNG molecule price to be charged at 10 USD per MMBTU.

3.3.5 Rental cost of a filled land in the industrial estate at 200,000 Baht/Rai/year.

3.3.6 Discount rate is assumed at 10%.

4. Deliverables

The report must have contents in the following order. Forms and some examples of deliverables are provided in the attachments.

1. Letter of Transmittal
2. Cover Page
3. Table of Contents
4. Abbreviations
5. Introduction/ Conceptual Design including block diagram/ Design Basis
6. Design philosophy
7. Control philosophy
8. Process Control System (PCS) and Safety Instrumented System (SIS)
9. Process Flow Diagram
10. Material Selection (optional)
11. Process Description
12. Material/Energy Balances
13. Preliminary hydraulic calculation
14. Preliminary Piping and Instrument Diagram
15. Utility Requirements
16. Equipment and control valve data sheet
17. Equipment List
18. Equipment Specification Sheets
19. Preliminary Plot Plan
20. Equipment Cost Summary
21. Power consumption and electrical load list
22. Economic Analysis (NPV, payback period, IRR)
23. Safety, Health, and Environmental Considerations
24. Other Important Considerations (optional)
25. Conclusions and Recommendations
26. Acknowledgements
27. Bibliography

28. Appendix/Calculation and Sizing Spreadsheets

Clarification Form

TiChE	National Chemical Engineering Student Design Competition 2019-2020			Clarification Form	
				Q. Ref. No.	
Question raised by		Status		Date	
				Date	
Related topic		Checked by		Date	
				Signature	

Background

Question 1: -

Question 2: -

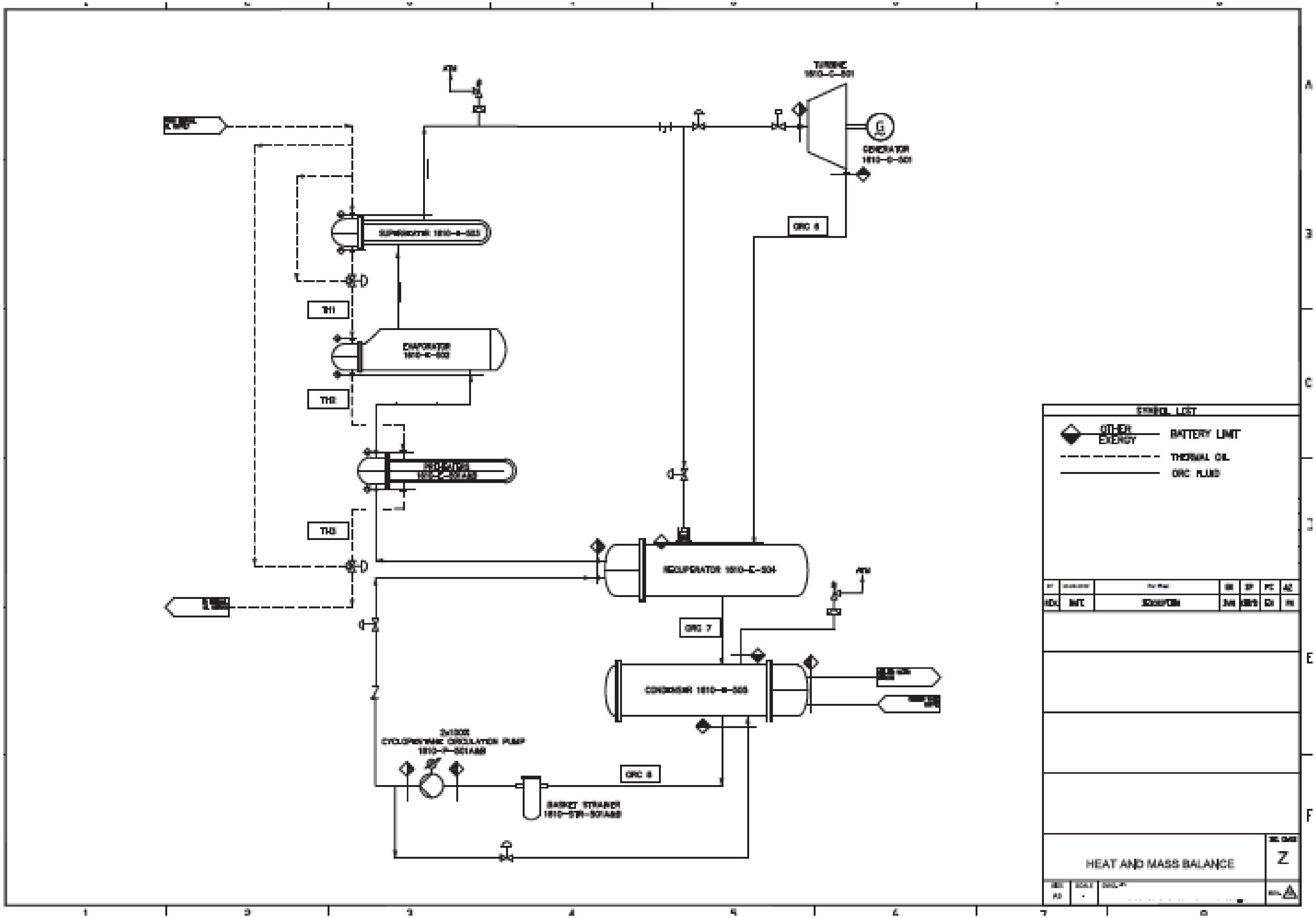
Answer 1: -

Answer 2: -

Clarified by		Clarified date	

Some Examples of Deliverables

*You can create deliver document based on your design.

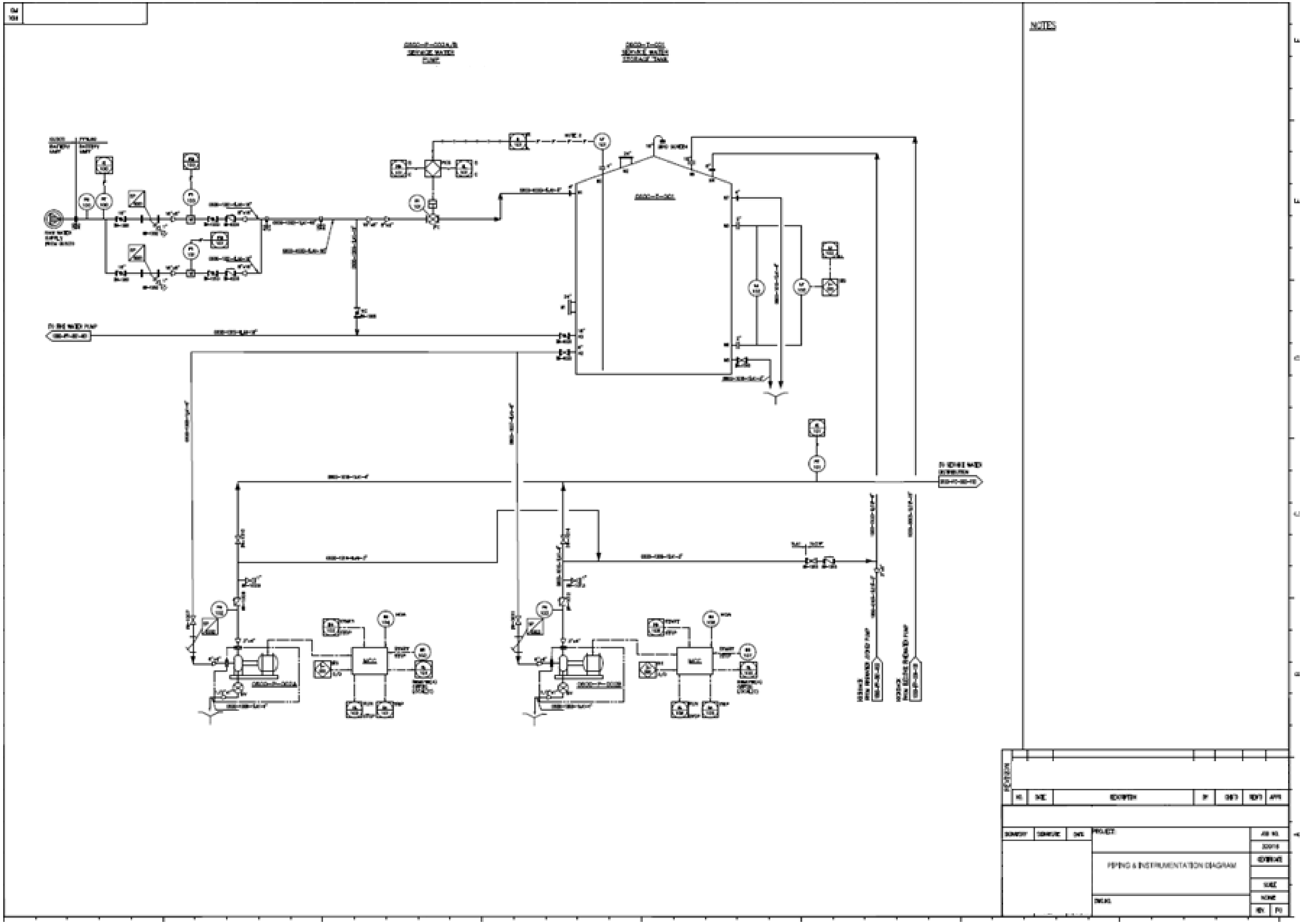

ATM
TURBINE
GENERATOR
SUPERHEATER
TH1
EVAPORATOR
TH2
TH3
RECUPERATOR
ORC 7
CONDENSER
CYCLOPENTANE CIRCULATION PUMP
BASKET STRAINER
SYMBOL LIST
OTHER ENERGY
BATTERY LIMIT
THERMAL OIL
ORC FLUID
HEAT AND MASS BALANCE
Z

HEAT & MASS BALANCE		
PARAMETER	UNIT	OPER. CASE: Case 1
AMBIENT TEMPERATURE	°C	29
THERMAL INPUT	kWth	21940
PERFORMANCE DATA		
GROSS POWER AT ORC GENERATOR TERMINALS	kWe	
ORC POWER CONSUMPTION	kWe	
ORC NET POWER EXCLUDING BOP AUXILIARIES (***)	kWe	
STREAM DATA		

OPER. CASE: Case 1 (2-GTG x 100%)									
PARAMETER	Flow	T.op	P.op	Density	µ	cP/cV	z factor	max allowable pressure drop	Molecular weight
UNIT	kg/s	°C	-	kg/m3	cP			mbar	kg/kmol
THERMAL OIL SUPPLY									
TH 1									
TH 2									
TH 3									
THERMAL OIL RETURN									
COOLING WATER SUPPLY									
COOLING WATER RETURN									
ORC 1									
ORC 2									
ORC 3									
ORC 4									
ORC 5									
ORC 6									
ORC 7									
ORC 8									

HEAT & MASS BALANCE		
PARAMETER	UNIT	OPER. CASE: Case 2 / Case 3
AMBIENT TEMPERATURE	°C	29
THERMAL INPUT	kWth	10970
PERFORMANCE DATA		
GROSS POWER AT ORC GENERATOR TERMINALS	kWe	
ORC POWER CONSUMPTION	kWe	
ORC NET POWER EXCLUDING BOP AUXILIARIES (***)	kWe	
STREAM DATA		

OPER. CASE: Case 2 (1-GTG x 100%) / Case 3 (2-GTG x 50%)									
PARAMETER	Flow	T.op	P.op	Density	µ	cP/cV	z factor	max allowable pressure drop	Molecular weight
UNIT	kg/s	°C	-	kg/m3	cP			mbar	kg/kmol
THERMAL OIL SUPPLY									
TH 1									
TH 2									
TH 3									
THERMAL OIL RETURN									
COOLING WATER SUPPLY									
COOLING WATER RETURN									
ORC 1									
ORC 2									
ORC 3									
ORC 4									
ORC 5									
ORC 6									
ORC 7									
ORC 8									



NOTES
PIPING & INSTRUMENTATION DIAGRAM
MCC
MCC

Appendix-1 Line Sizing and Hydraulic Review Summary

Unit	Stream No.	PFD	Line Description	Case	Phase	Mass Flow (kg/h)	Temp. (°C)	Inlet Pressure (barg)	Density (kg/m³)	Viscosity (cP)	MW	Compr. Factor	Roughness (mm)	Equivalent Line Length (m) Note 1	Fittings: Elbow 90°	Elbow 45°	Tee (Run through)	Tee as Elbow	Valve (Globe/ Butterfly/ Gate/Ball)	Check Valve	Dia. (in.)	Velocity (m/s)	ΔP_line (bar)	ΔP_static (bar)	ΔP_equipment & instrument (bar)	ΔP_CV (bar)	ΔP_total (bar)	Design High Limit: ΔP_allow (bar) (Start pressure - Destination pressure)	Max. Velocity Out (m/s)	Check Result: ΔP_allow	Max. Velocity out
BOG to transmission pipeline via Send-out Gas Compressor (Zero Send-out Mode) (Note-6,7)																															
0100	1	B-11	BOG Header Line	Rich	Vapor									391	4	1		1	1		36	2.34	0.000	0	0	0			20	OK	OK
0100	2	B-11	BOG Suction Drum Inlet											310	10		1		1		36	4.68	0.000	0	0.01	0			20		OK
0100	3	B-12	BOG Suction Drum Outlet											201	6		1		1		36	5.01	0.001	0	0	0			20		OK
0100	4	B-12	BOG Compressor Inlet (Header)											109	4		1				20	16.48	0.006	0	0	0			20		OK
0100	5	B-12	BOG Compressor Inlet											45	4						14	17.15	0.004	0	0.05	0			20		OK
0100	6	B-12	BOG Compressor Inlet (P.V. Design)											77	4				2		14	19.08	0.009	0	0	0			20		OK
0100	7	B-14	BOG Compressor Outlet											67	7			1	2	2	4	4.94	0.103	0	0	0			20	OK	OK
0100	8	B-14	BOG Compressor Outlet (Header)											459	8			1			6	4.36	0.334	0	0	0			20		OK
0100	9	-	Export Gas Metering Inlet											90	4						34	0.15	0.000	0	0	0			20		OK
0100	10	G-1	Export Gas Metering Outlet											83	3				2		34	0.15	0.000	0	0	0			20		OK
0100	11	G-1	NG Send-out to B.L. Line											421	3	1					42	0.10	0.000	0	0	0			20		OK
BOG to transmission pipeline via Send-out Gas Compressor (One BOG Compressor Failure) (Note-6,7)																															
0100	1	B-11	BOG Header Line	Rich	Vapor									437	4	1		1	1		36	9.71	0.005	0	0	0			20	OK	OK
0100	2	B-11	BOG Suction Drum Inlet											349	10		1		1		36	9.71	0.004	0	0.03	0			20		OK
0100	3	B-12	BOG Suction Drum Outlet											226	6		1		1		36	10.86	0.003	0	0	0			20		OK
0100	4	B-12	BOG Compressor Inlet (Header)											107	4		1				20	8.23	0.002	0	0	0			20		OK
0100	5	B-12	BOG Compressor Inlet											46	4						14	17.16	0.005	0	0.05	0			20		OK
0100	6	B-12	BOG Compressor Inlet (P.V. Design)											78	4				2		14	19.06	0.011	0	0	0			20		OK
0100	7	B-14	BOG Compressor Outlet											67	7			1	2	2	4	5.99	0.162	0	0	0			20	OK	OK
0100	8	B-14	BOG Compressor Outlet (Header)											459	8			1			6	2.64	0.124	0	0	0			20		OK
0100	9	-	Export Gas Metering Inlet											103	4						34	6.66	0.033	0	0.5	0			20		OK
0100	10	G-1	Export Gas Metering Outlet											97	3				2		34	6.66	0.032	0	0	0			20		OK
0100	11	G-1	NG Send-out to B.L. Line											440	3	1					42	8.76	0.193	0	0	0			20		OK
Sea Water Header Lines (Note-4)																															
0500	1	-	Sea Water Pump Discharge Line	-	Liquid						-	-		337	2				1	1	54	2.62	0.116	0	0.1	0			5	OK	OK
0500	2		Sea Water Header								-	-		1156	8		7	1			72	4.32	0.746	0	0	0			5		OK
0500	3		Sea Water Header to ORV Inlet								-	-		176	4			1	1		36	2.88	0.117	1.02	0.2	0.402			5		OK
Service Water Header Lines (Note-13)																															
0600	1	-	Service Water Pump Discharge Line	-	Liquid						-	-		33	2		1			1	6	0.75	0.014	0	0.2	0			6	OK	OK
0600	2		Service Water Header											456	6		1	1	2		6	0.63	0.104	0	0	0			6		OK
0600	3		Service Water Header to LNG Tanks											248	6			1	1		2	1.17	0.991	6.466	0	0			6		OK
Potable Water Header Lines (Note-14)																															
0600	1	-	Potable Water Pump Discharge Line	-	Liquid						-	-		35	3					1	4	1.26	0.064	0	0.2	0			6	OK	OK
0600	2		Potable Water Header											148	12				1		4	0.89	0.147	0	0	0			6		OK
0600	3		Potable Water Header											338	4			1	1		4	0.14	0.013	0	0	0			6		OK
0600	4		Potable Water Header											6053	16	1	1				2	0.61	4.924	0	0	0			6		OK
0600	5		Potable Water Header to Utility Station											17	2			1	1		1.5	0.79	0.04	1.015	0	0			6		OK
Service Air Header Lines (Note-15)																															
0700	1	-	Service Air Compressor Package Outlet	-	Vapor									36				1	1		3	5.04	0.012	0	0	0			20	OK	OK
0700	2		Service Air Receiver Dischager Line											203	1			1	2		3	5.04	0.067	0	0	0.921			20		OK
0700	3		Service Air Header											457	20			20	2		2	0.68	0.007	0	0.2	0			20		OK
0700	4		Service Air Header to Utility Station											351	2			5	1		1.5	1.30	0.026	0	0	0			20		OK
Instrument Air Header Lines (Note-16)																															
0700	1	-	Service Air Compressor Package Outlet	-	Vapor									36				1	1		3	5.04	0.012	0	0	0			20	OK	OK
0700	2		Service Air Receiver to Instrument Air Package											37				1	2		3	5.04	0.012	0	1	0			20		OK
0700	3		Instrument Air Package to Instrument Air Receiver											36				1	1		3	4.26	0.008	0	0	0			20		OK
0700	4		Instrument Air Receiver Discharge Line											552	19			22	2	1	3	4.26	0.147	0	0.2	0			20		OK
0700	5		Instrument Air Header (Trestle)											6086	16	1	1				3	1.72	0.246	0	0	0			20		OK
0700	6		Instrument Air Header to Arm Pneumatic Pump											32	2			1	1		2	4.03	0.010	0	0	0			20		OK
Nitrogen Header Lines (Note-17)																															
0800	1	-	Nitrogen Vaporizer Package Outlet	-	Vapor									3					3		2	7.80	0.004	0	0	0			20	OK	OK
0800	2		Nitrogen Vaporizer Package Outlet											24				1	2	1	3	3.85	0.006	0	0.2	0.79			20		OK
0800	3		Terminal Nitrogen Buffer Drum Discharge Line											506	12			20	2	1	3	0.68	0.005	0	0	0			20		OK
0800	4		Nitrogen Header to BOG Compressor											22	5	1	1				1.5	2.88	0.008	0	0	0			20		OK
Nitrogen Header Lines (Note-18)																															
0800	1	-	Jetty Nitrogen Buffer Drum Discharge Line	-	Vapor									20	10			5	2		2	12.61	0.070	0	0	0			20	OK	OK
0800	2		Jetty Nitrogen Header to LNG Unloading Arm											97	10	1	1	5			1.5	11.97	0.170	0	0	0			20		OK

Note 1. Equivalent line length includes straight line length and fittings

UTILITY EQUIPMENT LIST

System ID	Equipment Name	Tag Number	Nos. of Unit	Type	Unit Capacity	Operating Condition		Design						Location	Remarks
			Phase -1			Pressure (barg)	Temperature (°C)	Design Pressure (barg)		Design Temperature (°C)		Driver (kW)	Medium		
								min	max	min	max				
Power Generation and Distribution System	Emergency Power Generator	0300-U-001	1	Vendor Package											
	Diesel Day Tank	0300-T-001	1	Tank											
Service and Potable Water System	Service Water Storage Tank	0600-T-001	1	Cone Roof											
	Service Water Pump	0600-P-002A/B	2(1)	Centrifuge											
	Potable Water Storage Tank	0600-T-002	1	Cone Roof											
	Potable Water Pump	0600-P-001A/B	2(1)	Centrifuge											
	Jetty Water Tank	0600-T-003	1	Vertical											
Service and Instrument Air System	Service Air Compressor Package	0700-U-001A/B	2(1)	Oil-free Screw											
	Service Air Receiver	0700-V-001	1	Vertical											
	Instrument Air Receiver	0700-V-002	1	Vertical											
	Jetty Instrument Air Receiver	0700-V-003	1	Vertical											
Nitrogen System	Liquid Nitrogen Storage Vessel	0800-T-001	1	Vendor Package											
	Nitrogen Vaporizer	0800-E-001A/B	2(1)	Ambient Temperature											
	Terminal Nitrogen Buffer Drum	0800-V-002	1	Vertical											
	Jetty Nitrogen Buffer Drum	0800-V-003	1	Vertical											
Waste Water Treatment System	~~Sanitary Sewage Treatment Package #1~~	~~1100-U-001~~	~~1~~	~~Vendor Package~~											
	Oily Waste Water Lift Station Pit Pump	1100-P-001A/B	2(1)	Centrifuge											
	Primary Waste Water Treatment Package	1100-U-002	1	Vendor Package											
	Secondary Waste Water Treatment Package	1100-U-003	1	Vendor Package											
	Sanitary Sewage Receiver	1100-T-001	1	Tank											
Fire Fighting System	Diesel Driven Firewater Pump F4	1000-P-001A	1	Horizontal Split case											
	F4	1000-P-003A	1	Vertical Turbine											
		~~1000-P-004B~~	~~1~~	~~Vertical Turbine~~											
	Electric Motor Firewater Pump	1000-P-001B	1	Horizontal Split case											
	F4	~~1000-P-004A~~	~~1~~	~~Vertical Turbine~~											
	Jockey Water Pump F4	1000-P-002A/B	2(1)	Horizontal											
		~~1000-P-005A/B~~	~~2(1)~~	~~Horizontal~~											

INSTRUMENT TYPICAL DATASHEET
Control Valve

Doc. No.	1803088-32016-CS-DS-027		
Project			
Client			
Job No.	32016	Page	1 of 1

REV

GENERAL	1	Tag Number			(Typical)			
	2	Service			NG and utility system			
	3	Line No./Eqpt. No.						
	4	Area Classification			Class 1 Division 2 as minimum			
	5	Allowable Sound Pressure Level			85dBA *see notes 1			
	6	Tightness Requirements			ANSI Class IV *see notes 2			
	7	Available Air Supply Pressure	Min.	Max.	5 barg			
	8	Power Failure Position			*see notes 9			
	9	P&ID No.						
PIPE LINE	10	Line Size and Schedule	Inlet	Outlet				
	11	Pipe Material						
	12	Pipe Insulation						
PROCESS CONDITIONS	13	Process Fluid			NG and utility system			
	14	Upstream Condition						
	15	Differential Pressure						
	16				Units	@ Max. Flow	@ Norm. Flow	@ Min. Flow
	17	Flow Rate						
	18	Inlet Pressure			bar-G			
	19	Pressure Drop			bar			
	20	Inlet Temperature			degC			
	21	Inlet Density / Specific Gravity / Molecular Mass			-			
	22	Inlet Compressibility Factor			-			
	23	Inlet Viscosity			cP			
	24	Inlet Specific Heats Ratio			-			
	25	Inlet Vapour Pressure						
CALCULATED RESULTS	26	Flow Coefficient Cv			-			
	27	Travel			%			
	28	Sound Pressure Level @ Maximum Flow			dBA			

BODY AND TRIM	29	MFR	Model		
	30	Body Type		Globe	
	31	Body Size	Trim Size		
	32	Rated Cv	Characteris.		
	33	End Connec. & Rating		Flange End	
	34	Body Material		WCC carbon steel	
	35	Bonnet Type	Material	Standard	WCC carbon steel
	36	Flow Direction			
	37	Flow Action To			
	38	Lubricator	Isolat. Valve	No	No
	39	Guiding	No. of Ports	-	1
	40	Trim Type	Characteristic		*see notes 4
	41	Rated Travel			
	42	Plug/ Ball/ Disk Material		316SS *see notes5	
	43	Seat Material		316SS *see notes5	
	44	Packing type / material		Teflon	
	45	Gasket Material			
	46	Stem Material		316SS *see notes5	
	47	Blanced/Unbalanced		Balanced	
ACTUATOR	48	MFR	Model		
	49	Type		Pneumatic *see notes 3	
	50	Size	Area		
	51	Air Failure Valve			
	52	Handwheel Location		Side	
	53	Bench Range			
	54	Painting/coating color		Green	
	55	Power failure valve			

POSITIONER	56	MFR	Model		
	57	Signal: Inlet	Outlet	[illegible]	
	58	Increase Signal Valve			
	59	Cam Characteristic		by MFR	
	60	Bypass	Gauges	No	Yes
	61	Communication failure valve		*see notes 9	
	62				
SOLENOID VALVE	63	MFR	Model	-	-
	64	Type		-	
	65	When De-Enegr.Valve		-	
	66				
SWITCHES	67	MFR	Model	-	-
	68	Type	Quantity	-	-
	69	Contacts / Rating		-	
	70	Switching Position		-	
	71				
AIR SET	72	MFR	Model		
	73	Set Pressure			
	74	Filter	Gauge	Yes	Yes
	75	Isolation Valve		Yes (instrument ball valve, 316SS)	
TESTS	76	Hydro. Pressure		1.5 times work pressure	
	77	Leakage		FCI 70-2	
	78				
MANUFACTURE	79	Manufacturer			
	80	Model			
	81				
	82				

Notes:

Data Sheet for LNG Open Rack Vaporizer

CLIENT	[illegible]
PROJECT	
DOC. NO.	[illegible]
LOCATION	[illegible]
SYSTEM ID.	*0100, Process System*
ITEM NO.	JOB NO. 1602088 PAGE *1 of 2*

No.	OPERATING CONDITIONS					
1	**OPERATING CONDITIONS**					
2	CODES :	*ASME Section VIII, Div. 1*				
3	CAPACITY :	MIN. *(Note-3)* NOR.		MAX.	*210*	(t/h)
4	DESIGN PRESSURE :	Tube-side:	128	Sea water-side:	6.5	(barg)
5	OPER. PRESSURE :	Tube-side:	*50 to 80 (Note-7)*	Sea water-side:	*Note-3*	(barg)
6	DESIGN TEMP. :	Tube-side:	*- 165 / 65*	Sea water-side:	*65*	(°C)
7	OPER. TEMP (Inlet) :	Tube-side:	*-154*	Sea water-side:	*Min. 21/Max. 34*	(°C)
8	FLUID NATURE/PHASE :	Tube-side:	*LNG / NG*	Sea water-side:	*Sea Water*	
	LIQUID/GAS RATE :	Tube-side:	*210*	Sea water-side:	*Max. 6,600*	(t/h)
1	PRESSURE DROP :	Tube-side:	*less than 2*	Sea water-side:		(barg)
2						
3						

TYPE :	*Open Rack Type*
SERVICE :	*LNG Open Rack Vaporizer*
NO. REQUIRED :	*6 (six)*
MANUFACTURER :	-
WEIGHTS	*(Note-3)*
BLOCKS/PANEL MANIFOLDS :	(kg)
TROUGH :	(kg)
PIPING ASSY :	(kg)
OTHERS :	(kg)
TOTAL :	(kg)

4 PROPERTIES

5 Cold Side *(Note-4)*

No.	Characteristic		Lean		Rich		High N_2		Remarks
7			Inlet (LNG)	Outlet (NG)	Inlet (LNG)	Outlet (NG)	Inlet (LNG)	Outlet (NG)	
8	Pressure	(barg)	*62-52*	*80-50*	*62-52*	*80-50*	*62-52*	*80-50*	*(Note-7)*
9	Temperature	(°C)	*-154*	*≥ 15.6*	*-154*	*≥ 15.6*	*-154*	*≥ 15.6*	
10	Flowrate	(t/h)	*210*		*210*		*210*		
11	Density	(kg/m³)	*424.7*		*469.5*		*451.9*		*(Note-5)*
12	Heat Load	(MW)							
13	Thermal Condu.	(W/mK)							
14	Viscosity	(cP)							
15	Mol Weight		*16.06*		*18.61*		*17.27*		
16	Methane	(mol %)	*99.84*		*87.24*		*93.40*		
17	Ethane	(mol %)	*0.01*		*8.45*		*3.90*		
18	Propane	(mol %)	*0.00*		*3.15*		*1.12*		
19	i-Butane	(mol %)	*0.00*		*1.11*		*0.58*		
20	n-Butane	(mol %)	*0.00*		*0.00*		*0.00*		
21	i-Pentane	(mol %)	*0.00*		*0.05*		*0.00*		
22	n-Pentane	(mol %)	*0.00*		*0.00*		*0.00*		
23	Nitrogen	(mol %)	*0.15*		*0.00*		*1.00*		
24	CO_2	(mol %)	*0.00*		*0.00*		*0.00*		
25									
26									
27									
28									
29									

Hot Side

Characteristic		Sea Water *(Note-3, -6)* Inlet	Outlet	Remarks
Pressure	(barg)	*3*	-	*(Note-3, -8)*
Temperature	(°C)	*21 / 34*	*14 / 27*	*(Note-9)*
Flowrate	(t/h)	*6600*		*(Note-10, -11)*
Density	(kg/m³)	*1020*		
pH (at 25 °C)		*8.2*		
DO	(mg/l)			
Conductivity	(mS/cm)			
Salinity	(%)			
TSS	(mg/l)			
DTS	(mg/l)			
NH_4	(mg/l)			
NO_3	(mg/l)			
NO_2	(mg/l)			
SO_4^{2-}	(mg/l)			
Cl^-	(mg/l)			
Phenol	(mg/l)			
TOC	(mg/l)			
BOD	(mg/l)			
COD	(mg/l)			
Coli Form (MPN/100ml)				

30 MATERIAL *(Note-12)*

No.	Cold Side		Hot Side (Seawater)	
32	Heat Transfer Tubes	*Aluminum (Specified by SUPPLIER)*	Manifold & Nozzles	*(Note-3)*
33	Headers and Manifolds	*INLET : Aluminum (Specified by SUPPLIER)*	Header Pipe	*(Note-3)*
34		*OUTLET : Aluminum (Specified by SUPPLIER)*	Header Pipe Support	*Aluminum (Specified by SUPPLIER)*
35	Support Insulator for LNG Manifold	*Bakelite*	Trough and Guides	*Aluminum (Specified by SUPPLIER)*
36				
37	TRANSITION JOINT :	*Aluminum/316L Stainless Steel*		

No.	OTHERS	
39	Windbreaker	*FRP*
40	Deck with Handrail	*ASTM A36 (Outside the concrete structure), Structure : SS316L, Gratings : Aluminum (Inside the concrete structure)*
41	Deck with	
42	Access Door	*Iron Wood or equibavalent (in term or corrosion residance from sea water) with Tempered Glass.*
43		

44 CONSTRUCTION *(Note-3)*

No.		
45	UNITS :	
46	BLOCKS PER UNIT :	
47	PANELS PER BLOCK :	
48	TUBES PER PANEL :	
49	HEAT TRANSFER TUBES	TYPE :
50		LENGTH : O.D. THK. (mm)
51		PITCH : (mm)
52	HEADERS	INLET :
53		OUTLET :
54	MANIFOLD	INLET :
55		OUTLET :

ACCESSORIES

ลักษณะภูมิอากาศจังหวัดระยอง

มีลักษณะภูมิอากาศแบบมรสุมเขตร้อน ลมทะเลพัดผ่านตลอดปี อากาศอบอุ่น ไม่ร้อนจัดบริเวณชายฝั่งทะเลเย็นสบาย ในฤดูฝนจะมี ฝนตกชุกระหว่างเดือนพฤษภาคมถึงตุลาคมของทุกปี อุณหภูมิเฉลี่ยตลอดปี ประมาณ 28.3 องศาเซลเซียส อุณหภูมิสูงสุดเฉลี่ย 32.6องศาเซลเซียส อุณหภูมิต่ำสุดเฉลี่ย 25.0องศาเซลเซียส โดยมีอุณหภูมิสูงสุดในเดือนเมษายน วัดได้ 38.7 องศาเซลเซียสและอุณหภูมิต่ำสุดในเดือนมกราคมวัดได้ 17.8 องศาเซลเซียส

ปริมาณน้ำฝนจังหวัดระยองเฉลี่ย อยู่ระหว่าง 1000 – 2000 มิลลิเมตร ต่อปี โดยที่ ฝนตกชุกที่สุดเฉลี่ย 1800-2000 มิลลิเมตรต่อปีจะอยู่ที่บางส่วนของตำบลพังราด อำเภอแกลง รองลงมาเฉลี่ย 1600-1800 มิลลิเมตรต่อปี จะอยู่ในพื้นที่บางส่วนของอำเภอแกลง ที่ติดกับชายทะเล ปริมาณฝนเฉลี่ย 1400-1600 มิลลิเมตรต่อปี อยู่ในพื้นที่ส่วนใหญ่ของอำเภอแกลง บางส่วนของอำเภอเมือง และบางส่วนของกิ่งอำเภอเขาชะเมา พื้นที่ส่วนใหญ่ของจังหวัดจะมีปริมาณน้ำฝนเฉลี่ย 1200-1400 มิลลิเมตรต่อปี ซึ่งจะอยู่ในพื้นที่ของอำเภอบ้านฉาง กิ่งอำเภอนิคมพัฒนา อำเภอบ้านค่าย อำเภอปลวกแดง อำเภอวังจันทร์ และพื้นที่ส่วนใหญ่ของกิ่งอำเภอเขาชะเมา พื้นที่ที่ แล้งที่สุด จะอยู่ที่ ตำบลหนองไร่ อำ เภอปลวกแดง ซึ่งมีปริมาณน้ำฝนเฉลี่ยต่อปีอยู่ที่ 1000-1200 มิลลิเมตร