

**PROPOSAL
FOR
FEASIBILITY STUDY OF LNG CHAIN TRADING
BETWEEN
BOLIVIA AND URUGUAY
FOR YPFB, BOLIBIA**

May, 25. 2010

Prepared by GMB / Zentech Engineering Co., Ltd.

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1.0 Project Introduction

Introduction for Project

- ✦ The purpose of this document is to provide the Commercial Proposal for Feasibility Study of LNG Chain Trading between Bolivia and Uruguay for YPFB, Bolivia.
- ✦ Main Contractor of Feasibility Study is GENERAL MARINE BUSINESS Inc, Korea (hereinafter collectively referred to as the “GMB”.) and its consortium engineering partner is Zentech Engineering Co., Ltd., Korea (hereinafter collectively referred to as the “ZENTECH”) for successful completion of Feasibility of LNG Chain Trading between Bolivia and Uruguay with other associated works for YPFB, Bolivia.

Project Background

- This project is to supply 3,000,000 CMB/day of natural gas to Uruguay from Bolivia by the form of LNG (Liquefied Natural Gas) through the water way of Parana Paraguay.
- This proposal shall define a feasibility study of Turn Key Solution by GMB consortium and the scope of works required to provide feasibility studies of
 - ❖ Natural Gas Liquefaction Plant
 - ❖ LNG Transportation Barges and Tugs
 - ❖ LNG Receiving Barge and Re-gasification and Gas Delivery Plant.
- GMB Consortium shall propose the “LNG barge transportation and LNG Re-gasification/ Gas Direct Delivery solution” with the best economical and effectiveness for Bolivia and Uruguay regional circumstances.
- Following Figure is described route map of LNG Barge transportation from Bolivia LNG Plant to Uruguay LNG FSRU.

Project Introduction

Project Route Map

PROJECT ROUTE MAP



Project Introduction

LNG Value Chain

Production



Platform (Production)

Liquefaction



LNG FPSO (Production + Liquefaction)

Shipping



LNG C (Shipping)



LNG RV (Shipping + Re-Gasification)

Re-gasification



Onshore Re-gasification



FSRU (Re-gasification)

Project Introduction

Project Name for Phases



Project Name for Phases

1. LCT001: Natural Gas Liquefaction Plant and LNG Loading Terminal for LNG Barge.
2. LCT002: LNG Transportation Barges with Loading and Discharging system
3. LCT003: LNG FSRU and Riser part or Unloading LNG terminal and Re-gasification Plant.

Project Introduction

Site Survey Scope of work



The Construction Cost and FEED & Basic & Detailed Engineering Cost shall be depending on Site environment and condition such as Foundation condition, LNG Transportation route condition and LNG Receiving station area condition as well as Raw gas composition.

No	Description	Scope of Work
1	All site Arrangement and Coordinates	YPFB, BOLIVIA
2	LCT 001 Site Soil Condition Survey	GMB
3	LCT 001 Soil Investigation work	YPFB, BOLIVIA
4	LCT 001 Site Environmental Condition Survey	GMB
5	Provide for LCT 001 Site Environmental Data	YPFB, BOLIVIA
6	Provide for Raw Gas Chemical Composition	YPFB, BOLIVIA
7	LCT 003 Site Environmental Condition Survey	GMB
8	Provide for LCT 003 Site Environmental Data	YPFB, BOLIVIA
9	Arrange of Boat for sea condition survey	YPFB, BOLIVIA
10	Technical Meeting	GMB/YPFB

2.0 Project Summary

LCT001 PHASE

SUMMARY FOR LCT001

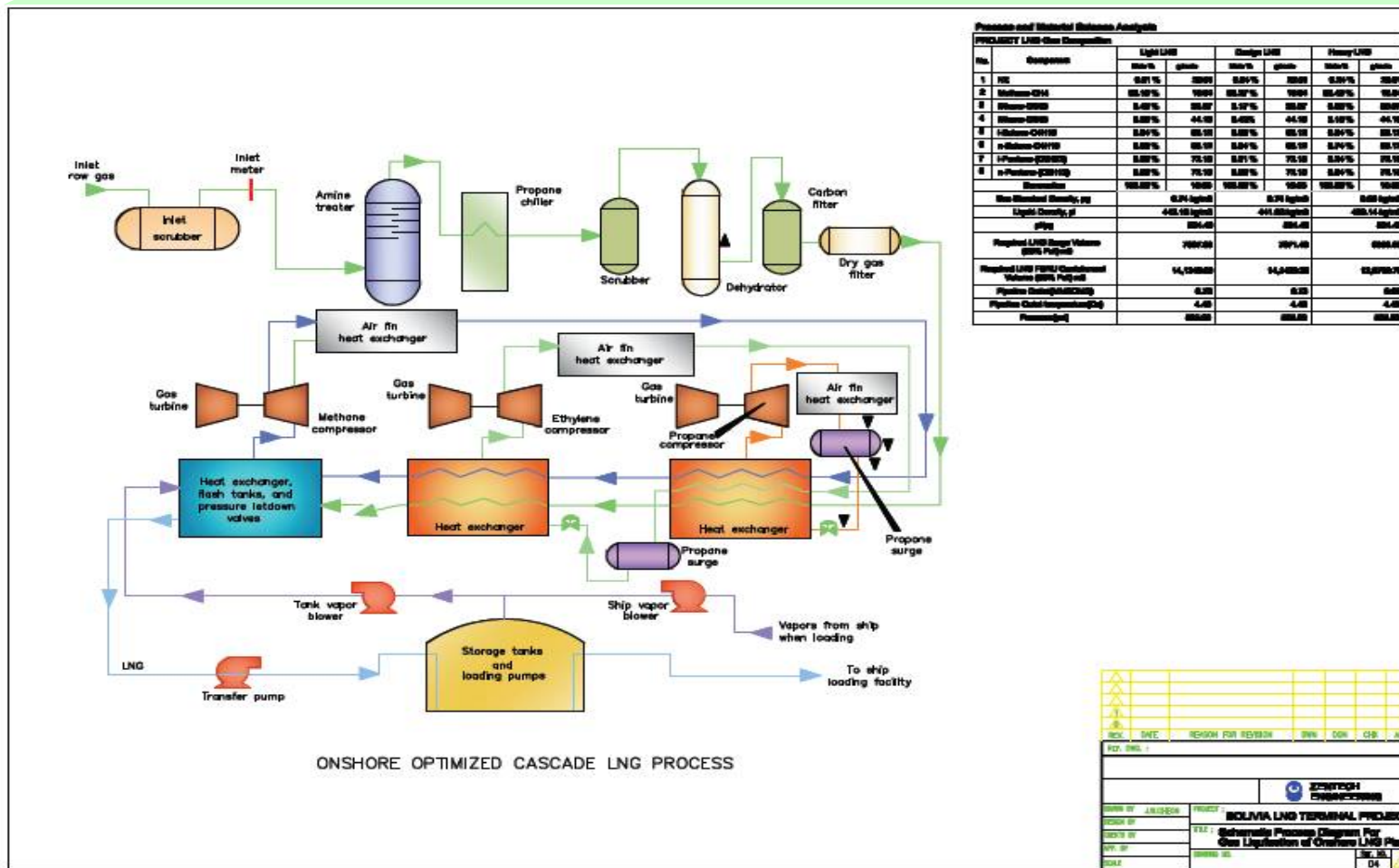
1. The Natural Gas Liquefaction plant and loading Terminal shall be located at Parana Paraguay Waterway to produce and load LNG to the LNG barge.
2. The capacity of LNG plant shall be 10,000 CM Per Day and another 10,000 CM Per Day shall be prepared for further expansion



2.0 Project Summary

LCT001 PHASE


SCHEMATIC PROCESS DIAGRAM FOR LCT 001



Process and Material Balance Analysis

PROPOSED LNG Gas Composition

No.	Component	Light LNG		Design LNG		Heavy LNG	
		mol%	g/mol	mol%	g/mol	mol%	g/mol
1	H ₂	0.01%	2000	0.01%	2000	0.01%	2000
2	Methane-CH ₄	85.50%	1600	85.50%	1600	85.50%	1600
3	Ethane-C ₂ H ₆	8.80%	88.00	8.50%	85.00	8.80%	88.00
4	Propane-C ₃ H ₈	0.80%	44.00	0.80%	44.00	0.80%	44.00
5	i-Butane-C ₄ H ₁₀	0.00%	58.10	0.00%	58.10	0.00%	58.10
6	n-Butane-C ₄ H ₁₀	0.00%	58.10	0.00%	58.10	0.00%	58.10
7	i-Pentane-C ₅ H ₁₂	0.00%	72.10	0.00%	72.10	0.00%	72.10
8	n-Pentane-C ₅ H ₁₂	0.00%	72.10	0.00%	72.10	0.00%	72.10
	Residual	100.00%	1000	100.00%	1000	100.00%	1000
	Max Molecular Weight (M)	0.24 kg/mol		0.24 kg/mol		0.24 kg/mol	
	Liquid Density, ρ	445.00 kg/m ³		441.00 kg/m ³		435.00 kg/m ³	
	ρ _{air}	890.00		890.00		890.00	
	Required LNG Storage Volume (20% Pad)	700.00		697.00		690.00	
	Required LNG FSHU (Overhead) Volume (20% Pad)	14,000.00		14,000.00		14,000.00	
	Pipeline Diameter (mm)	0.00		0.00		0.00	
	Pipeline Cold Temperature (°C)	4.00		4.00		4.00	
	Pressure (MPa)	80.00		80.00		80.00	

REV	DATE	REASON FOR REVISION	BY	CHK	CR	APP
 ZENTECH ENGINEERING						
DESIGN BY	ANIL KISHOR	PROJECT	BOLIVIA LNG TERMINAL PROJECT			
DESIGN NO		TITLE	Schematic Process Diagram For Gas Liquefaction of Onshore LNG Plant			
DATE		ISSUE NO		REV. NO.		
				04		

Project Summary

LCT001 PHASE

SCOPE OF WORK FOR FEASIBILITY(COST ESTIMATION)

- ✚ **LNG Liquefaction Plant for 10,000CM Per Day**
 - **Pre treatment facilities of Raw Gas.**
 - **Liquefaction Process**
 - **LNG Storage Tank**

- ✚ **Loading and berthing facilities for LNG Barge.**
 - **Quay (Berthing and Mooring Dolphin) and Terminal**
 - **Loading Arm System**

Project Summary

LCT002 PHASE

SUMMARY FOR LCT002

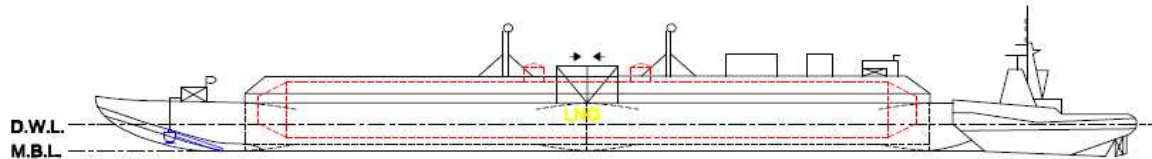
- ✦ For the safe and successful transportation of LNG through Parana Paraguay Waterway, a special type of self propelling LNG Barges shall be developed.
- ✦ Demand for natural gas in the South American Nations is at an all time high and projected to only increase, and there is huge amount of natural gas in Bolivia and Bolivia can use Parana Waterway to export their natural gas to other country by shipping LNG Barges instead of LNG Carrier or pipe lines.
- ✦ A key factor in meeting Uruguay demand of 3,000,000 CMB of Natural Gas will be delivering natural gas to LNG phase to the customer's door step.
- ✦ Economic analyses have shown that LNG can be transported by barge very economically, even if the barge is utilized only during the "peaking season" and out of service for the balance of the year.

Project Summary

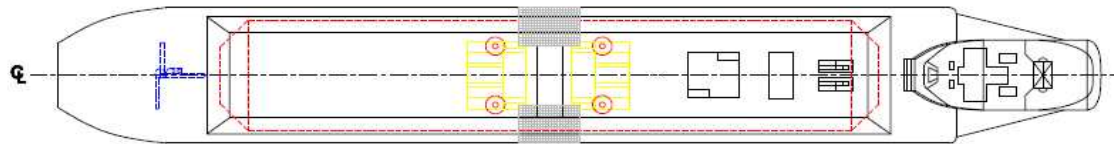
LCT002 PHASE

SUMMARY FOR LCT002(Membrain Type)

LNG Barge Concept G.A



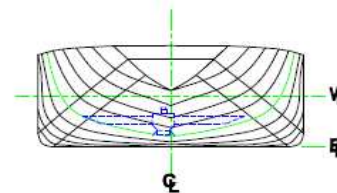
LNG Barge Concept G.A Side View



LNG Barge Concept G.A Plan View



LNG Barge Concept 3D View



LNG Barge Concept G.A Front View

Nota: The LNG barge is 60,000 DWT barge.
 D.W.L.: Design Water Line
 M.B.L.: Moled Base Line

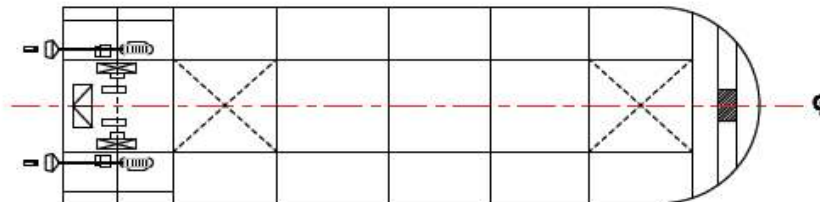
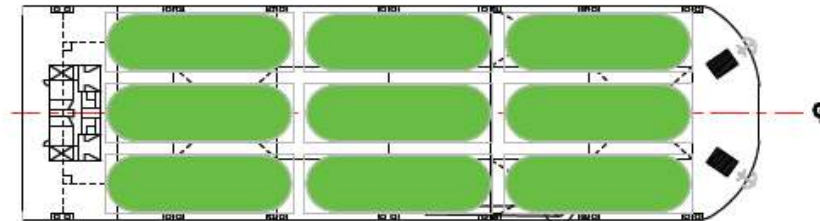
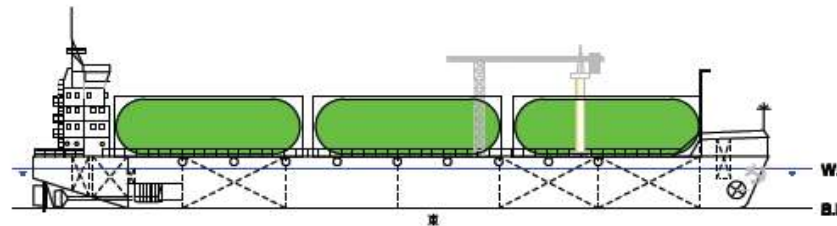
REV.	DATE	REASON FOR REVISION	OWN	CHK	DATE	APP

ZENTECH ENGINEERING	
DESIGN BY	PROJECT: BOLIVIA LNG TERMINAL PROJECT
CHECKED BY	TITLE: LNG Barge Concept G.A
APP. BY	DATE: 01/01/2010
SCALE	SHEET NO. 01 OF 0

Project Summary

LCT002 PHASE

SUMMARY FOR LCT002(ISO-Tank Type)



PRINCIPAL PARTICULARS

LENGTH O.A.	: 88.00 M
LENGTH B.P.	: 84.00 M
BEAM B.P.	: 8.00 M
DRAUGHT (MOL)	: 8.00 M
ISO LHD TANK	: 4x8.00 M x 22.00 M x 2.00 M
PERMISSIBLE CRANE	: 80 TON x 22M BEAM LENGTH
MAX. SPEED(KNOTS)	: 18
TWIN SCREW	: 2.8 M - 4PUSH
ENGINE	: 2 SETS - 3,000 KW
SCW TENDER	: 1

FLUID CHARACTERISTICS

DENSITY OF LHD	: 475.0 KG/M ³
DEAD WEIGHT	: 3,000 MT
TEMPERATURE OF LHD	: -101.00 °C
LHD PRESSURE	: 1.57 ATMG

REV.	DATE	SEARCH FOR REVISION	ISS.	CHK.	APP.

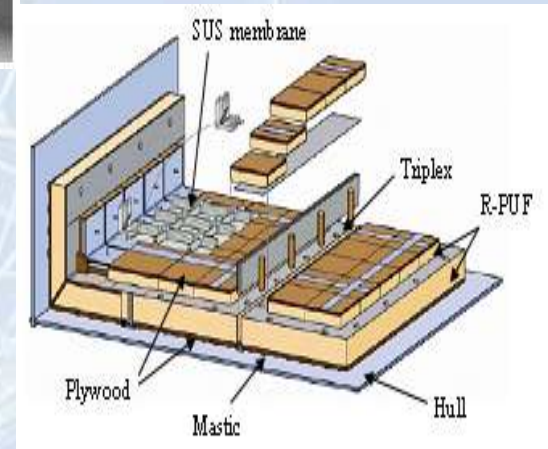
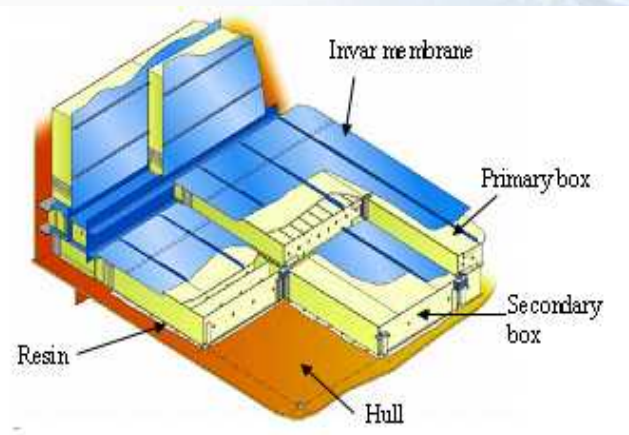
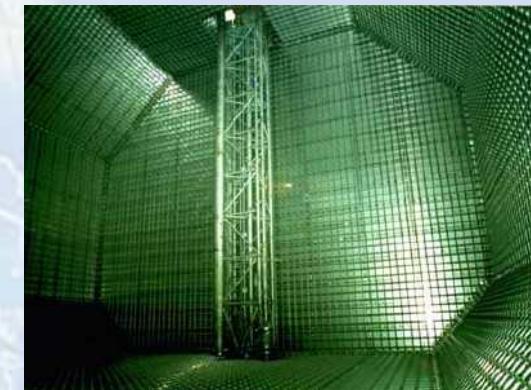
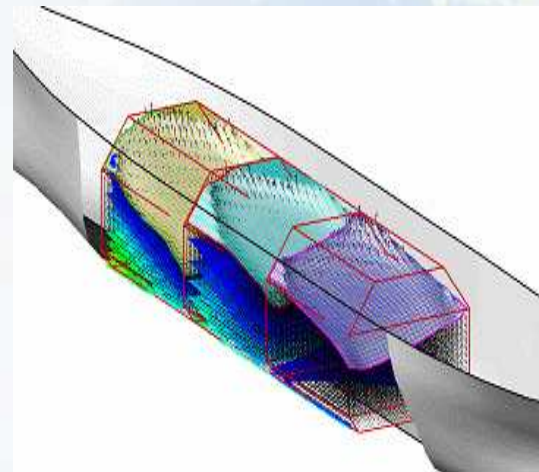
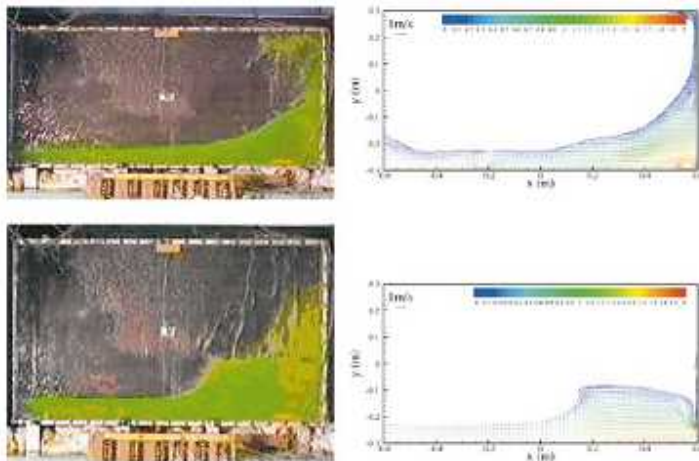
ZEN TECH ENGINEERING	
DESIGN BY	DATE
CHECK BY	TITLE
APP. BY	SUMMARY LHD GENERAL ARRANGEMENT
DATE	REV. NO.
01	0

Project Summary

LCT002 PHASE

SUMMARY FOR LCT002

Sloshing Effect of Membrane Tank



Mark III Tank and Insulation

NO96 Tank and Insulation

Project Summary

LCT002 PHASE

SCOPE OF WORK FOR FEASIBILITY(COST ESTIMATION)

- ✦ Since a ratio of natural gas(NG) and liquefied natural gas(LNG) phase is 1/600, 3,000,000 CM Per day of natural gas is equal to 5,000 CM Per day of LNG.
- ✦ In order to transport 5,000 CMB LNG Per Day to Uruguay
 - Current Speed = 3Knots
 - Voyage Speed = 7Knots
 - River Distance = 2600Km
 - Return Trip Distance = 5200Km
 - Period of Return Trip = 406.5 Hours
 - Loading and Unloading = 12Hours
 - Total Required Hours = 418.5 Hours
 - Working Hour/day = 17 Hours
 - Required Return Trip Days = 24.6 Days
 - Required Supply to Uruguay = 5000CMD
 - Required LNG Barge = 24 Nos

Project Summary

LCT002 PHASE

SCOPE OF WORK FOR FEASIBILITY(COST ESTIMATION)

- Due to the waterway condition (Barge draft limitation) between Bolivia and Uruguay, one 5,000 CBM LNG Barge is not navigable.

Project Summary

LCT003 PHASE

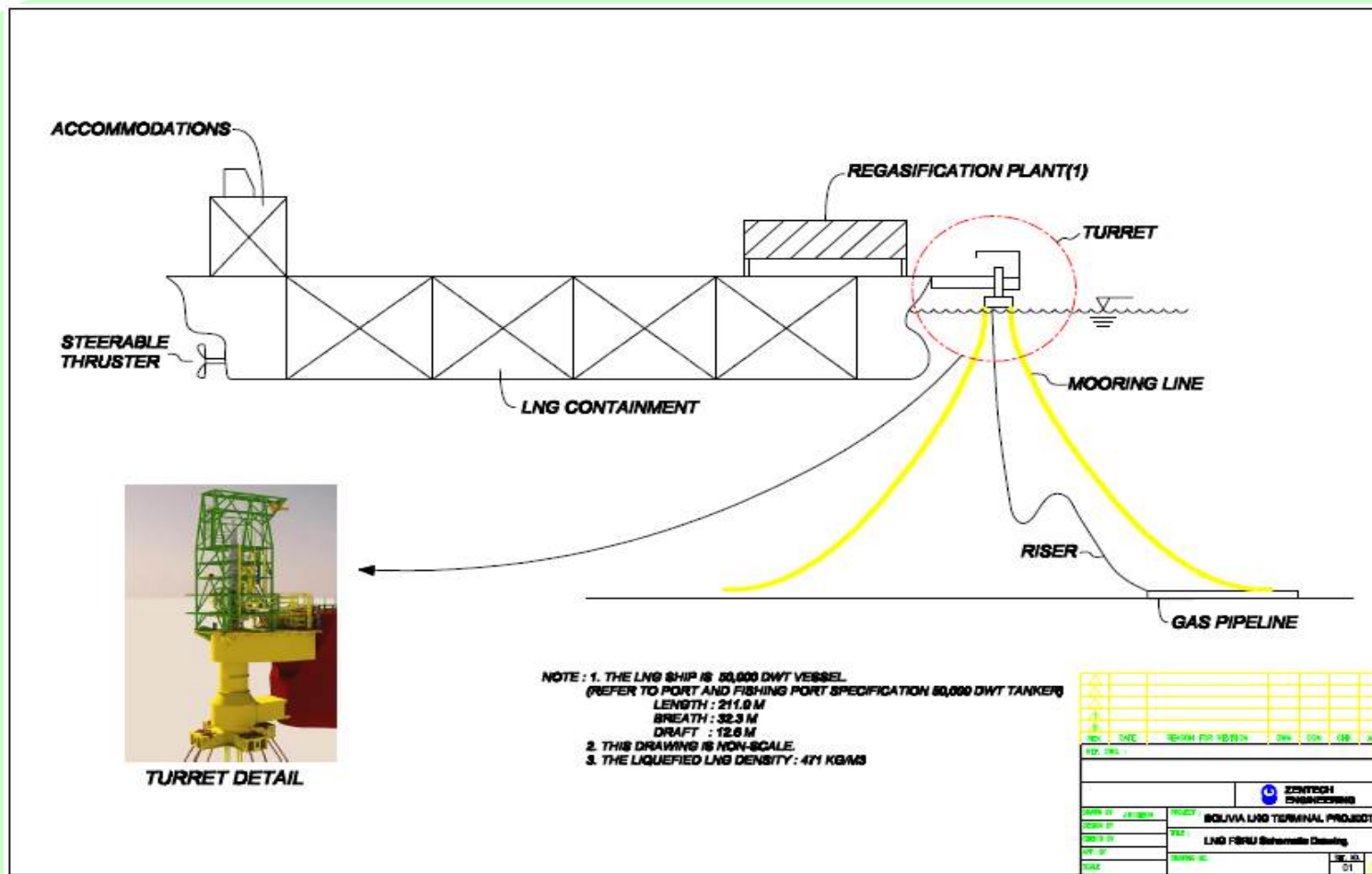
SUMMARY FOR LCT003

The FSRU receive LNG from LNG Barges at its LNG storing tank and Regasification unit of FSRU regasify LNG to natural gas(NS) and then the natural gas is transferred to the shore. Cold temperature recovery plant can also be accommodated on the flat and wide deck.

Project Summary

LCT003 PHASE

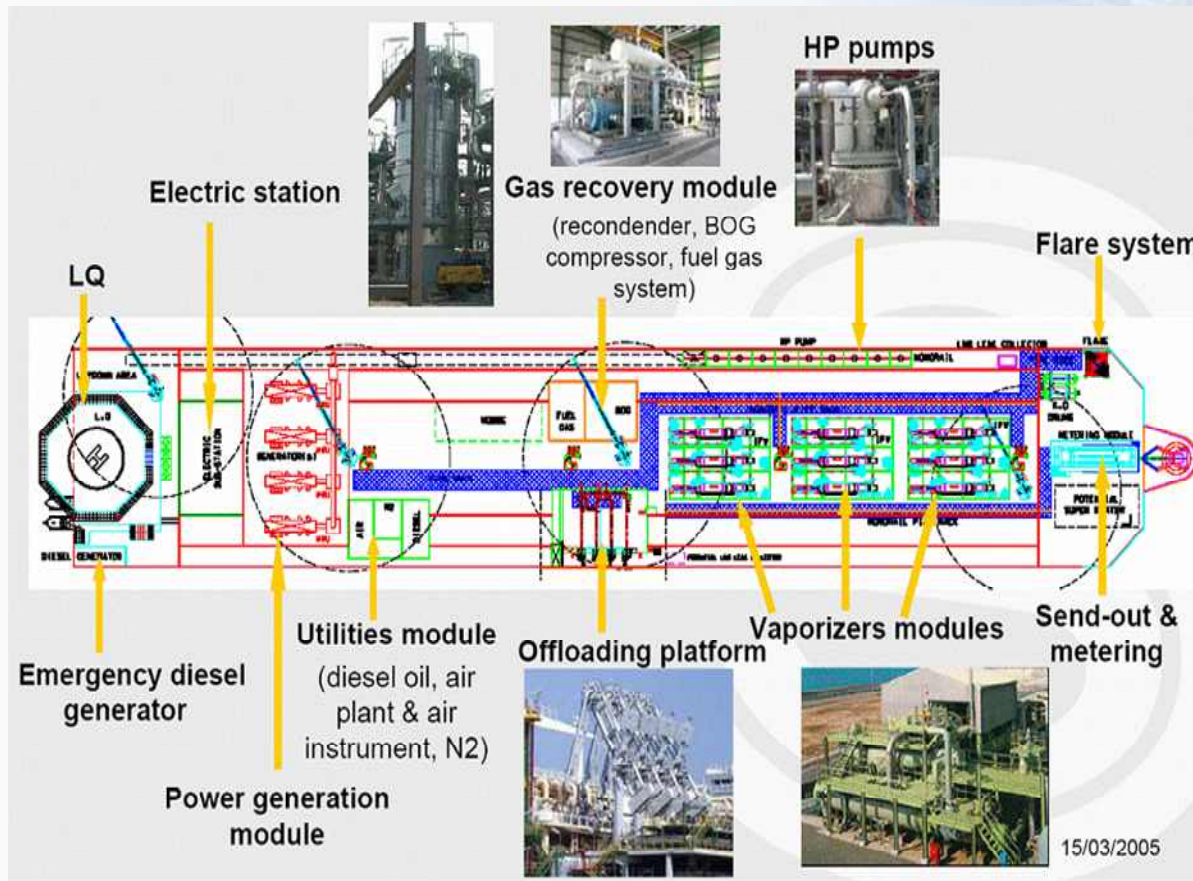
SUMMARY FOR LCT003



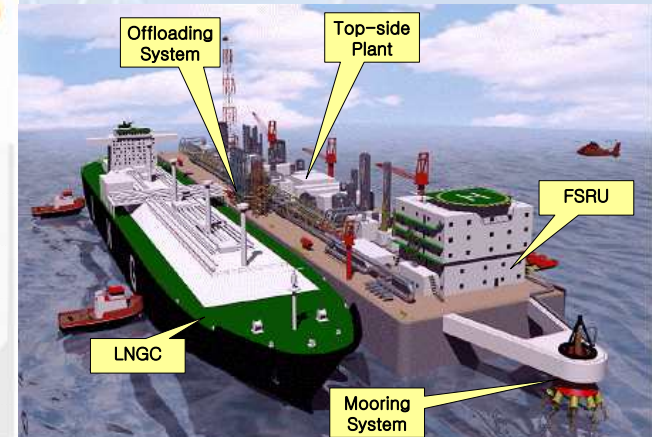
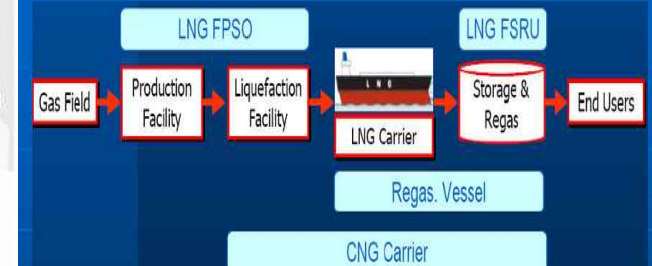
Project Summary

LCT003 PHASE

- Hull Structure [FSRU Hull]
- Mooring System
- Berthing for LNGC
- LNG Loading and Unloading System
- LNG Re-gasification Plant
- Monitoring and Control System
- Accommodation



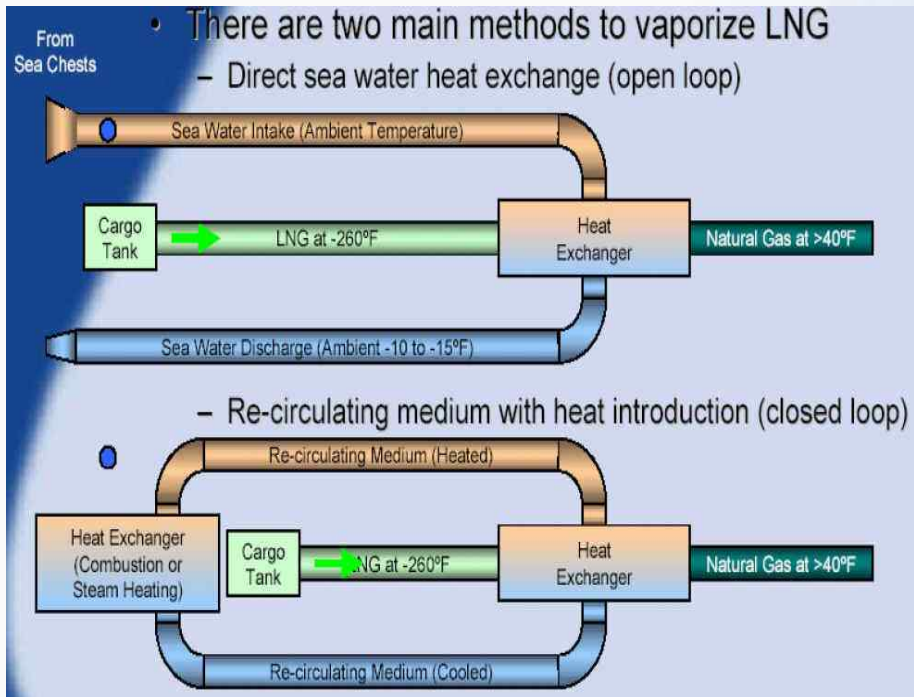
New Products Revolutionizing NG Production & Supply



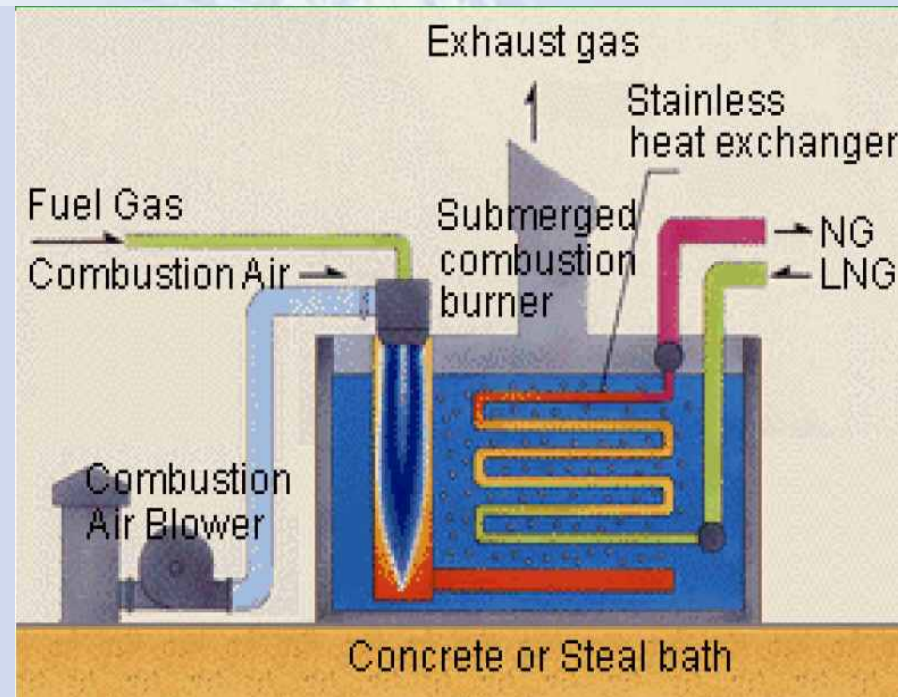
Project Summary

LCT003 PHASE

REGASIFICATION SYSTEM FOR LCT 003



ORV (OPEN RACK VAPORIZER)



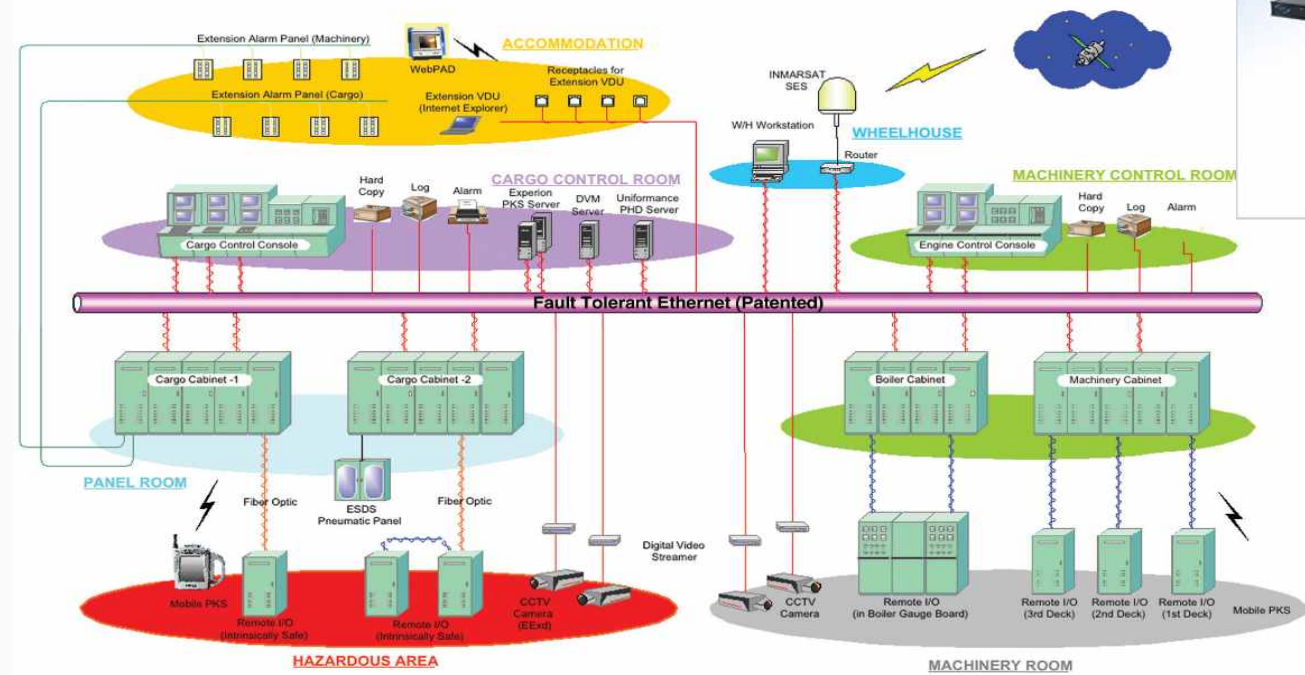
SCV (SUBMERGED COMBUSTION VAPORIZER)

Project Summary

LCT003 PHASE

Monitoring and Control System FOR LCT 003

Item	Top-side	UnderWater
Compo nents	<ul style="list-style-type: none"> . Hull Monitoring . Single Buoy Monitoring . Environmental Monitoring . Location Monitoring . Acceleration Monitoring . CCTV Monitoring . Emergency Monitoring . Sloshing Pressure 	<ul style="list-style-type: none"> . ROV Monitoring . Mooring Line Tension Monitoring . SPM Monitoring . Environmental Monitoring . Hull Monitoring(Underwater) . CCTV Monitoring . Touchdown zone Monitoring . Riser and Anchor Chain Monitoring



Fluid Dynamic Measurement Device

Project Summary

LCT003 PHASE

SCOPE OF WORK FOR FEASIBILITY(COST ESTIMATION)

- ✦ LNG FSRU of storage 50,000CM per FSRU with Turret and Riser/Pipeline to Onshore Receiving Station.
- ✦ Water depth will be required around 10m from chart datum line

3.0 Project Organization

Design Office Address:

6Fl, Chung-Am Bldg, 834-46 Yeoksam Dong, Gangnam Gu, Seoul #135-080, Korea

Contact Point :

Tel No. : (82)-2-556-0781~2
and Fax No. : (82)-2-556-0796

e-mail :
bychoi@zentechpe.co.kr

Contact personnel : B. Y. CHOI



4.0 Project Consideration

LCT001: Liquefaction LNG PLANT

- Supply 3 mil. CM Per Day of natural gas to LNG 5,000CM Per Day.
 - Considering efficiency of production, it will be capable of 10,000CM Per Day.
- 1) Raw Gas Composition
 - 2) Site Environmental condition such as Seismic, Wind and River of Amazon's current and Wave
 - 3) Site Soil and Foundation Condition and Water depth of LNG loading Terminal

Project Consideration

LCT002: LNG BARGE

- To transport 5,000 CMB LNG Per Day to Uruguay, almost fourteen (14) 2,500 CMB self propelling LNG Barges having barge draft 2.1 meter shall be required.
- 1) Minimum required storage Volume of LNG Barge
 - 2) Water depth of transportation Route for river of Amazon around 2,600Km
 - 3) Water wave and current for Dry and Flooding season of Amazon River.

Project Consideration

LCT003: LNG FSRU

- LNG FSRU of storing LNG 50,000CM with Turret and Riser/Pipeline to Onshore Receiving Station.
 - 1) Minimum required storage in FSRU including emergency condition
 - 2) Water depth of FSRU location
 - 3) Distance from Shore to FSRU for subsea pipeline
 - 4) Site Environmental condition such as Wave, Current and Wind information
 - 5) Torrent Mooring Anchored Seabed Soil information.
 - 6) Capacity for 10 days LNG consumption quantity

5.0 Design Criteria

LCT001: Liquefaction LNG PLANT

- ✦ Supply 3,000,000 CM Per Day of Natural Gas to LNG
5,000CM Per Day.
- ✦ However considering efficiency of production, it will be
capable of producing 10,000CM Per Day.
- ✦ Raw gas Composition

Design Criteria

LCT001: Liquefaction LNG PLANT

Raw Gas Component	Typical Analysis	Range
	(mole %)	(mole %)
Methane	95.2	87.0 - 96.0
Ethane	2.5	1.5 - 5.1
Propane	0.2	0.1 - 1.5
iso - Butane	0.03	0.01 - 0.3
normal - Butane	0.03	0.01 - 0.3
iso - Pentane	0.01	trace - 0.14
normal - Pentane	0.01	trace - 0.04
Hexanes plus	0.01	trace - 0.06
Nitrogen	1.3	0.7 - 5.6
Carbon Dioxide	0.7	0.1 - 1.0
Oxygen	0.02	0.01 - 0.1
Hydrogen	trace	trace - 0.02
	100.01	
Specific Gravity	0.58	0.57 - 0.62
Gross Heating Value (MJ/m ³), dry basis *	37.8	36.0 - 40.2

Design Criteria

LCT002: LNG BARGE

- ✚ LNG Barge of 2,500 CM per LNG Barge with associated Cargo handling System that will be located Santa Cruz in BOLIVIA.

LCT003: LNG FSRU

- ✚ LNG FSRU of storage 50,000CM per FSRU with Turret and Riser/Pipeline to Onshore Receiving Station will be located in Uruguay Port.

6.0 Discipline Scope of Work

- 
- **Project Management Team**
 - 1) **Global Coordinates and Feasibility Works**
 - 2) **Feasibility Works Review.**
 - 3) **Technical Meeting**
 - 4) **All Activities**

 - **Feasibility Study Team**
 - 1) **Each Phase Feasibility Works**
 - 2) **Schematic Design Work.**
 - 3) **Process and M&E Works**
 - 4) **Civil and Structure Works**
 - 5) **LNG Barge and FSRU Hull Schematic Design Works**
 - 6) **B.O.Q and Construction Cost Estimation Works**
 - 7) **Construction Method Feasibility Works**

 - **Site assistant**
 - 1) **Site Surveyor Team**
 - 2) **Site Soil Condition Investigation Works**
 - 3) **Site Environmental Condition Investigation Works**
 - 4) **Raw Gas Composition Investigation Works.**

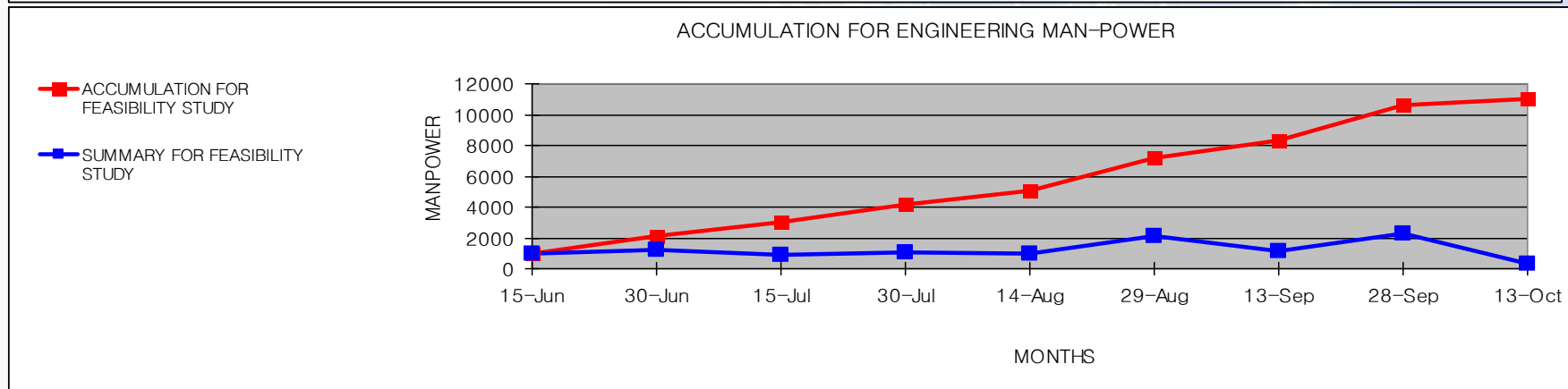
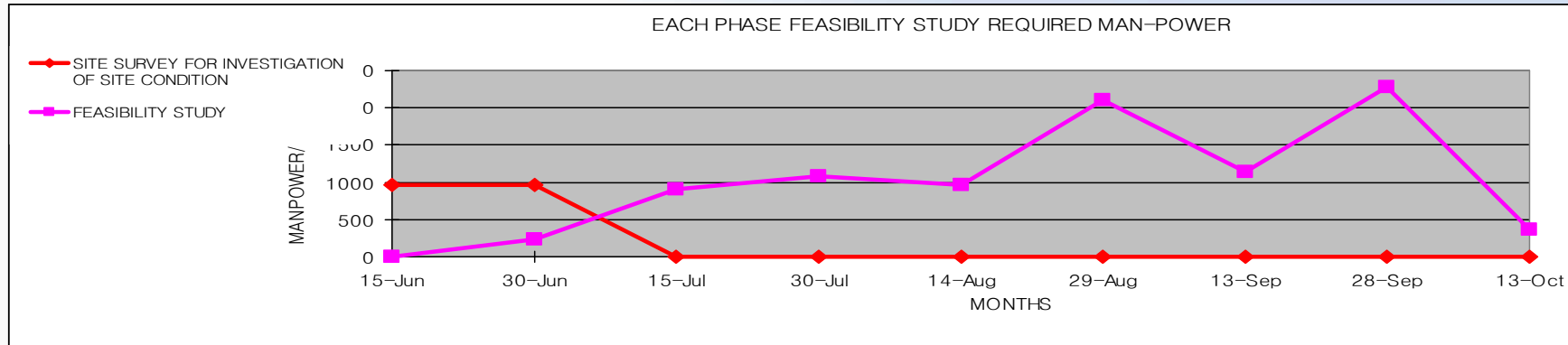
7.0 Feasibility Schedule

Feasibility Detail Schedule


No	CATEGORIES	Man	2010									SUMMARY
			Jun-2010		Jul-2010		Aug-2010		Sep-2010		Oct-2010	
			15-Jun	30-Jun	15-Jul	30-Jul	14-Aug	29-Aug	13-Sep	28-Sep	13-Oct	
	Milestone		LCT001		LCT002		LCT003		Final issue			
1	SITE SURVEY FOR INVESTIGATION OF SITE CONDITION	8	960	960	0	0	0	0	0	0	1920	
	1) LCT001 Site Condition and Raw Gas Information	4	480	480							960	
	3) LCT003 Site and Environmental Condition	4	480	480							960	
2	FEASIBILITY STUDY	50	0	240	900	1080	960	2100	1140	2280	360	9060
	1) LCT001	15	0	240	900	900	0	0	0	0	0	2040
	(1) Process/Mech/Elec	4		240	240	240						720
	(2) Foundation/Jetty/Module Structure	4			240	240						480
	(3) Equipment/Civil/Structure BOQ and Cost	4			240	240						480
	(4) Equipment Installation/Shipment Method	3			180	180						360
	2) LCT002	16	0	0	0	180	960	960	0	0	0	2100
	(1) Cargo Handling System	4					240	240				480
	(2) Cargo Handling Piperack Design	3					180	180				360
	(3) LNG Barge/Containment/Barge Motion Design	3				180	180	180				540
	(4) LNG Barge BOQ and Cost	3					180	180				360
	(5) LNG Barge Tran from Fab Yard to site Method	3					180	180				360
	3) LCT003	19	0	0	0	0	0	1140	1140	2280	0	4560
	(1) Regasification Process/ M&E	4						240	240	480		960
	(2) Regasification Topside/Riser/Pipeline Design	4						240	240	480		960
	(3) FSRU Hull/ Containment/FSRU Mooring Design	4						240	240	480		960
	(4) FSRU BOQ and Cost	4						240	240	480		960
	(5) FSRU/Riser/Pipeline Installation Method	3						180	180	360		720
4)	FINAL Presentation / Discussion and Final Submission	3	0	0	0	0	0	0	0	0	360	360
SUMMARY FOR FEASIBILITY STUDY		61	960	1200	900	1080	960	2100	1140	2280	360	10980
ACCUMULATION FOR FEASIBILITY STUDY		61	960	2160	3060	4140	5100	7200	8340	10620	10980	10980

Feasibility Schedule

Schedule for S-Curve



Working Period for Feasibility

-  **SITE SURVEY(1 month)**
-  **FEASIBILITY FOR LCT001/LCT002/LCT003(3 months)**
-  **PRESENTATION / DISCUSSION/ FINAL SUBMISSION(0.5 month)**

8.0 Cost for Feasibility Study of LCT Project

Cost of Feasibility Study for LNG Chain Trading between Bolivia and Uruguay for YPFB, Bolivia has been included Site Survey and Final discussion in Site of Bolivia.

No.	Phase	Required M/H	Unit Price	Total Cost
SITE SURVEY				153,600
1	SITE SURVEY	1,920M/H	80USD/HR	153,600
FEASIBILITY				637,800
1	LCT001	2,040M/H	70USD/HR	142,800
2	LCT002	2,100M/H	70USD/HR	147,000
3	LCT003	4,560M/H	70USD/HR	319,200
4	Presentation / Discussion and Final Submission	360M/H	80USD/HR	28,800
SITE SURVEY AND FEASIBILITY COST				791,400

Total Lump-sum Price; Seven Hundred Ninety One Thousand and Four Hundred US Dollar Only.

FEASIBILITY STUDY OF LNG CHAIN TRADING BETWEEN
BOLIVIA AND URUGUAY FOR YPFB, BOLIBIA



Thank You !

Visiting address for ZENTECH ENGINEERING

6 Fl. Chung-Am Bldg. 834-46 Yeoksam-Dong, Gangnam-GU, Seoul #135-080, Korea

Phone: 82-2-556-0781~2

email : bychoi@zentechpe.co.kr (Seoul)

Fax: 82-2-556-0796

: knam@zentechpe.co.kr (Johor, Malaysia)

Key personnel : B.Y. CHOI (C.E.O-Seoul)

: K. H. NAM (Johor)