Report

on

SAARC Workshop on Experience Sharing of Construction, Operation and Maintenance of LNG Facilities in India

In Collaboration with
GAIL Training Institute, Noida, Uttar Pradesh, India

22-23 April, 2014
River View Resort, Chiplun, Near Dabhol, Maharashtra, India.

SAARC Energy Centre
House No. 697, Street No. 43, E-11/4 (NPF), Islamabad,Pakistan
Web: www.saarcenergy.org, E-mail: info@saarcenergy.org

1. The SAARC Workshop on **Experience Sharing of Construction, Operation and Maintenance of LNG Facilities in India** was held in River View Resort, Chiplun, Near Dabhol, Maharashtra, India on 22-23 April 2014 with the collaboration of GAIL Training Institute, Noida, Uttar Pradesh, India.

2. The programme of the workshop is attached as *Annex.- I*.

3. The following 15 delegates from the Member States namely Afghanistan, Bangladesh, India, Maldives and Sri Lanka participated in the workshop.

Afghanistan	Mr. Zahid Waleed Commercial attache Consulate General of Afghanistan-Mumbai
Bangladesh	Dr. Syed Masum Ahmed Choudhury Deputy Secretary Energy & Mineral Resources Division Ministry of Power, Energy and Mineral Resources
	Mr. Kazi Mohammad Anwarul Azim Manager (LNG Cell) Bangladesh Oil, Gas and Mineral Corporation (Petrobangla)
India	Mr. Manas Das DGM (Marketing) GAIL (India) Limited
	Mr. Asheesh Shrivastava SM (BD) GAIL (India) Limited
	Mr. Ayush Gupta DGM (HRD) GAIL (India) Limited
	Mr. Saikat Chakraborty Deputy Manager GAIL (India) Limited
	Mr. Aneel Bhatt Sr. Manager (Marketing) GAIL (India) Limited
	Mr. A.K. Thapa Deputy Manager (HR) GAIL (India) Limited

	Mr. S. Roy Mandal DGM (O & M) GAIL (India) Limited
	Mr. R.K. Potla Chief Manager (HR) GAIL (India) Limited
Maldives	Mr. Abdullah Maumoon Managing Director Maldives Gas Private Limited
	Mr.Ahmed Mohamed Shuaib Assistant Manager State Trading Organization
Sri Lanka	Mr. R.J. Gunawardana Addl. Secretary (Technical) Ministry of Power & Energy
	Mr. M.G.A. Goonetilleke Director (Technical) Ministry of Power & Energy

4. The delegation from each Member State made their country presentation to the participants of the workshop on the subject as well as overview of energy supply and demand situation in their respective country. Their presentations are attached as *Annex.- II to V*.

5. The workshop included various technical sessions on LNG industry overview, issues & challenges in the LNG value chain, experience sharing on terminal commissioning, operation & maintenance of LNG facility and economics of the LNG facility. The Resource Persons for this workshop were renowned LNG Industry experts from GAIL (India) Limited, Ratnagiri Gas and Power Private Limited (RGPPL), Petronet LNG Limited (PLL), Indian Oil Corporation Limited, Hazira LNG Private Limited and Shell. The following five Resource Persons participated in the workshop. Their topics are given in front of their names.

    - *LNG Industry Overview: Issues & Challenges (including LNG Value Chain: Exploration, Liquefaction, Shipping, Storage & Regasification)* by Mr. V. N. Datt, General Manager (Marketing), GAIL (India) Limited;

- *LNG Facility Project: from concept to commissioning* by Mr. A. K. Jana, Deputy Managing Director, Ratnagiri Gas and Power Private Limited (RGPPL), India;

- *Operation & Maintenance of LNG Facility* by Mr. Sanjay Kumar Rastogi, General Manager (Operations), Petronet LNG Limited (PLL), India;

- *Economics of LNG Facility* by Mr. Sham Sunder, Principal Advisor (Business Development-Gas), Indian Oil Corporation Limited and Ex-Director-PLL , India;

- *Safety in LNG Facilities* by Mr. Devendra Bathija, HSE Manager, Hazira LNG Private Limited, India;

The presentations of Resource Persons are attached as *Annex.-VI to X*.

6. The workshop was inaugurated by Mr. A. K. Jana, Deputy Managing Director, Ratnagiri Gas and Power Private Limited (RGPPL), India. Mr. Sunil Kumar, General Manager (Training), GAIL (India) Limited delivered his Welcome Speech in inaugural session of the workshop. His speech is placed at *Annex.- XI*.

7. On behalf of Director SAARC Energy Centre, Islamabad, Mr. Md. Anwarul Islam, Research Fellow welcomed the delegates in SAARC workshop. His Welcome Speech is placed at *Annex.-XII*.

8. A Welcome Dinner was hosted for the participants on 21 April 2014 in River View Resort, Chiplun which was also attended by senior officials of GAIL (India) Limited which provided an excellent opportunity for informal exchange of views on LNG Industry.

9. In the valedictory session, after exhaustive discussion amongst the participants the following recommendations have been made:

    - It is recommended to organize such workshops more frequently in large scale for the SAARC nations and the capability building will have a very positive multiplier effect on the Energy-Economy of SAARC nations;

- To ensure regional energy security, SAARC Energy Centre may consider to arrange further workshops for Policy Makers from the Member States to ensure regional cooperation with special emphasize on LNG business;

- SAARC Energy Centre may arrange more workshops and training programmes exclusively on LNG sourcing, negotiation and contracting;

- SAARC Energy Centre may arrange ASME Certification Program with the help of GAIL (India) Limited;

- Options of LNG re-export from the planned/existing LNG receiving/re-gasification terminal(s) in India to the other SAARC nations may be explored;

- Transnational pipelines & natural gas trade among SAARC countries may be explored with the consideration of installing regional/sub-regional LNG terminals with associated facilities;

- Delegates recommend that SAARC Energy Centre may organize the visits of technical teams from Member Countries to the LNG facilities as well as Oil & Gas Processing facilities in other SAARC countries.

- GAIL (India) Limited, due to its vast presence in the entire LNG value chain, may be engaged/requested to guide and facilitate in development of the LNG facilities in other SAARC Member States.

10. On behalf of the participants from the Member States Mr. M.G.A. Goonetilleke, Director (Technical), Ministry of Power & Energy, Sri Lanka expressed a Vote of Thanks.

11. A field visit was arranged on 22 April 2014 to LNG Facility at Dabhol of Ratnagiri Gas & Power Private Limited (RGPPL) to give on ground perspective to the workshop participants. The participants visited jetty, control room, storage facility & other facilities at RGPPL's LNG terminal. Mr. Probhat Singh, Director-Marketing, GAIL (India) Limited attended in the Concluding Session as a Chief Guest, and distributed certificates among the participants.

Annex.-I

ADMINISTRATIVE CIRCULAR

SAARC Workshop on "Experience Sharing of Construction, Operation and Maintenance of LNG Facilities in India"

In collaboration with
GAIL Training Institute, NOIDA
Uttar Pradesh, India.

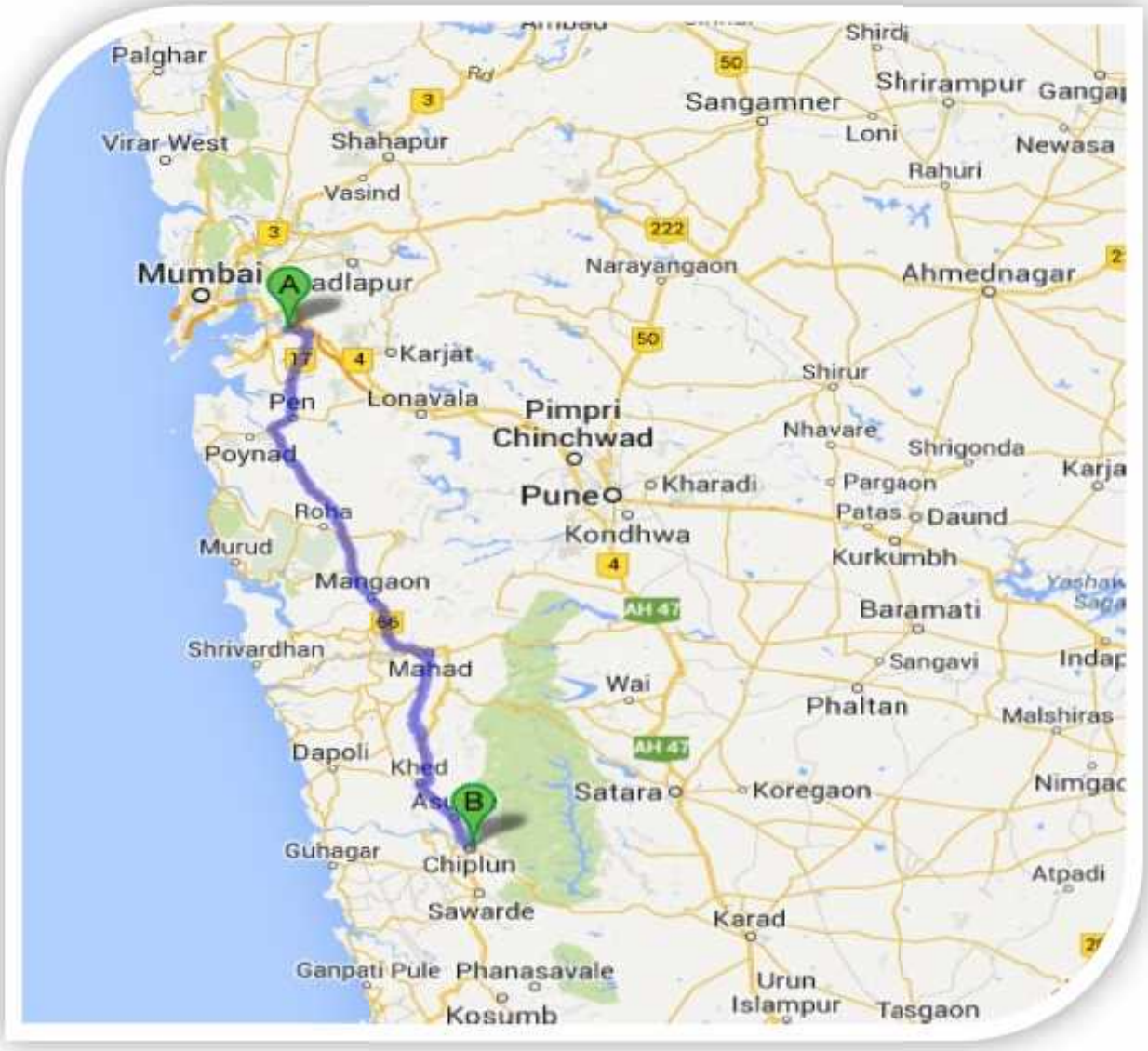
22-23April, 2014
River View Resort,ChiplunNearDabhol, Maharashtra, India.

SAARC Energy Centre
697, St No 43, E-11/4 (NPF), Islamabad, Pakistan
www.saarcenergy.org

SAARC Workshop on "Experience Sharing of Construction, Operation and Maintenance of LNG Facilities" is being organized at River View Resort Chiplun, Near LNG Terminal of M/s Ratnagiri Gas and Power Pvt. Ltd. Dabhol in Maharashtra, India in collaboration with GAIL Training Institute NOIDA Uttar Pradesh, India from 22-23 April, 2014. The Programme of the Workshop is attached.

Location of River View Resort, Chiplun.

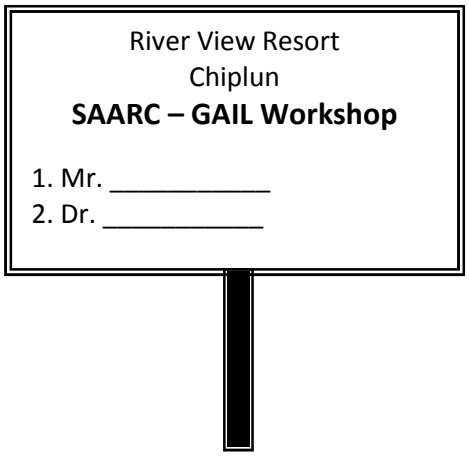
River View Resort Chiplun is 255 km from Mumbai International Airport and it takes 6 hours to reach there.



Address of River View Resort, India.

Dhamandivi, ParshuramKshetra, Near Parshuram Temple,
TalukaKhed, Lote, DistRatnagiri. Maharashtra 415707 India
Telephone Nos: +(91) 2355 259081 upto 83 & 205754 upto 56
Mobile No.: +(91) 9011009425
Fax: +(91) 2355 259080.
Email: info@chiplunhotels.com; alpanachauhan@chiplunhotels.com

A representative will be present at the Mumbai International Airport holding a placard (as per sample below) to receive the delegates. In case of facing any problem in tracking the representative of Hotel, please contact 24 hours hotel's concierge at +(91)2355259081. However, if there is any issue with regards to logistics, pick up/ drop arrangements, Mr. B K Kullu from GAIL may please be contacted at +(91)9967925113.



Contact officials for the workshop

1. **Mr. Md. Anwarul Islam**
   Research Fellow
   SAARC Energy Centre, Islamabad.
   Phone No.:+92-51-222 8802
   Cell No.: +92-345-4054344
   Email:anwar@saarcenergy.org

2. **Mr. Sunil Kumar**
   GM (Training)
   GAIL Training Institute
   Phone No.:+91-120-2515353
   Cell No.:+91 98 1198 8897
   Email: sk02404@gail.co.in

Information Regarding Hotel Rooms

SAARC Energy Centre has already reserved accommodation for the delegates who have confirmed their participation for the Workshop and reservations have been made in River View Resort, Chiplun. For guidance in this regard, please contact 24 hours hotel's concierge (contact numbers already provided on Page 2 of this Circular) or Mr. Shashank Saxena (Contact No. +91-88-0009-6084) from GAIL Training Institute.

Important Information

- Each delegate/participant is required to obtain visa for India pursuant to the Indian Rules and Regulations.
- The participants are required to take polio drops before traveling to India as per Indian immigration rules.
- SEC will provide hospitality for maximum three nights; delegates are advised to arrive in Mumbai in the forenoon on 21 April 2014 and depart on 24 April 2014.
- On 22 April 2014, the Workshop is scheduled to start at **0900** hrs whereas registration will be done from 1900 hrs to 2000 hrs on 21st April 2014. Programme of the Workshop is attached.
- Kindly furnish your travel itinerary to SEC (if you have not already done) so that you are received at the Mumbai International Airport, India and transported to River View Resort, Chiplun on complimentary basis.
- Please indicate in case you have any specific meal requirements so that hotel management is apprised about it.
- Kindly send the passport, VISA scanned copies &your travel itinerary by 5 April 2014 so that hotel is informed accordingly.
- A Welcome Dinner will be hosted for all delegates and dignitaries on 21 April 2014 at Hotel River View Resort, Chiplun from 2000 hrs onwards.
- During the Workshop on 22 and 23 April 2014, lunches will be provided. There shall be two tea breaks each on 22 and 23 April2014 during which tea/coffee and snacks will be served.
- No workstation shall be available; delegates are requested to bring their own laptops (if required), however, all presentations will be loaded on the laptop installed in the Workshop Venue.

General Information

- The temperature is expected to remain between 34-35 °C in Chiplun, India.
- The Currency of Indian Rupee (INR)- 1 US Dollar is approximately equivalent to INR **61.05.** Currency and foreign exchange rates can be calculated at http://www.oanda.com/currency/converter/
- The delegates may enjoy complimentary buffet breakfast, three pieces pressing of clothes per day per person and internet, however, facilities such as mini bar, telephone calls, room service and other incidentals are not included.

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Programme

SAARC Workshop on "Experience Sharing of Construction, Operation and Maintenance of LNG Facilities in India"

22-23April, 2014

River View Resort, Chiplun, India.

Monday, 21April, 2014	
Guests Arrive in Chiplun, India.	
Time(hrs)	**Description**
1900 onwards	Registration followed by Welcome Dinner
Tuesday, 22 April 2014	
Inaugural Session	
Time(hrs)	**Description**
0900 – 0905	Inaugural Programme: Welcome of Delegates
0905 – 0910	Welcome Address by Mr. Sunil Kumar, GM (Training), GAIL
0910 – 0915	Lighting of Lamp
0915 – 0920	Welcome Address by Md. Anwarul Islam, Research Fellow, SEC
0920 – 0925	Inaugural Address by Mr. A. K. Jana Dy. Managing Director, Ratnagiri Gas and Power Private Limited
0925 - 0930	Short Film on GAIL Training Institute, Noida
0930 - 1000	Group Photo, Refreshments, Networking
1000 – 1100	Country Presentations (10 minutes for each Member State) • Afghanistan • Bangladesh • India • Maldives • Sri Lanka
Technical Session – I **By: Shri V N Datt, GAIL**	
1100 – 1230	LNG Industry Overview: Issues & Challenges (including LNG Value Chain: Exploration, Liquefaction, Shipping, Storage & Regasification)
1230 – 1330	Travel for Ratnagiri Gas &Power Pvt.Ltd. (RGPPL),Dabhol

Time(hrs)	Description
1330 – 1430	Networking Lunch at RGPPL
Site Tour for RGPPL LNG Facility	
1430 – 1700	Visit to Jetty, Control Room & other facilities at RGPPL
1700 – 1730	Networking Tea at RGPPL, Dabhol
1730 – 1930	Visit to Guhagar Beach
1930 – 2030	Travel from RGPPL to River View Resort, Chiplun
Wednesday, 23rd April 2014	
Technical Session – II **By: Shri A K Jana, Ratnagiri Gas & Power Pvt. Ltd.**	
0930 - 1100	LNG Facility Project: from concept to commissioning
1100 – 1130	Networking Tea
Technical Session – III **By: Shri Sanjay Rastogi, Petronet LNG Ltd.**	
1130 – 1300	Operation & Maintenance of LNG Facility
1300 – 1400	Networking Lunch
Technical Session – IV **By: Shri Sham Sunder, Ex-Director, PLL**	
1400 – 1530	Economics of LNG Facility
1530 – 1600	Networking Tea
Technical Session – V **By: Shri DevendraBathija, Hazira LNG Pvt. Ltd.**	
1600 – 1730	Safety in LNG Facilities
Valedictory Session	
1730 - 1740	Recommendations and Roadmap
1740 – 1745	Concluding remarks by Research Fellow, SEC
1745 – 1800	Award of Certificates
1800 – 1805	Address by the Chief Guest
1805 – 1810	Vote of Thanks
Thursday, 24 April 2014	
Delegates Depart	

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Annex.-II

An Introduction To Afghanistan Natural Gas Resources

- The U.S. Geological Survey–Afghanistan Ministry of Mines and petroleum Joint Oil and Gas Resource Assessment Team, Using a geology-based assessment methodology, estimated mean volumes of undiscovered natural resources in Afghanistan: 1,596 million barrels of crude oil, 15,687 billion cubic feet of natural gas, and 562 million barrels of natural gas liquid.
- Exploration of Natural gas was started in 1957, Afghan natural gas production reached 275 million cubic feet per day (Mmcf/d) in the mid-1970s.

- Due to decline in reserves from producing fields, output gradually fell to about 220 Mmcf/d by 1980.
- Then Jorquduq field was drilled and it was expected to boost Afghan natural gas output to 385 Mmcf/d by the early 1980s.
- In the 1980s, **USSR** decided to build a 180km pipeline that would export natural gas across the Amu Darya into the country. The natural gas production increased to 240 Mmcf/d and 97 percent was exported to the USSR via the pipeline.
- Civil war and conflict severely hampered the export of natural gas and finally cut off the natural gas export. By the mid-1990s there was little mineral or oil and gas extraction.

Significant Hydrocarbon Basins are located in

I. **Amu-Darya basin:** Northern regions of Afghanistan, extended to Tajikistan.
II. **Afghan- Tajik basin:** Northern regions of Afghanistan extended to Uzbekistan and Turkmenistan.
III. **Helmand basin:** South-west of Afghanistan extended to Pakistan.
IV. **Katawaz basin:** south-east of Afghanistan extended to Pakistan.
V. **Herat basin(Tripul):** West of Afghanistan extended to Iran.

Map and table showing the major natural gas basin in Afghanistan

Basin	Area (km^2)	Crude Oil Potential (MBO)	Natural Gas Potential (TCF)
Amu Darya	57,000	76	8
Afghan Tajik	35,000	1,800	
Mazar-i-Sharif Block	31,000	1,600	7
Kunduz Block			
Helmand	131,000		
Tirpul (Herat)	26,000	27	
Katawaz	40,000		

Gas Reserves in northern Afghanistan that are stabilized to exploit :

- **Angot :** this Field is 6 km far from sary pul town, and 14 exploratory wells have been drilled in this field ,The overall reserve is about 4 million tones .
- **Aq Darya**: this field is located in four kilometers east of the Sarypul town and the first exploratory well was drilled in may 1974 and the overall reserve is estimated at about 2 million tones.
- **Khwaja Burhan** :Is located in 35 kilometers south-east of the city of Sheberghan and the over all reserve has been estimated 4 to 5 billion cubic meters.

- **Yatem Taq**: Is one of the largest gas fields in Jawzjan province and the over all reserve of this field is estimated around 20 to 25 billion cubic meters.
- **Khwaja Gugrdak:** This field is located 22 kilometers southeast of the town of Sheberghan overall reserves are estimated about 8/46 billion cubic meters operation started from 21 October 1967 .This area is part of the gas produced exported by pipeline to the Soviet Union and the other part of it was transferred to the power and fertilizer plant in Mazar-i-Sharif.
- **jarghdouq:** The field is located in Sheberghan and gas reserves are estimated around 41 billion cubic meters.

Gas resources present utilization

- present production from 35 producing well of 4 fields-Gerqudq, Yatim Taq, Khoja Gerdak and shakarak is: 567000 cubic meter.
- Gas supplied to Northern Fertilizer plant at Mazar sharif is: 456000 cubic meter
- About 100,000 cubic meter Gas is supplied to domestic consumers Sheberghan, Aqcha and Khoja dokoh Districts .
- A pilot project for CNG production is now at advanced stage at Shebergan.

Why to Invest in Afghanistan

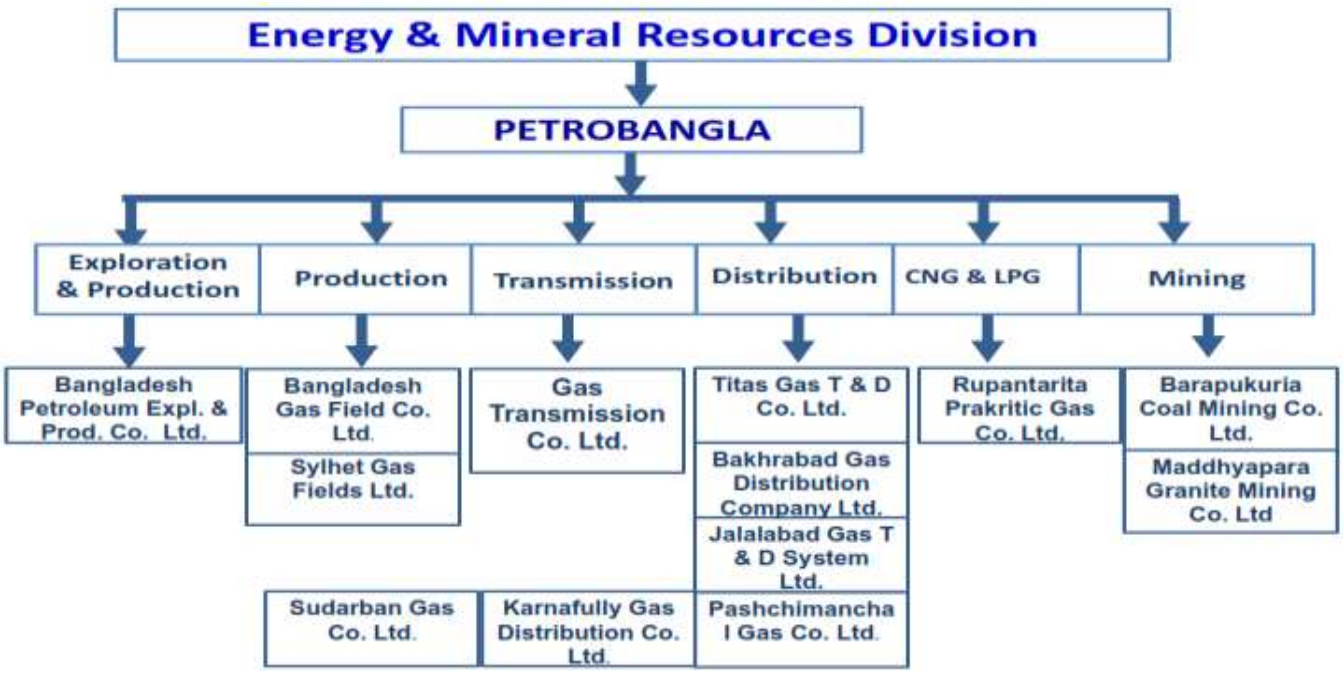
- Unique opportunities to access untapped mineral resources and underexplored region.
- Competitive and stable fiscal regime
- Strong support from government of Afghanistan and International community.
- Proximity to key growth markets, Afghanistan is the conduit between central, south and west Asia and Europe .
- Infrastructure development program focused on resource corridors.
- Assets located in Stable provinces with "Mines Protection Unit" Established to provide security.

Thank You

WELCOME
TO THE
Presentation on
ENERGY SECTOR OF BANGLADESH

SAARC – ENERGY WORKSHOP, CHIPLUN, INDIA

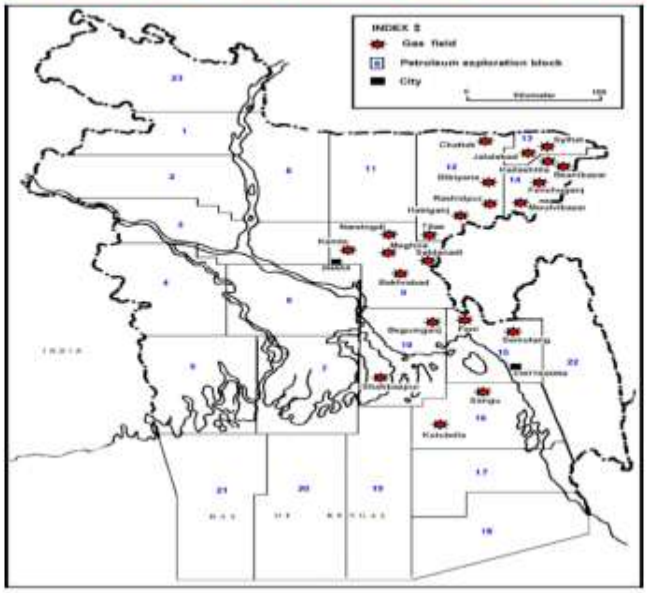
22 April , 2014



Vision 2021

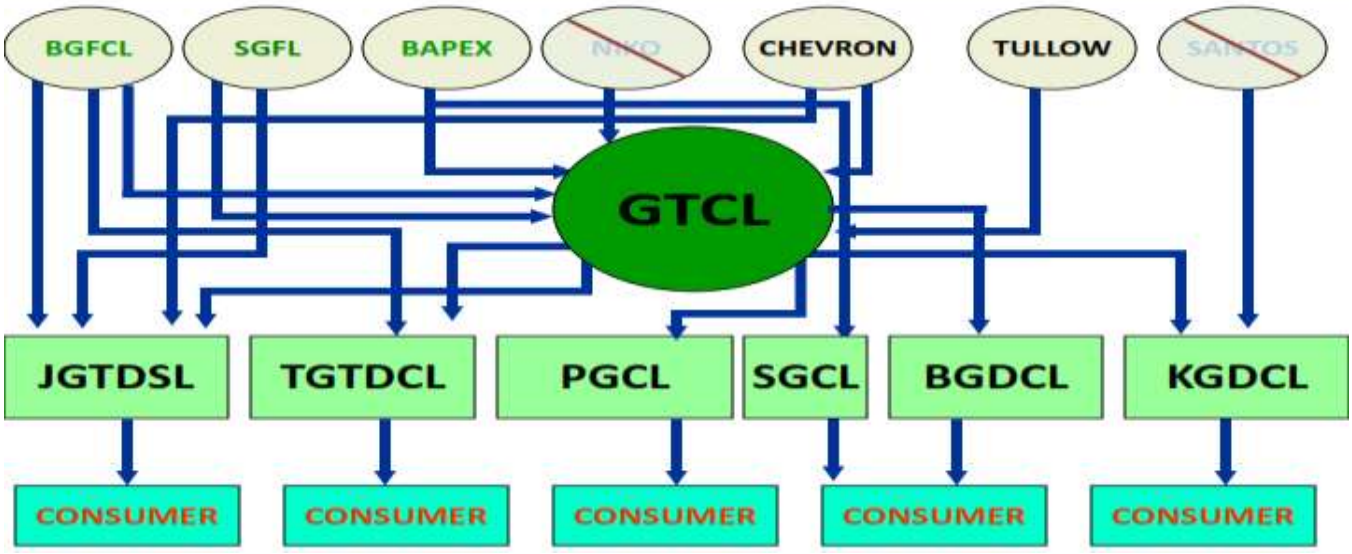
- ✓ Boosting GDP growth to 10% by 2021 and sustained thereafter
- ✓ Reducing poverty rate to 15%
- ✓ *Enhancing electricity supply to 20,000 MW (Coal base 53%)*
- ✓ *Domestic Coal Production : 10Mton/year*
- ✓ Provide affordable and reliable electricity for all by 2021
- ✓ Raising the economy to the level of a middle-income country

Location of gas fields of Bangladesh

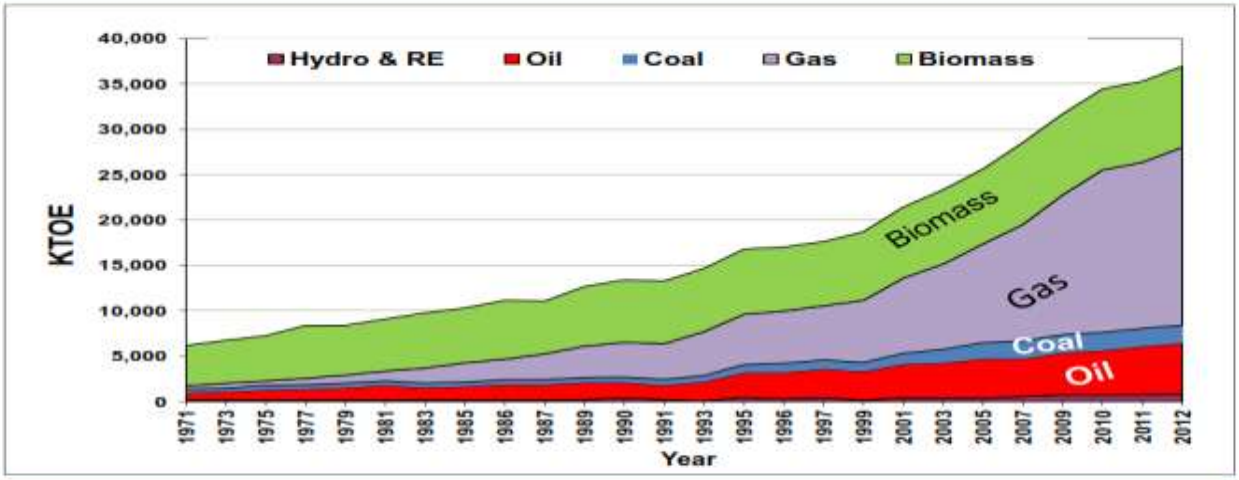


- All the producing gas fields are located far away from the port city.
- Chittagong is located at the southern extremity of north-south elongated pipe line.
- Withdrawal of gas from the high pressure Ashugonj-Chittagong pipe line results severe pressure drop in Chittagong Ring Main.

GAS MANAGEMENT

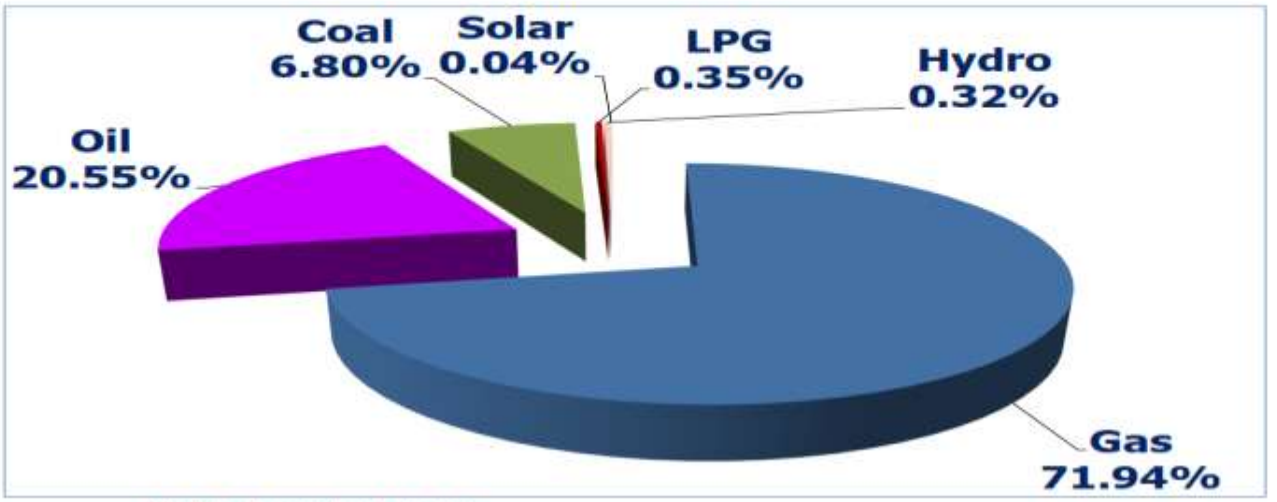


Primary Energy Supply in Bangladesh



Energy mix is not rational compared to world energy consumption. Dependence on NG has increased rapidly.

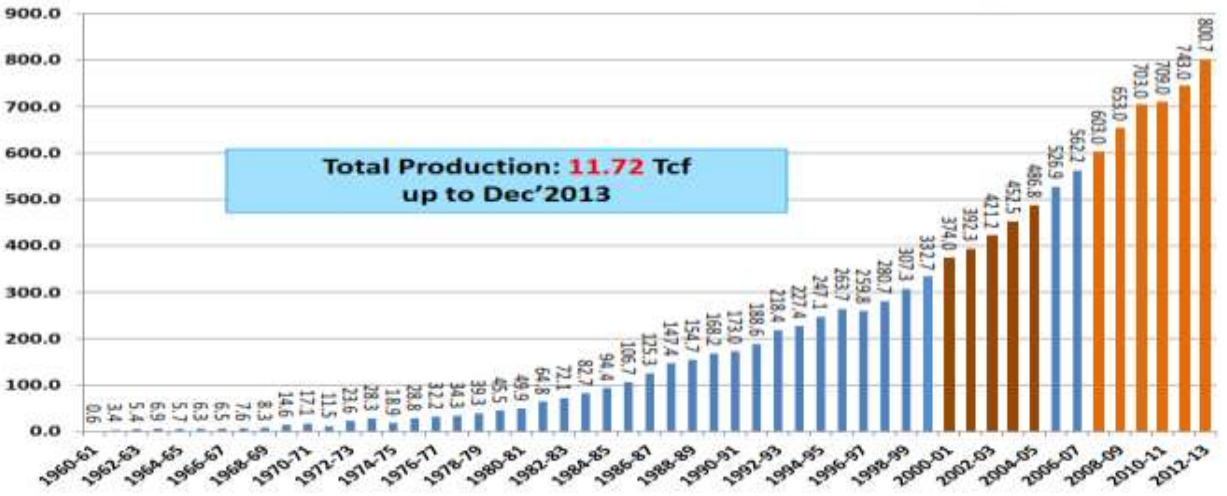
Primary Commercial Energy Supply -2012
Bangladesh



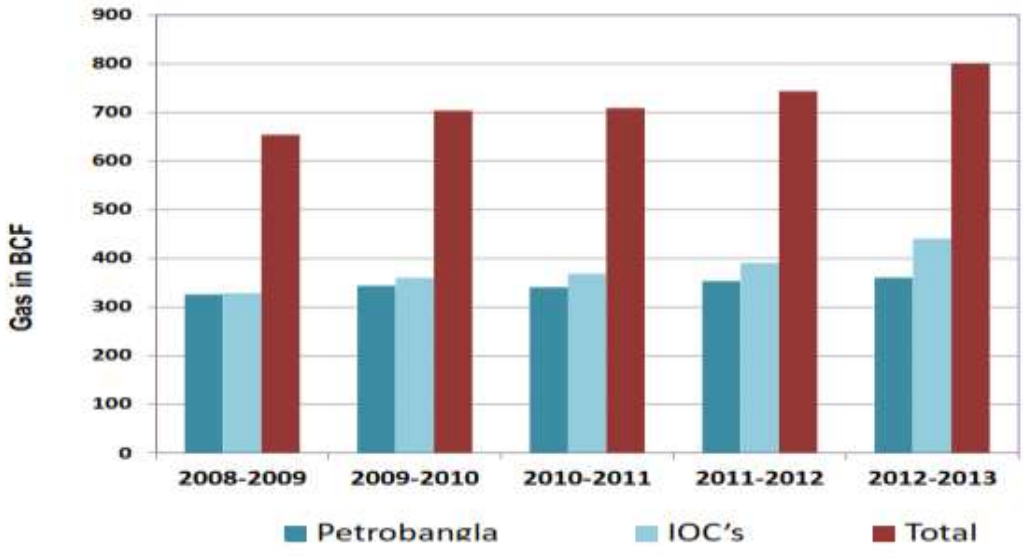
Highly dependent on gas

Gas Production History

Figures in Bcf



Year-wise Gas Production

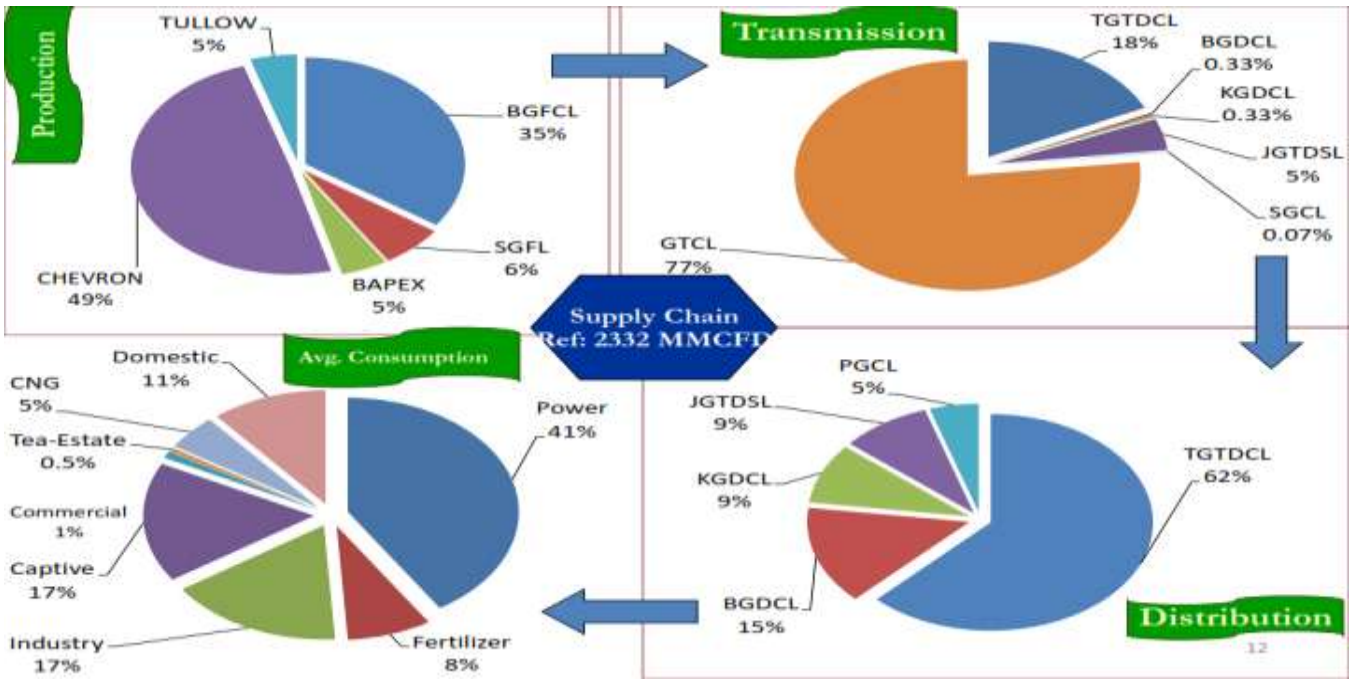


Gas Reserves as on January 2014

- GIIP (Proven + Probable) : 37.7 Tcf
- Recoverable (Proven + Probable): 27.04 Tcf
- Present Daily Gas Production(Average) : 2300 MMcf
- Yearly Production in 2012-13: 800.7 Bcf
- Cumulative Production (Upto Dec 2013): 11.72 Tcf
- Net Remaining Recoverable: 15.32 Tcf

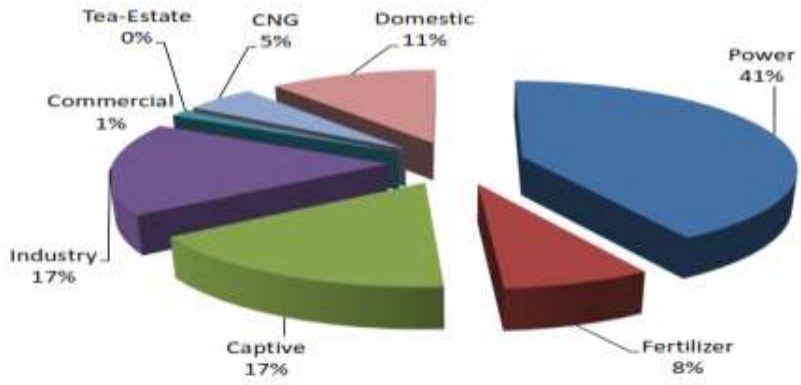
Present Gas Sector - At a Glance
(January 2014)

Total number of gas fields	: 25
Number of gas fields in production	: 19
Number of producing wells	: 92
Highest gas production so far (29/01/2014)	: 2,332 MMCFD
Total recoverable (proven + probable) reserve	: 27.04 TCF
Total production of gas up to Dec 2013	: 11.72 TCF
Total reserve remaining as on Jan 2014	: 15.32 TCF
Present daily gas production by Petrobangla	: 1,052 MMCFD (46%)
Present daily gas production by IOCs under PSC	: 1,262 MMCFD (54%)
Total Customers (upto Oct 2013)	: 24.9 Lac (aprox.)
Daily gas demand of Existing Customers	: 2800 MMCFD
Daily shortage of gas supply	: 468 MMCFD



Category-wise Gas Consumption

FY-2012-2013



Total Consumption: 795 Billion Cubic Feet

Category-wise Gas Users

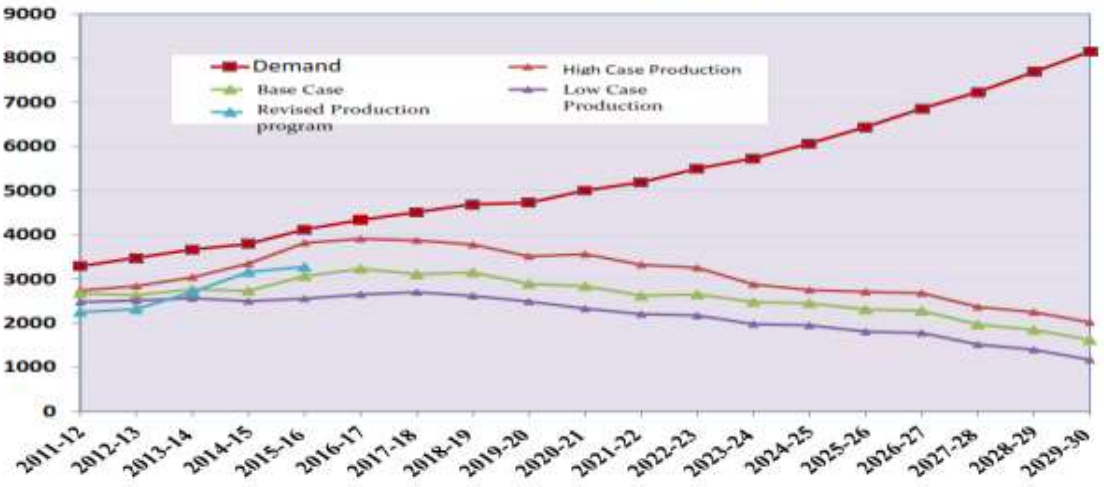
Category	Company					
	TGTDCL	BGDCL	KGDCL	JGTDSL	PGCL	Total
Power	34	13	5	13	7	**72**
Fertilizer	3	1	4	1	0	**9**
Industry	4,574	157	919	88	77	**5,815**
Captive P.	1,060	72	163	88	32	**1,415**
CNG	330	87	62	52	25	**556**
Commercial	10,909	2,140	2,530	1,481	313	**17,373**
Domestic	1,58,8,800	209,623	4,12,921	1,80,302	74,004	**24,65,650**
Others	12	0	1	93	0	**106**
Total	**1,563,334**	**206,313**	**369,703**	**177,067**	**59,173**	**24,90,996**

Natural Gas Tariff

Taka per Mcf

Eff. From	Power	Captive Power	Fert.	Ind.	Com.	CNG	Domestic		
							Meter	Single Burner	Double Burner
Mar 94	47.57		41.34	103.07	147.53	43.05	82.12	160.00	250.00
Dec 98	54.65	86.37	47.57	118.93	169.90	43.05	94.86	185.00	290.00
Sep 00	62.86	99.11	54.65	195.39	195.39	43.05	109.02	210.00	330.00
Jan 02	65.98	104.21	57.48	143.57	157.16	43.05	114.40	275.00	350.00
Sep 02	70.00	100.00	60.00	140.00	220.00	43.05	120.00	325.00	375.00
Jul 04	72.45	100.00	62.15	145.20	228.12	70.00	126.10	340.00	390.00
Jan 05	73.91	105.59	63.41	148.13	233.12	70.00	130	350.00	400.00
Jul 09	79.82	118.26	72.92	165.91	268.09	282.30	146.25	400.00	450.00
May11						509.70			
Sep 11						651.29			

Gas Demand & Supply Forecast



Demand Supply gap is increasing, supply is likely to decline from 2016-17

How to Bridge Demand & Supply Gap

Short term	Enhance production from existing fields
	Demand side management
	Efficient use of energy
	Energy Conservation
Medium term	Enhance production from existing fields
	Demand side management
	LNG import
	Increased Domestic Coal Production & Import of coal
Long term	Demand side management
	LNG import
	Increased Domestic Coal Production & Import of coal
	Intensify exploration activities for new reserve
	Pipeline gas import
	Diversify energy sources (LPG, RE incl. Solar, Nuclear etc)

Production Augmentation over Last Five Years

Gross Gas Production Capacity Increase : 895 MMcfd

Net Capacity Increased after Depletion : 588 MMcfd

Net Incremental Flow to Trans. Network(Apprx.) : 550 MMcfd

Present Max Gas Production = 2332 MMCFD

Prouction in January 2009 = 1744 MMCFD

Milestone Achievements during last Five years

- Daily gas production capacity increased: 895 MMCFD
- Exploration Well Drilling : 7 nos
- Development Well Drilling: 22 nos.
- Workover Well Drilling: 17 nos
- New gas field discovery: Sundalpur and Srikail
- Muchai & Ashuganj Compressror Station commissioned
- Elenga compressor stations will be commissioned in April 2014

Milestone Achievements during last Five years

- 3 Modern Rigs purchased
- Introduced 3D seismic survey by BAPEX
- Introduced initiatives for promotion of energy efficiency
- Coal Production Capacity increased from 2,000 ton/day to 4,500 ton/day
- Coal production Doubled by introducing LTCC system
- Compensation & Resettlement of Mine affected people Completed

Production Sharing Contracts

Production ongoing

Chevron	**Jalalabad-13 Maulavibazar-14 Bibiyana-14**
Santos	Sangu-16 (Suspended 01-10-13)
Tullow	Bangura-9

Exploration ongoing

Conoco Philips	**Deep Sea Offshore -DS10 & 11**

Exploration Upcoming

Company	Blocks	Expected Signing
Conoco Philips	Shallow Offshore –SS-7	**February 2014**
ONGC	Shallow Offshore –SS-4 & SS-9	**February 2014**
Santos –Kriss Energy-JV	Shallow Offshore –SS-11	**February 2014**
Bid Recvd. (12-01-2014)	**Deep Sea DS-12, 16 & 21**	**Bid under evaluation**

LNG Import

- A Project to import of LNG equivalent to 500 MMSCFD has been undertaken
- MOU has been signed with Qatar for import of LNG
- Selection of Investor for FSRU at Maheshkhali is under process
- Route selection for Anwara – Maheshkhali 30inch X 91 Km pipeline has been finalized to evacuate LNG.

Source: Google Earth

Transmission Capacity Enhancement Projects

Sl No	Description	Completion Time
1.	Monohardi-Dhanua Elenga- East Bank of Jamuna (30" Dia, 51 Km)	Completed
2.	Banpara – Rajshahi (12"Dia, 53 Km)	Completed
3.	Bakhrabad-Siddirganj (30"Dia, 60 Km)	June 2014
4.	Compressor Station at Ashuganj	March 2014
5.	Compressor Station at Elenga	April 014
6.	Ashuganj- Bakharabad(30"Dia, 58Km)	June 2015
7.	Hatikarul-Ishwardi-Beramara (30 " Dia, 82 Km)	June 2014
8.	Bheramara- Khulna (20"Dia, 165 Km)	June 2014
9.	Bibiyana-Dhanua (36"dia, 137 Km)	June 2014
Total Transmission Line 606 km by June '15		

Coal Resources in Bangladesh

No.	Place/Field (Discovery)	Depth (Meter)	Area (Sq. Km)	Resources (M. Metric Ton)
1.	Barapukuria, Dinajpur (1985)	118-509	6.68	390
2.	Dighipara Dinajpur (1995)	328-407	-	600
3.	Khalaspir, Rangpur (1995)	257-488	12.00	685
4.	Phulbari, Dinajpur (1997)	150-240	30.00	572
5.	Jamalganj, Jaipur (1959)	640-1058	16.00	1,053
Total				3,300

Domestic Coal Production Forecast

Aggressive mining strategy needed to meet country's demand

Future Programs in Coal Sector

- Open pit mining at Barapukuria North : Hydro Geological Survey & Water modeling work is going on.
- 2-D Seismic Survey to be conducted in Dighipara
- Feasibility study for Coal Bed Methane(CBM) in Jamalganj Coal Field
- Development of Dighipara and Khalashpir coal fields on recomended by Coal Expert Comitee
- Fulbari Coal Field : Awaiting decision from the Govt.

Challenges Ahead

- Narrowing demand supply gap
- Efficient use of gas
- Market price adjustment
- Import of LNG
- State of the art capacity building
- Popularization of LPG for domestic use
- Import of natural gas through pipeline
- Use of Coal as alternate fuel particularly in Power Generation.

WELCOME TO THE PRESENTATION ON INDIAN LNG INDUSTRY SCENARIO

SAARC

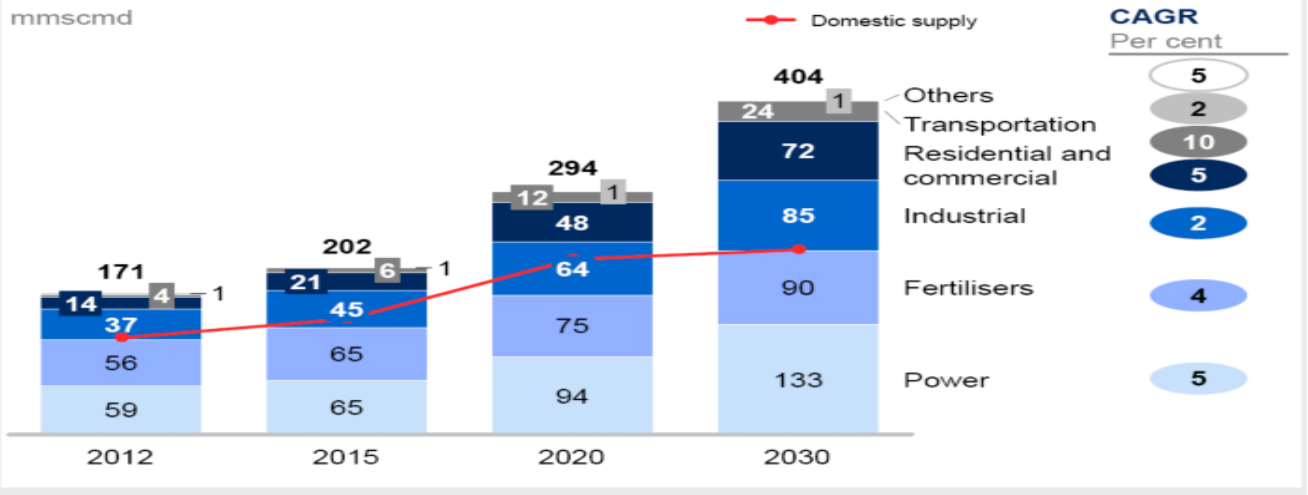
CHIPLUN , INDIA 22nd APRIL 2014

Content

- Indian Scenario
  - Natural Gas Demand-Supply
  - Supply & Consumption of NG
  - Existing & Planned LNG Terminals
  - Gas Pipeline network
  - Policy Initiatives
  - Conclusion

Indian Scenario

India gas supply and demand scenario

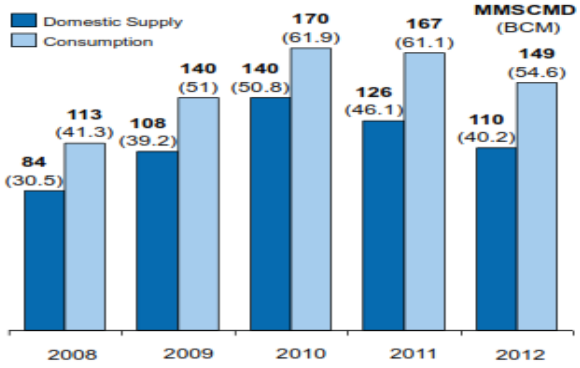


SOURCE: FACTS; McKinsey analysis

India: Existing Supply, Demand, Infrastructure

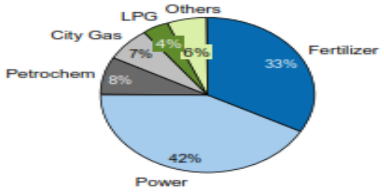
India's appetite for natural gas has exceeded domestic production, e.g., in 2012, 55 BCM consumed versus 40 BCM of domestic supply

Domestic Natural Gas Supply and Consumption
In MMSCMD (BCM)

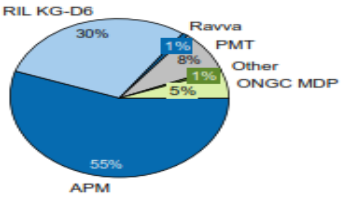


Demand-supply mismatch driven by production shortfall from KGD6 & rising domestic demand from fertilizer, power & CGD

2012 Consumption by Segment



2012 Domestic Supply by Source

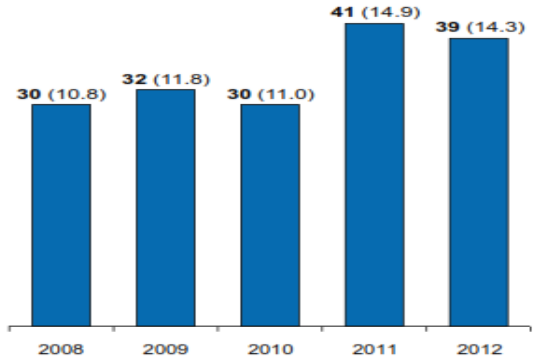


Source: BP Statistical Review of World Energy 2013, Booz & Company analysis

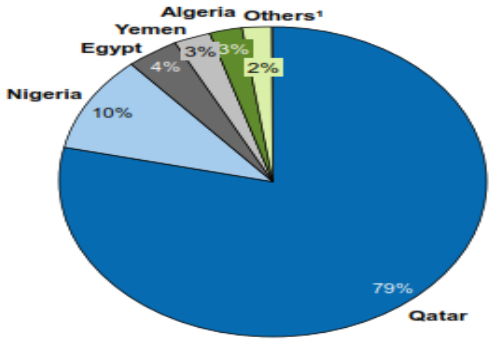
India: Existing Supply, Demand, Infrastructure

This shortfall has been met by LNG imports which have risen in 2011-12 with Qatar providing ~80% of LNG supplies in 2012

Historical LNG Imports to India
In MMSCMD (BCM)



2012 LNG Imports by Source
Including Long Term, Medium Term & Spot Purchases

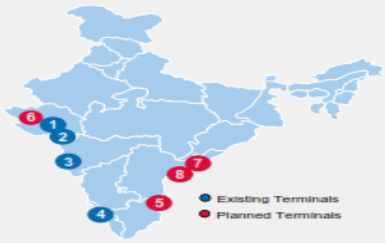


1) Others includes Indonesia, Malaysia and US
Source: BP Statistical Review of World Energy 2013, Argus Data, Booz & Company analysis

India : Existing Supply, Demand, Infrastructure

To cater to increasing LNG imports, regas capacity addition plans are underway to bolster the existing ~23 MMTPA in 4 terminals

LNG Terminals in India



- 100% FDI is allowed for development of terminals
- Terminal charges fixed by operator
- Terminal capacity is usually contracted by promoters for long term import contracts
- Some capacity is mandated as open access

Existing LNG Terminals

	1 Dahej	2 Hazira	3 Dabhol	4 Kochi
Ownership	Petronet LNG	Shell, Total	RGPPL	Petronet LNG
Capacity (MMTPA)	10	5	3	5
Expansions (MMTPA)	15 (by 2017)	10 (by 2017)	5 (by 2016)	10 (2017-22)

Planned LNG Terminals¹

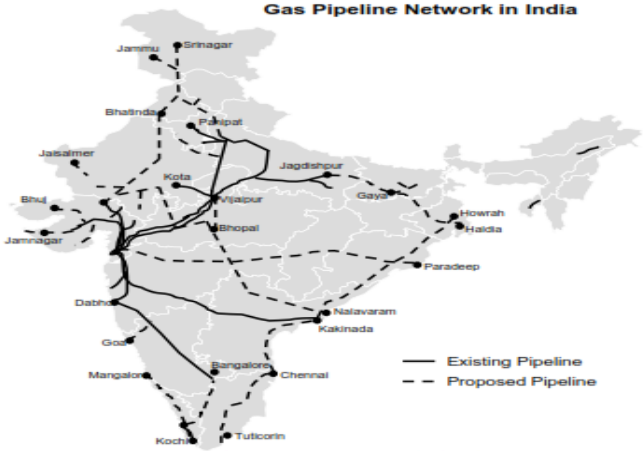
	5 Ennore	6 Mundra	7 Gangavaram	8 Kakinada
Ownership	IOCL, TIDCO	GSPC, Adani	Petronet LNG	Kakinada FSRU
Capacity (MMTPA)	5	5	5	5
Planned Dates	2018	2018	2018	2016

1) There are numerous (upwards of 12) new terminals being discussed, the four shown in the table above are some of the more credible projects
Source: Ministry of Petroleum & Natural Gas, Booz & Company analysis

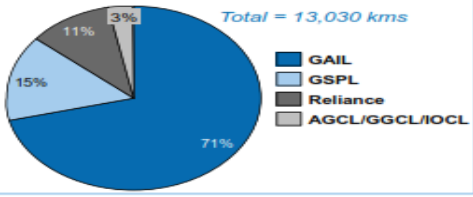
India : Existing Supply, Demand, Infrastructure

At the same time, large public private investments are being made in augmenting the pipeline network to tap latent gas demand

Gas Pipeline Network in India



2012 Share of Gas Pipeline Network



Investment in Gas Pipeline Network

- Investment of $ 14 Billion expected in natural gas infrastructure by 2017 (12th plan)
  - Transmission Network: ~$ 7.3 Billion
  - CGD Networks ~$ 6.7 Billion
- Planned pipeline infra.to be 32,727 kms by 2030:
  - 29 gas pipelines representing 15,928 kms additional network with design capacity of 416 MMSCMD or 151.82 BCM to be commissioned in 12th five year plan
  - 3,360 kms with 60 MMSCMD to be added in 13th plan

1) All major pipelines and terminals in India are connected to National Gas Grid
NOTE: Pipeline network length increased to 13, 505 in 2013
Source: Ministry of Petroleum & Natural Gas, PNGRB; Secondary Research, Booz & Company analysis

India: Regulation & Pricing

Currently pricing and allocation for regulated (domestic) and unregulated (LNG imports) supply follows different mechanisms

	Upstream Source	Gas Marketing Co.	Pricing Scheme	Downstream Allocation[1]
REGULATED SUPPLIES	1 APM based Producer Price 2 Pre-NELP PSC based price 3 NELP PSC based pricing formula	GAIL, Reliance, OIL INDIA LIMITED, GSPC, CAIRN, ONGC, GEEC	1 Gas priced as per the APM regime 2 Gas priced as per PSC agreement.. Diff. between PSC, APM price made up through gas pool account mechanism for priority sectors 3 Gas priced as per NELP PSC	High priority ▪ Fertilizer ▪ LPG ▪ Power plants ▪ City gas ▪ Refineries, Petrochemicals ▪ Others Low priority
UNREGULATED SUPPLIES	4 Long/Mid term contracts 5 Spot cargo prices	GAIL, Reliance, GSPC, Total	4 Imported LNG price linked to oil (Brent, JCC), gas (Henry Hub, NBP) indices 5 Global spot LNG price	Customers ▪ Industrial, power, CGD Marketing mechanism ▪ Long Term, Medium Term ▪ Electronic sales platform

1) Historical allocations were done for APM gas; Shortfalls in APN gas were made up by allocations of non-APM gas in priority sectors
Source: Booz & Company analysis

India: Regulation & Pricing

Going forward, three key policy changes are expected to have a major influence on the natural gas market in India

Overview of Key Policy Areas

A PSC Structure and Gas Pricing	▪ Natural gas commodity market comprises regulated (domestic) and unregulated (LNG import) market segments with pricing of domestic gas supplies being govt. controlled (incl. PSC or NELP PSC) ▪ Reforms in the PSC structure and domestic gas pricing proposed by the Prime Minister appointed Rangarajan Committee are being finalized
B Fertilizer Policy	▪ Fertilizer industry is a key demand driver of natural gas with 33% share of the total natural gas market ▪ Regulations likely to positively impact demand for natural gas in fertilizers due to: – Mandate to convert all fuel oil base units to gas in 2014 and naptha to gas by 2016 – New Investment Policy and Nutrient Based Subsidies for urea sector to drive expansion and increased demand for natural gas
C Power and CGD Policy	▪ Power sector pricing is regulated which adversely impacts the adoption of natural gas to fuel plants – Budget 2012-13 envisaged basic customs duty exemptions for LNG imports for the power sector – Open market trading access has allowed companies to sell some power through power exchanges ▪ CGD seen as a strong growth avenue given positive economics of natural gas usage for residential use. PNGRB focused on policies to provide impetus for growth

Source: Booz & Company analysis

Conclusion

- Technology has played a major role in the growth of LNG industry
- Unconventional like shale gas in USA & new major discoveries in other geographies have brought in paradigm shift in the LNG market
- The spot LNG market has picked up because of flexibility of contracts & divertibility
- Upcoming Transnational & Deep-sea pipelines will further add to world gas trade & regional co-operation
- Though India has large appetite of LNG and Regas & pipeline infrastructure are being put in place but the market is price-sensitive

Country Presentation

Sri Lanka

We never had energy issues 100...

Ministry of Power & Energy
Sri Lanka

SAARC Workshop on Experience Sharing of Construction, Operation and Maintenance of LNG Facilities in India, Mumbai
22-23 April 2014

100 years ago ....

50% Forest cover

Sri Lanka Energy Situation - 2013

Population	**20.4**	**million**
Electrification Level	**96**	**%**
Per Capita Electricity Consumption	**518.7**	**kWh**
Per Capita GNP at market Prices	**3,191**	**US$**

Petroleum/Coal – Imports in m MT

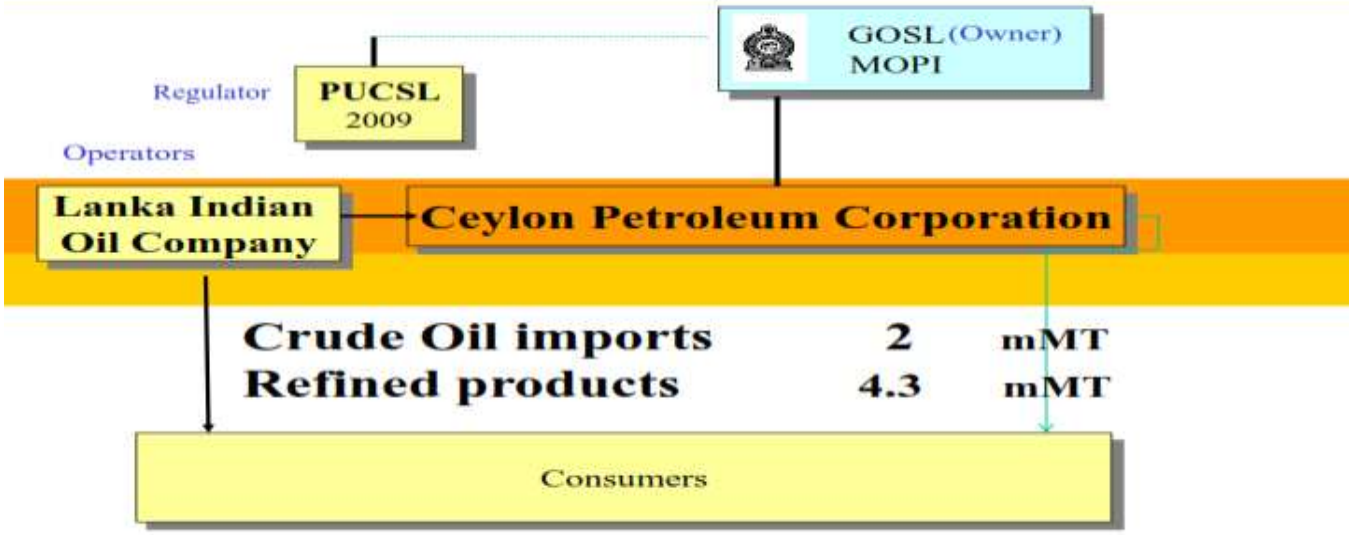
Crude Oil imports	**1.7**
Refined products	**3.2**
Coal	**1.5**
LP Gas	**0 .2**

Electricity Sector- 2013

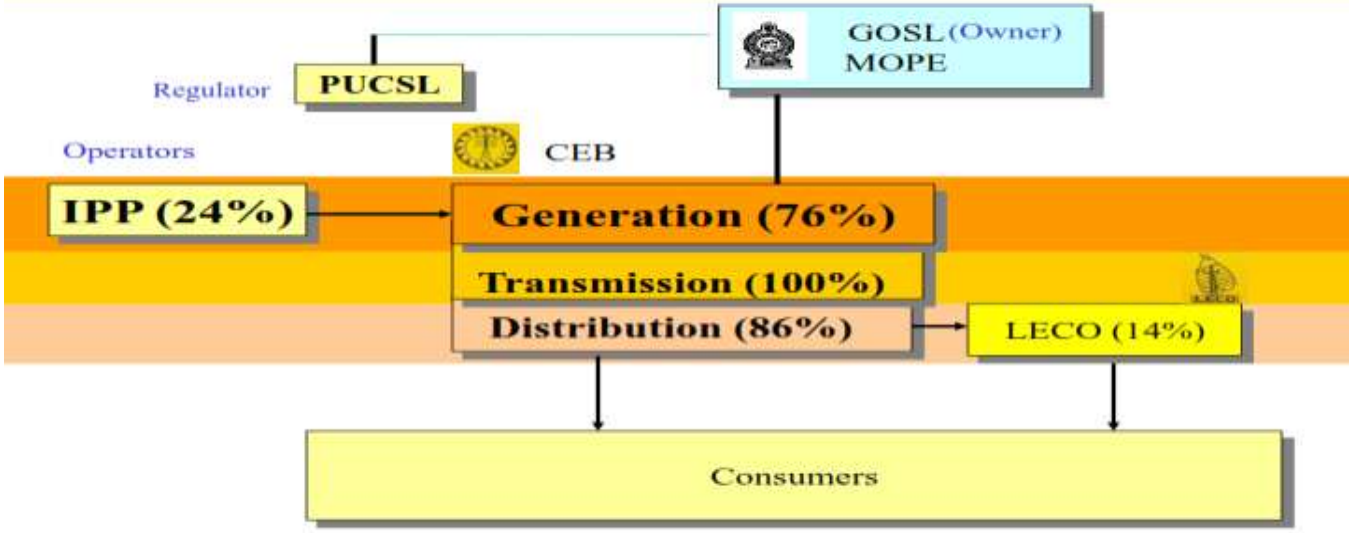
Installed Capacity	**3,371 MW**
Hydro	**1,623 MW**
Thermal	**1,649 MW**
Consumers	**5.7 Million**
Energy Sales	**10,625 GWh**

Source: Central Bank of Sri Lanka-2013/Annual Report

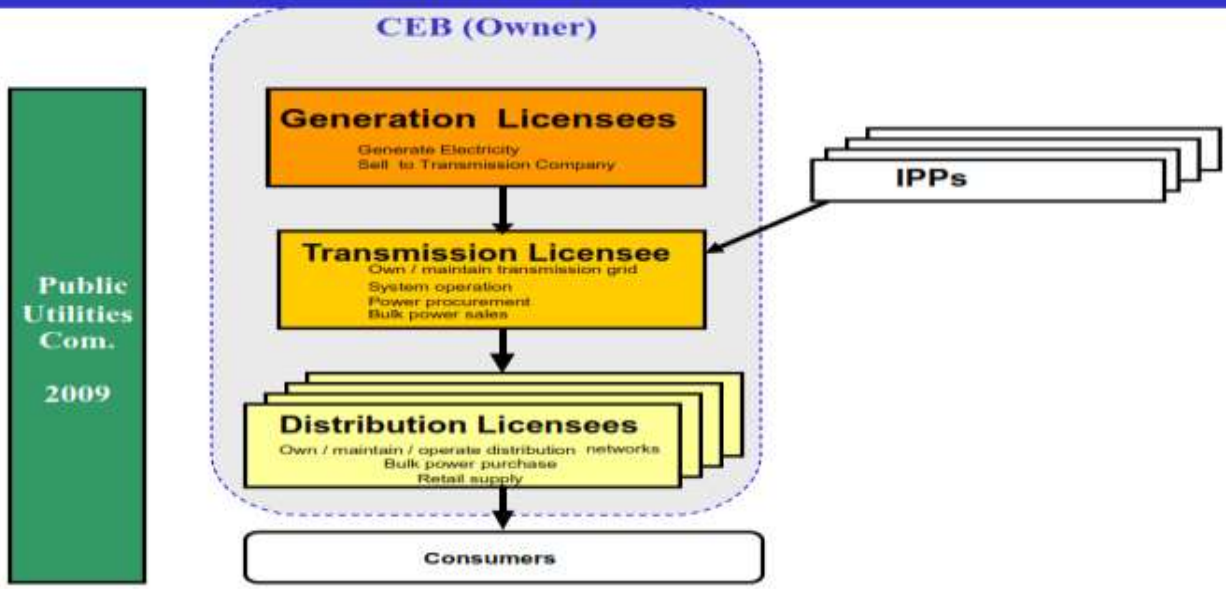
Oil Sector



Power Sector



Industry Structure



Electricity Generation – 2013 to 2025

	2013(%)	2025(%)
• Oil	28	1
• Hydro	49	19
• Coal	13	60
• NCRE	10	20

Challenges of the Sector

- Target ~100% Access to electricity
  by the end of 2014 (1-2% off grid)
- Meet demand growth 8-10%
- NCRE share (energy) now 10 %

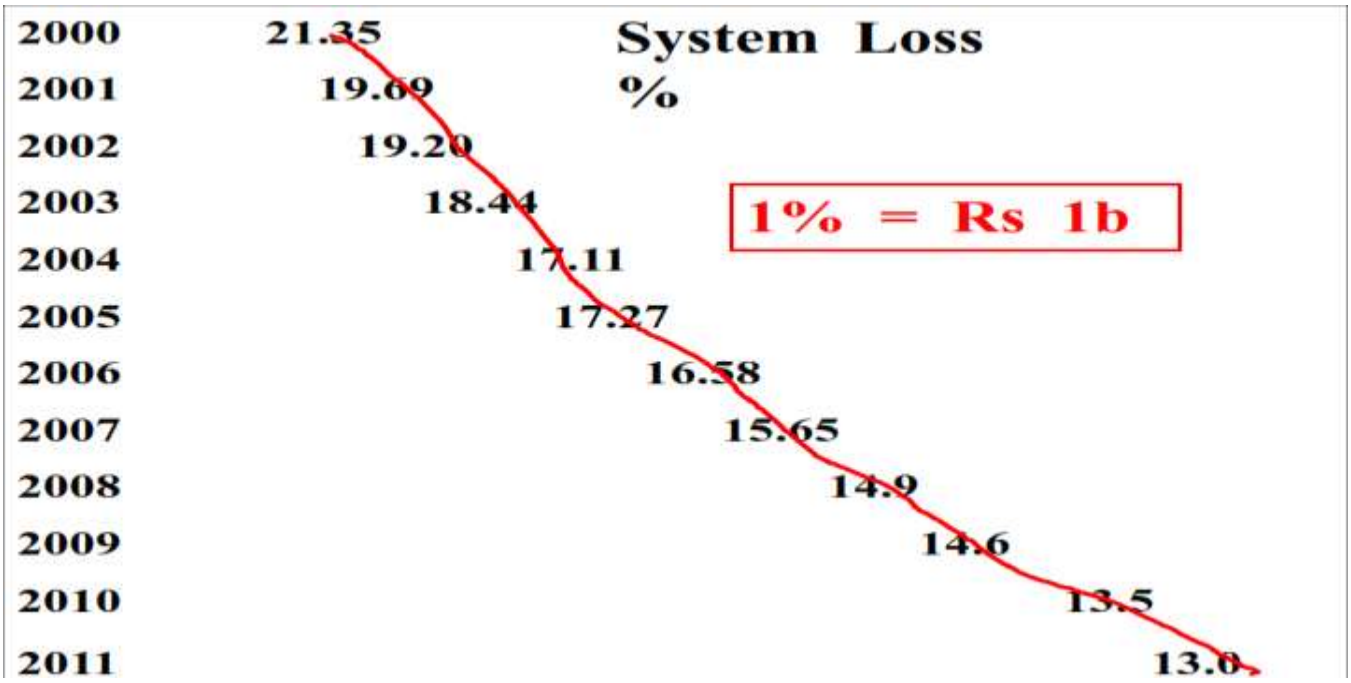
  by 2020 - 20%

Investments required US$ 500 m/yr

Non-Conventional Renewables

	Plants	MW
Mini hydro	95	240
Wind	3	30
Bio mass	3	11
Solar	4	1.3

Private sector: Uganda, Kenya, Rwanda



Key areas for consideration

- Generation, Transmission and Distribution
- Knowledge sharing in Wind Power Technologies
- Grid connectivity for NCRE sources
- Efficient Appliances
- System Reliability, SCADA, Metering
- Exchange of expertise

LNG

Natural gas is used for power generation in countries that have their own gas. Also, LNG transported by ship is used by countries that need more electricity, but when existing power plants and other industrial emissions cause the air quality standards to be violated at certain locations developed countries import LNG and run power plants because they simply cannot build any more coal-fired power plants in certain areas of their countries, owing to prevailing heavy pollution levels.

LNG –issues related to Sri Lanka

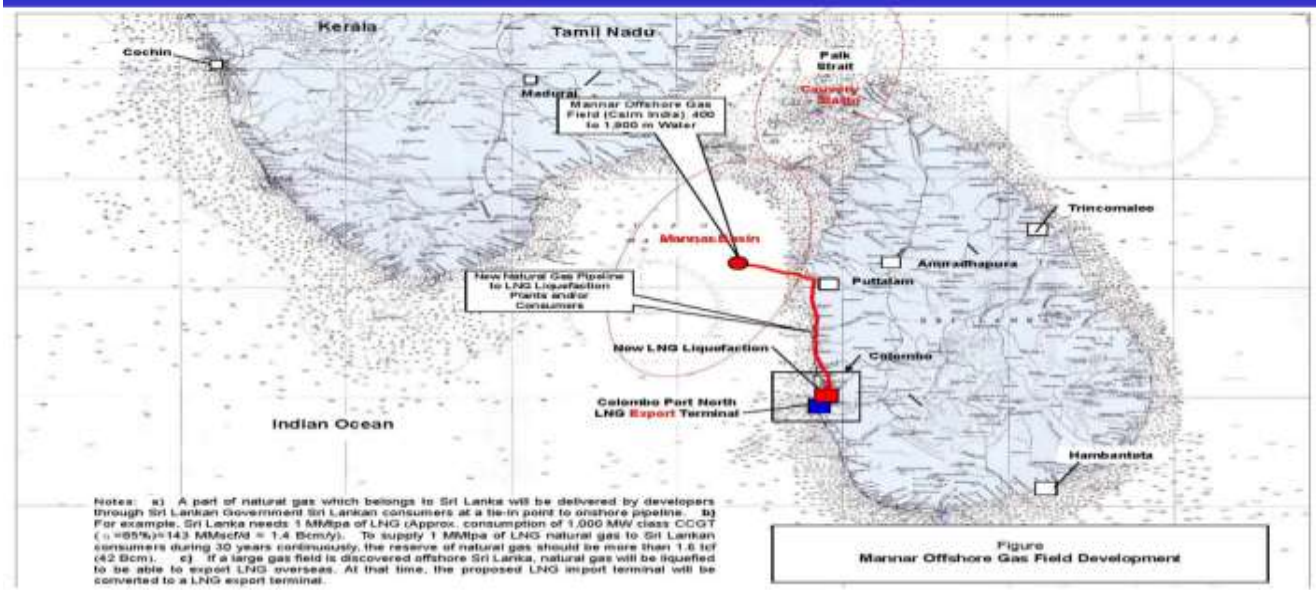
1. As per the legal provisions in the Sri Lanka Electricity Act and the National Energy Policy, any new plant has to be based on the Least Cost Option.
2. Accordingly the latest Generation Expansion Plan prepared for 2013 to 2032 has identified that LNG fuel prices are not economically competitive with the current coal prices.
3. Unless the Energy Policy is revised due to Energy Security and enhance the Energy Mix, LNG option may not viable in the near future.

Option of introducing LNG to Sri Lanka

- Site selection
- EIA for selected sites
- Study on LNG pricing and procurement
- Study for the potential of NG uses for other sectors viz. Transport, City Gas, Industry etc.

However, with the recent findings of NG in Mannar Basin it may be possible if commercialized

Management of Mannar Gas if Commercialised



Notes: a) A part of natural gas which belongs to Sri Lanka will be delivered by developers through Sri Lankan Government Sri Lankan consumers at a tie-in point to onshore pipeline. b) For example, Sri Lanka needs 1 MMtpa of LNG (Approx. consumption of 1,000 MW class CCGT (η =55%)=143 MMscf/d = 1.4 Bcm/y). To supply 1 MMtpa of LNG natural gas to Sri Lankan consumers during 30 years continuously, the reserve of natural gas should be more than 1.6 tcf (42 Bcm). c) If a large gas field is discovered offshore Sri Lanka, natural gas will be liquefied to be able to export LNG overseas. At that time, the proposed LNG import terminal will be converted to a LNG export terminal.

Figure
Mannar Offshore Gas Field Development

Conclusions so far – Feasibility Study

- LNG Demand for power generation – 300 MW each in years 2020~2023 at a LNG price of 13 $/MMBtu
- LNG Demand for Power Generation: 0.7 MMtpa in 2030
- LNG price scenario for SL
  - (based on Henry Hub)

HH $/MMBtu	3	4	5	6	9.5
SL	8.48	9.63	11.28	11.93	15.96

- Finalized site:
  - Unloading, Storage and Regasification Facility at Colombo Port
  - 4 X 300 MW Power plant in Colombo each year from 2020~2023
  - A 20 inch UG Submarine Gas pipeline from Terminal to Power Plants
  - A 36 inch UG Gas pipeline from Terminal to Power Plants

Actions to realize the Project

1. Obtain EIA approval.
2. Establish a Sri Lankan National "LNG Introduction Preparatory Committee" by relevant Sri Lankan stakeholders such as MOPE, CEB, CPC, etc.
3. Establish a national energy policy and strategies including LNG with all other energy forms.
4. Need to promote use of LNG in SL and World. This will entice,
   - LNG-utilized business and industries in SL.
   - Coming up new industries including LPG to LNG conversion,
   - town gas,
   - CNG vehicles,
   - bunkering natural gas-powered vessels,
   - FDI (Foreign direct investment).
5. Secure funds from International Lending Agencies by showing a strong will to use LNG by way of energy policies and strategies

Actions to realize the Project cont.

6. Establish Sri Lankan regulatory laws, rules and regulations on LNG and natural gas;
7. Organize an operational entity of LNG import terminal by Sri Lankans.
8. Education and training of Sri Lankan operating staffs through,
   - Education programs
   - EPC&I contract of LNG import terminals
   - On-the-job training services by suppliers
9. Start negotiating about LNG SPA (Sales and purchase agreement)with international traders
10. Thinking of Export of electricity to South India
11. Be aware the progress of Mannar offshore gas fields

Thank You

LNG Industry Overview:

Issues & Challenges(including LNG Value Chain : Exploration, Liquefaction, Shipping, Storage & Regasification)

By
Shri V. N. Datt
General Manager (Gas-Marketing)
GAIL (India) Limited

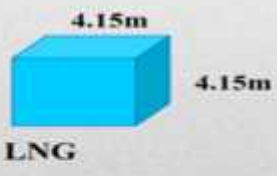
- LNG – What is LNG & Why LNG?
- LNG Supply-Demand Scenario
- LNG Supply Chain
  - Gas Supply for LNG Projects
  - Liquefaction
  - LNG Shipping
  - LNG Receiving Terminals
- LNG Commercial Chain
- Indian LNG Scenario
- GAIL – A brief Profile

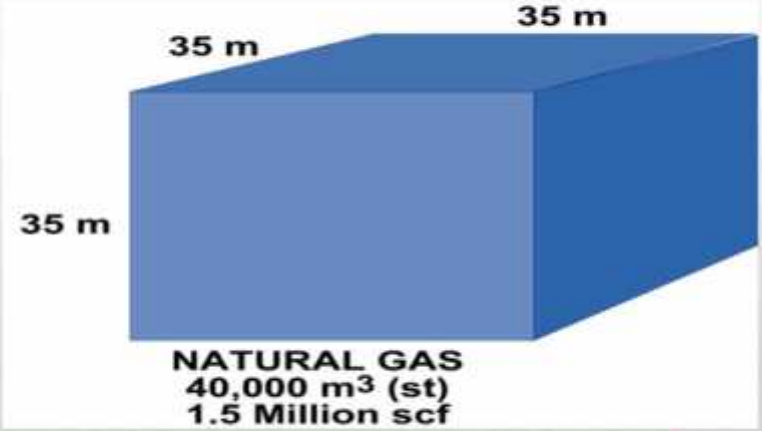
LNG – What is LNG
Why LNG?

LIQUEFIED NATURAL GAS (LNG)

- LNG is natural gas cooled to -161° Celsius.
- Its volume is around one six-hundredth of its volume as a gas.
- It is stored and transported at atmospheric pressure as a boiling liquid.
- It is an odourless, colourless liquid.

Liquefaction reduces the volume

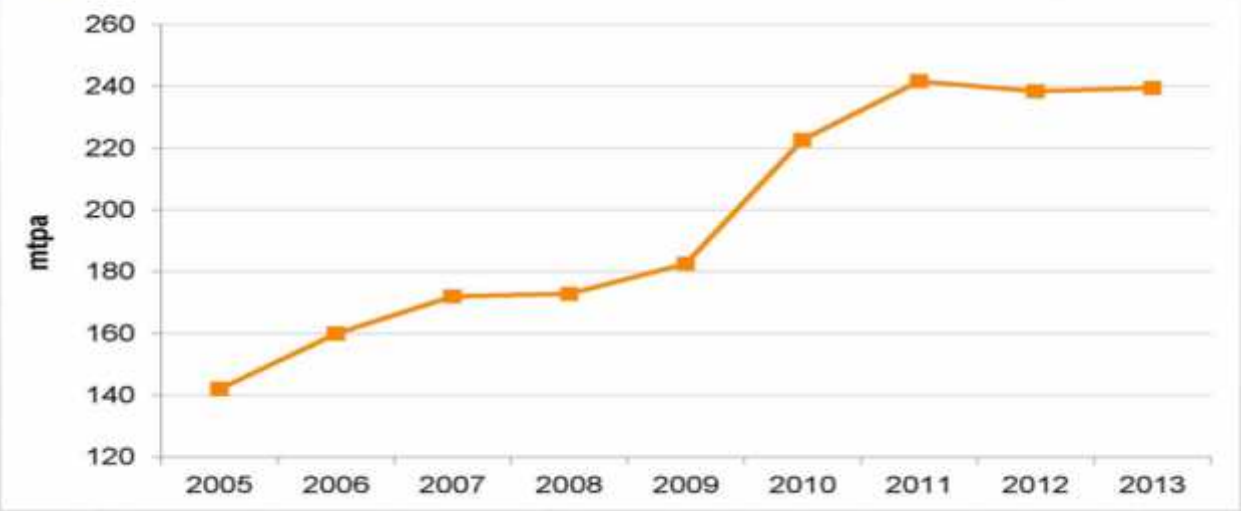




Gas is being found remote from markets increasing the need for LNG

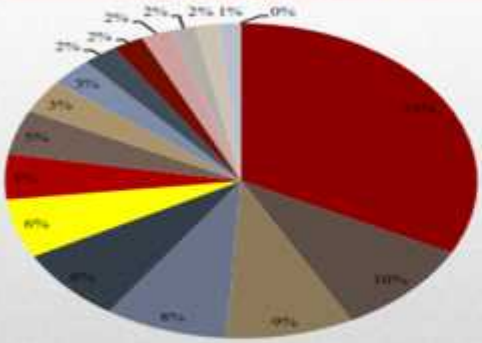
LNG SUPPLY-DEMAND SCENARIO

LNG SUPPLY: 2005 To 2013



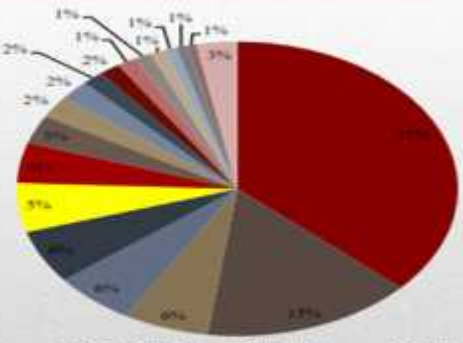
Source: BG - Global LNG Market Overview 2013-14

LNG Export, 2012



Qatar, 77.4 | Malaysia, 23.1 | Australia, 20.8 | Nigeria, 20.0
Indonesia, 18.1 | Trinidad, 14.4 | Algeria, 11.0 | Russia, 10.9
Oman, 8.1 | Brunei, 6.8 | UAE, 5.6 | Egypt, 5.1
Yemen, 5.1 | Peru, 3.9 | Eq. Guinea, 3.8 | Norway, 3.4
US, 0.2

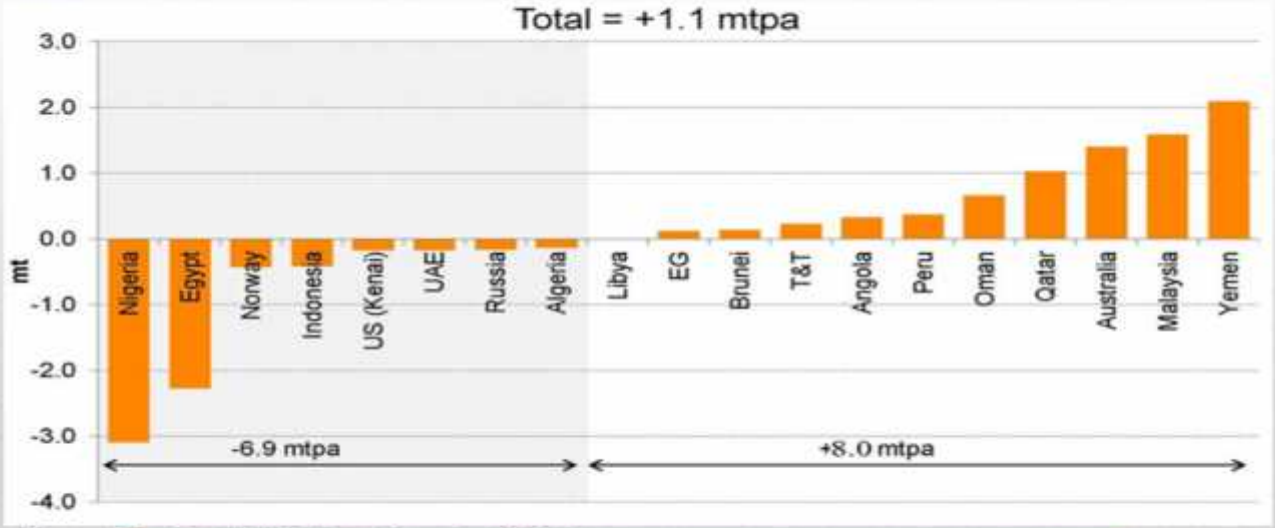
LNG Import, 2012



Japan, 87.3 | South Korea, 36.8 | China, 14.8 | Spain, 14.2
India, 14 | Taiwan, 12.8 | UK, 10.5 | France, 7.5
Turkey, 5.7 | Italy, 5.2 | Argentina, 3.8 | Mexico, 3.6
US, 3.3 | Chile, 3.0 | Brazil, 2.5 | Kuwait, 2.1
Belgium, 1.9 | Portugal, 1.7 | Other, 7.1

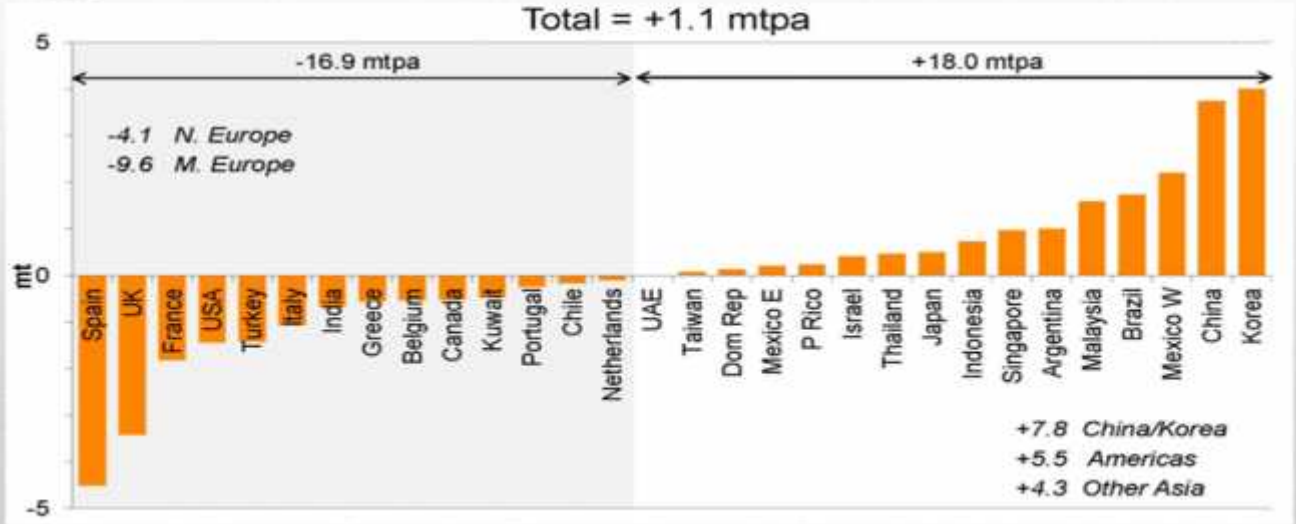
Source: IGU World LNG Report – 2013 Edition

COUNTRY-WISE LNG SUPPLY (EXPORT): YOY



Source: BG - Global LNG Market Overview 2013-14

LNG MARKETS (IMPORT): YOY

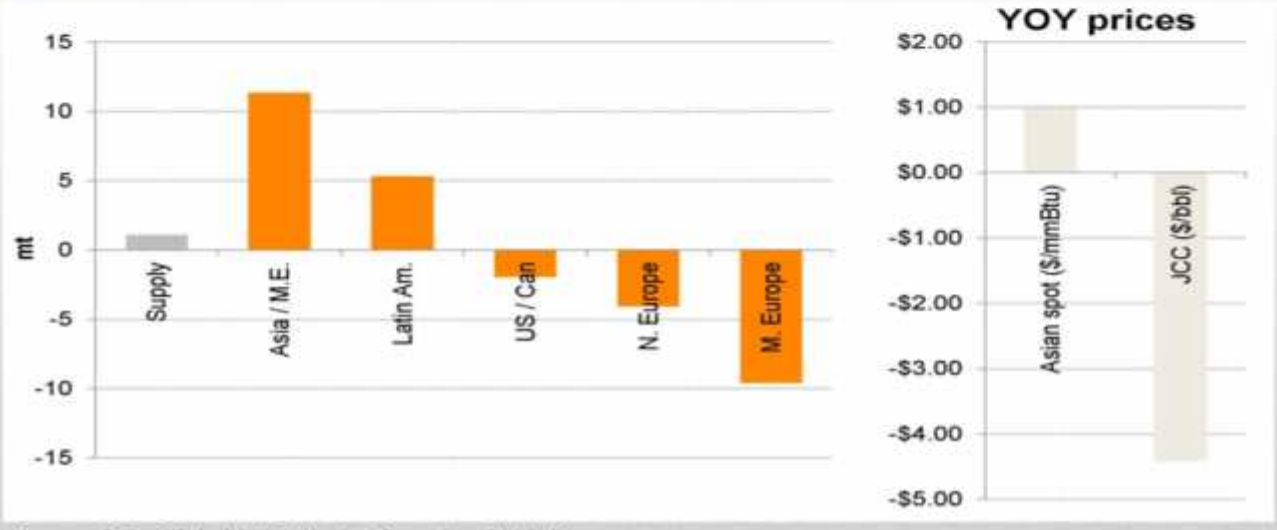


Source: BG - Global LNG Market Overview 2013-14

Global LNG Trade

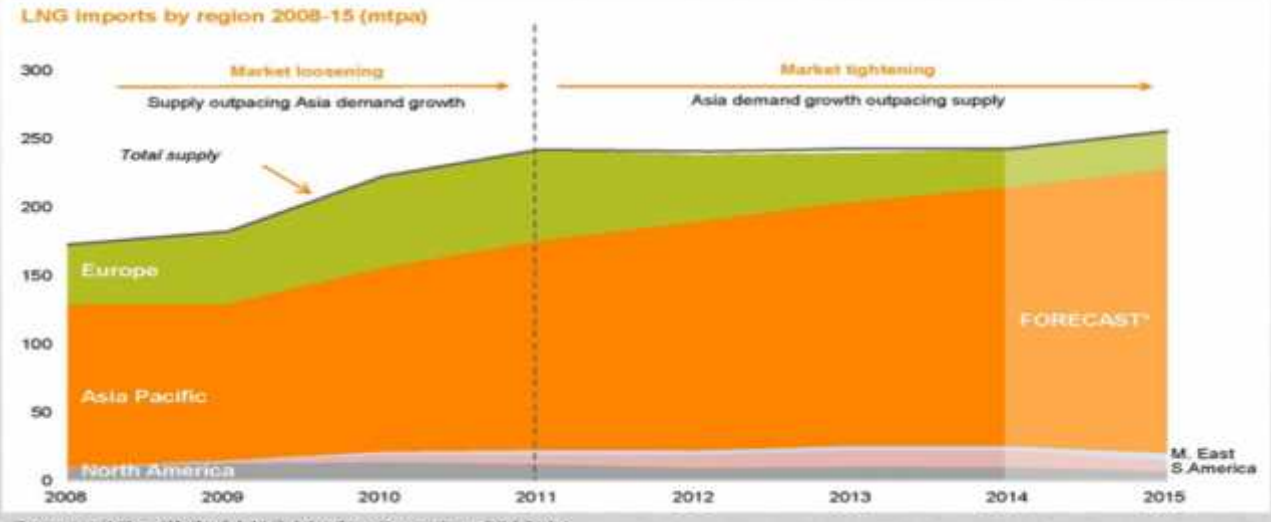
- **About 240 MMTPA in 2013**
  - Japan is the dominant importer – 37% of global imports
  - 33% of global trade is non-LT (about77 MTPA)
    - Qatar –Nigeria supply 44% of these volumes.
    - 74% of this is consumed in Asia
- **Global Capacity:**
  - Liquefaction: 290 MT
    - 17 countries
    - Additional 100 MT expected between 2015-2018
  - Shipping: 357 carriers
    - 54 MMCM combined capacity
  - Re-gasification:
    - 688 MT
    - 29 countries
- **Re export of LNG:**
  - 4.6 MT in 2013
  - Spain 44% of re export volumes

LNG TRADE BALANCE: 2013 (YOY)



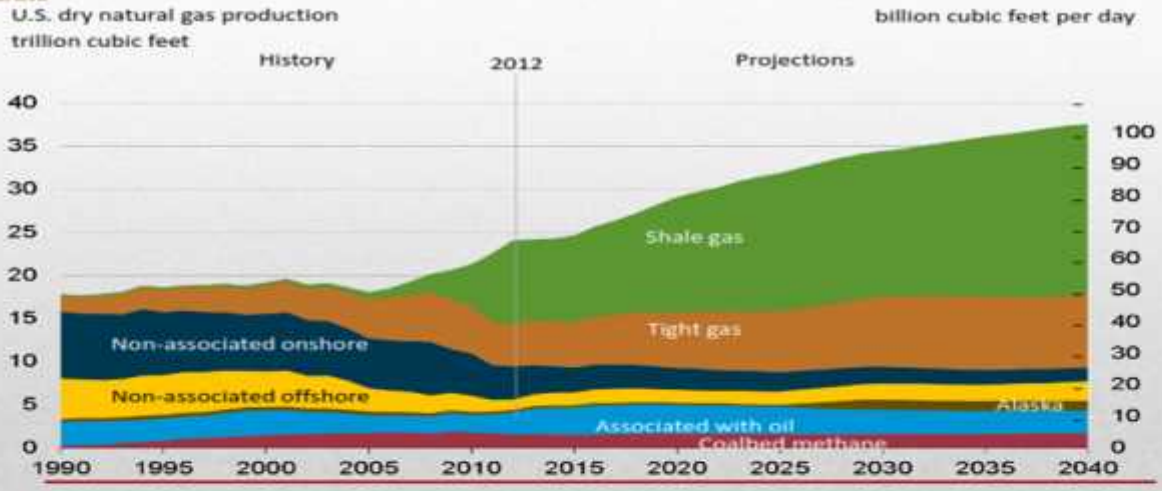
Source: BG - Global LNG Market Overview 2013-14

LNG MARKET HAS TIGHTENED



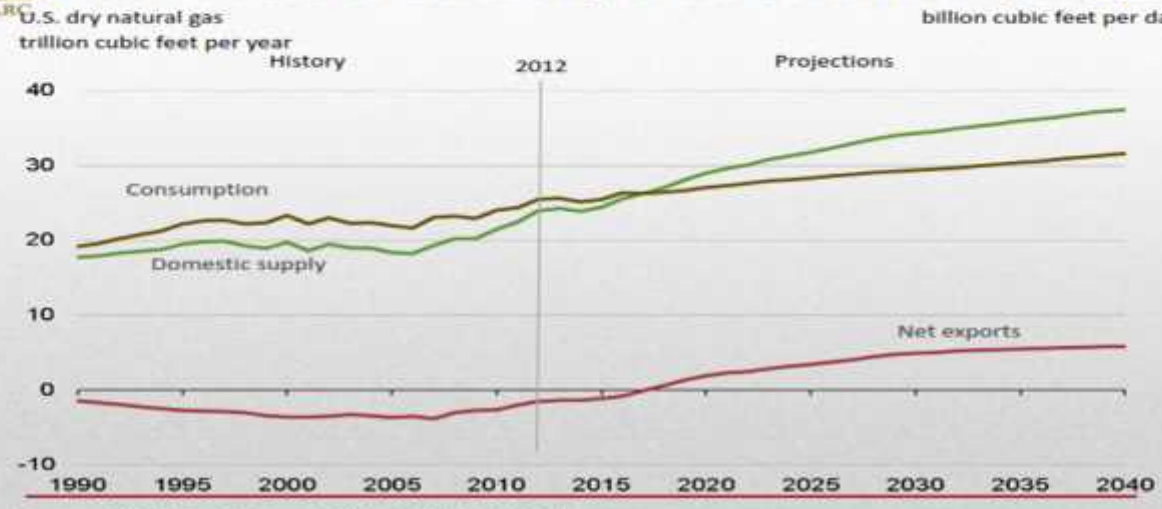
Source: BG - Global LNG Market Overview 2013-14

US Shale Gas Production



Source: EIA, Annual Energy Outlook 2014 Early Release

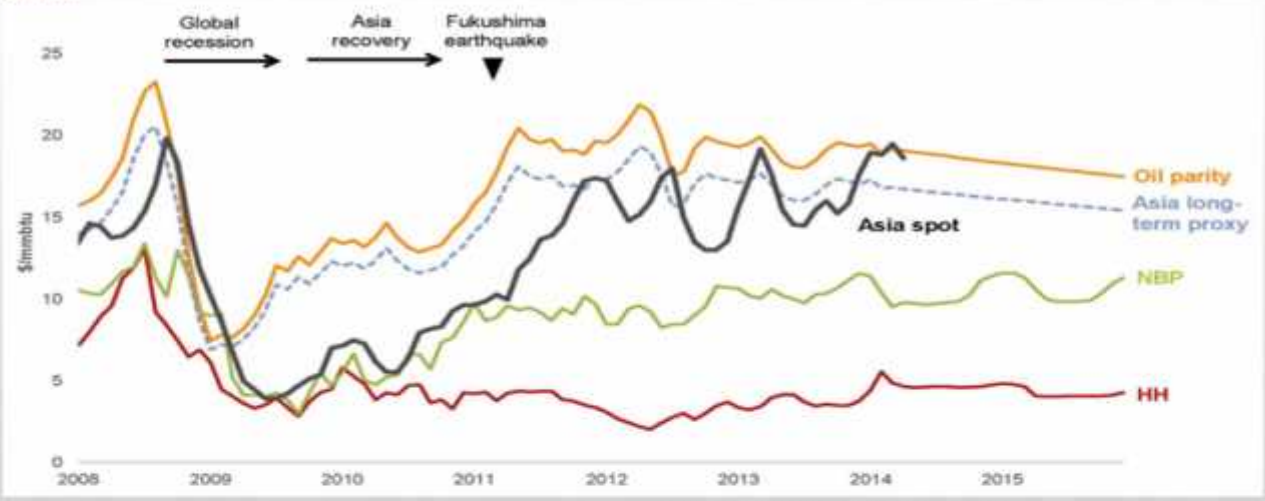
US becomes a net exporter of natural gas



Source: EIA, Annual Energy Outlook 2014 Early Release

US EXPORT PROJECTS: Potential > 100 MMTPA

GAS / LNG PRICES

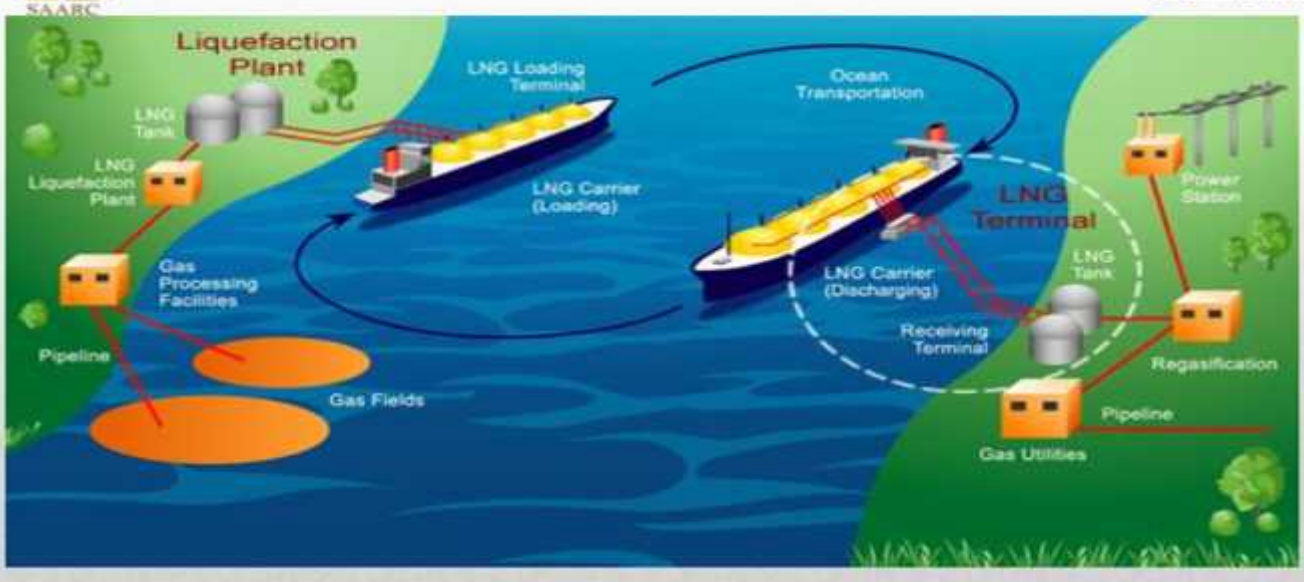


Source: Platts, Heren, PAJ & Bloomberg

Note: Asian Long-Term Proxy = 14.85% of JCC + 0.5
Oil Parity = JCC

THE LNG SUPPLY CHAIN

LNG SUPPLY CHAIN



Indicative returns in LNG show the value usually resides in the upstream

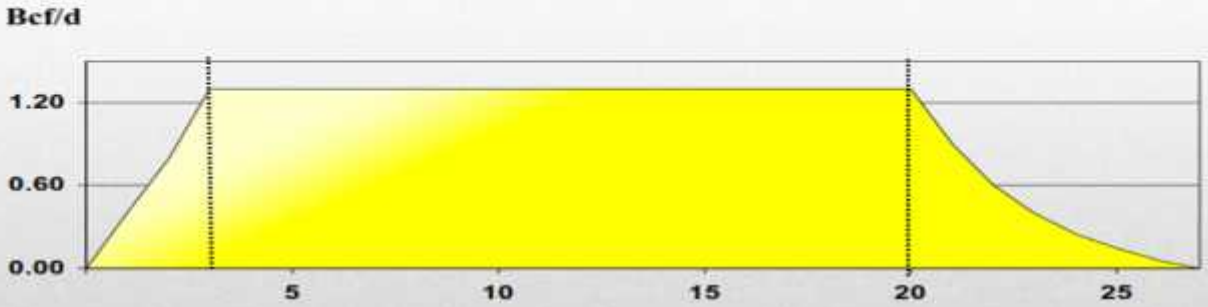
"Typical" investment (5 mmtpa project)	Upstream	Liquefaction	Shipping	Re-gas	Total
	Increasingly integrated, but structures can vary from country to country, project to project US$ 15 billion (89%)		US$ 0.8 billion (5%)	US$ 1 billion (6%)	***US$ 16.8 billion*** ***(100%)***

GAS SUPPLY FOR LNG PROJECTS

SECURING GAS SUPPLY

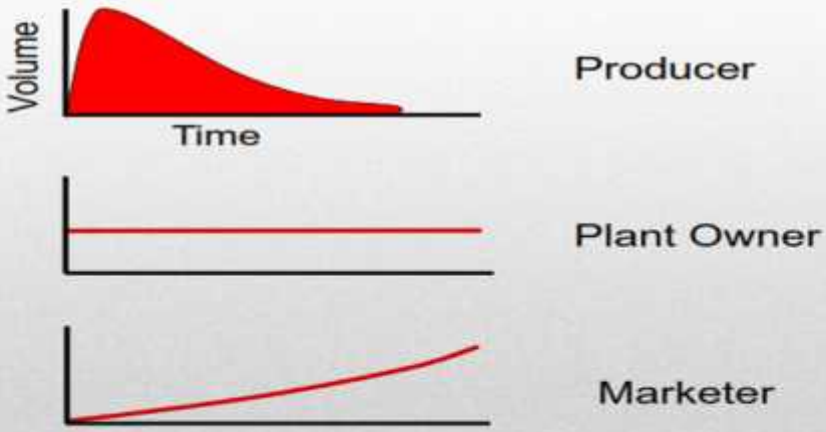
- **Greenfield Exploration**
  - E&P is high risk, high reward
  - Field development is over a long time horizon
- **"Farm-in" to an existing gas field**
  - When (exploration or production phase)?
  - Reducing risk (but higher cost) over time as reserves firmed up
- **Buy gas from a company with reserves**
  - Lower risk (if the gas is firmed up)
  - Matching of delivery schedules

Gas sourcing for 8 mmtpa LNG project



Total reserve required (approx.) :11 to 13 Tcf

Competing Aspirations



What else is required of the gas reserves?

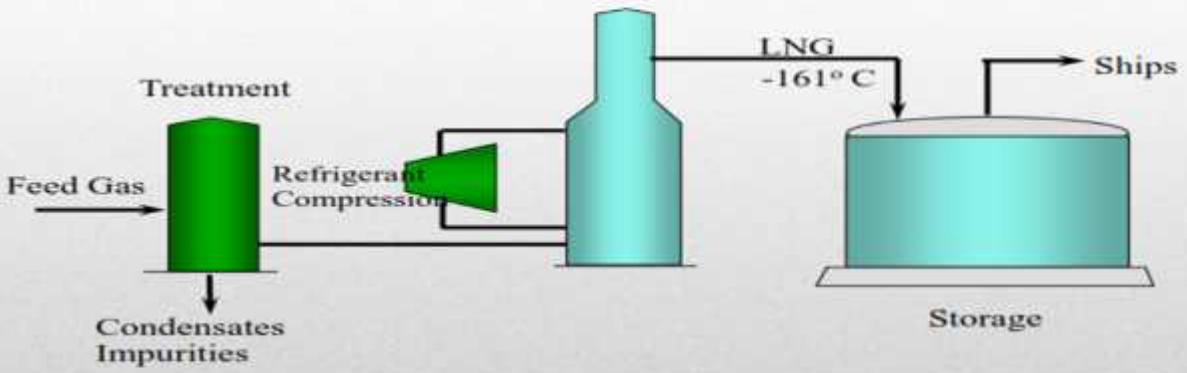
- Reservoir dedicated to the project for duration of contract
- Sufficient volume to produce at plateau level for Long-Term
- Reliable supplies to the LNG plant
- Binding Long Term contracts
- Mutual verification & assurances

LIQUEFACTION

Liquefaction Plant – Facilities

- Receipt of gas from production facilities
- Gas Treatment
- Liquefaction trains
- Storage facilities (LNG, condensate, LPGs)
- Jetty and berthing facilities
- Utilities

Typical Liquefaction plant



LNG storage

- **Provides buffer between plant and ships**
  - Avoid delay to ships
  - Avoid plant shutdown because tanks full
- **To have sufficient capacity vis-à-vis contractual obligations**

LNG SHIPPING

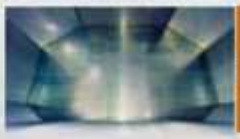
Membrane containment system - the most preferred type

LNGC Containment Systems

Descriptions

Moss

- Self supporting spherical tanks
- Independent of hull structure
- Whole cargo liquid load is borne by the membrane stress of the tank shell structure



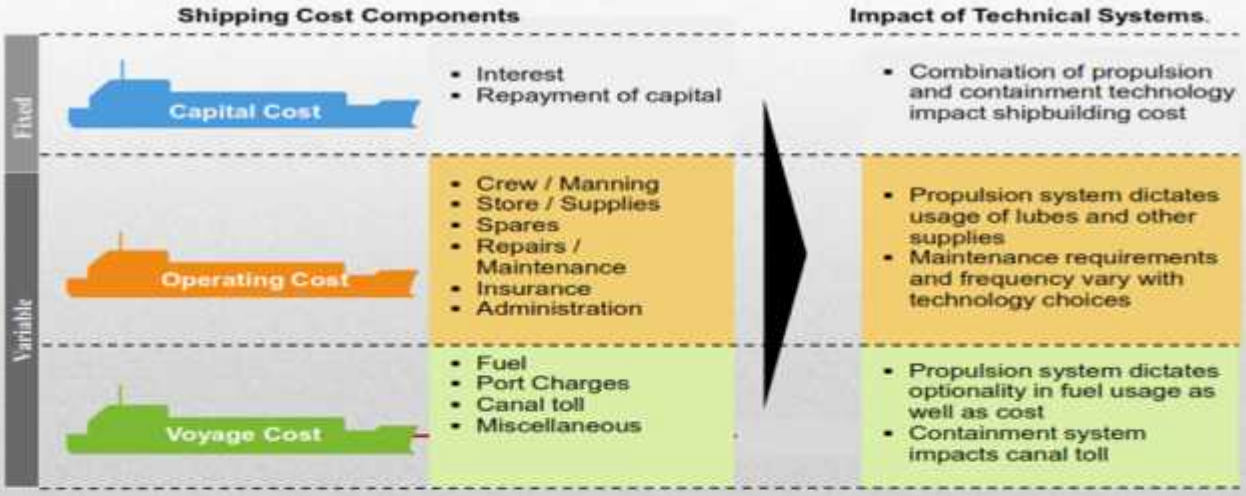
Membrane

- Non-self supporting tanks with flat deck space
- Insulation material is installed on inner hull and its surface is covered with a membrane sheet
- Cargo liquid load acts directly on the hull via the insulation

IHI SPB

- Self supporting prismatic tanks
- Independent of hull structure
- Sloshing eliminated by internal bulkheads provided in horizontal and traverse directions

Impact of technology on shipping cost



Membrane ships have lower canal charges than moss ships

EXAMPLE

LNGC Containment System Comparison

Membrane vs. Moss, Size: 177,000 m³

ILLUSTRATIVE

Suez Canal Toll Calculation*

Membrane vs. Moss, Size: 145,000 m³

- Containment type : Membrane
- Ship capacity : 145,000 m³
- Deadweight : 75,000 T
- Suez canal tonnage[1] : 85,000 SCNT
- Suez canal charges[2] : USD 407,760

- Containment type : Moss
- Ship capacity : 145,000 m³
- Deadweight : 75,000 T
- Suez canal tonnage[1] : 105,000 SCNT
- Suez canal charges[2] : USD 487,800

1) For LNG vessels the SCNT depends on the construction, and the SCNT is reflected on the volume of the hull, not the cargo carrying capacity
2) Assumed SDR / USD Exchange Rate : 1.45
Source: MarineTraffic.com, Suez Toll Calculator, Booz & Company analysis , Marine Service GMBH

Determining the number of LNG ships for a project or trade

- Capacity of each ship
- Average service speed
- Distance between LNG plant and receiving terminal(s)
- LNG plant daily production
- Number of berths
- Risk of delays to carriers
- Priorities at receiving terminal

Objective: ***Ensure sufficient shipping to satisfy contractual commitments while minimising surplus shipping capacity***

Voyage costs

Cost Elements

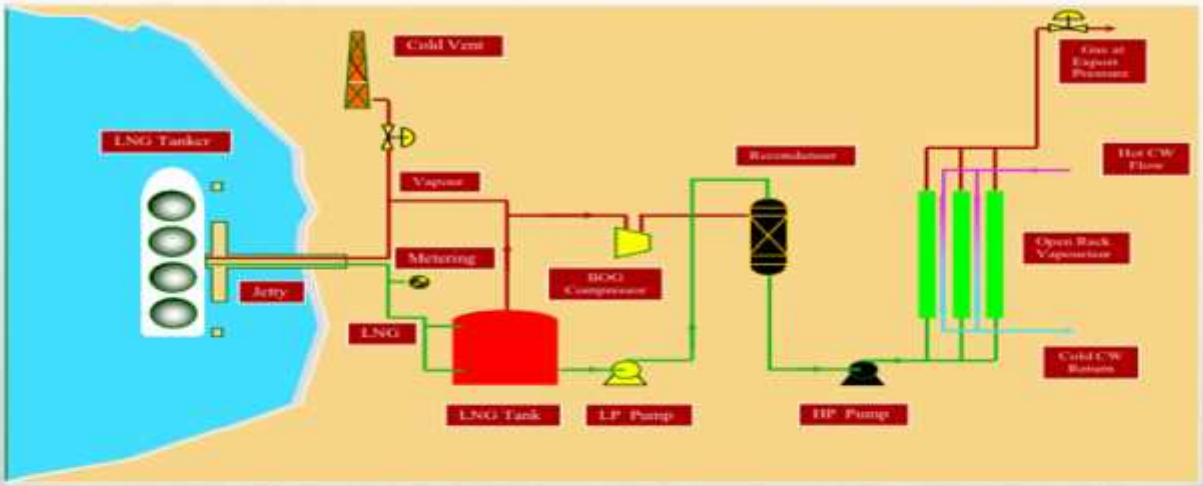
- **Daily hire rate**
  - Capital repayment
  - Crew costs
  - Maintenance
  - Insurance
  - Administration
  - Profit
- **Port cost**
  - Including Suez Canal costs where applicable
- **Fuel costs**
  - Fuel oil
  - Boil-off gas

LNG RECEIVING TERMINALS

LNG Terminal – Main facilities

- Jetty to berth and unload ship
- Storage tanks
- Vaporisers to regasify LNG
- Connection to pipeline grid or power plant

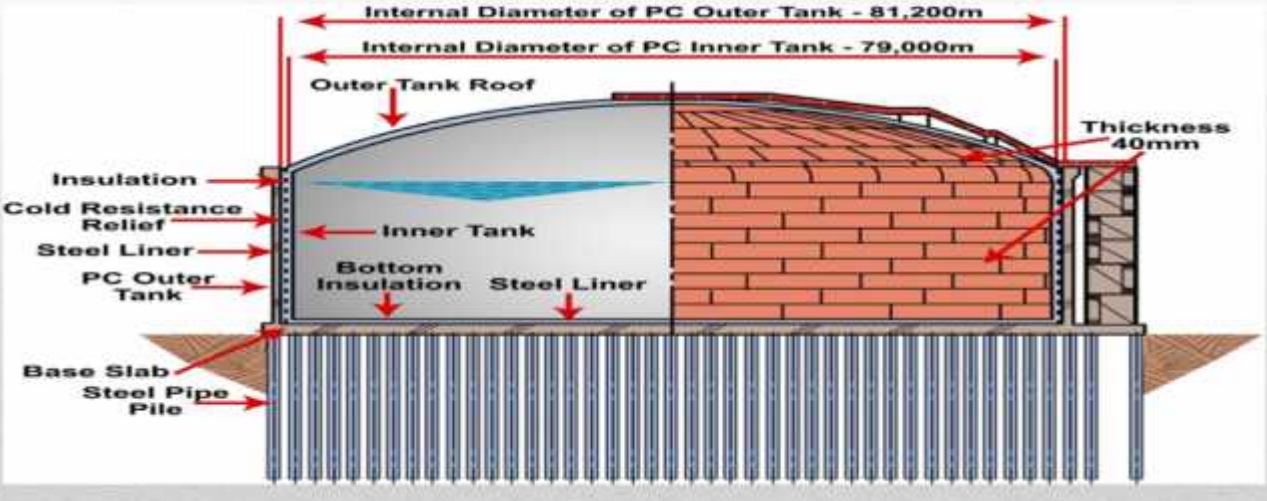
LNG Receiving Terminal



Types of storage tank

- **Single Containment**
  - Inner tank, generally nickel steel, contains liquid and vapour
  - Outer tank, generally carbon steel, holds insulation but would not hold liquid if inner tank was breached
  - A bund around the tank would contain the spilt liquid
- **Double Containment**
  - Inner tank holds liquid and vapour
  - Outer tank would contain liquid in case of breach of inner tank but vapour would escape
  - Inner tank typically nickel steel and outer tank concrete
- **Full Containment**
  - Inner tank holds liquid
  - Outer tank holds liquid and vapour

Diagram of 140,000 m³ LNG Storage Tank (Double Containment)



Storage capacity

- Must be sufficient to unload ships without delay
- Has to provide back-up storage to ensure supply to market maintained if ship is delayed
- May be required to provide strategic storage (e.g. in Japan and Korea)
- May be used to help manage seasonal variations in demand (e.g. Korea)

VAPORISERS

- Open Rack Type LNG Vaporiser
- Open Rack Seawater Vaporiser
- Closed Cycle Vaporiser

Open Rack Seawater Vaporiser

Dabhol LNG Receiving Terminal

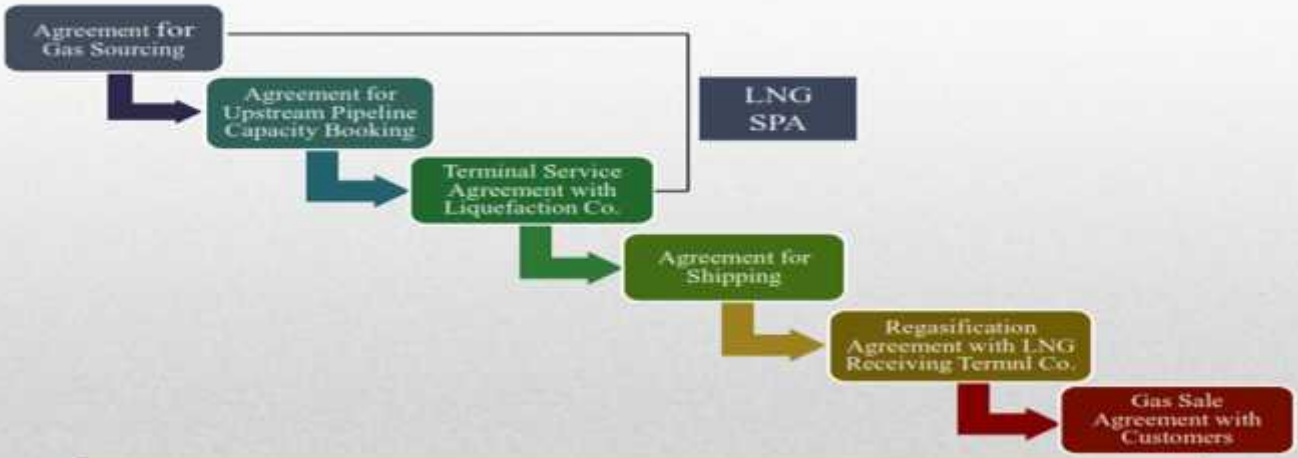
Dahej LNG Receiving Terminal

- ✓Capacity-10 MMTPA , Commissioned in June, 2009.
- ✓60% marketing rights with GAIL
- ✓PLL Dahej RLNG - Serving 20% of the total gas demand of the country.

- ✓Second LNG Jetty at Dahej under construction
- ✓ Capacity augmentation from 10 MMTPA to 15 MMTPA by 2014-15 in process

LNG COMMERCIAL CHAIN

Various Contracts in the LNG Chain



GSPA (for Gas purchase)

Major Clauses

- Conditions Precedent
- Quantities
- Take or Pay
- Pricing Structure
- Security of Payment
- Suspension & Termination
- Quality & Measurement
- Force Majeure
- Legal Issues

Upstream Pipeline Agreement

Major Clauses

- Conditions Precedent
- Quantities
- Bank Guarantee
- Ship or Pay
- Imbalance
- Pipeline Tariff
- Delivery Point, Receipt Point
- Payment Security
- Suspension & Termination
- Quality & Measurement
- Force Majeure

Terminal Service Agreement (Liquefaction Terminal)

Major Clauses

- Term of Agreement
- LNG Processing Service Obligations
- Delivery Points, Receipt Points, Title & Risk of Loss
- Quantities
- Rates – Bidirectional Daily Rate, Overrun Charge, etc.
- Billing & Payment
- Transportation & Transfer
- Quality & Measurement
- Assignment
- Force Majeure
- Legal Issues

Time Charter Agreement (Shipping)

Major Clauses

- Design, Construction & Acceptance of the Vessel
- Charter Period
- Trading Limits
- Rate of Hire
- Payment of Hire
- Cargo Capacity of the vessel
- Bunkers & LNG
- Assignments & Subletting
- Ship to Ship Transfers
- Performance Warranties
- Availability of Liquefaction & Discharge Terminals
- Law & Jurisdiction
- Measuring Devices

SPA – Sales and Purchase Agreement

- The agreement that defines the terms on which LNG will be purchased and sold over the life of the contract.
- Generally legally binding but it may only become effective after conditions precedent are met.
- Used by the seller to raise finance.
- Most sellers will want an SPA for a large part of the intended output to be in place before making a Final Investment Decision (FID)

LNG SPA – Major Clauses

- **Duration**
- **Quantities**
  - Build-up volumes
  - Annual Contract Quantity (ACQ) at plateau
  - Downward Quantity Tolerance (DQT)
  - Upward flexibility
- **Take-or-Pay Provisions**
- **Transportation Arrangements**
- **Scheduling (Annual Delivery Programme)**
- **Price**
- **Quality**
- **Invoicing and Payment**
- **Measurement and testing**
- **Force Majeure**
- **Liabilities**
- **Applicable Law**
- **Arbitration**
- **Conditions Precedent**

Regasification Agreement (LNG Receiving Terminal)

Major Clauses

- Term & Commencement of Parties Obligations
- Title & Risk
- Quantities
- Facilities
- Delivery Pressure & Temperature
- Shipping & Unloading of LNG
- Price
- Billing & Payment
- LNG & RLNG Measurements
- Quality & Measurement
- Use or Pay Obligation
- Termination

GSA with Customers

Major Clauses

- Term
- Title & Risk
- Commencement Date
- Contracted Quantities
- Take or Pay Obligations
- Price
- Nominations & Scheduling
- Overdrawll
- Billing & Payment
- Payment Security
- Quality & Measurement
- Force Majeure
- Arbitration
- Termination

Types of LNG sale

- **Free on Board (FOB):** Buyer takes care of all paperwork and/or expenses necessary (including insurance) to collect the goods from the seller and place them on an international carrier.
- **CIF (Cost, Insurance and Freight):** Seller is responsible for paying the freight and insurance costs in advance. Seller will collect these later when it invoices its customer.
- **CFR (Cost and Freight):**Same as CIF except that Seller doesn't have to pay for the insurance.
- **Delivered Ex-Ship (DES):** Risk does not pass from seller to buyer until the ship has arrived at the named port of destination and the goods made available for unloading to the buyer. The seller pays the same freight and insurance costs as he would under a CIF arrangement. Unlike CFR and CIF terms, the seller has agreed to bear not just cost, but also Risk and Title up to the arrival of the vessel at the named port.

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LNG pricing in Asia

Prices for most contracts for LNG are based the following pricing formula:

$$P(LNG) = A \times P(Crude\ Oil) + B$$

Where:

P(LNG)	=	Price of LNG in $/MMBtu
P(Crude Oil)	=	Price of crude oil in $/bbl
B	=	A constant in $/MMBtu

Buyer's Expectations out of Future LNG Contracts

Flexibility:
- Diversion clauses
- Price reviews
- Creative pricing mechanism: 'S'-curves, step-up, tranche pricing
- Equity LNG offtake
- Shipping terms (FOB/DES)
- DQT

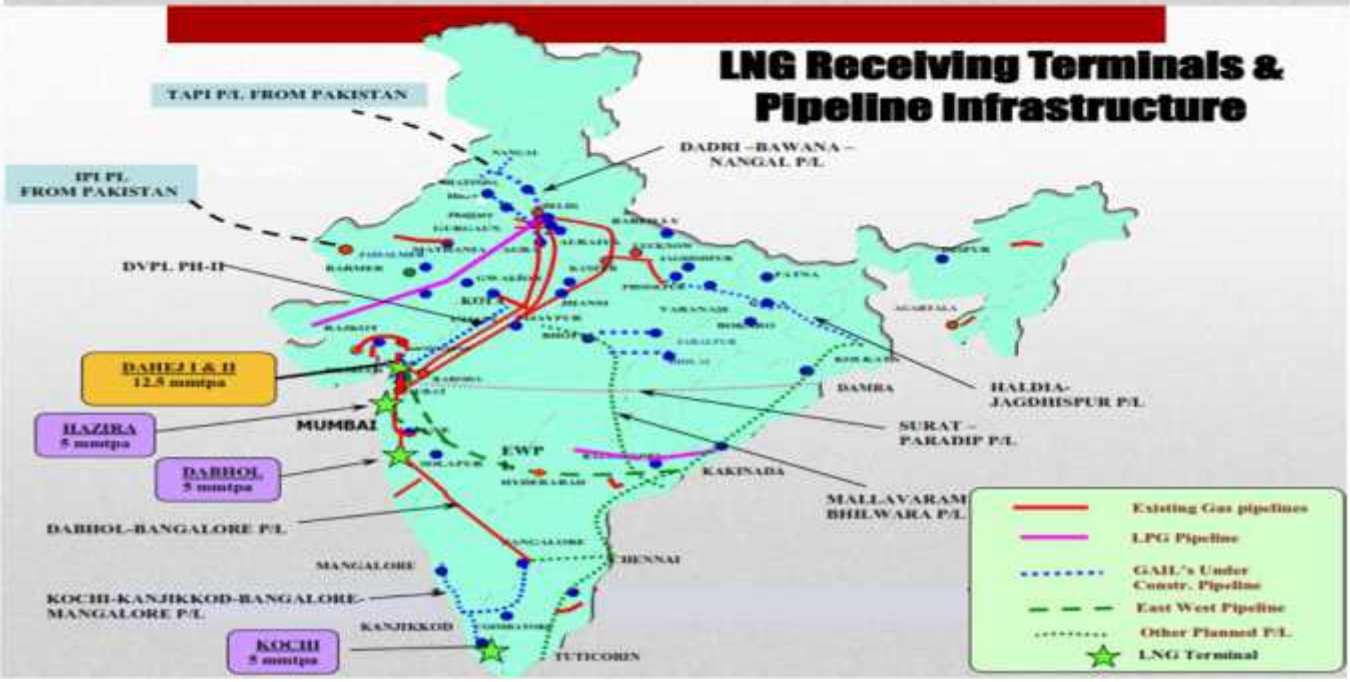
Future gas price benchmark?
- HH/NBP + X
- HH/NBP + Oil
- JCC

New supply source:
Africa?
Americas? (Shale)

Emergence of **new marker:**
Middle East / India / Singapore

INDIAN LNG SCENARIO

LNG Receiving Terminals & Pipeline Infrastructure



EXISTING & UPCOMING LNG TERMINALS

	13-14	14-15	15-16	16-17	13th Plan
Dahej	12.5	12.5	15.0	15.0	15.0
Hazira	5.0	5.0	7.5	10.0	10.0
Dabhol	5.0	5.0	5.0	5.0	5.0
Kochi	5.0	5.0	5.0	5.0	10.0
Ennore	0	0	5.0	5.0	5.0
Mundra	0	0	5.0	5.0	10.0
East Coast				5.0	15.0
Total Capacity	27.5	27.5	42.5	50.0	70.0
Expected Availability	16.0	23.8	35	40.6	70.0

Source : MoPNG working group report 12th five year plan

GAIL – A BRIEF PROFILE

Corporate Mission & Vision

Incorporated on 16th August, 1984

MISSION

To accelerate and optimise the effective and economic use of Natural Gas and its fractions to the benefit of the national economy

VISION

Be the leading company in natural gas and beyond with global focus, committed to customer care, value creation for all stakeholders and environment responsibility

GAIL - An integrated & diversified gas company ...

Pipelines

- NG Transport Capacity: 230 MMSCMD (~10,800 Km)
- LPG Transport Capacity 3.8 MMTPA (~2050 Kms.)

International sourcing & Trading

- Gas Marketing ~ 80 MMSCMD
- Imported 25 cargoes (5.4 MMSCMD) in 2013-14
- Signed mid / long term contracts

Petrochemicals

- Significant Player (~ 20%)
- Capacity 450 KTA
- Expanding to 900 KTA in 2014.
- 70% stake in BCPL (280 KTA)
- 17% stake in OPaL

LHC

- Sizeable contribution
- 7 LPG Plants across India
- (1.4 MMTPA)

...with significant presence across gas value chain

Exploration & Production

- 28 Domestic Blocks
- 2 Overseas (2 Myanmar)
- 20% working interest in Shale Gas Asset in U.S.A

Overseas

- First substantial investment
- Opened office in Egypt, USA, Singapore

City Gas

- Wholly owned Subsidiary - GAIL Gas Ltd.
- 8 Joint Ventures

Diversification / Others

LNG
- Dahej- 10 MMT; Kochi- 5 MMT; Dabhol- 5 MMT
- Renewable (wind-118 MW, Solar-5 MW)
- RGPPL – Power (2150 MW)
- GSEG – Power (156 MW)

Global Presence .....

Egypt
- Equity in 2 Retail Gas Companies

Myanmar
- Partner in A1, A3 E&P Blocks
- Partner in Myanmar-China Gas P/L

United States of America
- GAIL Global U.S. holds 20% stake in producing Shale Asset in Eagle ford

China
- Equity Partner in China Gas (Retail Gas Company)
- 50:50 JV With China Gas

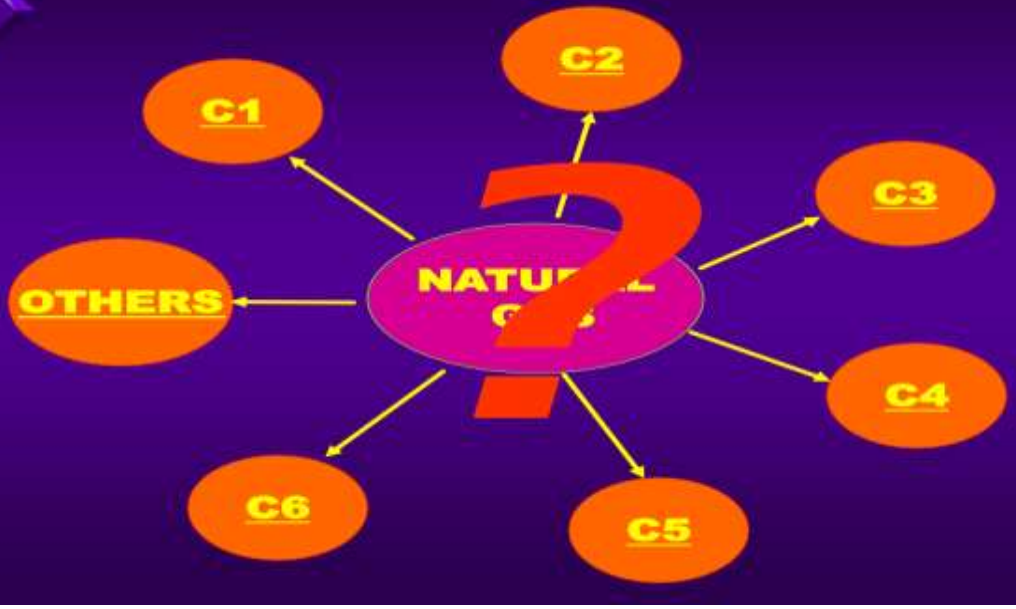
Singapore
- 100% Subsidiary – GAIL Global (Singapore) Pte. Limited – Overseas investment & Trading / Sourcing arm

Thanks!

LNG VALUE CHAIN

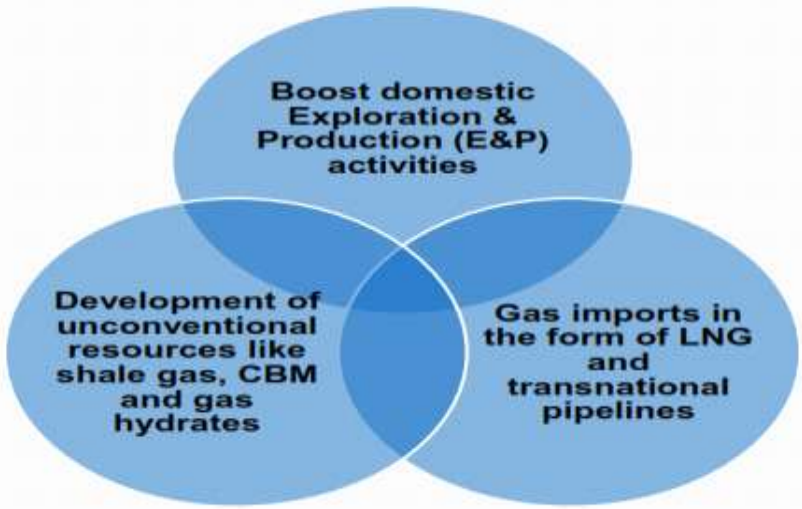
N G

WHAT IS NATURAL GAS



NATURAL GAS PRODUCTS

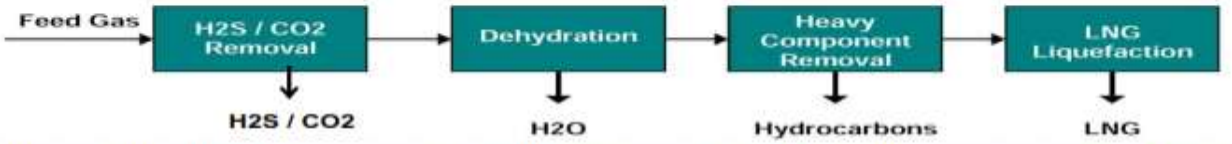
WAYS TO MEET DEMAND SUPPLY GAP IN GAS ERA



LNG

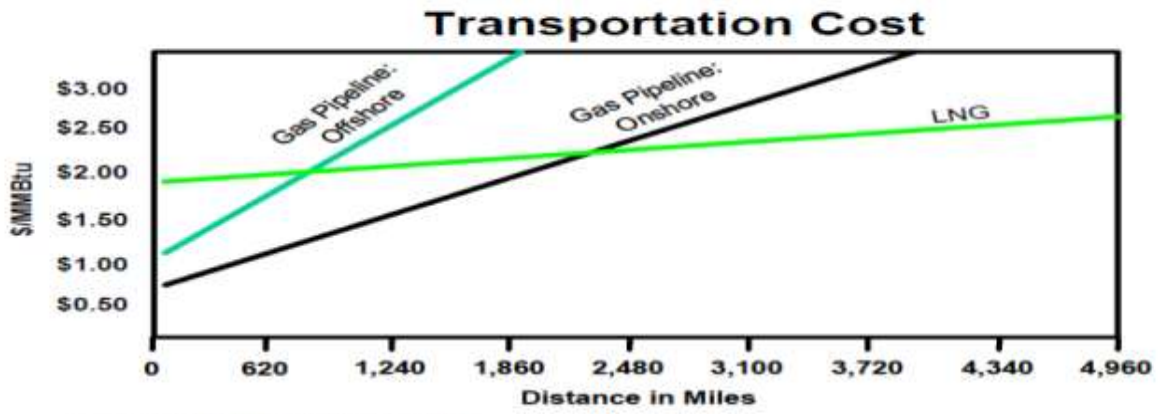
- LNG occupies 600 times less volume and can be economically transported by ships
- Natural gas in liquid state at (–)161 °C
- Weight of LNG is about half that of water – evaporates if spilled in ocean
- LNG vapors are lighter than air- less chance of ignition if emitted
- LNG is not under pressure while transporting or storage- less chances of explosion
- LNG is odorless, nontoxic& non corrosive

LNG Liquefaction Process



Composition (mol%)	Natural Gas	Rich LNG (Dahej)	Lean LNG
C1	75 - 90	85 (min)	98 - 99
C2	6 - 8	9.2 (max)	0.5 - 1
C3	2 - 5	3.00 (max)	0.00
C4	1 - 3	2.00 (max)	0.00
C5	0.2 - 1	0.25 (max)	0.00
C6+	0.1 - 0.5	0.00	0.00
N2	0.01 - 1	1.25 (max)	0.01 - 1
CO2	2 - 5	0.00	0.00
Total Sulphur	0 - 1200 ppmv	24 ppmw (max)	24 ppmw (max)
H20	Saturated	Nil	Nil

Economics : LNG Vs Pipeline



Source: Institute of Gas Technology.

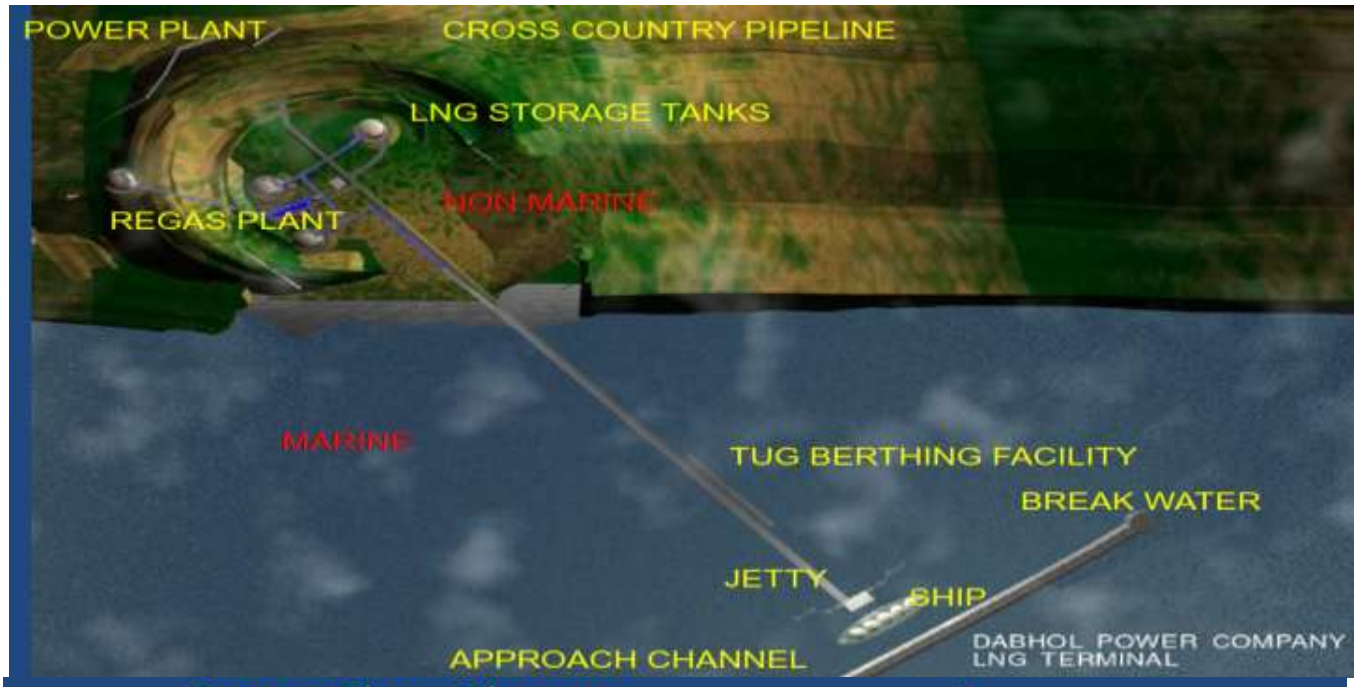
LNG is economically attractive at distances greater than 3,500 kms

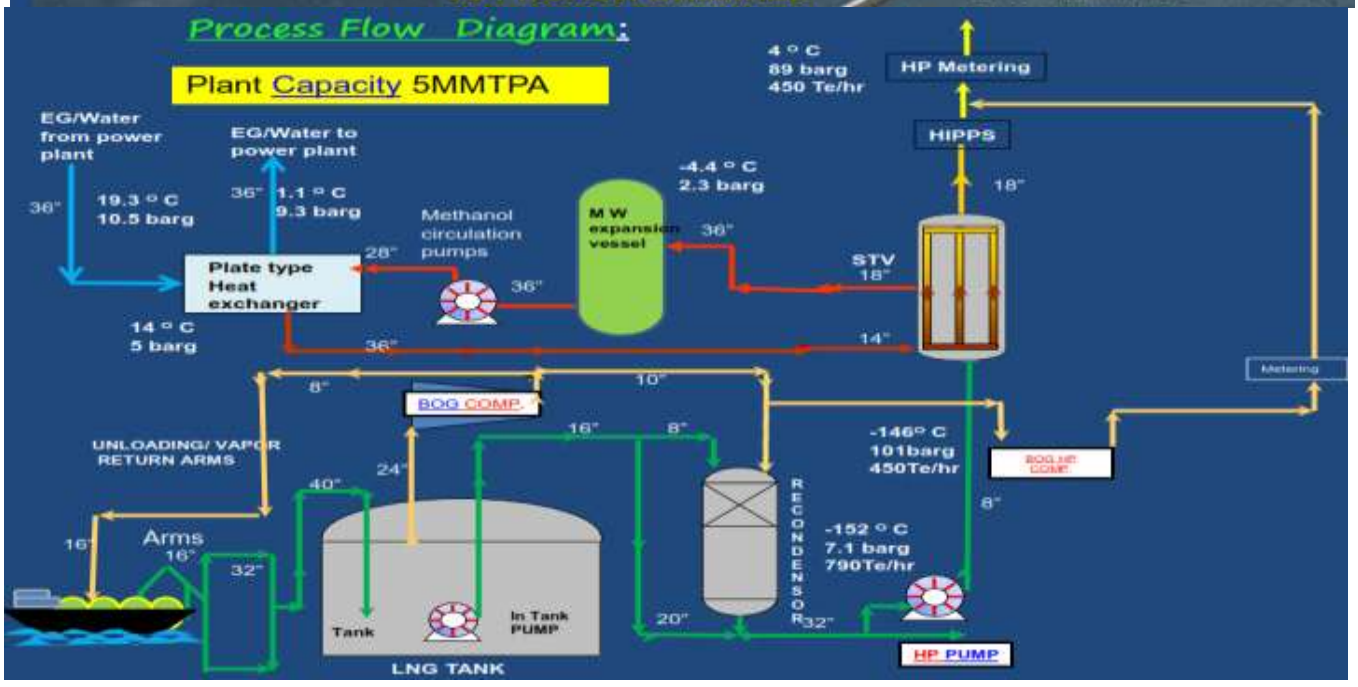
LNG Value Chain

LNG Regas Terminal / FSRU

LNG TERMINAL

- **Non – Marine**
  - **LNG Tanks**
    - 3 LNG Storage Tank of 160,000 M3 capacity Each
  - **Re- Gasification Facility**
    - Regas - 5.0 MMTPA
- **Marine**
  - **Jetty & Berthing System**
    - Jetty Trestle - 1.8 Km
    - Berthing System- 400m
  - **Channel & Dredging**
    - Channel of 8 Km by 300 m with turning circle of 700 m Diameter
  - **Break Water**
    - 2.3 Km Long


POWER PLANT
CROSS COUNTRY PIPELINE
LNG STORAGE TANKS
NON MARINE
REGAS PLANT
MARINE
TUG BERTHING FACILITY
BREAK WATER
JETTY
SHIP
APPROACH CHANNEL
DABHOL POWER COMPANY
LNG TERMINAL


Process Flow Diagram:
Plant Capacity 5MMTPA
EG/Water from power plant
EG/Water to power plant
19.3 ° C
10.5 barg
1.1 ° C
9.3 barg
Plate type Heat exchanger
14 ° C
5 barg
Methanol circulation pumps
M W expansion vessel
-4.4 ° C
2.3 barg
4 ° C
89 barg
450 Te/hr
HP Metering
HIPPS
STV
BOG COMP.
UNLOADING/ VAPOR RETURN ARMS
Arms
Tank
In Tank PUMP
LNG TANK
RECONDENSOR
-146° C
101barg
450Te/hr
BOG HP COMP
-152 ° C
7.1 barg
790Te/hr
HP PUMP
Metering


An Experience
On
Revival Of An
abandoned Project.

Background of the Project

- Dabhol Power Corporation (formed by the Enron Corporation, USA) started the project in 1993
- DPC abandoned the project in 2001

Status of the project:

Power Block: 90% completed and having operated partially on Liquid Fuel

LNG Block: (i) 85% completed

Balance jobs:
(i) Dredging: 55%
(ii) Breakwater construction: 60%
(iii) Jetty: 80%
(iv) Regas Facility: 80%

19

Background of the Project

- Govt. of India formed an EGoM in 2004 for revival of this project
- EGoM formed Ratnagiri Gas and Power Private Limited (RGPPL) a Special Purpose Vehicle (SPV) with NTPC & GAIL to revive and operate the plant
- The Assets were taken over by RGPPL in October, 2005 through Hon'ble High Court of Mumbai without any past Liabilities

20

Equity holders of RGPPL – A Conglomerate of the best in business

NTPC Limited

- Largest power utility of India incorporated in 1975
- Current installed capacity of 40 GW having 23 coal based station & 8 gas/ liquid based stations & JVs.
- Turnover – USD 12 Billion, Profit – USD 2 Billion

GAIL India Limited

- India's flagship Natural Gas company (Estb. year 1984)
- 10,700 km of Natural Gas high pressure trunk pipeline, 7 LPG Gas Processing Units, one Petrochemical Complex
- Turnover – USD 8 Billion, Profit – US 0.7 Billion

MSEB Holding Company

- Largest Generating, Transmission & Distribution companies of amongst the States
- Principal beneficiary

Indian Financial Institutions

- SBI and Canara Bank : Top Public Sector Banks in India
- ICICI Bank Ltd. is the largest Private Sector Bank in India
- IDBI Bank is a leading Private Sector Bank in India

Ownership and Management

(Equity and Debt Figures in Rs Crores)

Equity Partner	Equity				Debt	Nominee Directors
	Committed	% Stake	Paid up	% Stake		
NTPC	974	32.86	895.26	32.47	Nil	3
GAIL	974	32.86	895.26	32.47	Nil	3
GoM (MSEB Holding Co.)*	517	17.42	467.04	16.94	Nil	2
FIs	500	16.86	500	18.12	8873.68	3
Total	2965	100	2757.56	100		

- Chairman is nominated by NTPC and GAIL on 2 year tenure by rotation
- MD, a full time Board member, is always a nominee of NTPC
- Dy MD, a full time Board member, is always a nominee of GAIL

* Including Rs 265 Cr Non-cash equity

Project Cost

- Original Project Cost was Rs. 10303 Cr.
- Current Project Cost Estimate is Rs. 13909.87 Cr.
  - Power Block Cost – Rs. 8739.69 Cr.
  - LNG Block Cost – Rs. 5170.18 Cr.
    - *Incurred so far – Rs. 4303 Cr.*
- Funding Sources
  - Equity – Rs. 2965 Cr.
    - *Power – Rs. 1765 Cr. (including Rs. 265 Cr. sweat equity)*
    - *LNG – Rs. 1200 Cr.*
  - Debt
    - *IFI – Rs. 7186 Cr. (Original CTLA) plus Rs. 1364 Cr. (funded interest during Fin. Restructuring)*
    - *PFC – Rs. 1230 Cr.*
    - *NTPC - Rs. 170 Cr.*
- Reasons for increase in project Cost
  - Increase in revival cost due to surprises and failures in abandoned assets
  - Increase in IDC due to shifting of respective CoD

Power Block [1967.08 MW]

Block #1	Block #2	Block#3
640 MW 2 GTs 9341 FA [205 MW] 1 ST [220 MW]	663.54 MW 2 GTs 9351FA+ [213 MW] 1 ST [237.54 MW]	663.54 MW 2 GTs 9351FA+ [213 MW] 1 ST [237.54 MW
COD: 19.05.2009	COD:01.09.2007	COD: 21.11.2007

Gas Supply Commencement : 28.08.2007

- Gas requirement : 8.5 MMSCMD
- Gas Allocation : 7.6 MMSCMD (Reliance) & 0.9 MMSCMD (ONGC)
- Gas Supply : Almost Nil
- GSPA (Reliance) and GTA (RGTIL & GAIL) : valid up to Mar' 2014

Power Tariff Sensitivity

Tariff sensitivity at gas prices

Gas Price ($/MMBTU)	4.43	5.50	6.00	7.00	8.00	8.50	9.00	9.50	10.00
Weighted Landed Cost ($/MMBTU) (7.6 MMSCMD KG D6 + 0.9 MMSCMD ONGC)	5.56	6.56	7.03	7.98	8.93	9.4	9.87	10.35	10.82
Variable Cost (Rs./kWh) (1 $= Rs. 65)	2.73	3.23	3.46	3.93	4.39	4.62	4.86	5.09	5.32
Fixed CoG (Rs./kWH) (Corresponding to 80% DC)	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50	1.50
Total Energy Cost (Rs./kWh)	4.23	4.73	4.96	5.43	5.89	6.12	6.36	6.59	6.82

Tariff sensitivity on RLNG from RGPPL LNG Terminal

Ex Ship LNG Price ($/MMBTU)	10	12	13	15	18	20
R-LNG Ex-Terminal Price ($/MMBTU)	11.20	13.26	14.29	16.35	19.44	21.50
Variable CoG (Rs./kWH) (1 $= Rs. 65)	5.51	6.52	7.03	8.04	9.56	10.58
Fixed CoG (Rs./kWH) (Corresponding to 80% DC)	1.50	1.50	1.50	1.50	1.50	1.50
Total CoG (Rs./kWH)	7.01	8.02	8.53	9.54	11.06	12.08

Salient Features of LNG Terminal

- India's first Integrated LNG terminal (with Gas based power plant)
- Asset Value of 1 Billion US$ (Rs 5170 Cr)
- LNG Capacity : 5.0 MMTPA
- Gas Distribution : 2.1 MMTPA (LP at 41 kg/cm²)
  2.9 MMTPA (HP at 92 kg/cm²)
- No. of Storage Tanks : 03 Nos.
- Storage / Tank : 1,60,000 m³ (68,000 MT)
- Total Storage Capacity : 4,80,000 m³ (2,04,000 MT)
- Re-gassification Capacity : 18 ~ 20 MMSCMD
- Ship Handling Capacity / Year : 80 ~ 120 Nos.

Unique Features of LNG Terminal

- Most of the equipments were installed more than 12 years before & remain idle under preservation
- Some of the instruments & technology have already become obsolete. Difficult to get spares & vendor support
- Some of the equipments cannot be tested before commissioning or actual use
- Most of the vendors are from overseas
- LNG Jetty is exposed to open sea condition
- Breakwater is partially built up
- Very long ring main consist of 62 no of bellows, which are considered to be very sensitive & requires longer time for commissioning with special monitoring.
- Integration with power plant for exchanging cold through Methanol & Ethylene Glycol (EG) circuit and requires close co-ordination


05 Sep 00


CHILLED WATER RECIRCULATION
PUMP - D
9X-MP-VW002D

BOG Compressor Gear Box Bearing Replacement (2011)

CONSTRUCTION STAGE

CONSTRUCTION STAGE

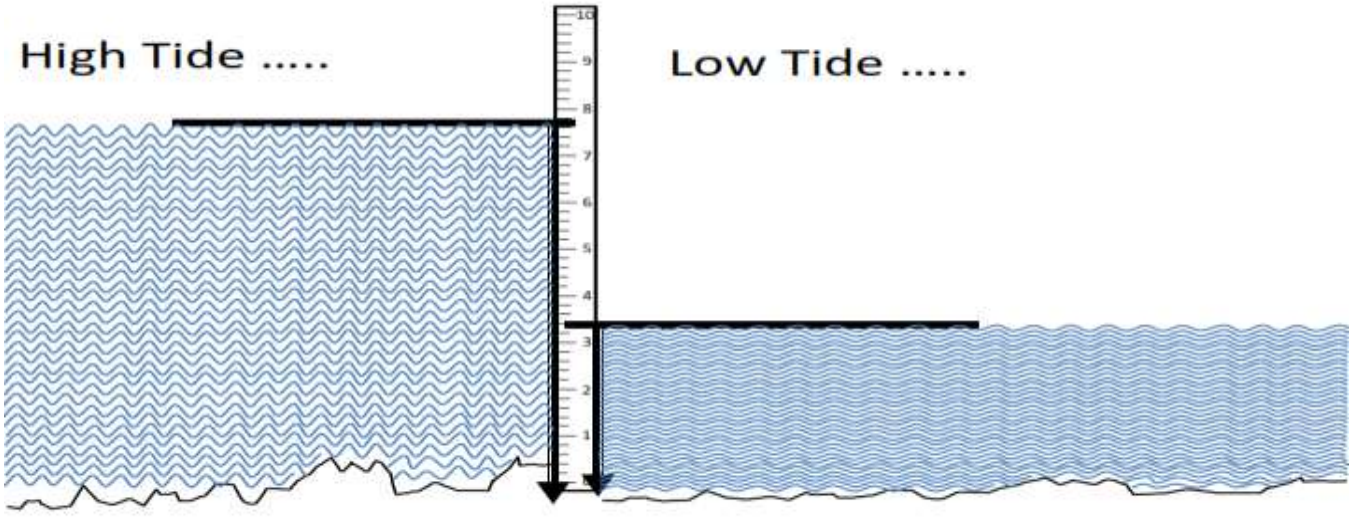
- **Experienced Consultant**
- **Capable Suppliers and Contractors**
- **Project team from Owner's side**
- **Studies and their mitigation** : HAZOP, SIL, QRA, Surge Analysis
- **OEM Support Services** : Contracts to be lined up before commissioning.
- **Spare Management** : Inventory to be built up before commissioning.
- **O&M preparedness**

LNG TERMINAL

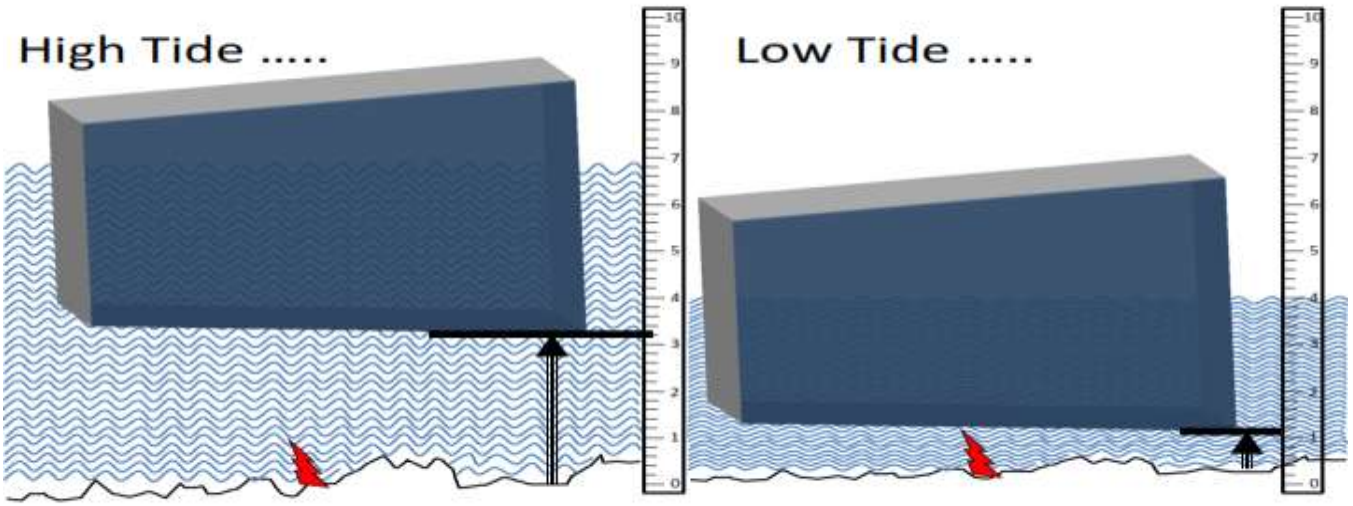
DREDGING OF CHANNEL
For Safe Berthing Of Ship

- CAPITAL DREDGING
- MAINTENANCE DREDGING

Water Depth: Variation in Tidal Depth

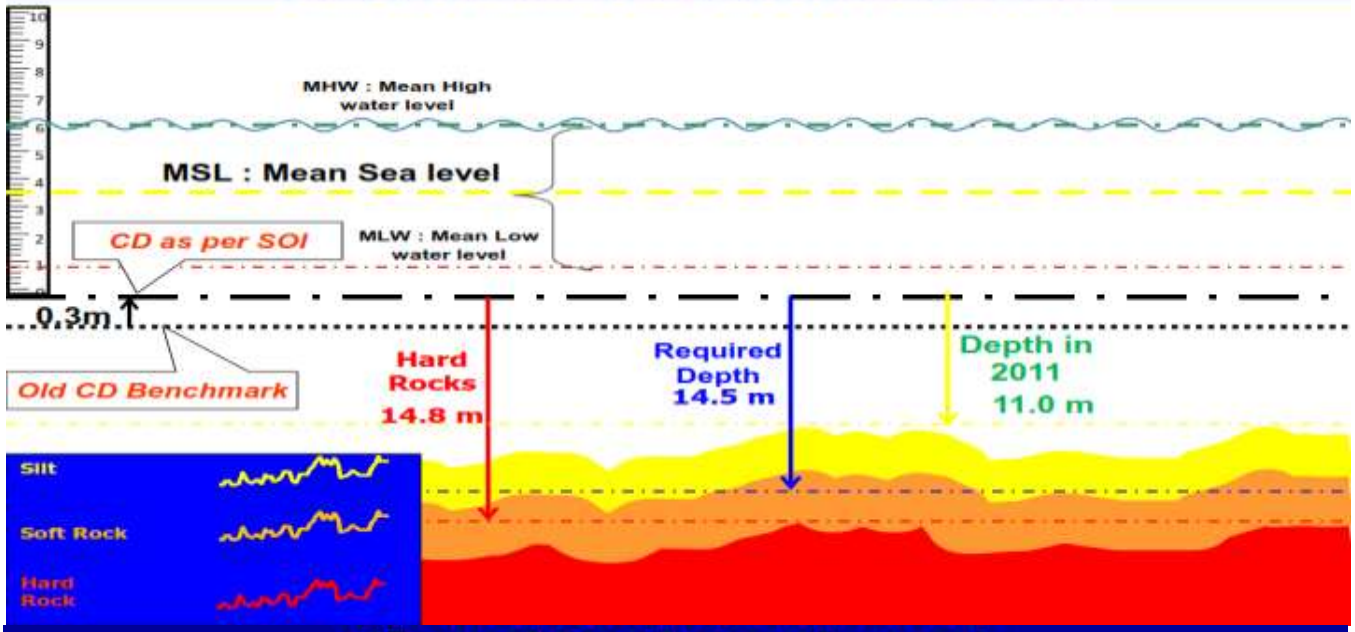


Depth Below Bottom of Vessel : Ocean



Level : Tides – Wrong Predictions

Chart Datum: Vertical Measurement

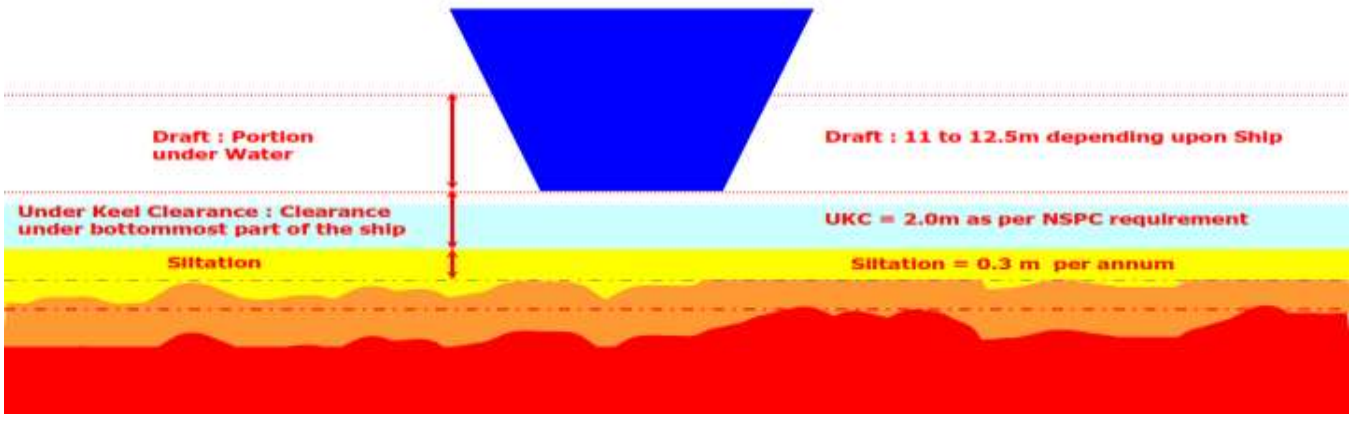


Channel Depth Requirement

- Channel Depth = Draft + UKC + Siltation + Margins

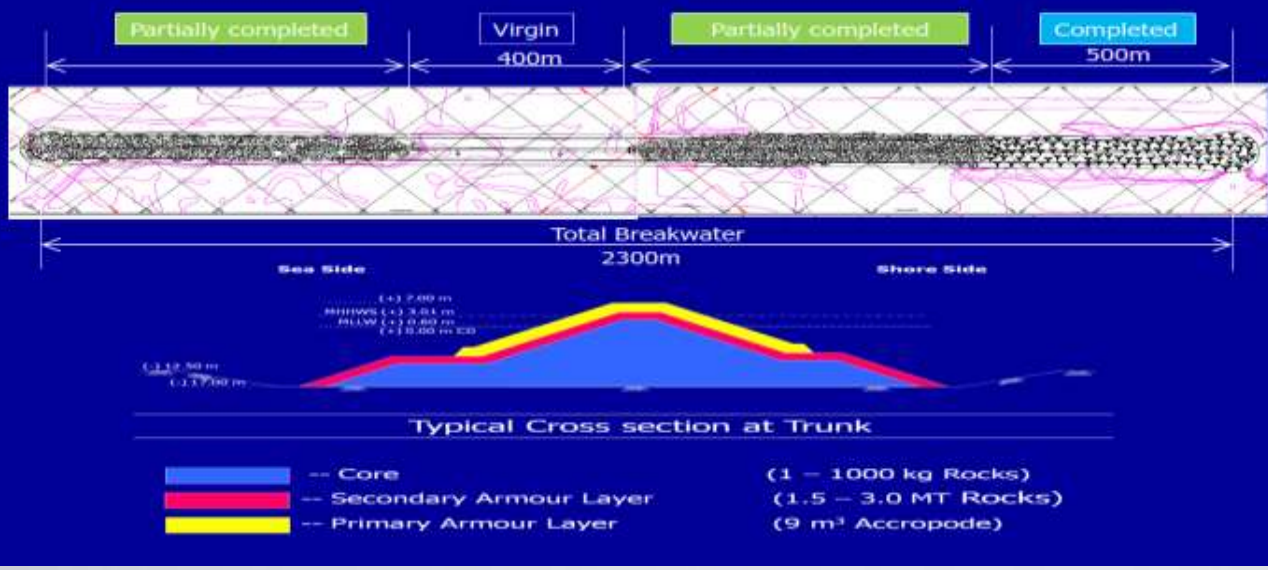
  12.1 + 2.0 + 0.3 + 0.1

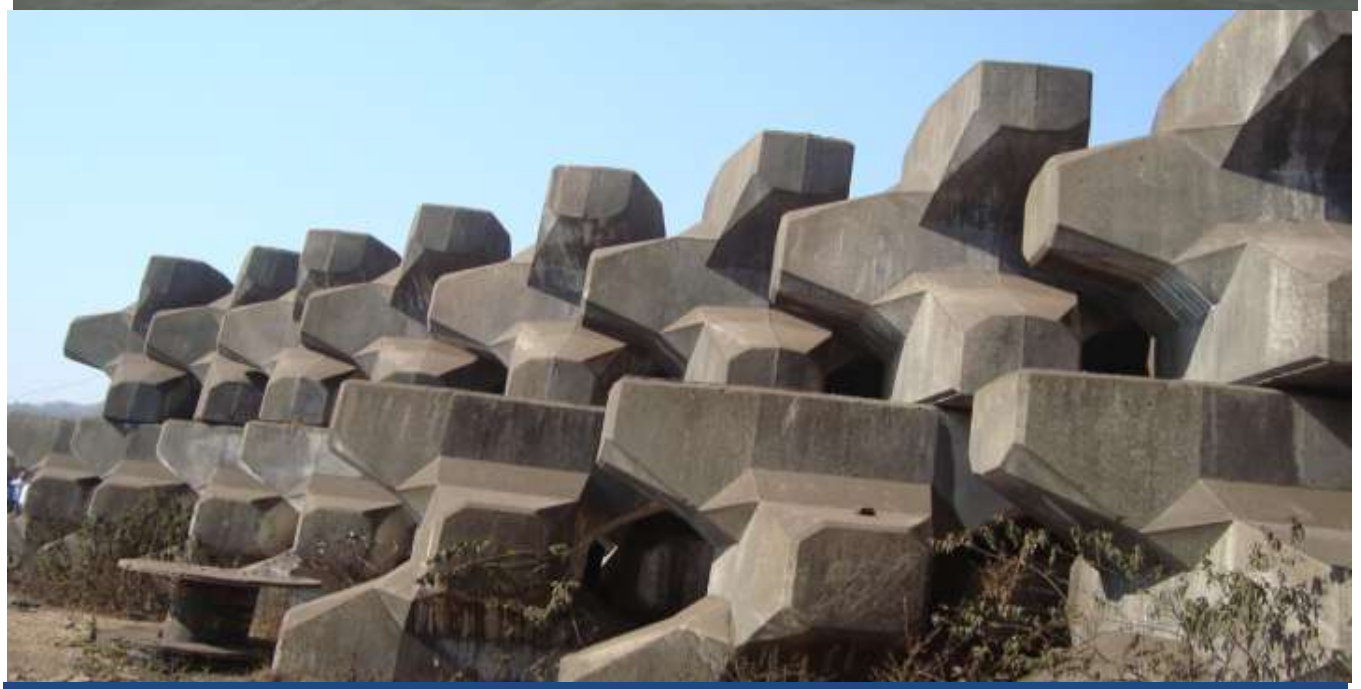
  14.5 m



BREAKWATER CONSTRUCTION

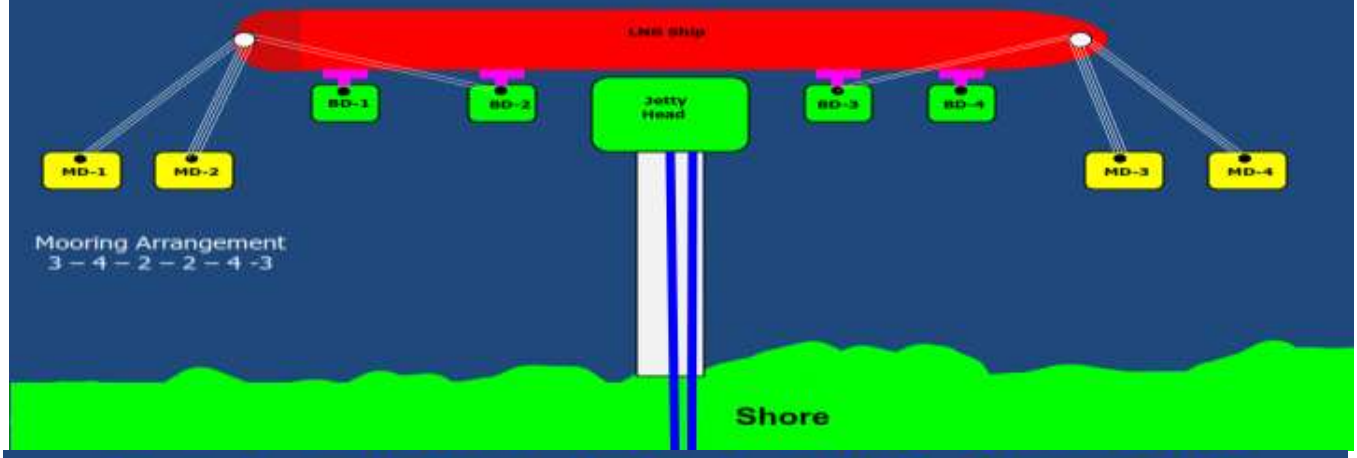
Status of Existing Breakwater Works





MOORING & BERTHING SYSTEM

Berthing / Mooring Arrangement



Turning of Commissioning LNG Cargo Ship

Berthing & Mooring of Commissioning LNG Cargo Ship

Mooring of LNG Ship at RGPPL Jetty

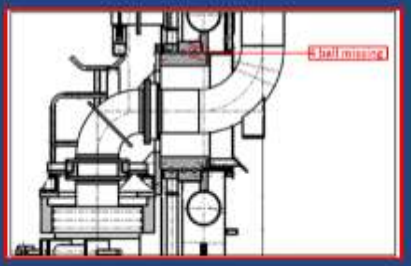



Gangway




Unloading Arms



Fenders

- 4 Nos. of Fenders (comprising of 2 cell element) installed at RGPPL Jetty. Each Fender is designed to absorb total berthing energy alone.
- M/s Bridgestone (Fender OEM) inspected the Fender in 2010 & found the same usable.
- Fenders are designed to absorb berthing energy for 80 ships per year.
- However, during commissioning, fenders could sustain berthing energy for 8 days round the clock & fender at BD-1 , 3 & 4 failed.
- Availability of similar fenders was explored at various ports & vendors including OEM.
- Similar fenders designed to absorb comparable berthing energy were located at Hi-tech, Ahmedabad
- Fender replacement started on war – footing basis & fenders were replaced on 25.04.2012.
- However, Cone fender could withstand berthing energy for 36 hours. & vessel was de-berthed safely on 28.04.2012 , 10:15 Hrs.

Fenders

Fenders

BD -1

BD - 2

BD - 3

BD - 4

Loading of Hydra on Berthing Dolphin




Installation of New Fender Cell




68

Installation of Fender Cell & Frontal Frame




69

Replacement of Fendeing System

Old Fendering System

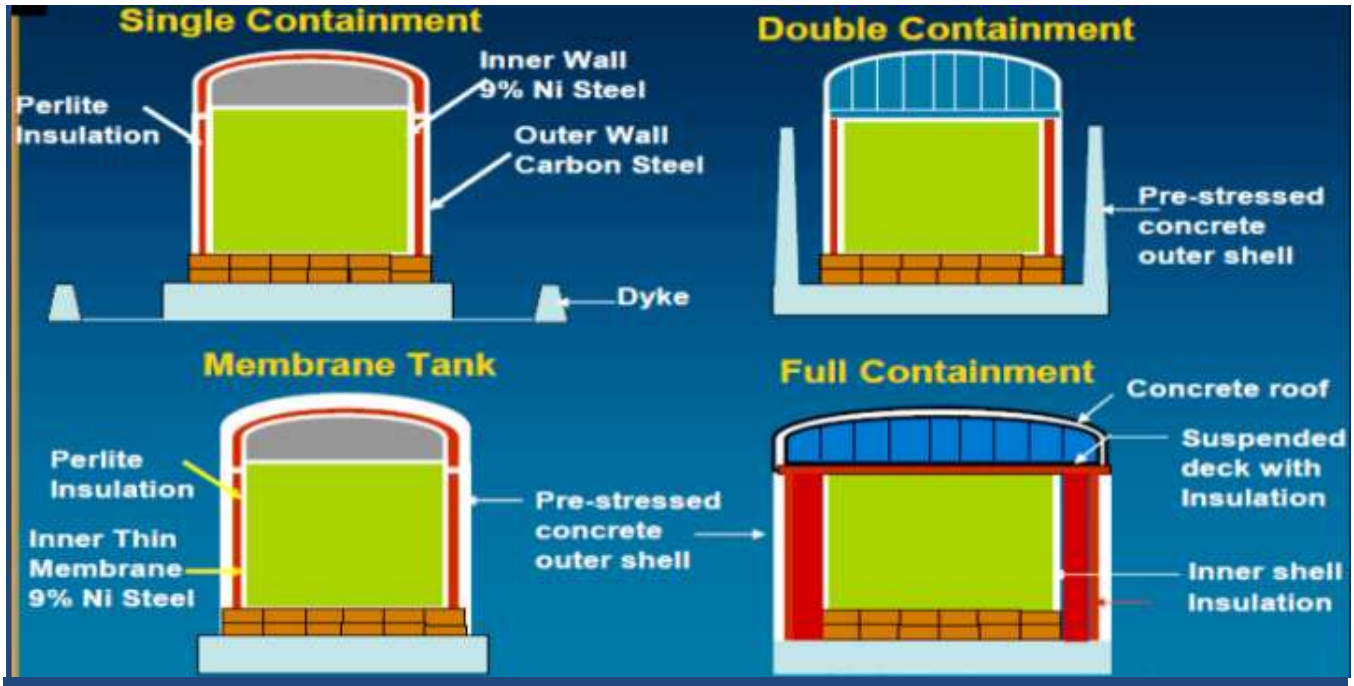
New Fendering System

Replacement of Fendering System

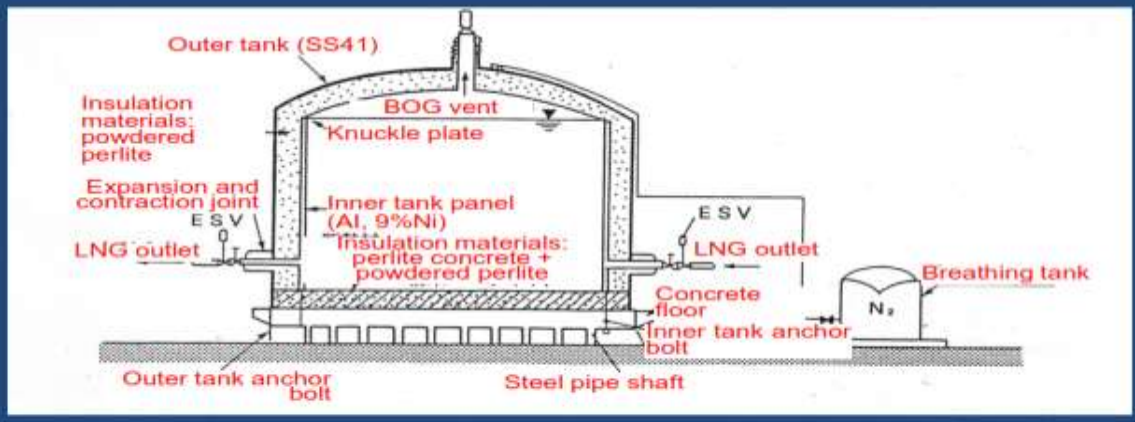
Old Fendering System

New Fendering System

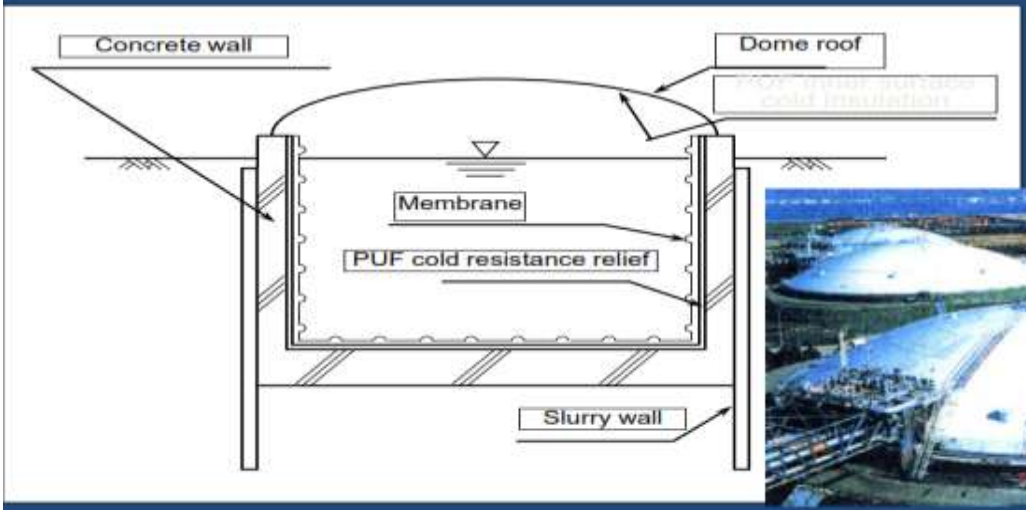
NON MARINE FACILITIES



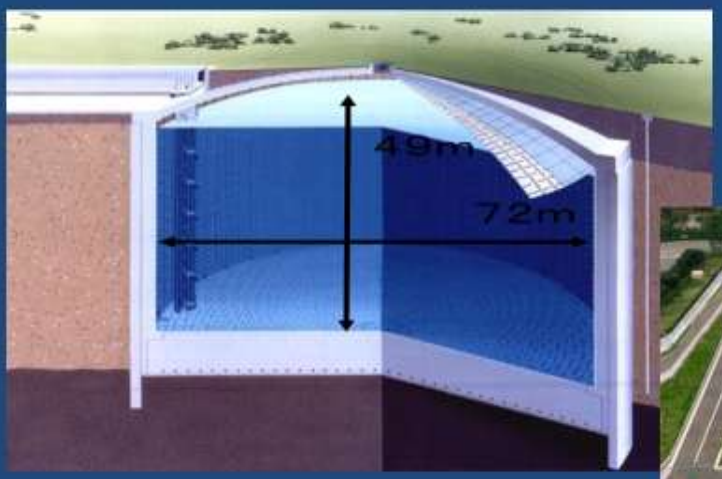
Aboveground Double-Walled Tanks



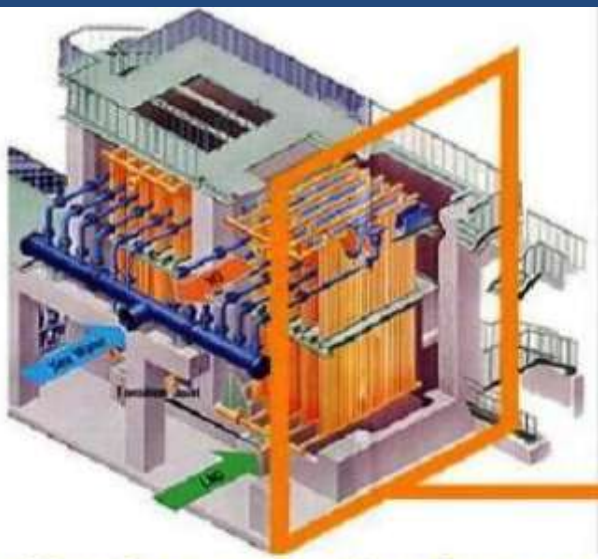
Inground membrane concrete tank

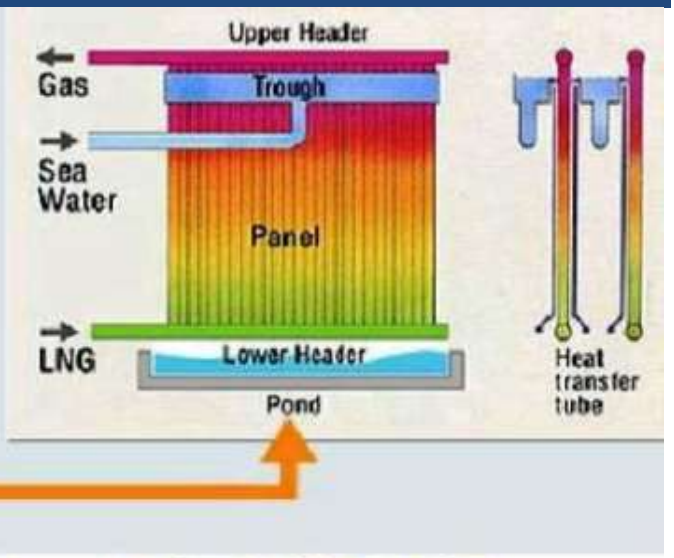


Underground Membrane Concrete Tank



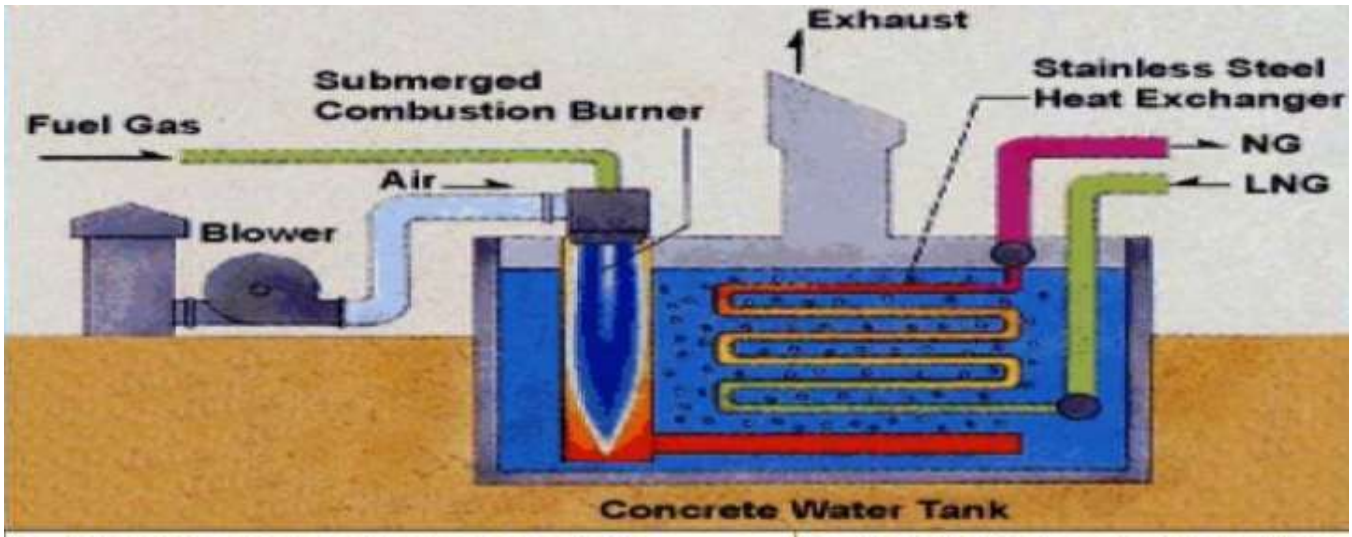
OPEN RACK VAPORIZERS





- Simple construction & operation.
- No controls, reliable and safe.
- High turndown ratio.
- Capital intensive.
- Environmental issues
- High maintenance.

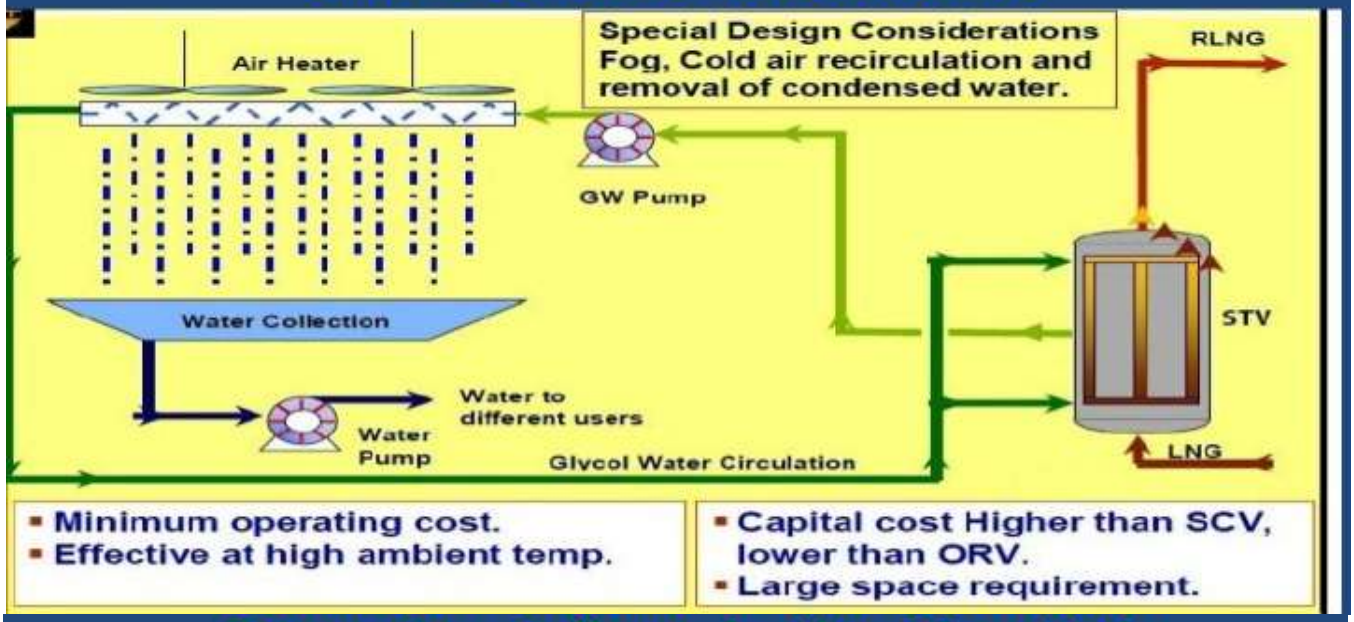
SUBMERGED COMBUSTION VAPORIZERS



- Simple and compact design.
- Large load fluctuations.
- Lower capital cost
- Low ambient temp. application.

- 1.5% fuel consumption
- Green house effect.
- The control is more complex.

SHELL & TUBE VAPORIZERS

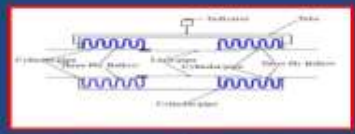


- Minimum operating cost.
- Effective at high ambient temp.

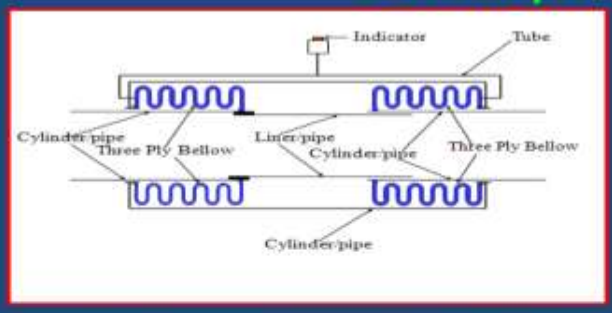
- Capital cost Higher than SCV, lower than ORV.
- Large space requirement.

Expansion Bellows in the Ring Main

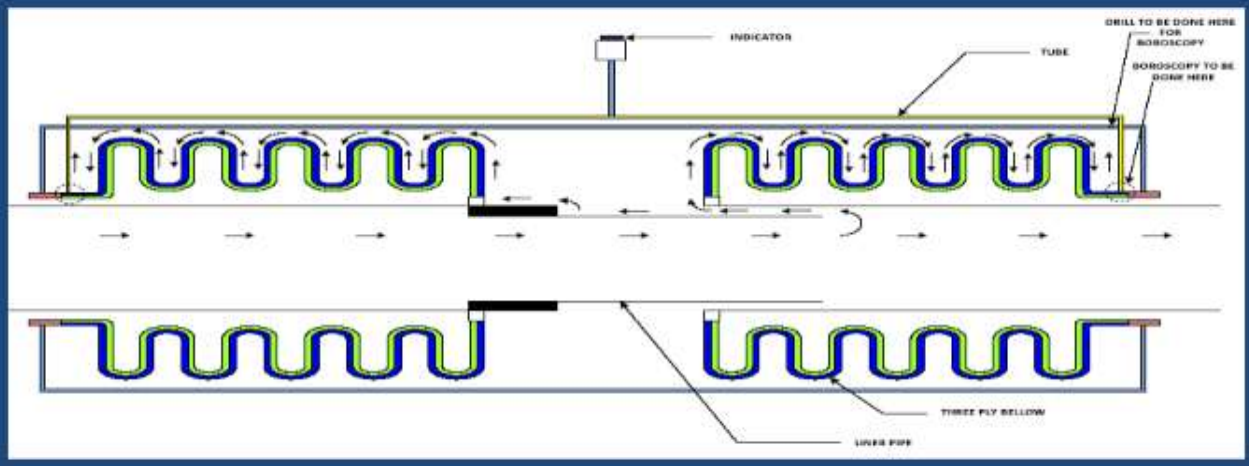
- Bellows (with Red-Pop up indicator for leak detection) [31 Sets (62 Nos)] of Senior Flexonics, USA installed in Ring-main for taking care of contraction and expansion due to temperature variation
- Bellows are designed at par with ring-main design pressure of 18.9 Bar & tested at pressure of 28.3 bar.
- Ring-main was tested in 2009 & was kept under N_2 preservation since then till LNG was introduced on 08.04.2012.
- During Ring-man warm-up after safe de-berthing of LNG Cargo on 28.04.2012, leakage (red pop-up indication) in 5 bellows & 100 % LEL detection was observed in additional 5 bellows.
- Based on assessment by OEM and Experts, 6 bellows replaced



An Expansion Bellow



Bellow- Schematic Diagram



Expansion Bellows Testing & Replacement

Other Modifications

Bellow Leakage Collection Line

Ring Main Re-circulation Line Hook-Up

BOG Hook-Up

91

Past vs Present : A historical Transformation

2000

2005

2012

2013

COMMISSIONING STAGE

93

Commissioning Preparedness

- Port Operation Services
- Commissioning Cargo
- Commissioning procedure
- Vendor Mobilization
- Commissioning Team mobilization

COMMISSIONING STAGE

- **Commissioning time selection : Best weather window Analysis**
- **Mock Drills : Fire fighting drills, marine ship drill**
- **Commissioning Audits in advanced periods**
- **Commissioning Ship**
  - **Contractual : 15 days stay with extra stay charges clarity**
  - **Quantity : One full Ship of 135 K; 60 K for commissioning and balance for inventory.**
  - **Ship facility to meet commissioning requirements like BOG flow and temperature controls, Back to Ship, cold flaring, stay time management**
- **Statutory permissions in place**

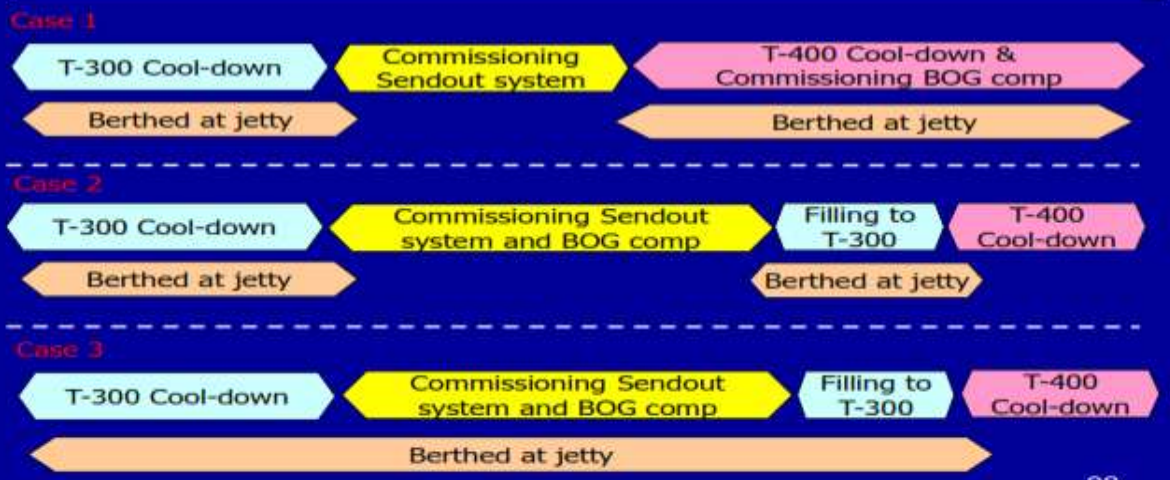
Statutory Permissions

SN	Name of Act(s)/Permissions sought for	Compliance /Exception
1	ISPS (International Ship and Port Facility Security) Compliance	Permission obtained. Certificate of Compliance awaited. However, the terminal can operate.
2	NSPC (Navigational Safety Port Committee) clearance	Follow up Audit for extension beyond 15.05.2012 to be conducted on 21.12.2012
3	Execution of Lease with MMB (Maharashtra Maritime Board)	Permission obtained for Commissioning & stabilization. Lease agreement for Captive Jetty in Progress.
4	Customs Clearance	Notification for unloading of Fuel (Merchant sale) at Dabhol published.
5	PESO (CCOE) permission for commissioning	Permission obtained on 21.03.2012
6	Notification of Port by Ministry of Shipping	Port Notified under Petroleum rules 2002. Permission valid till Mar 2015
7	Chart Updation by NHO	Chart Updated on 16.03.2012
8	Radar/ AIS/ VHF	Permission for AIS obtained. Radar and VHF – Fees paid to cover duration upto Sept 2013 -being followed up issuance of license
9	Coast Guard (Oil spill contingency plan)	Plan approved. Oil spill equipment procured as per plan.
10	Factory License (combined with Power block)	Valid up to 31.12.2014
11	MPCB consent to operate	Valid till 31.12.2012. Application for Renewal submitted in Sept 12. Being followed up for issuance.
12	Electricity Authority inspection (combined with power block)	Permission obtained.
13	PESO (CCOE) approval for LNG storage tanks	NOC for all LNG Tanks obtained.
14	PESO (CCOE) approval for Methanol tanks	Permission renewed till 31.12.2015.

Commissioning Schedule (2 Phase)

Sl NO.	Activity	Day 1	2	3	4	5	6	7	8	9	10	11	12	13	14
		Dec-12				Jan-13									
		28	29	30	31	1	2	3	4	5	6	7	8	9	10
1	Arrival of Commissioning Cargo														
2	Pre-cooling of Ring Main by cold vapor														
3	Mixing LNG to cold vapor and LNG filling														
4	Start Tank T-300 Cool-down														
5	LNG filling to Tank (Partial)														
6	LNG Ship De-Birth & Stay at Anchor														
7	HP pump & HP Pump Disch. line cool down														
8	BOG compressor Start-up														
9	Start-up HP Gas Send-out system														
10	LNG Ship Re-Berthing														
11	Filling up T-300														
12	Start-up BOG recovery system														
13	LNG ship Departure														
14	Tank T-400 Cooldown														

Cool-down Basic Procedure - Options



98

Action taken for post monsoon commissioning

- **Technical Experts :** Scott-Wilson & Tokyo Gas hired respectively in Aug 2012.
- **Fender Design :** M/s Bridgestone (OEM) reviewed Fender Design & finalised the revised Design. Marine Consultants reviewed the Bridgestone recommendations & ratified design
- **Unloading Arms :** Considering change of Berthing line due to longer fenders, We contacted FMC (Unloading Arm vendor) & arms were found compatible with new fendering system with various LNG Ships. Same was reviewed / accepted by Scot Wilson.
- **Bellows Failure Analysis and replacements :** RGPPL had carried out the Bellow testing through OEM. Further, based on TGE Feedback, ring-main testing was done at 8.5 Bar to ascertain the faulty bellows & 6 nos bellows were found faulty. 6th Bellow was sourced from Spare procured by RGPPL. 2" bellow leakage collection system connected with all bellows was envisaged for reducing risks.
- **Ring Main Circulation :** In order to reduce cool-down period & taking up maintenance of Ring-main section, Proposed 6" / 8" Line parallel to ring-main was accepted by Tokyo gas.

99

Action taken for Post Monsoon Commissioning

- **BOG Hook-ups :** BOG Hook-up were proposed before last commissioning, schemes were finalised by EIL in consultation with TGE.
- **Commissioning without WPJV :** With availability of Technical Consultants ; Tokyo Gas & Scott Wilson & mobilisation of commissioning vendors , RGPPL team was geared up for Commissioning without WPJV.
- **Vendor Mobilisation :** Considering delay in mobilisation of Commissioning vendors, RGPPL have contracted various OEM vendors for post-commissioning assistance which can be utilised during commissioning.
- **Hiring of BOG Booster :** Considering availability of only 2 LNG Tanks, terminal will not able to sustain no-ship period during monsoon with min. LP/HP send out & hiring of BOG Booster compressor become necessity. Contract award fast forwarded to ensure availability by March 2013.

Commissioning Cargo

- 85,000 m^3 LNG (approx.) was required for commissioning of LNG Terminal.
- Vessel finalized as per following details :

LNG Vessel	:	LNG Pioneer
Shipper	:	Gazprom
Vessel Volume	:	1,38,121m^3 (100%)
Vessel Sch. Arrival Date	:	28.12.2012
LNG Price (DES Basis)	:	US$ 16.55/mmbtu
Boil Off Rate	:	205 mmbtu/hour
Ship Retention Charges	:	US$ 3,000,000 (For 15 Days)
Demurrage Charges	:	US$ 125,000 per Day from 16th day

A VIEW OF UNLOADING ARMS CONNECTED TO SHIP- UNLOADING IN PROGRESS

Issues overcome during commissioning in Jan 13

- Flare Limitation – 35 m3/ hr compared to 160 m3/hr
- Vapour Locking – design limitation, initial cool down of 25 m3/hr compared to 160 m3/hr req., Local venting
- LNG Leakages – Glands
- HP system leakages – flange tightening
- HP pump vent line leakage – PSV bypass line utilised
- Strainer Cleaning arrangement – cooling process blocked
- Bellow cooling - deflection under control by vapour (-) 100 C

Commissioning Vendors involved

Sl No.	Package / Equipment	Supplier	Order placement	Deployment from	No.of Days	Confirmation
1	Ship to Shore Communication	Sea Technik	PO Placed	27-Dec-12	7	2nd Jan 2013
2	LNG Unloading Arms	FMC/ Lloyd Steel	Under Process	27-Dec-12	24	Lloyd Steel in place as req.
3	In-Tank LNG Pump	Nikkiso	PO Placed	01-Jan-13	10	5th Jan 2013
4	HP & LP LNG Pump	Ebara	PO Placed	01-Jan-13	10	4th Jan 2013
5	Tank Gauging System	Wartsila	PO Placed	31-Dec-12	10	27th Dec 2012
6	Fire & Gas Detection System (PLC)	Rockwell Automation	PO Placed	28-Dec-12	5	26th Dec 2012
7	BOG Compressor	Siemens	PO Placed	03-Jan-13	5	9th Jan02013
8	LNG Sampling System	Imtech	Under Process	01-Jan-13	5	(non critical)
9	LP Metering System (New)	Instromet	PO Placed	08-Jan-13	5	Deployed
10	HP Metering System	Daniel	PO Placed	08-Jan-13	5	4 days notice

Commissioning Vendor

SN	Package / Equipment	Supplier	Deployment from	No. of Days	Confirmation
11	DCS	Invensys	26-Dec-12	12	Deployed
12	ESD System	GE Fanuc	26-Dec-12	12	Deployed
13	Vibration Monitoring	Bentley Nevada	01-Jan-13	4	28th Dec 2012
14	Tank Base Heating System	Tyco	07-Jan-13	4	Non-critical
15	Vaporisers	Mannes & Lewis	07-Jan-13	5	Phone facilitation agreed.
16	Rotork Actuators	Rotork	28-Dec-12	12	28th Dec 2012
17	Flare System	Agra Birwelco	28-Dec-12	7	-
18	Gutor UPS	Gutor	28-Dec-12	7	As Required
19	Plate Heat Exchangers	APV / SPX	07-Jan-13	5	As Required
20	Mooring System / Mooring Hooks	Marimatech	28-Dec-12	5	15th Jan 2013

Fire Fighter - 1 (FiFi-1) Drill




COMMISSIONED WITH LNGC PIONEER

- FROM GAZPROM / MOL
- STAYED FROM 28TH DECEMBER 2012 TO 11TH JAN 2013
- LNG QUANTITY OF 1,25,482 m³ UNLOADED

Commencement of R-LNG Supply

January 10, 2013

LNGC GALLINA

- FROM SHELL
- LNG Qty : 1,27,000 m^3 unloaded on 22-03-13.
- Unloading Time (28 hrs) well within Total Lay Time

LNGC BERGE ARZEW

- **FROM SONATRACH**
- **LNG QUANTITY 1,32,000 m^3 UNLOADED ON 29-04-13.**
- **UNLOADING TIME (22.5 hrs)WELL WITHIN LAYTIME**

RGPPL - A SUCCESS STORY

- **Terminal successfully commissioned on 10th Jan'2013**
- **12 nos. LNG ships unloaded till date**
- **Ready to receive LNG cargo of apprx. 160,000 m^3, except during monsoon period due to absence of complete breakwater**
- **Cold chain maintained by BOG Booster compressor**
- **Global energy suppliers like British Gas, Nigeria LNG, Gazprom, GDF, Shell, Sonatrach and GNF delighted with their experience at Dabhol**
- **Received acceptance from Ras Gas and Conoco Philips for supplying LNG cargo**

The path being followed .....

Why Dabhol should be your preferred destination

- Our commercial operator GAIL is having presence in Value Chain and adequate Financial strength.
- Global acceptance received for LNG cargo unloading
- Technical advantage for ships due to clean waters, low tidal range, dredged channel (14.5 m CD) and insignificant current
- No waiting time due to captive channel, better slot availability and lesser marine traffic in the vicinity leading to safer and faster navigation.

CONCEPTUALIZATION & DESIGN
LNG Terminal

a. Site selection
b. Technology Selection
c. Project Execution & Commissioning
d. Evacuation system
e. Statutory clearances

CONCEPTUALIZATION & DESIGN

- **SITE SELECTION**
  - For safe berthing of LNG cargo, proper marine study to be done for
    - swell,
    - current,
    - tidal variations and
    - wind patterns

    Or breakwater to be built to overcome above.
  - Natural deep water draft and Lesser approach channel distance
    - Avoid annual dredging costs
    - Reduce laytime and Mooring Duration
    - Both side maneuverability to avoid turning circle needs
  - Shorter Jetty distance from Shore:
    - Reduce cost of Jetty approach, Ring Main,
    - Ring main BOG generation (Boil off Gas)
  - Plain land for cost reduction and safety aspects

CONCEPTUALIZATION & DESIGN

Technology Selection

A. Type of Terminal

- Land based On-shore terminal
- FSRU (Floating Storage & Regasification Unit)

B. Ring Main Design

- With U-loop
- With expansion Bellows

C. LNG Tank Design

- Above ground double-walled tanks
- Membrane concrete in-ground tanks

CONCEPTUALIZATION & DESIGN

D. Type of Vaporizers

- ORV: Sea Water
- SMV: Combustion in water

E. Utilization of Cold – Energy Efficient Terminal

- Integrated Power Plant
- Nitrogen Plant
- Fish storage unit

F. Other factors

- Truck Loading facility
- Ship Loading facility
- Avoid cold flaring
- Space for future expansion

Projected LNG Import Capacity in India

LOCATION	CAPACITY (MMTPA)			OWNED BY
	2013	2016	2020	
Existing				
Dahej	10.00	15.00	20.00	Petronet LNG
Hazira	5.00	5.00	5.00	Shell & Total
Dabhol	3.00	5.00	5.00	GAIL
Kochi	5.00	5.00	5.00	Petronet LNG
Total	***23.00***	***30.00***	***35.00***	
Under Construction				
Total	-	-	-	
Proposed				
Gangavaram	-	5.00	5.00	Petronet LNG
Mundra	-	5.00	5.00	Adani/ GSPC
Ennore	-	5.00	5.00	IOCL
Total	-	***15.00***	***15.00***	
Possible				
West Coast	-	-	2.50	Hiranandani
Kakinada	-	-	5.00	Shell or GAIL
Pipavav (FSRU)	-	2.50	5.00	Swan Energy
Total		***2.50***	***12.50***	
Grand Total	**23.00**	**47.50**	**62.50**	

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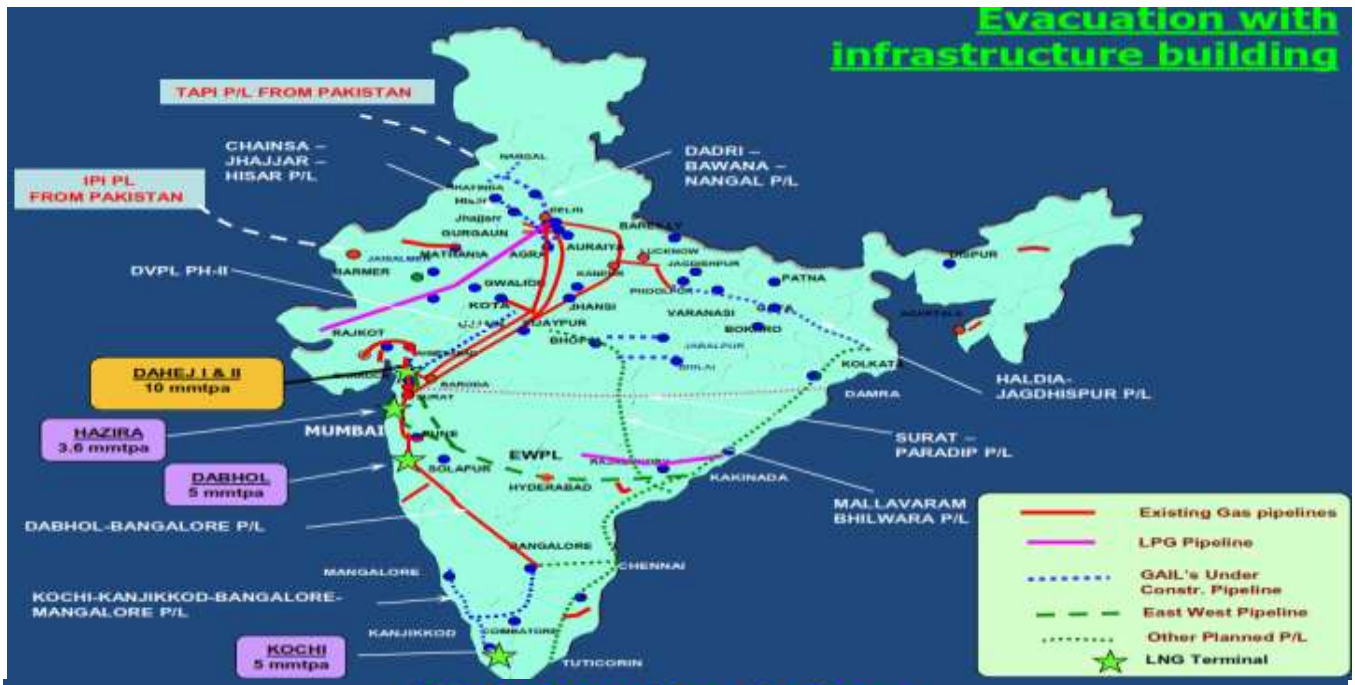
Evacuation with infrastructure building



Statutory Permissions

SN	Name of Act(s)/Permissions sought for	Compliance /Exception
1	ISPS (International Ship and Port Facility Security) Compliance	Permission obtained. Certificate of Compliance awaited. However, the terminal can operate.
2	NSPC (Navigational Safety Port Committee) clearance	Follow up Audit for extension beyond 15.05.2012 to be conducted on 21.12.2012
3	Execution of Lease with MMB (Maharashtra Maritime Board)	Permission obtained for Commissioning & stabilization. Lease agreement for Captive Jetty in Progress.
4	Customs Clearance	Notification for unloading of Fuel (Merchant sale) at Dabhol published.
5	PESO (CCOE) permission for commissioning	Permission obtained on 21.03.2012
6	Notification of Port by Ministry of Shipping	Port Notified under Petroleum rules 2002. Permission valid till Mar 2015
7	Chart Updation by NHO	Chart Updated on 16.03.2012
8	Radar/ AIS/ VHF	Permission for AIS obtained. Radar and VHF – Fees paid to cover duration upto Sept 2013 -being followed up issuance of license
9	Coast Guard (Oil spill contingency plan)	Plan approved. Oil spill equipment procured as per plan.
10	Factory License (combined with Power block)	Valid up to 31.12.2014
11	MPCB consent to operate	Valid till 31.12.2012. Application for Renewal submitted in Sept 12. Being followed up for issuance.
12	Electricity Authority inspection (combined with power block)	Permission obtained.
13	PESO (CCOE) approval for LNG storage tanks	NOC for all LNG Tanks obtained.
14	PESO (CCOE) approval for Methanol tanks	Permission renewed till 31.12.2015.

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EXECUTION OF LNG PROJECTS

- Pre Project Activities
  - Surveys & Studies
  - Land Survey
  - Collection of ambient data
  - Bathymetric Study
  - Topography Survey
  - Geotechnical Studies
  - Oceanographic Studies
  - Marine and Terrestrial Studies (Rapid & Comprehensive)
  - Project Feasibility Study including Mooring analysis & Ship Maneuvering Study
  - Basic Engineering package(FEED)
  - Finalization of Methodology for project execution
  - Techno Commercial Documents for selection of PMC & contractors

Safety Studies

The following conditions should be implemented for "Permit to Construct" and "Permit to Operate."

- **Process Safety Management (PSM) during design-**
  - **Design HAZOP, Final HAZOP**
  - **Management of Change due to HAZOP and documentation.**
- **Process Safety Management (PSM) during construction-**
  - **Mechanical Integrity – QA/QC during fabrication/construction**
  - **Operating procedures**
  - **Training based on operating procedure**
  - **Emergency planning and response**
  - **Security management.**
- **Reporting during design and construction.**
- **Pre-start-up review- by team of engineering, construction, maintenance, operation.**

Hazard Identification

- **External Origin**
  - **Natural Risks** (earthquakes, flooding, wind, typhoons and lighting)
  - **Non Natural Risks** (from other industry, marine traffic, aircraft crash, terrorist attack)
- **Internal Origin**
  - **Release of LNG**
    - Release from tanker, Spill from un-loading arms
    - Failure of transfer line, Inner / outer tank failure
    - Overfilling of storage tanks, Send out pump failure
  - **Release of NG**
    - Tank safety valves, Vaporizer safety valves, Flare stack
  - **Process upsets** like equipment failure, utility failure, roll over .

Operation of LNG Terminal

CONTENTS

1. TYPICAL REQUIREMENT OF LNG TERMINAL

- The terminal to receive liquefied natural gas (LNG) from Ship tankers with capacity from 65,000 to 216,000 m^3.
- LNG to be stored, regasified in the terminal, and sent out via pipeline network to consumers.
- All Process utilities system designed to cater 5.0 MMTPA Sendout

2. DESCRIPTION OF PROCESS UNITS

2.1 LNG TANKER UNLOADING SYSTEM

2.2 LNG STORAGE SYSTEM

2.3 LNG HOLDING/RECIRCULATION SYSTEM

2.4 BOG VAPOR HANDLING SYSTEM

2.5 LNG SEND-OUT SYSTEM

2.6 COLD RECOVERY SYSTEM

2.7 HEAT RECOVERY SYSTEM

2.8 FLARE SYSTEM

2.9 TRUCK LOADING FACILITY

2.1 LNG TANKER UNLOADING SYSTEM

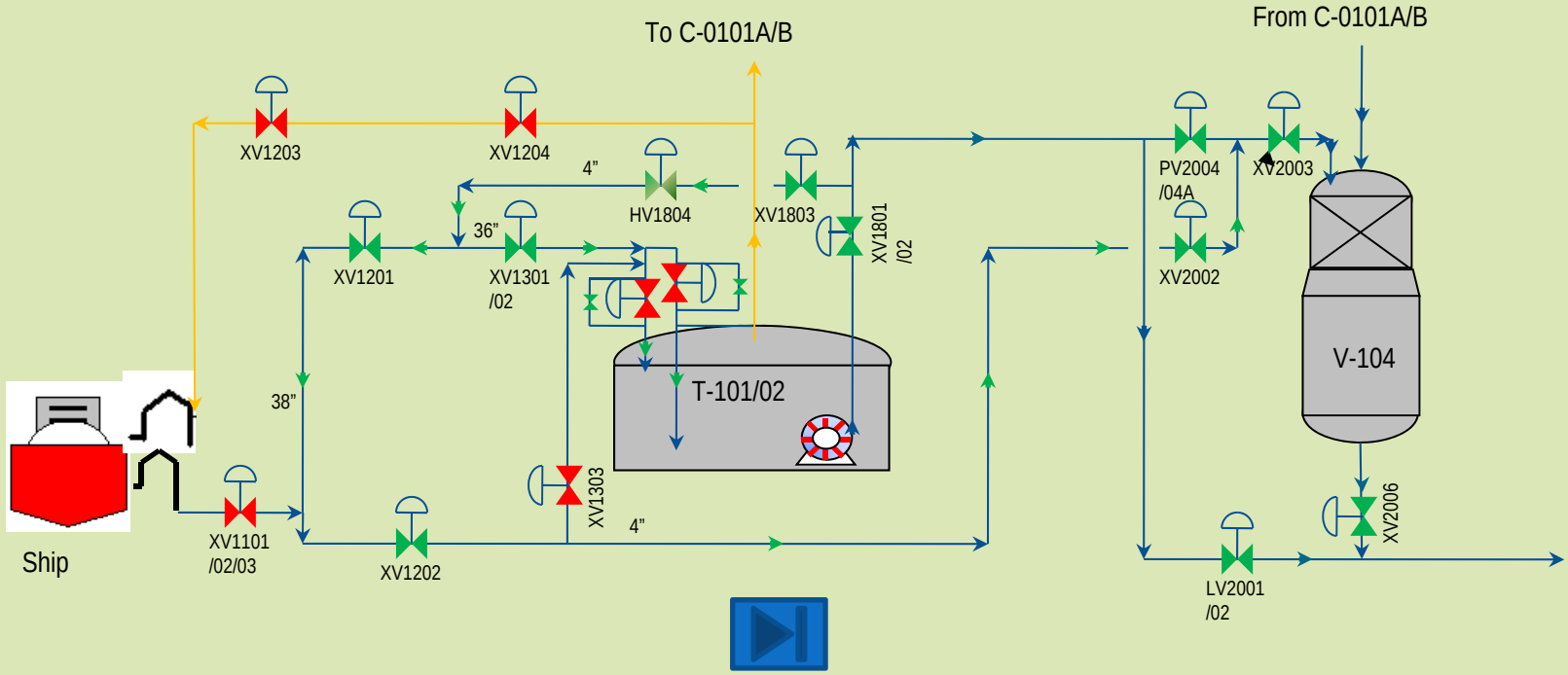
- The facility designed to unload only one tanker of 65,000 to 216,000 m^3 capacity. Ship will be at maximum saturation pressure of 0.15 kg/cm^2g on arrival at berth and transfer LNG at maximum unloading flow rate of 15,000 m^3/h.
- The LNG is pumped via the ship's pumps to LNG Storage Tanks.
- The delivered LNG will be unloaded from the ship through LNG Unloading Arms to the storage tanks through main LNG unloading header.

2.2 LNG STORAGE SYSTEM

- Two full containment LNG Storage Tanks of 155,000 m^3 net capacity.
- Each tank provided with top and bottom filling options to unload product into the tanks considering the density of the product in the tank and that received from the ship.

2.3 LNG HOLDING/RECIRCULATION SYSTEM

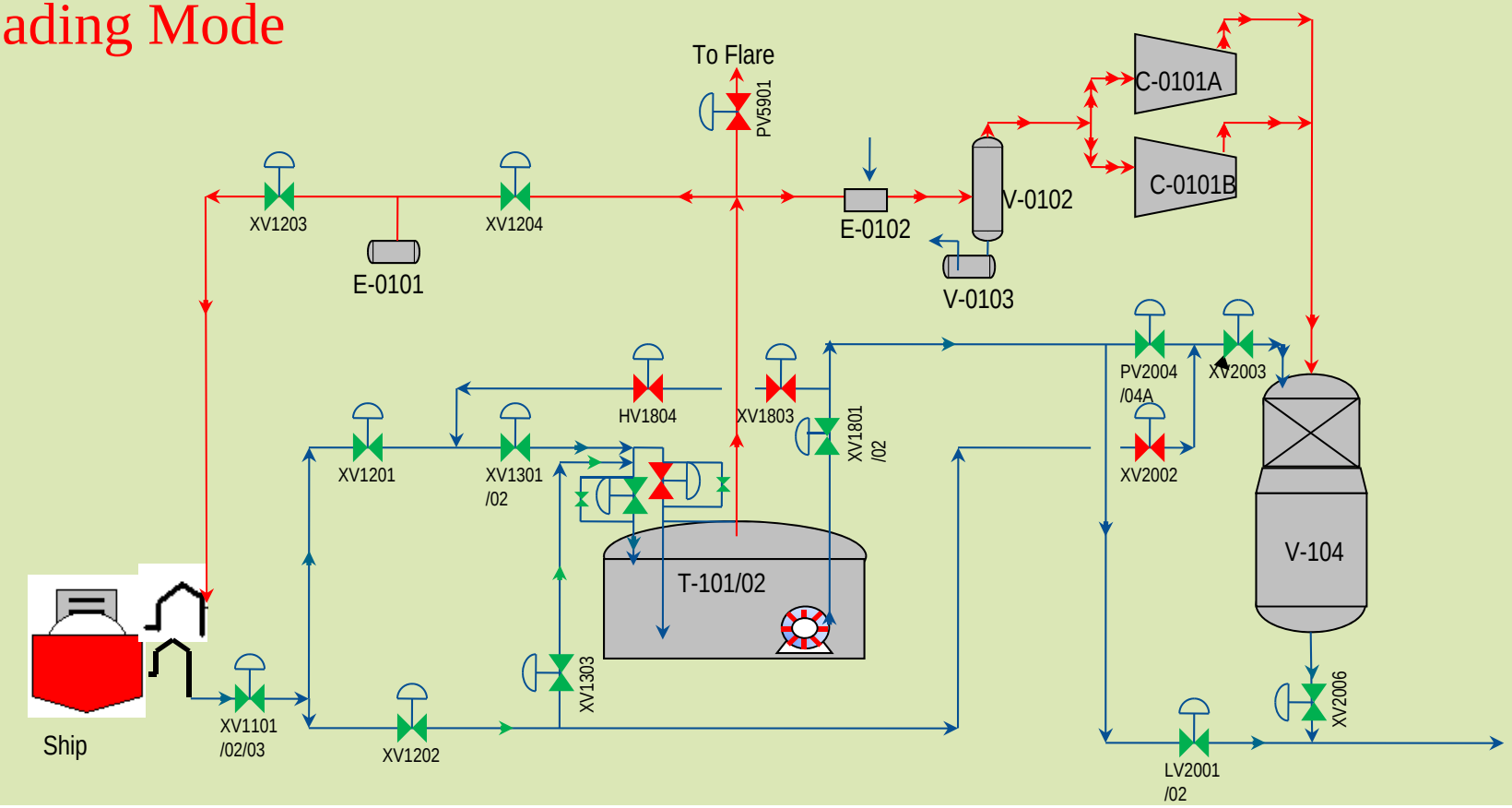
When the terminal is in holding mode, a part of the LNG from the tank send-out pumps is required for cooling down the LNG unloading line between tanks and jetty head.



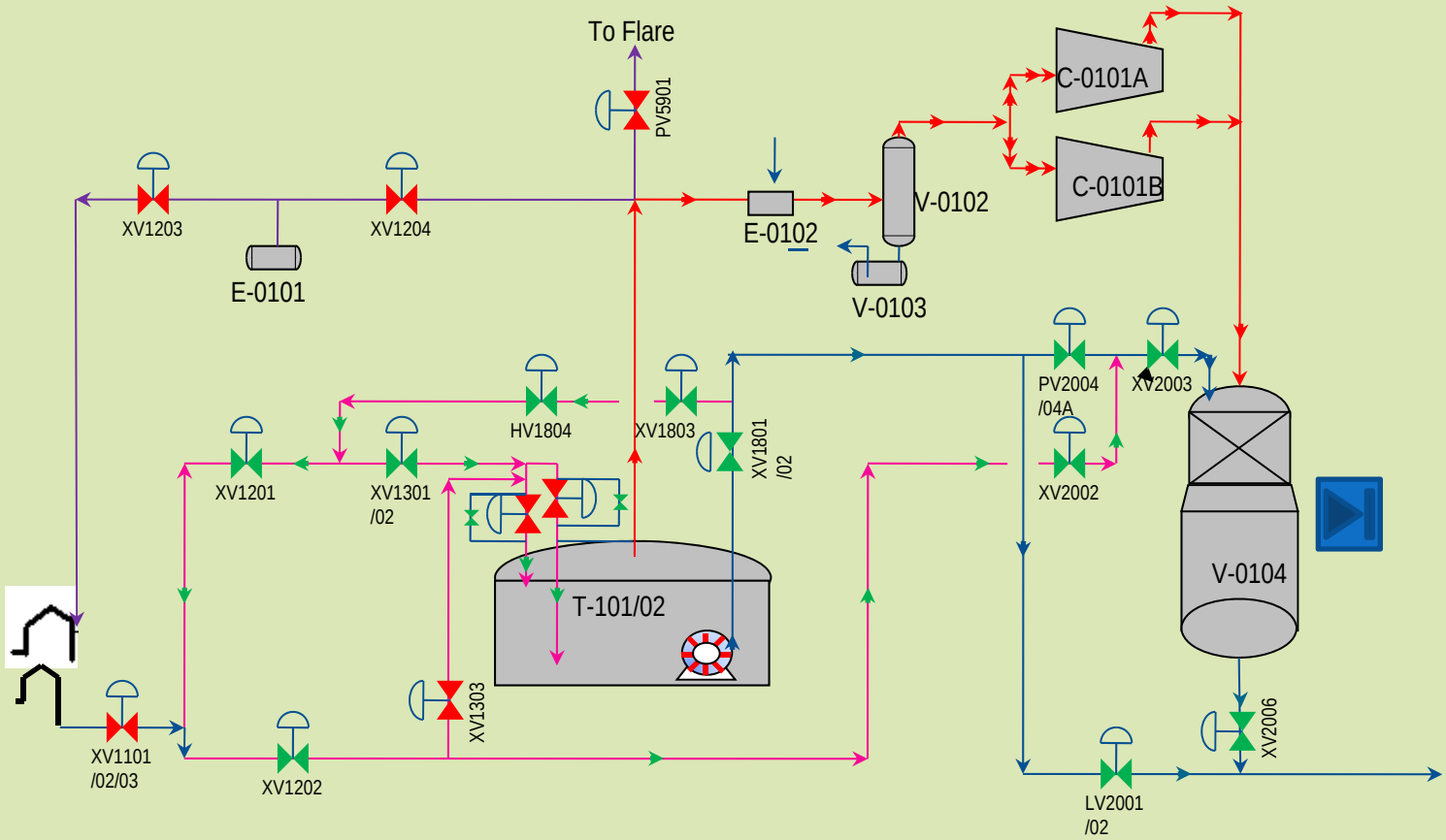
2.4 BOG VAPOR HANDLING SYSTEM

BOG from the storage tanks is routed to the boil-off gas header. BOG header further connects to BOG Suction Knock Out Drum (V-0102). The BOG flows from V-0102 to each BOG compressor. The header pipe line also connects the storage tank to ship vapor return line, flare stack, and BOG compressor.

Unloading Mode



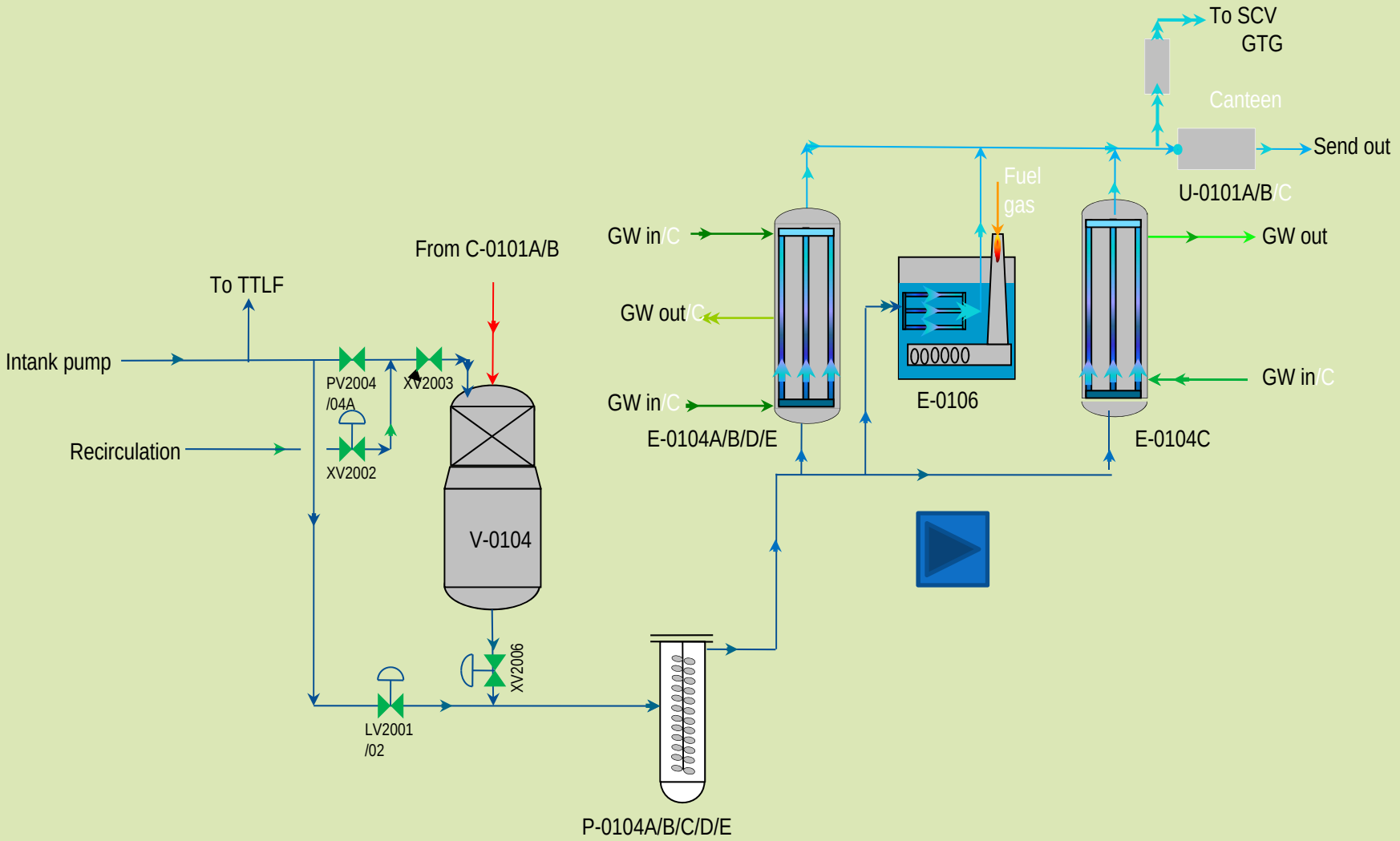
Holding Mode



2.5 LNG SEND-OUT SYSTEM

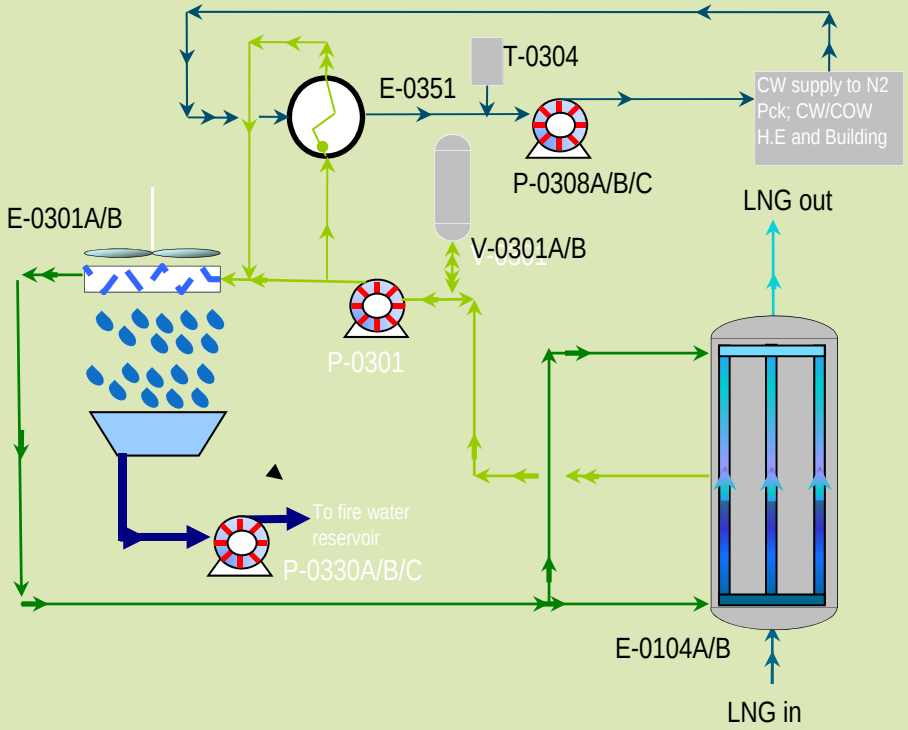
- LNG from the storage tanks is pumped by LNG In-tank Pumps. Part of the pumped flow can be sent to an LNG truck loading station. The main flow is sent to the HP send-out pumps and the vaporizers. The LNG flow is split into two streams.
- The LNG from the recondenser is directed to the LNG HP Pumps, which discharge the LNG to the vaporizers.
- HP Pumps discharge LNG to Vaporizers.
- Natural gas(RLNG) is finally sent to ultrasonic metering station before being conveyed to the gas pipeline.

2.5 Continue…..


To SCV
GTG
Canteen
Send out
U-0101A/B /C
Fuel
gas
GW in/C
GW out
GW out/C
GW in/C
GW in/C
E-0104A/B/D/E
E-0106
E-0104C
From C-0101A/B
To TTLF
Intank pump
PV2004
/04A
XV2003
Recirculation
XV2002
V-0104
XV2006
LV2001
/02
P-0104A/B/C/D/E

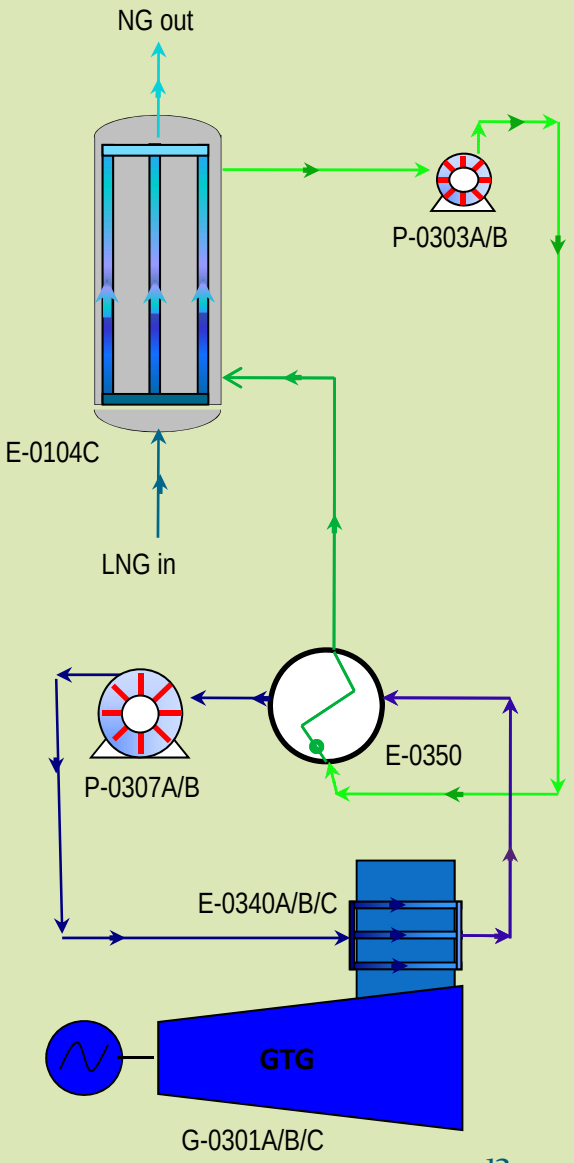
2.6 COLD RECOVERY SYSTEM

The cold energy taken by the glycol water (GW) solution by vaporizing LNG in the STV is utilized to chill down in CW/GW Heat exchanger (E-0351) for providing cold to the water required for various facilities like N2 Package, CW/COW Heat exchanger (E-0710)



2.7 HEAT RECOVERY SYSTEM

- The Cogeneration Heat Exchangers (E-0340A/B/C) is installed in flue gas duct of GTG (G-0301A/B/C). The heat recovered in these exchangers is transferred to hot water (HW).
- HW enter the exchangers at 100 °C and exit at 152 °C.



2.8 FLARE SYSTEM

A disposal system is provided to safely relieve any excess gas from the storage tank area.

The flare is designed to collect any relief from recondenser and compressor including any blow down from LNG tanks, vaporizers, etc. The following systems are connected to flare header:

- Vents from BOG Compressors (C-0101A/B)
- Relief from fuel gas system
- Blow down from LNG vaporizers (SCV and STV)
- Blow down from LNG tank vapor system
- Blow down from NG send-out header

2.9 TRUCK LOADING FACILITY

- LNG send-out via truck to users is provided as well.
- One truck loading scale is designed to load around 15,000 kg of LNG per truck. LNG Truck Loading Arm and Truck Return will be in service of truck loading facility.

3. DESCRIPTION OF UTILITY AND OTHER SUPPORTING UNITS

- SERVICE WATER SYSTEM
- POTABLE WATER SYSTEM
- FIRE PROTECTION SYSTEM
- INSTRUMENT AND PLANT AIR SYSTEM
- NITROGEN SYSTEM
- FUEL GAS SYSTEM
- DIESEL OIL SYSTEM

POTABLE WATER SYSTEM

Raw water source

i) Rain water collected from top roof of both two LNG tanks

ii) Water through barge at the location of the tug berth.

iii) The raw water from local municipal source.

FIRE PROTECTION SYSTEM

- The system consist of fire water system, dry chemical powder system, portable & wheeled extinguisher, mobile fire fighting equipments/tenders, clean agent system etc.
- Fire water is collected in a Fire & Service Water Reservoir with two compartments separated by concrete wall.
- The fire water distribution system delivers fire water to hydrants, indoor hose cabinets and water spray system

INSTRUMENT AND PLANT AIR SYSTEM

Instrument air with dew point of (-)40 ^{o}C at atmospheric pressure is used for:

Pneumatic instruments, ignition air for flare pilots and as feed air to nitrogen generation units.

Plant air is used for:

Pneumatic tools and air driven pumps through hose stations.

Instrument air is compressed and dried through air dryer. The instrument air is distributed at a nominal pressure of 8.0 kg/cm^2 g.

The system consists of Air Compressors, Air Dryers and Plant Air Receiver and Instrument Air Receiver.

NITROGEN SYSTEM

- Nitrogen Generation Package consists of one 100% capacity air separation unit (ASU), two liquid nitrogen storage vessels and two units of 100% natural draft nitrogen vaporizer.
- ASU separates nitrogen from the instrument air and produce both gaseous and liquefied nitrogen with less than 100 ppm oxygen.
- The gaseous nitrogen can be directly supplied to the nitrogen distribution network, meanwhile the liquid phase nitrogen is stored in two nitrogen vessels.
- Upon using the liquid phase nitrogen, it needs to be vaporized in nitrogen vaporizer and then sent to the nitrogen distribution network.

FUEL GAS SYSTEM

- Send-out NG is used as fuel. The NG is taken at the upstream of the metering stations. The fuel gas which temperature is reduced at around (-)34.5 ^{o}C due to pressure let down from 90 to 26.5 kg/cm^{2} g, is heated by Fuel Gas Air Heaters and the exit temperature is maintained between 5 ~ 15 ^{o}C.

- The heated fuel gas at 26 kg/cm^{2} g is supplied to the gas turbine generators and flare pilot, SCV, and canteen.

DIESEL OIL SYSTEM

- Diesel oil is supplied from outside by truck unloading arrangement. The connection is located at the suction line of the Diesel Oil Pumps.
- Diesel oil is pumped and stored in the Diesel Oil Tank. The diesel oil pump will also supply diesel oil to users such as Fire Water Pumps, two units of Gas Turbine Generators (G-0301A/B) and Emergency Generator (G-0302).

UNLOADING OPERATION

- Prior to the ship unloading, the pressure of storage tank should be reduced to 70-80 mbarg (lower than average operating pressure), which is below the pressure in the ship's cargo tank (0.15 kg/cm^2g).
- This enables the boil-off gas from the ship to pass to the tanks via the vapor return arm . This will partially cool down the vapor return arm and vapor headers.
- During ship unloading, the pressure of the LNG storage tank will raise up to 0.20 – 0.23 kg/cm^2g (maximum 0.25 kg/cm^2g). Both BOG compressors may be in service for some tiimes to control tank pressure.

Unloading Operation-2 of 6

Following step of operations will be performed on arrival of LNG cargo:

- Stopping LNG circulation.
- Confirm Nitrogen purge of unloading arms swivel joint.
- Mooring of LNG carrier.
- Setting and fixing gangway to ship side.
- Connecting the communication cable / test.
- Connecting the pneumatic hose (for ESD transmission)
- Preparing joint safety check before unloading operations.
- Vapor and liquid arm connection, N_2 purging and leak test.
- Pre-unloading meeting.
- Initial gauging of cargo.

Unloading Operation-3 of 6

The preparation of unloading operation will include:

- Emergency shut down test in hot condition.
- The cargo piping cooling down followed by cooling down of liquid arms. Cargo tank spray pumps will be used for this activity. Cooling down will be completed when temperature of the liquid line reaches (-)120 deg C.
- Emergency shut down test in cold condition. It will be activated from the ship and the shore terminal respectively. The ship vaporizer may be started up to be ready if required in case the terminal is having any problem to supply vapor to prevent any drop in pressure in the cargo tank.

Unloading Operation-4 of 6

The LNG density in the tanker relative to the LNG density in the terminal storage will determine whether the bottom or top storage tank fill connection must be used.

The important matters regarding the LNG unloading will be given as follows:

- The ship pumps are started one by one beginning with low flow rate and after terminal agreement.
- Following the terminal request, the flow rate of each pump will be increased until the pump reaches its nominal value within range of 30 to 60 minutes.

Unloading Operation-5 of 6

- As the unloading operation proceeds, the decrease of cargo tank pressure is compensated by the return of gas from the LNG receiving tank.
- Operators have the duty to check the BOG pressure and tank levels (including ship and terminal storage level tank).
- The maximum operating pressure of LNG storage tank is 0.25 kg/cm^2g. If the BOG pressure is higher than 0.23 kg/cm^2g, the operator shall start the second compressor.
- If the high level pre-alarm setting approaches for LNG level inside the tank is activated then the unloading will be switched to the other tank by opening the filling valves (bottom or top) of the second tank followed by closing the filling valves of the first tank. Normally, the liquid filling is not allowed to across the high level.
- During tanker unloading, LNG stream is sampled to analyze the composition by LNG sampling system.

Unloading Operation-6 of 6

- As the unloading operation approaches completion, Unloading arms are isolated one by one.
- After completion of LNG unloading, LNG loading arms are drained and purged one by one.
- Unloading arm is disconnected after ensuring that there is no presence of hydrocarbon inside arm.
- Vapour unloading arm is disconnected at last.
- Closing CTM
- Disconnection of pneumatic hose.
- Disconnection of Communication cable.
- Disconnection of Gangway tower.
- Unmooring of ship and departure.
- Re-establish LNG circulation in LNG Unloading header

Maintenance Of LNG Terminal

Maintenance Philosophy

- Preventive Maintenance
- Predictive Maintenance
  - Continuous monitoring of health of static/rotating equipment's, plant installations.
- Breakdown Maintenance
  - Maintenance of non critical equipment's with respect to operation of terminal.

Critical equipments

- Jetty and Unloading arms
- In tank and HP LNG pumps
- BOG compressors
- FW pumps
- Instrument air compressors
- GTG & EDG

Mechanical Maintenance

Preventive Maintenance

- Periodic maintenance activities for equipment's are based on
  - Time- Monthly, quarterly, half yearly , yearly basis.
  - Running hours- 1000 hrs., 2000hrs., 4000 hrs. etc. basis.
- Schedule for the preventive maintenance is prepared based on the OEM recommendations and based on the past experience with particular equipment or similar type of equipment.
- Schedule for preventive maintenance can also be prepared based on the criticality of equipment's.

Preventive maintenance

- BOG Compressor:
  - 4000hrs: Inspection of Valves, End clearance checking, Unloader actuator inspection etc.
  - 8000hrs: In addition to above checking of bearing clearances, crosshead shoe inspection etc.
- LNG In-tank Pump/ HP Send-out pump:
  - 8000hrs: checking of bearing clearances, wear ring clearances etc.
  - Subsequent maintenance can extended as per the recommendation of OEM based on maintenance observations.

Preventive maintenance

- Unloading Arm:
  - Monthly: Visual inspection of unloading arm with respect to corrosion leakages etc. for hydraulic system, pantograph cables etc. Operation checking of arm for smooth operation and to identify any abnormal sound etc.
  - Quarterly: Greasing of structure bearings, coupler etc., Check all components for damage , inspecting for loose nuts and bolts, cracks, bent parts, etc.
  - PMI with FMC every two years.
- Gas Turbine:
  - A type inspection-9000 hrs. – inspection of Gas generator, combustion chamber, power turbine.
  - B type inspection-18000 hrs.- Inspection of combustion chamber
  - C type inspection-27000 hrs.- Inspection of combustion chamber
  - D type inspection-54000 hrs.- Power turbine inspection.

Predictive Maintenance

- Monitoring Condition/health of static , rotating equipment's, piping and other plant installations.
- Vibration monitoring of rotating equipment’s.
- Ultrasonic thickness measurement of static vessels, piping systems.
- Piping inspection: inspection support, spring support, corrosion etc.
- Corrosion monitoring of plant installations.

Electrical Maintenance

Preventive Maintenance

➢ ***Cathodic protection system***

Healthiness of CP system

- Measurement of pipe to soil potential.
- Frequency is 6 months as per OEM recommendations.
- Corrective action based on the recorded values.

Healthiness of TRU

- Measurement of TRU internals like fuses, MCB's etc.
- Frequency is 6 months.

Preventive Maintenance

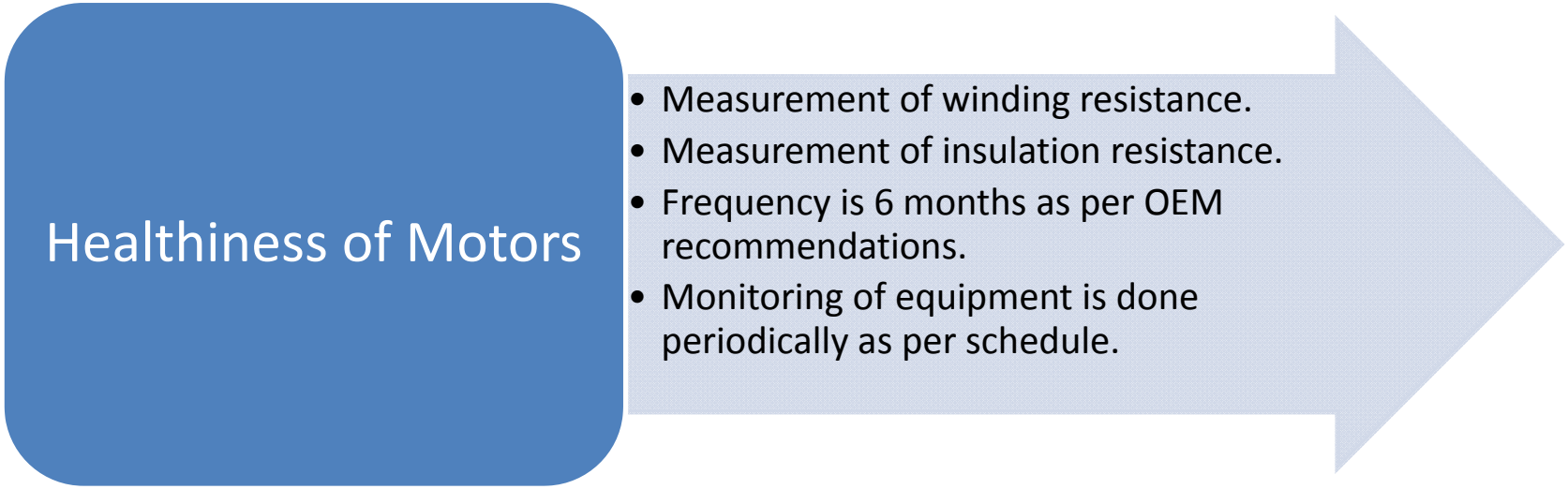
➢ ***Transformers***

Healthiness of transformers

- Measurement of winding resistance.
- Measurement of insulation resistance.
- Frequency is 6 months as per OEM recommendations.
- Oil testing for dielectric strength is done once every year.
- Daily routine checks for any abnormality.

Preventive Maintenance

➢ ***Motors***



Preventive Maintenance

➢ ***Fire Alarm system***

Healthiness of Fire Alarm system

- Detectors checking with spray.
- Frequency is 6 months as per OEM recommendations.
- Hooter operations are checked.

Preventive Maintenance

➢ ***Emergency DG set***

EDG

6.6 KV- 2MVA.

- Weekly trial run for healthiness checking.
- Parameter recording during trial run.
- Breaker maintenance frequency is 6 months.

Preventive Maintenance

➢ ***Gas Turbines***

GTG

6.6 KV- 13.4MW.

- Auxiliary motors trial run every week.
- Water wash as per running hours.
- Inspections as per OEM recommendations.

Preventive Maintenance

➢ ***Earth Pits***

Earth Pits.

- Earth pit resistance measurement is done.
- With grid and without grid measurements is done.
- Frequency is 6 months.

Instrument Maintenance

➢ INSTRUMENT – PM

- FIRE AND GAS DEVICE INCL. GAS DETECTORS, GAS BEACONS, FLAME DETECTORS, FLAME BEACONS, MANUAL CALL POINTS, GAS AND FIRE SOUNDERS AND LNG SPILL DETECTORS IN EVERY 6 MONTHS
- EMERGRNCY SHUT DOWN VALVE FOR EVERY 6 MONTHS
- FLOW, TEMPERATURE, LEVEL AND PRESSURE TRANSMITTER IN EVERY 12 MONTHS
- FLOW, TEMERATURE, PRESSURE AND LEVEL CONTROL VALVES IN EVERY 12 MONTHS

➢ INSTRUMENT – PM

- ❑ STATUS OF INPUT /OUTPUT CARDS, DCS, ESD AND ESD CONTROLLERS ON DAILY BASIS
- ❑ CONTROL SYSTEM MARSHELLING CABINETS HEALTH MONITORING THROUGH TEMPERATURE MONITORING, FAN AND LIGHTS STATUS ON DAILY BASIS
- ❑ DELUGE VALVE FUNCTIONAL TESTS IN EVERY 6 MONTHS
- ❑ METERING STATION PRESSURE & TEMPERATURE INSTRUMENTS ALONG WITH GC JOINTLY WITH GAIL IN EVERY MONTH

Process Flow Diagram of LNG Terminal

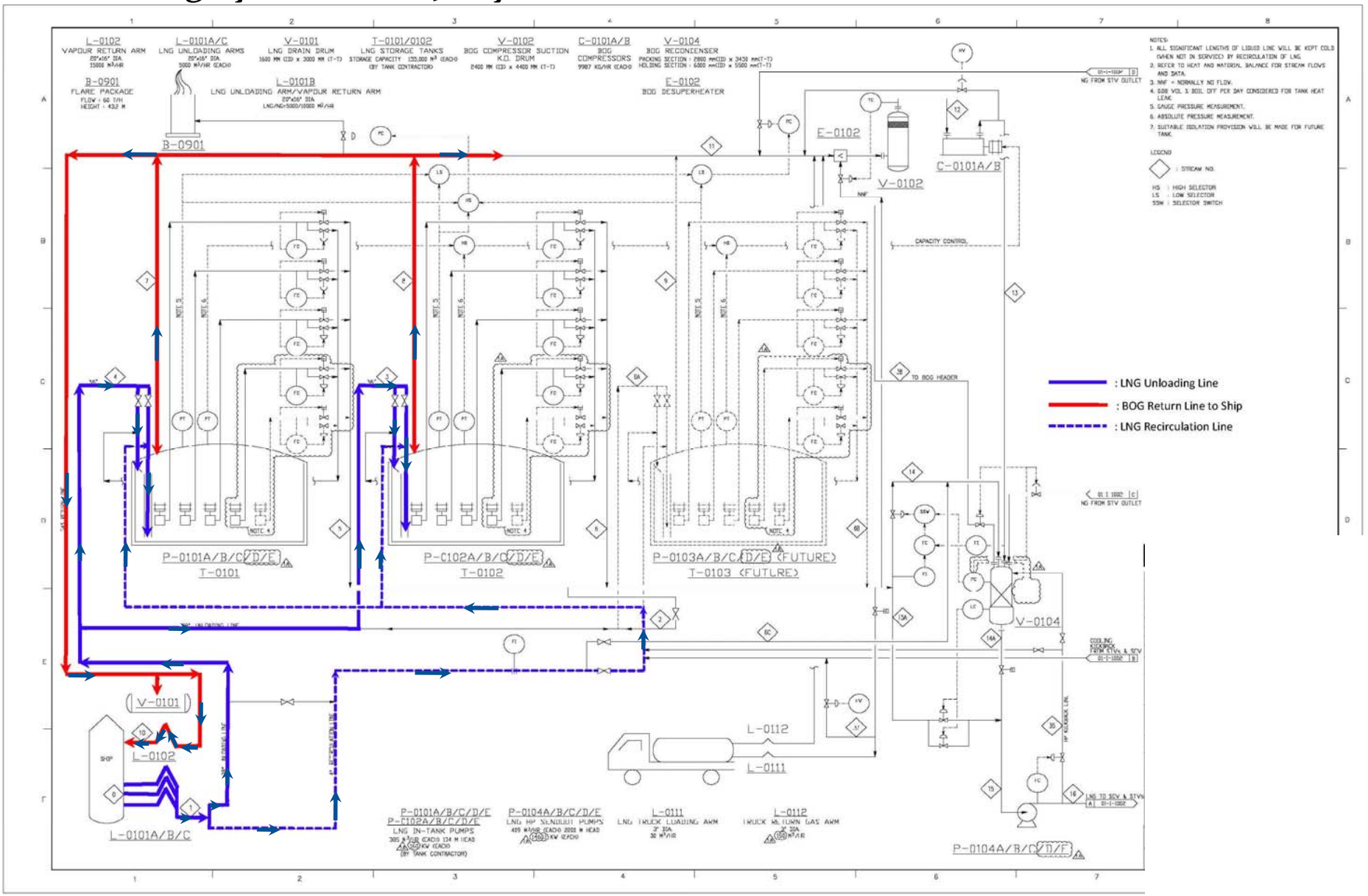
1. REGAS TERMINAL DESIGN CONDITIONS

- Send-out of capacity of 5.0 MMTPA.
- Terminal designed to have uninterrupted on-line availability of send-out facilities for 365 days.
- The terminal to receive LNG from LNG ship (65,000 to 216,000 m^3 capacity), store in two LNG storage Tanks and re-gas the LNG by means of LNG vaporizers, and then send the RLNG to the gas purchaser directly through gas trunk piping.
- The truck loading facility to provide LNG filling facility into the truck for LNG transfer to the consumers by land transportation.
- LNG transfer to the consumer by sea transportation, by loading LNG ship from tank via unloading line by using unloading arm.

Terminal Process Flow Diagram 1 of 7

Unloading System

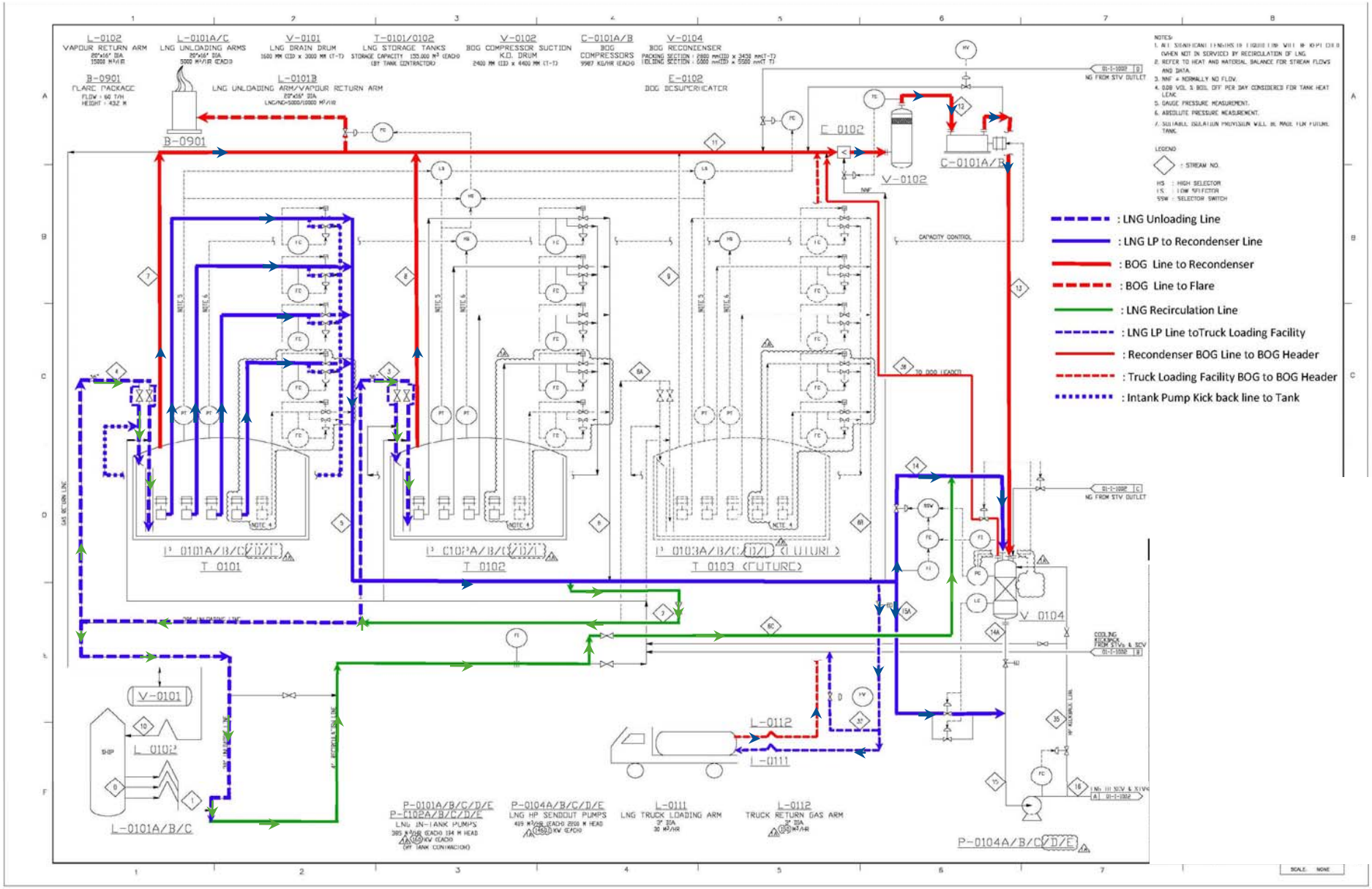
Unloading System from Jetty to Tank



Terminal Process Flow Diagram (PFD) 2 of 7

Recirculation; LP
Sendout & BOG System

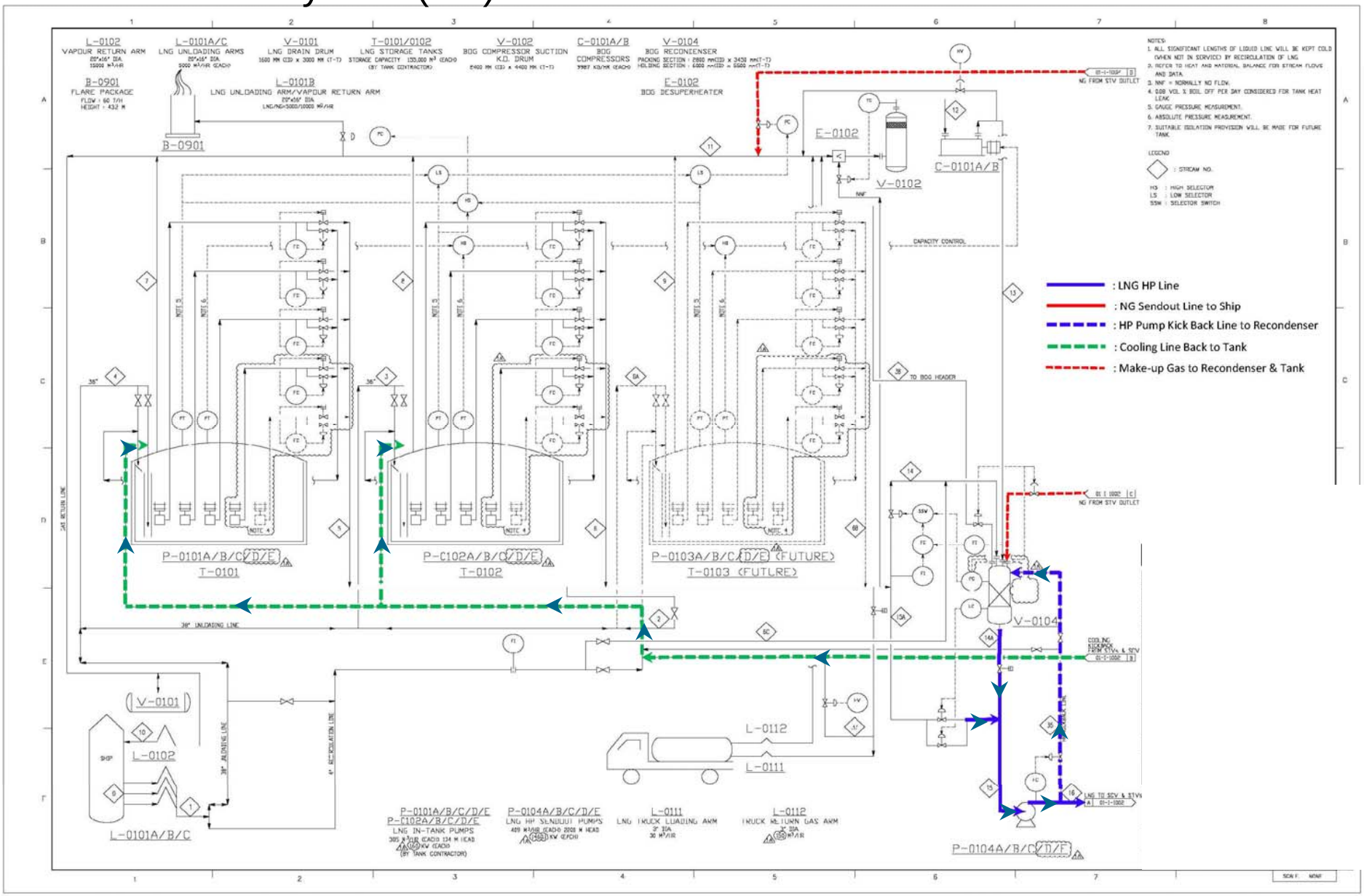
Recirculation; LP Send-out and BOG System (Holding Mode)



Terminal PFD 3 of 7

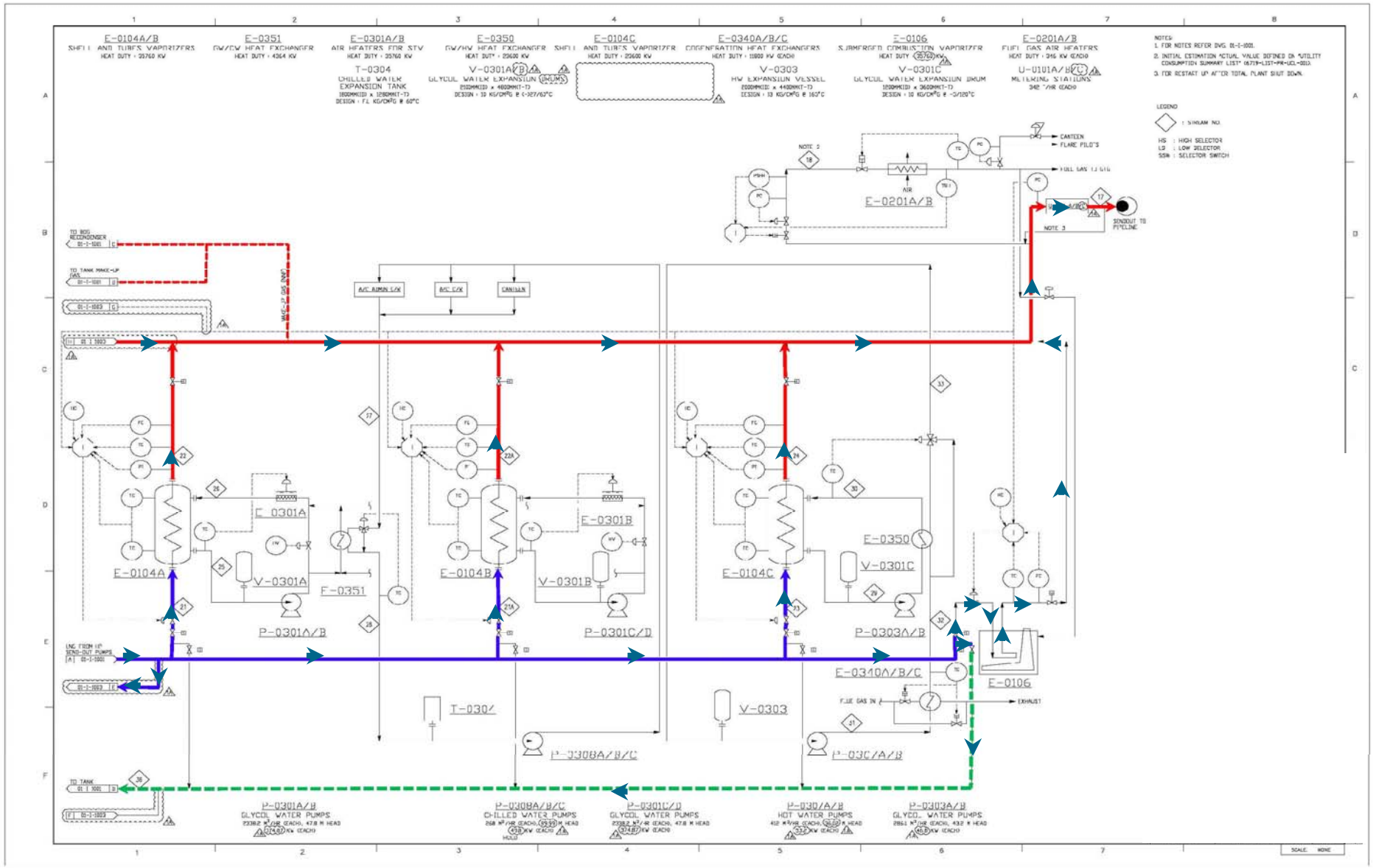
LNG Send-out

LNG Send-out System (1/3)



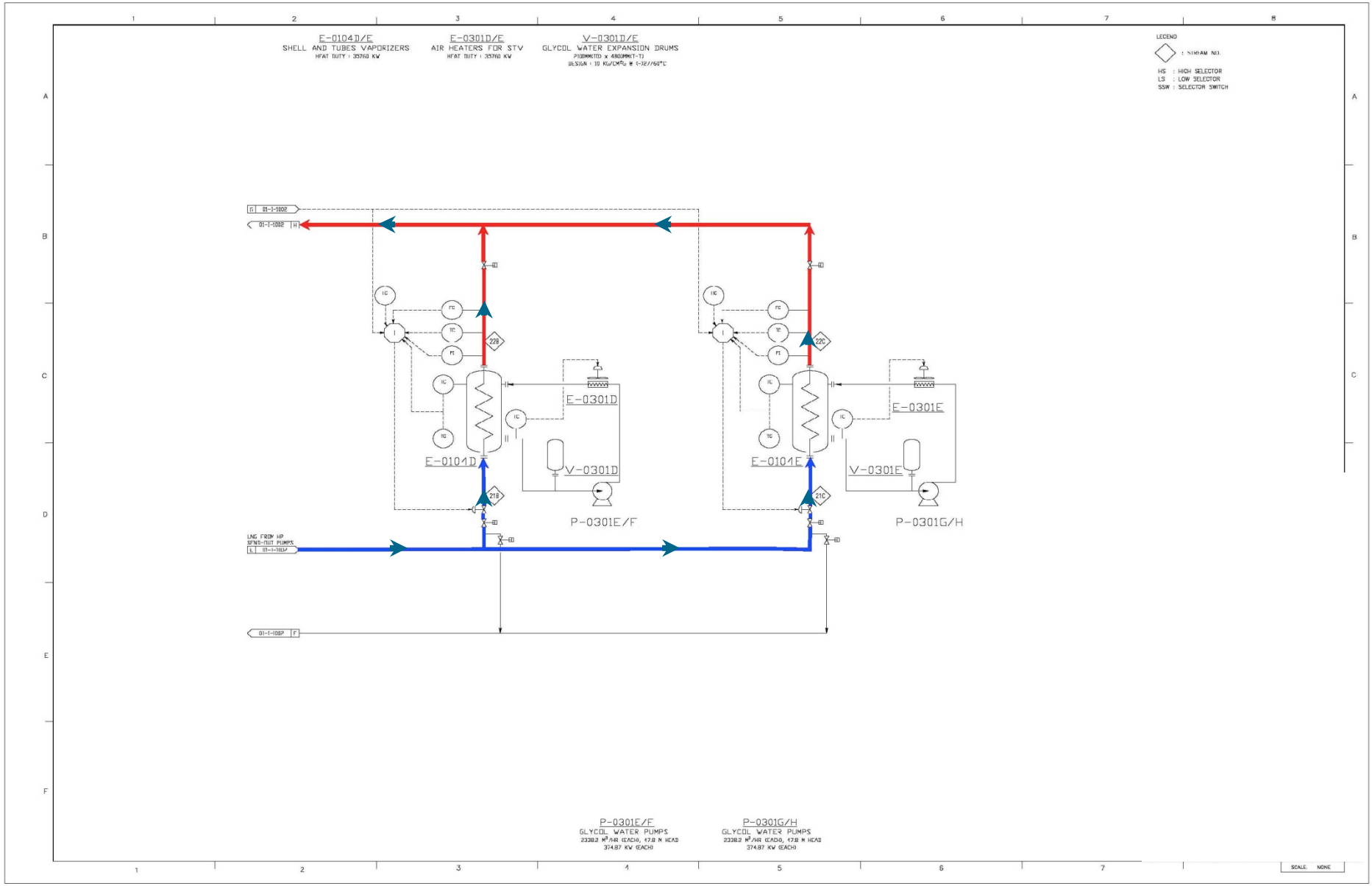
Terminal PFD 4 of 7

LNG Send-out System (2/3)



Terminal-PFD 5 of 7

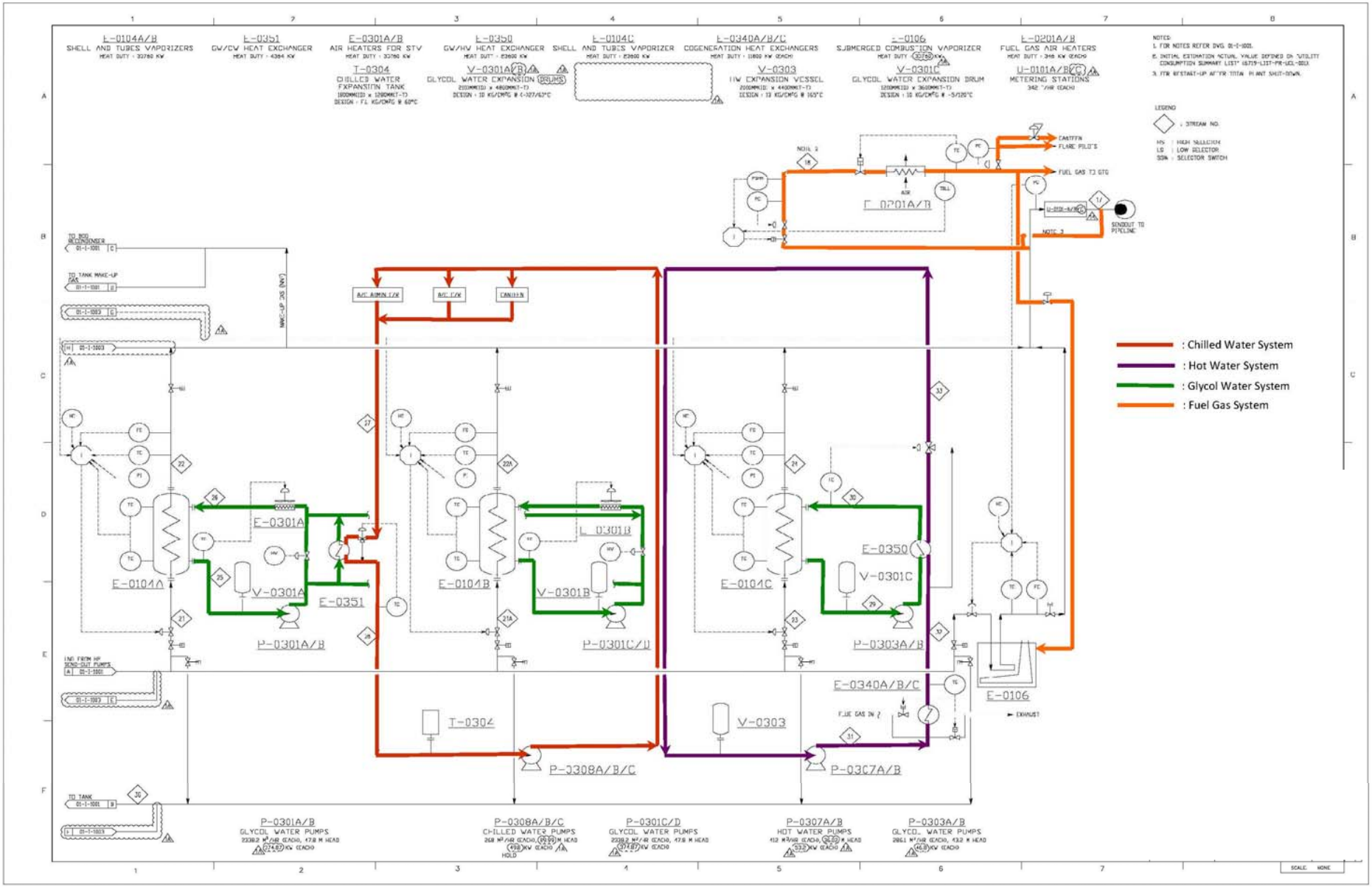
LNG Send-out System (3/3)



Terminal-PFD 6 of 7

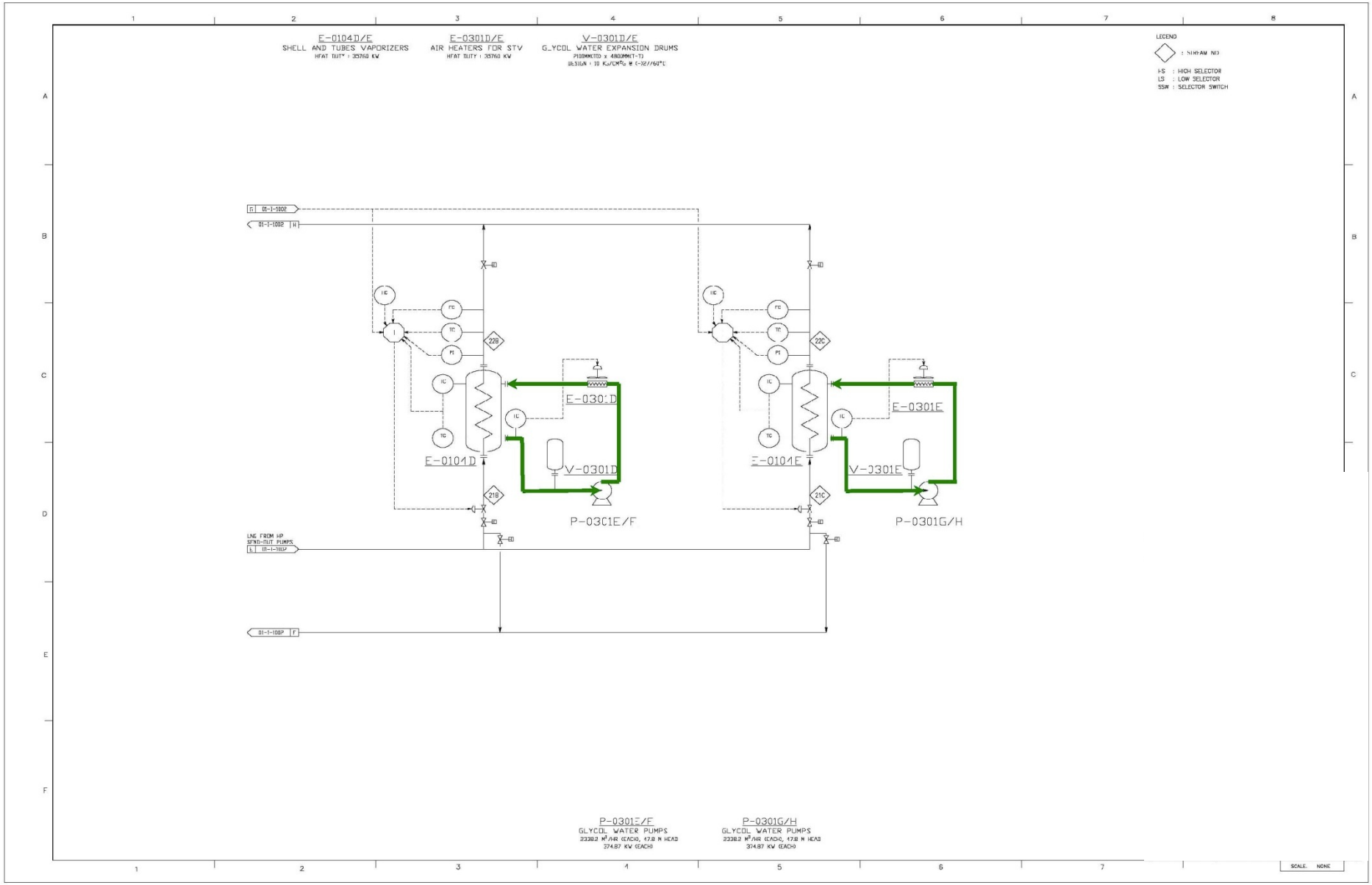
Utility system

Utility System (1/2)



Terminal-PFD 7 of 7

Utility System (2/2)



Economics of LNG Facilities

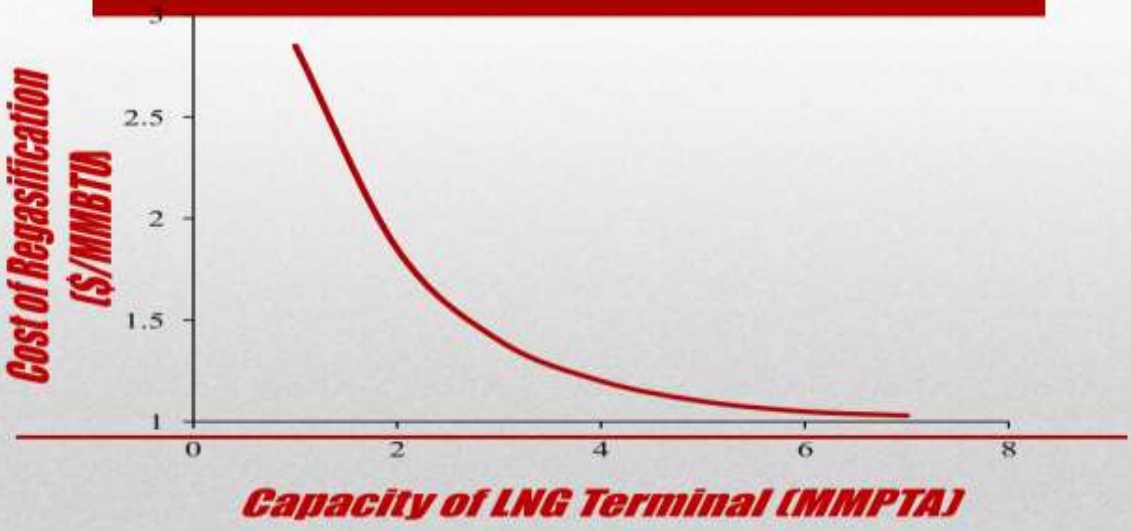
By Sham Sunder, Consultant

23rd April 2014

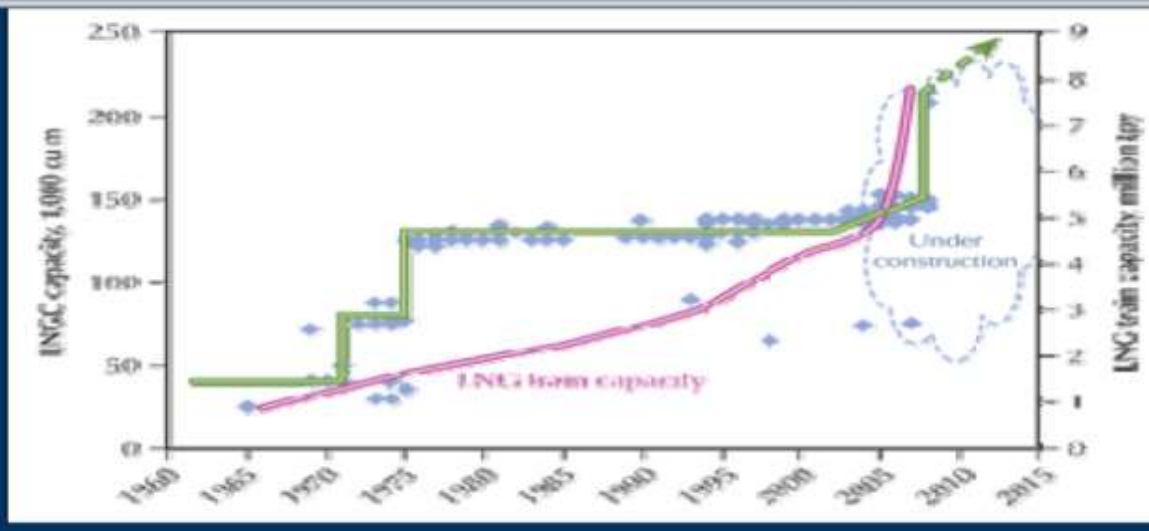
- Capacity
- Site Conditions & Location
- Ambient Conditions
- Statutory Requirements
- Processing Schemes & Type of Storage Tanks
- Project Execution Methodology

Economics of LNG Facility depends on

CAPACITY VS. COST OF REGASIFICATION



LNG Tanker Size Liquefaction Trains



- Topography & Load Bearing Strength of Soil
- Elevation w.r.t HFL
- Earthquake Seismic Zones
- Marine Facilities
  - Existing Port
  - New Port Development
  - Bathymetric Conditions
  - Geo-technical Conditions
  - Requirement of Breakwaters

Site Conditions & Location

- Minimum & Maximum Ambient Temperature
- Wind Conditions
- Tsunami Prone Area
- Sea Water Temperature
- Sea Water Quality
- Oceanographic Conditions
  - Swells
  - Tide
  - Currents

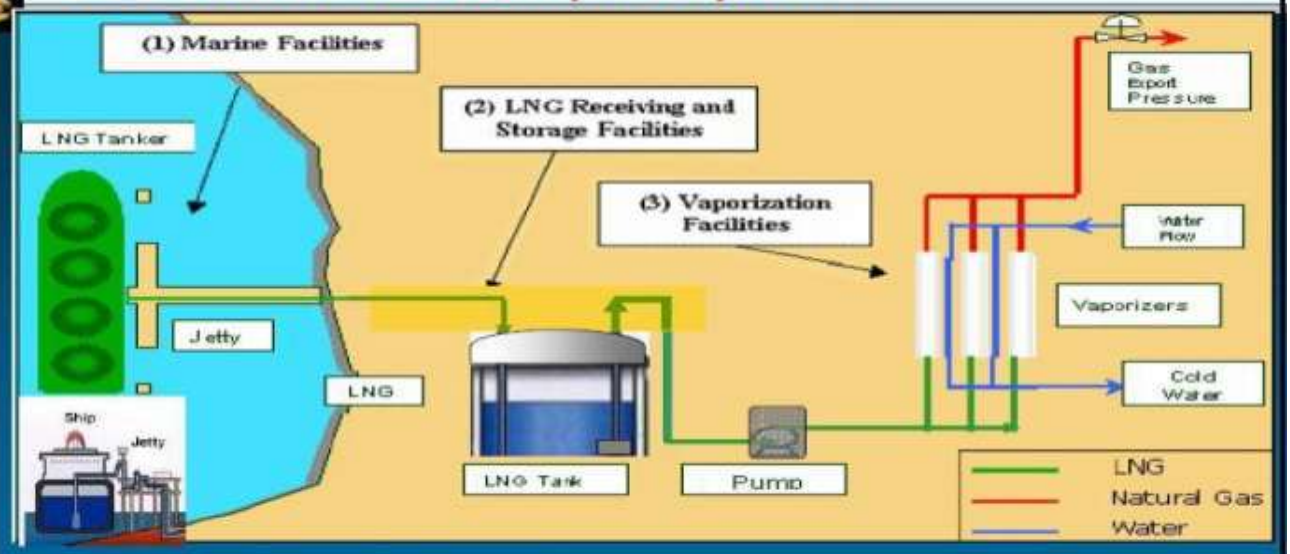
Ambient Conditions

- Green Belt Requirement
- Condition for Sea Water Disposal
- Fire Fighting Facilities
- Disposal of Effluents
- Port Authorities Requirement
- Corporate Social responsibility

Statutory Requirements

SELECTION OF REGASIFICATION PROCESS & TYPE OF STORAGE TANK

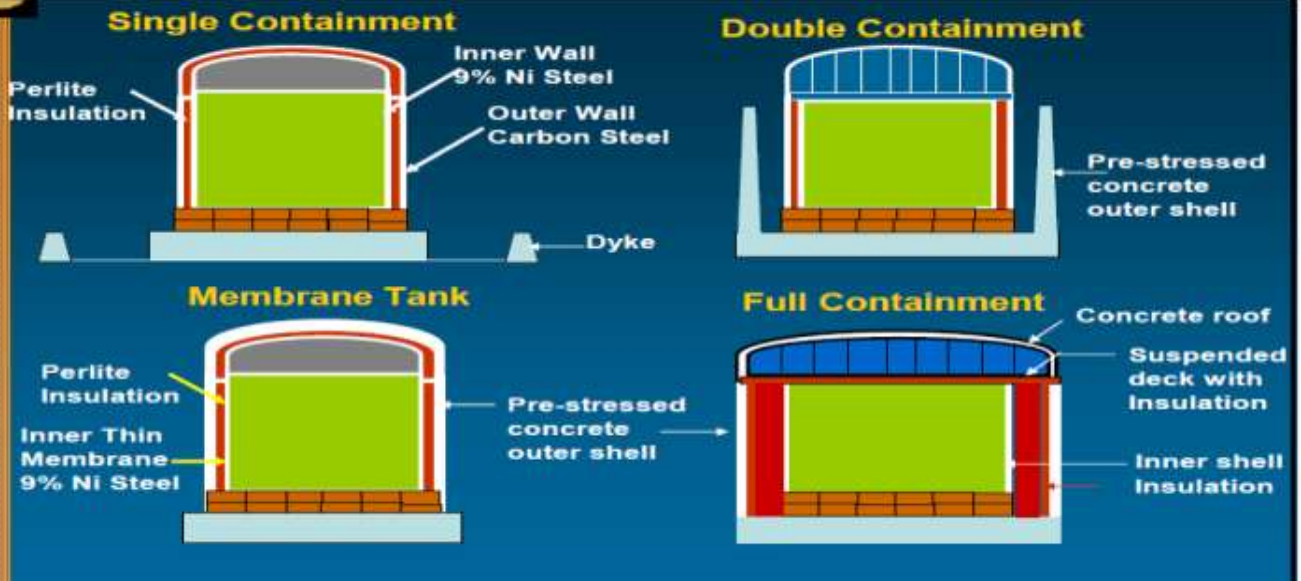
LNG Terminal – A Simple Depiction



Typical Unloading System

- The most common tanker size is 75,000 to 135,000 M^3 LNG Carriers.
- Industry trend is towards bigger ships upto 265,000 M^3.
- LNG transfer from ship by 2 pumps per cargo tank, 4 tanks.
- Pumping rate - 10000-18000 M^3 /Hr. Unloading time 10-15 hours.
- Loading lines could be two parallel lines of 24" or one line of 30".
- The vapor in storage tanks gets pushed out during filling and is sent to the tanker by vapor return lines.

Types of LNG Storage Tanks



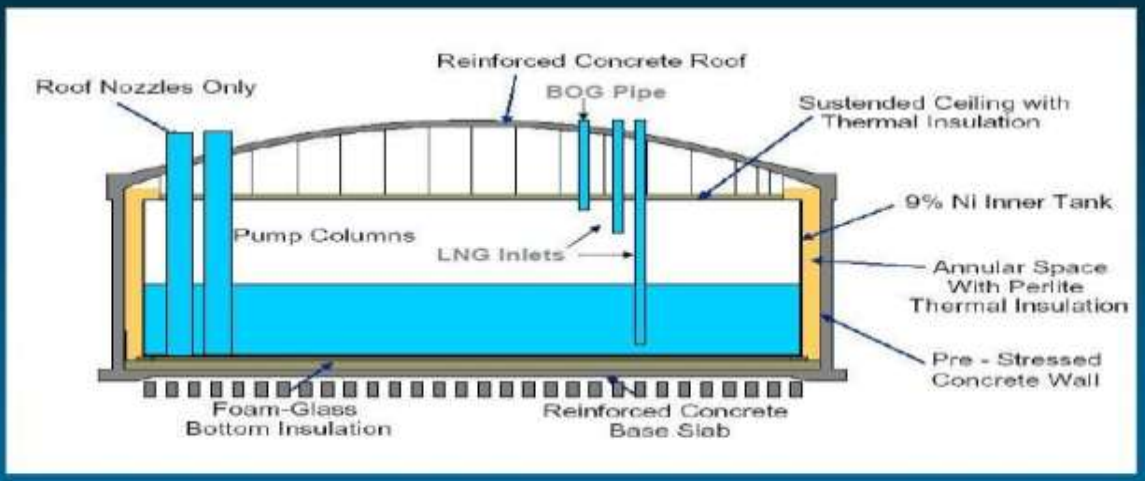
Underground LNG Storage Tanks

Aboveground tank

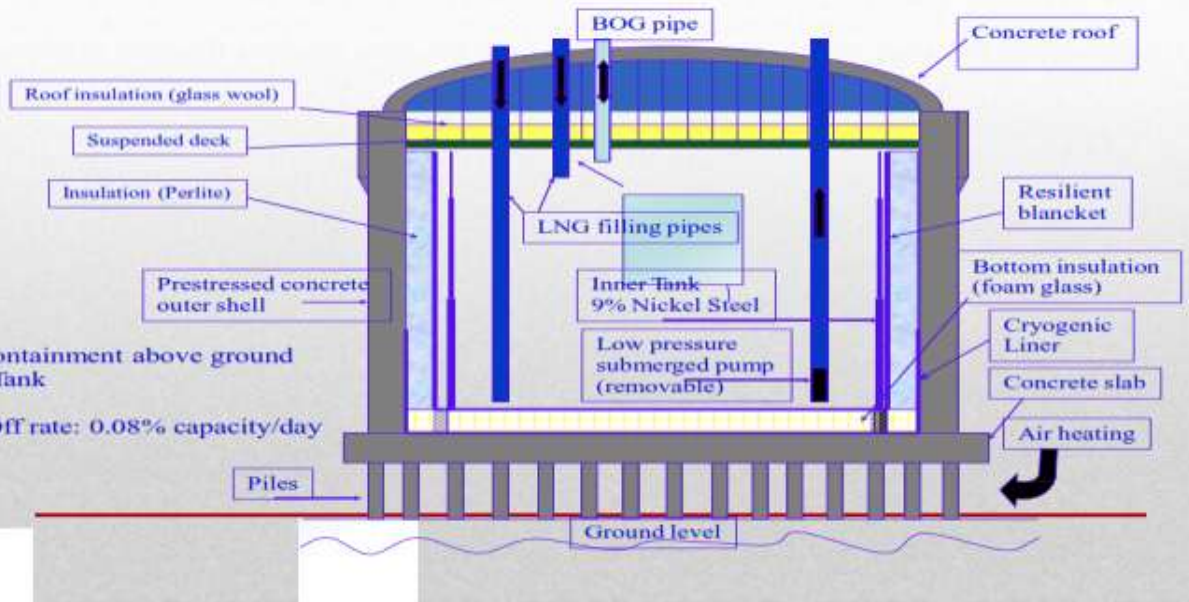
In-ground tank

Underground tank

Full Containment LNG Tank



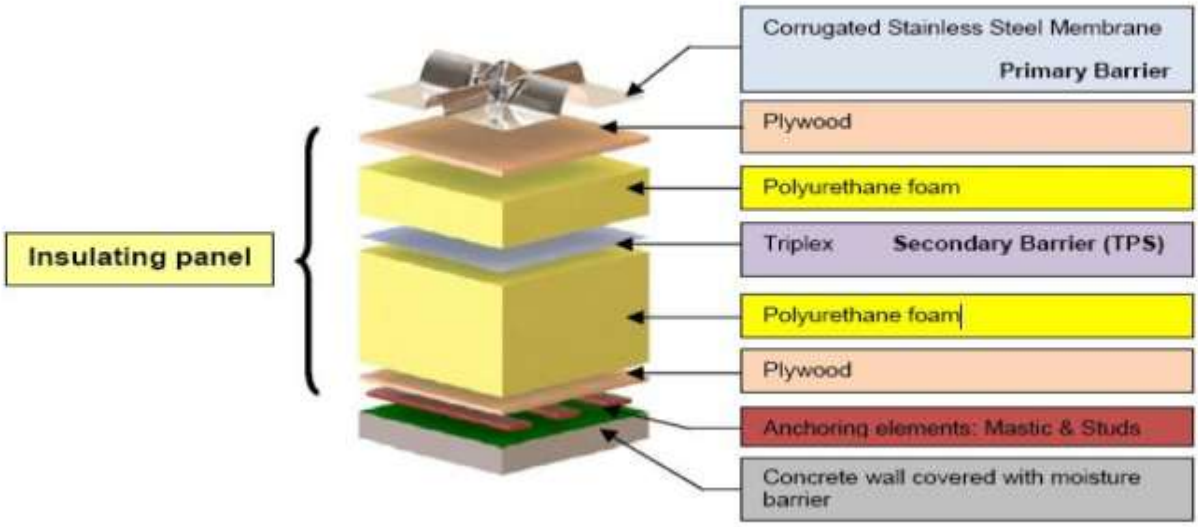
LNG STORAGES TANK-Full Containment



Full containment above ground LNG Tank

Boil Off rate: 0.08% capacity/day

Description of the Membrane Containment System Components



World Scenario for LNG Storage Tanks

- Total Numbers: 610
- Single/Double Containment: 130
- Membrane Type: 105*
- Full Containment: 375

* Mostly in Japan & South Korea

Membrane Storage Tanks Pros & Cons

- Lower Capital Cost (Only For more than 160000 cubic meter capacity)
- Lower Construction Time
- More Sustainable at high seismic area
- Skilled labour requirement
- Special tools
- Probability of LNG leak frequency is more

Membrane Storage Tanks Issues in India

- Large space requirement (dyke area)
- Non availability of skilled welders
- Automatic welding machines need to be imported
- Special precaution required for in-tank pumps removal

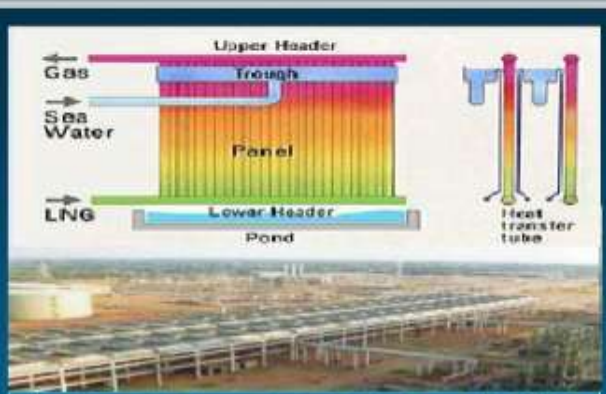
TANK SAFETY

Results of Consequence Modeling

		Containment Type			Remarks
		Single	Double	Full	
Heat flux due to LNG Fire	At Location 1	Acceptable (0.9 Kw/m2)	Acceptable (nil)	No affect outside plant	NFPA 59 A Criteria is 5 KW/m2
	At Location 2	Acceptable (1.2 Kw/m2)	Acceptable (0.1 Kw/m2)	No affect outside plant	Flux causing structural damage estimate is 25 Kw/m2
	5 Kw/m2 distance	700 m	300 m	77 m	Minimum distance to property line
	3 Kw/m2 distance	1200 m	700 m	88 m	
Hazardous Vapour Cloud	Spread	Unacceptable (2500 m to 5600 m)	Unacceptable (1100 m to 1200 m)	Acceptable (57 m)	LEL not to spread outside battery limit

LNG Re-gasification

- LNG vaporization is an energy intensive process.
- Typically, vaporizing 1200 MMSCFD (30 MMSCMD) of LNG requires roughly 750 MM Btu/hr of heat duty.
- This requires 20 MMSCFD (0.5 MMSCMD) natural gas to heat it. Sea Water or air are often used for heating.
- Sea water can be used as heating medium. In the above case, sea water requirement (15 °F/ 8 °C rise) will be 100,000 gpm (24,000 M³/Hr).

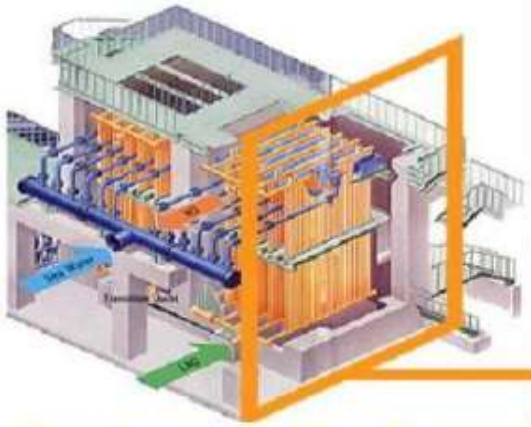


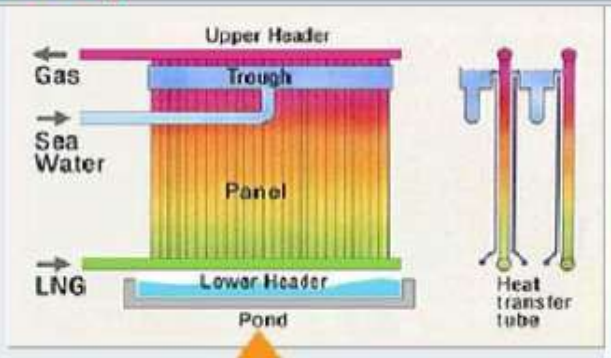
- Energy recovery during vaporization can be done by integrating power plant with LNG facility and using low level heat from power plant.

Types of Vaporizers

- Open Rack Vaporizers (ORV)
- Submerged Combustion Vaporizers (SCV)
- Intermediate Fluid Vaporizers (IFV)
  - Hydrocarbon Mixture (Rankine Cycle)
  - Glycol / Methanol Water System
- Ambient Air Vaporizers (AAV)

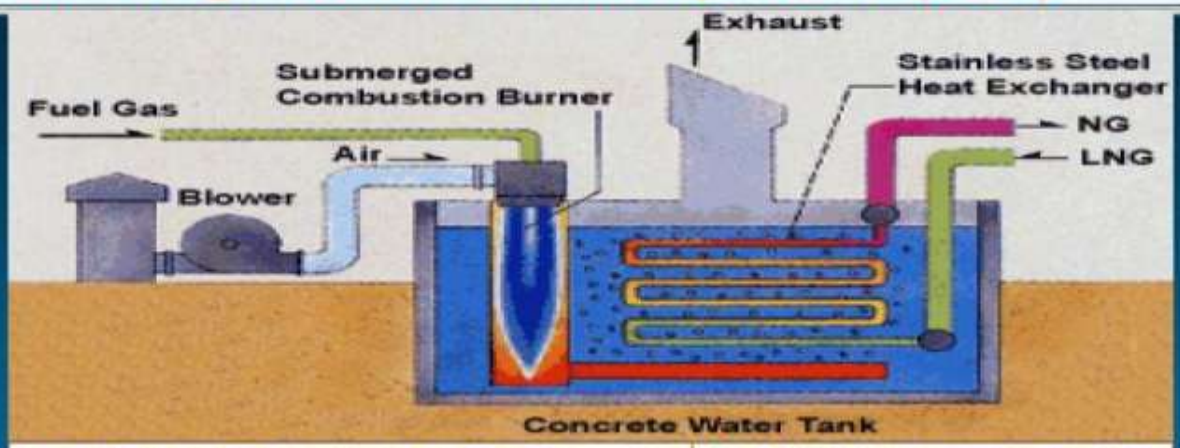
Open Rack Vaporizers (ORV)





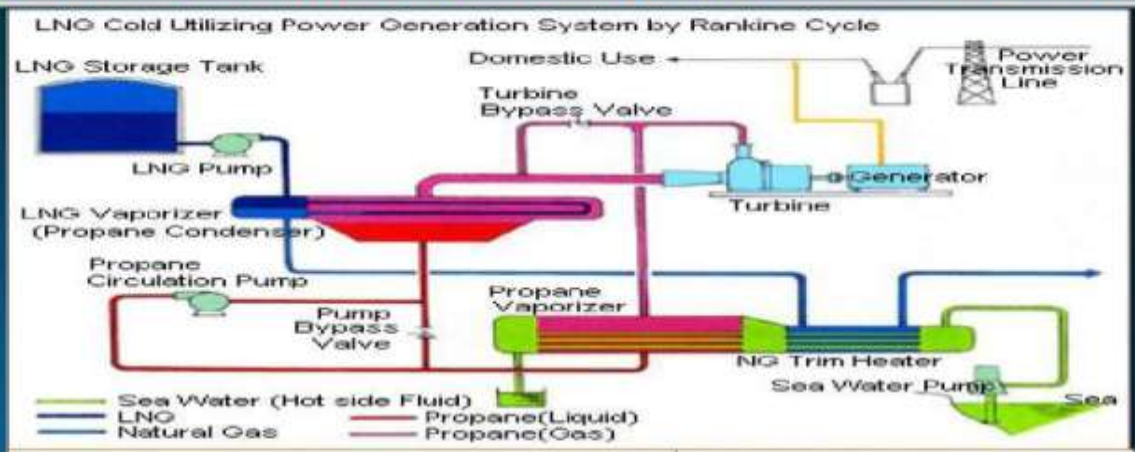
- Simple construction & operation.
- No controls, reliable and safe.
- High turndown ratio.
- Capital intensive.
- Environmental issues
- High maintenance.

Submerged Combustion Vaporizers (SCV)



- Simple and compact design.
- Large load fluctuations.
- Lower capital cost
- Low ambient temp. application.
- 1.5% fuel consumption
- Green house effect.
- The control is more complex.

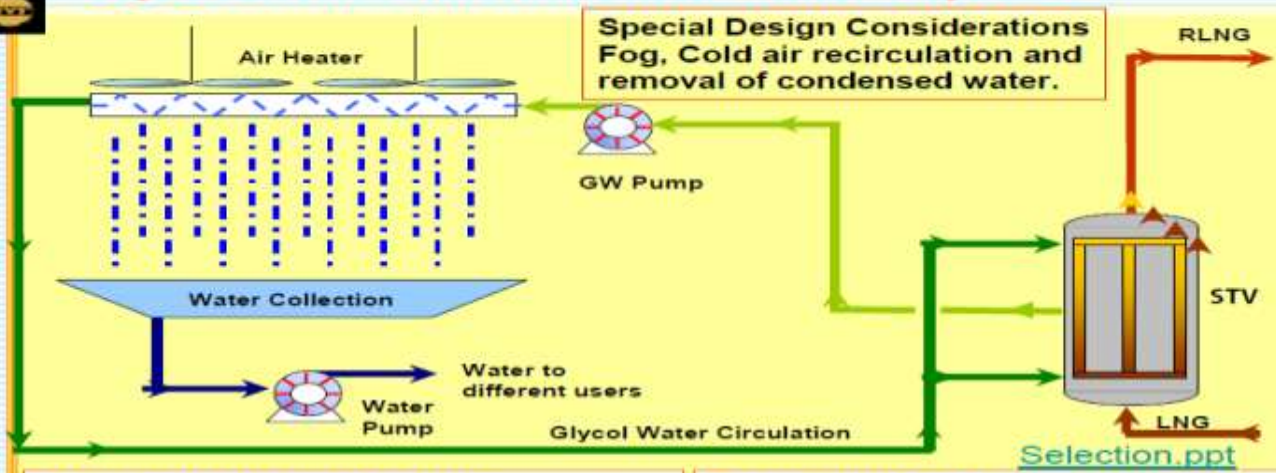
Intermediate Fluid Vaporizer (IFV) with Rankine Cycle



- Cold energy for power generation.
- No greenhouse effect.
- Complex process and controls.

- Higher capital cost
- Turndown ratio limits.
- Longer start-up time.

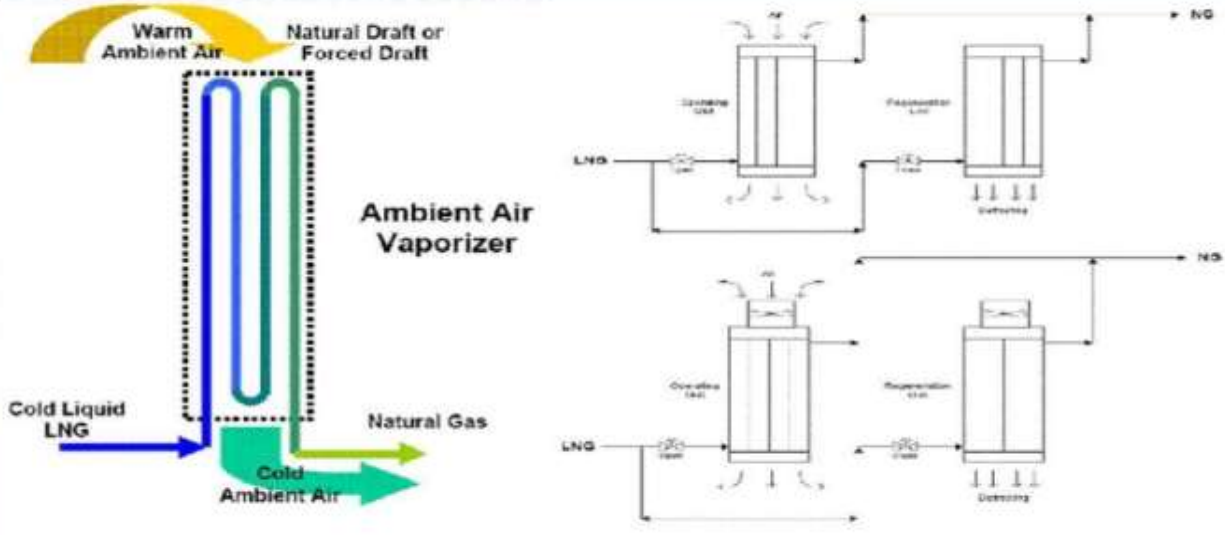
Glycol-Water Intermediate Fluid Vaporizer



- Minimum operating cost.
- Effective at high ambient temp.

- Capital cost Higher than SCV, lower than ORV.
- Large space requirement.

Natural Draft Direct Ambient Air Vaporizers.



NATURAL DRAFT DIRECT AMBIENT AIR VAPORIZERS

Ambient Air Vaporizers

- Natural draft ambient air
- No intermediate fluid
- Direct transfer from air to vaporized fluid
- No power / fuel)
- Wide fin spacing allows for icing design
- Effective to -80 F [-62 C]

Ambient Vaporizers

- **Simplest and most reliable systems**
- **More complex to model**

Consider the following:

- **Simultaneous heat and mass transfer**
- **Diffusion of water vapor**
- **Equilibrium rarely exists**
- **Ambient conditions, not controllable**

Decisions on ambient vaporizer sizing is dictated by prevailing weather conditions, tempered with other considerations based on job specific requirements.

FORCED DRAFT DIRECT AMBIENT AIR VAPORIZERS

Forced Draft Ambient Air Vaporizer

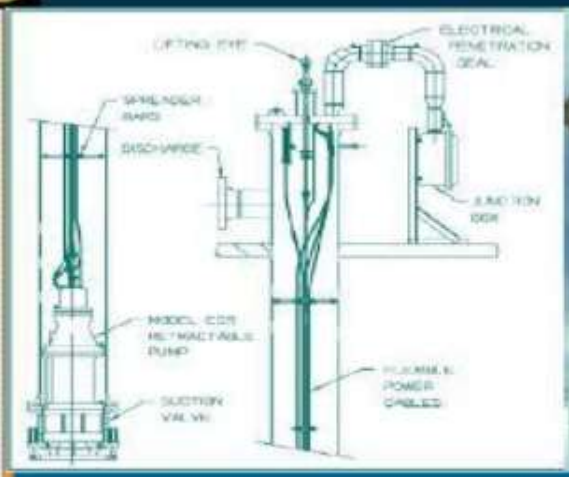
- Fan assisted ambient air
- Increased external coefficient
- Direct transfer from air to vaporized fluid
- Highly efficient, no intermediate fluid
- Wide fin spacing allows for icing design
- Effective to -80 F [-62 C]

Vaporizer Selection Criteria

Local environment – sea water quality, ambient temperature.

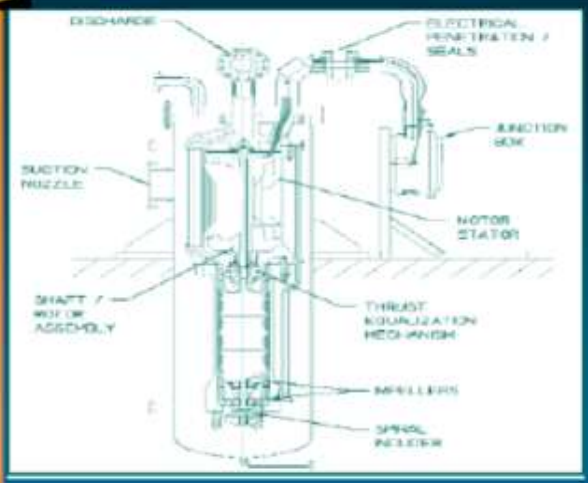
- Environmental Considerations
  - Atmospheric pollution
  - Impact on ocean ecosystem
- Cost – Investment and operating cost
- Space requirement
- Ease of operation
- Maintenance problems

Primary Pump (SEMP)



- Transfers LNG from tank to secondary pumping.
- 200-400 M3 /Hr, 3-8 Kg/sq. cm pressure. 1 or 2 stages.
- Motor and pump with shaft directly submerged in LNG.
- No seal, no leakage of vapor to atmosphere.
- No coupling between motor and pump. No alignment problem.

Secondary Pump

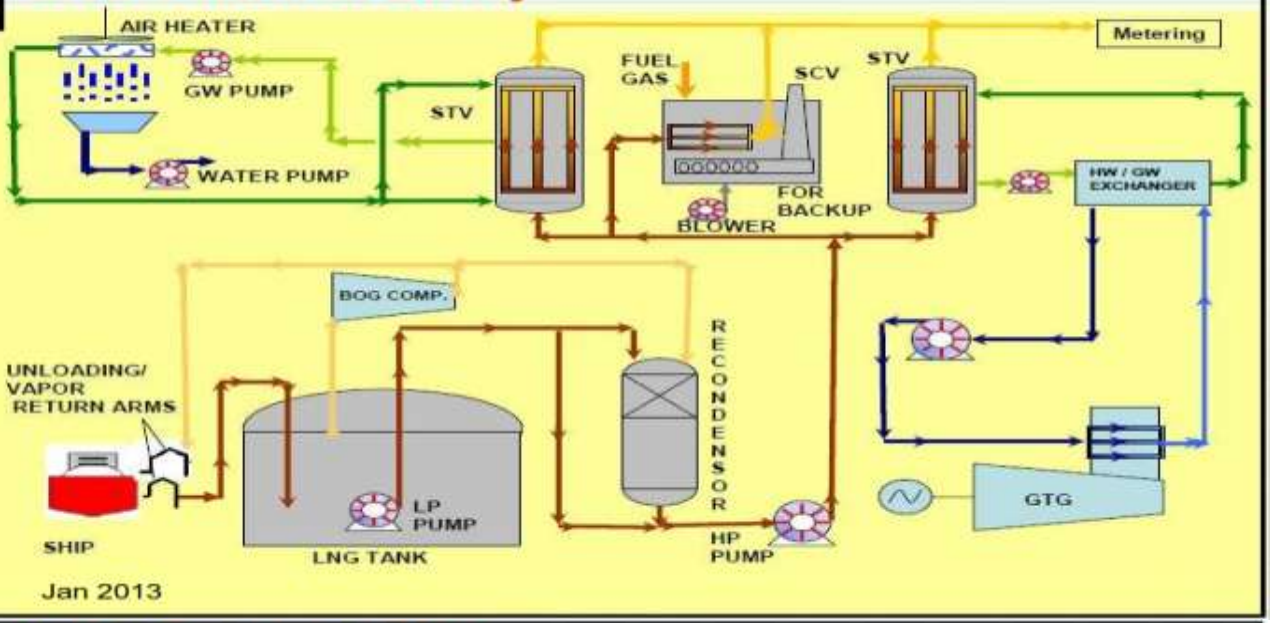


- High pressure (100-140 Kg/ sq. cm) multistage vessel mounted submerged pump.
- Installed in self-contained suction vessel.
- The vessel venting is important.
- Pumps are installed in banks or rows.
- Widely accepted due to inherent safety.

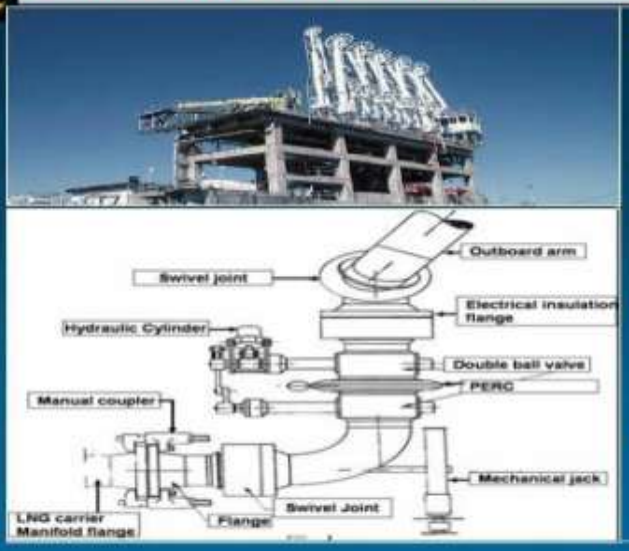
Design Features of LNG Pumps

- Submerged in LNG. No seals, no vapor leakage.
- Common shaft, submerged motor, no air. Explosion proof motor not required, though used for extra-safety.
- Power cables connected at their junction boxes located on or near the head plate of the vessel.
- Primary pumps require 400-440 V power, 50-60 Hz. Secondary Pumps require 4160-6600 V power, 50-60 Hz.

LNG Terminal Dahej



Unloading Arm Safety



- A mooring study is conducted to ensure that the ship can stay in position with the pier during extreme wind speeds.
- Load sensors on the mooring hooks will detect and warn any over or under load.
- Alarm and emergency shutdown system to stop loading.
- The liquid unloading arms will be fitted with Powered Emergency Release Couplings (PERCs).

LNG TRUCK LOADING FACILITY

- Truck Loading facility at Dahej terminal was commissioned in August 07
- Facility can handle 2500 loadings per year

VAPORISATION FACILITIES AT CUSTOMER'S END

EXECUTION OF LNG PROJECTS

EXECUTION OF LNG PROJECTS

- **Pre Project Activities**
  - ➢ Surveys & Studies
    - ✓ Land Survey
    - ✓ Collection of ambient data
    - ✓ Bathymetric Study
    - ✓ Topography Survey
    - ✓ Geotechnical Studies
    - ✓ Oceanographic Studies

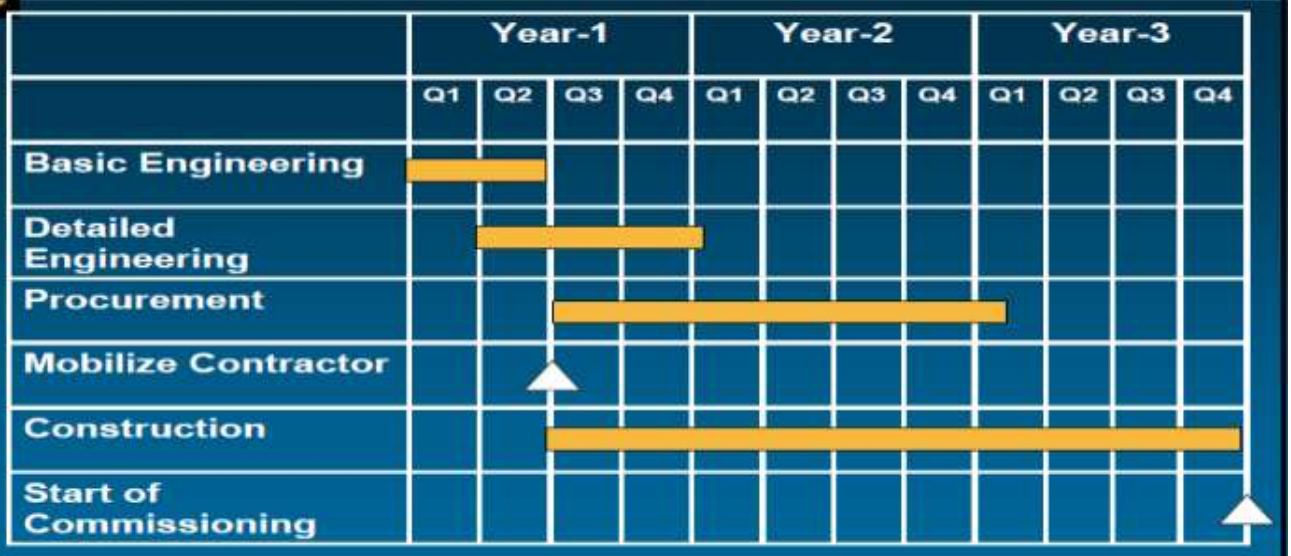
Cont..

- ✓ Marine and Terrestrial Studies (Rapid & Comprehensive)
- ✓ Project Feasibility Study including Mooring analysis & Ship Maneuvering Study
- ✓ Basic Engineering package(FEED)
- ✓ Finalization of Methodology for project execution
- ✓ Techno Commercial Documents for selection of PMC & contractors

▪ Approvals from Statutory Authorities

- ➢ State pollution control
- ➢ Costal Regulation Zone (CRZ) approval
- ➢ Department of environment & Forest
- ➢ Ministry of Environment & Forest
- ➢ Chief Controller of Explosives

Typical Project Schedule

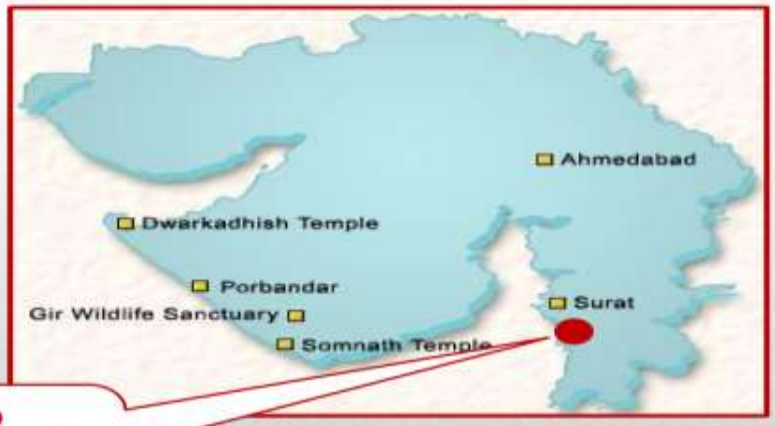


- Conventional Process
- Lump sum EPCC Turnkey Single Contract
- Lump sum EPCC Packages (3/4)

Execution Methodology

Hazira LNG Pvt. Ltd

5 MTPA LNG Storage and Regasification Plant



- HAZIRA LNG PVT LTD
- Location : South Gujarat
- Village : Hazira, 3 km
- City : Surat, 35 km

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Summary of presentation

- HSE Issues - Challenges v/s Opportunities
- HSE Management System
  - Leadership and Commitment
  - Policies & Strategic Objectives
  - Organization, Responsibilities, Resources and Standards
  - Hazards and Effects Management Process
  - Planning and Procedures
  - Implementation and Monitoring
  - Audits
  - Management Review
- Contractor HSE Management: Key aspect of a successful HSE Performance
- HSE Culture - Cultivate a deep ownership and commitment through Cultural and behavioral aspects.

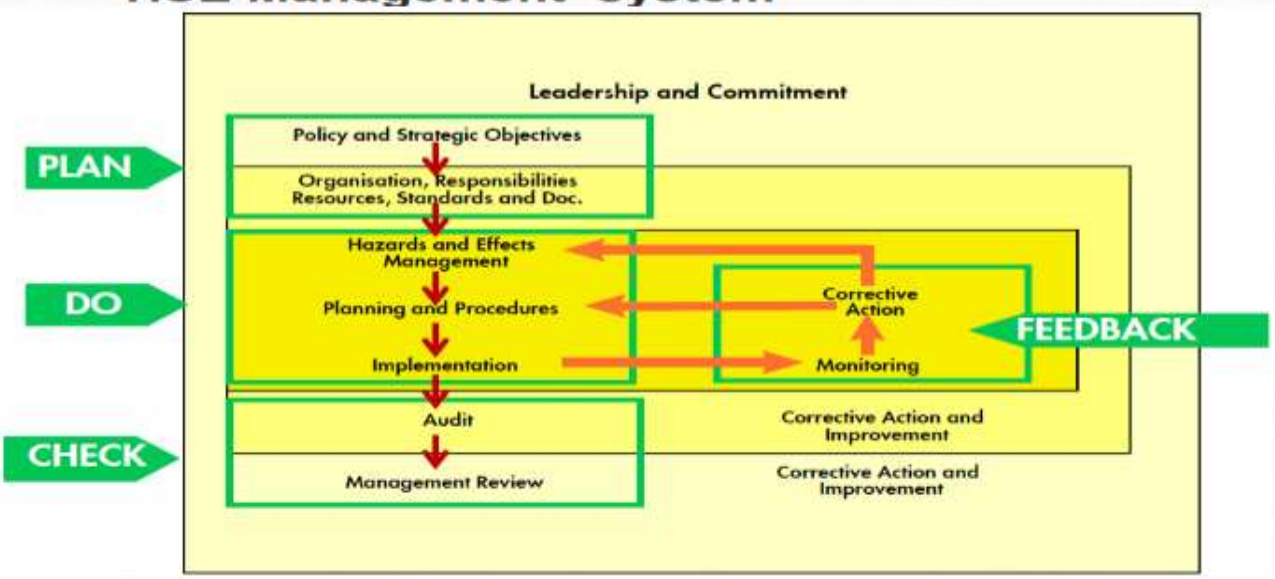
Health Safety & Environment (HSE)

With Systematic planning and controls, all accidents / incidents can be prevented.

HSE Is the Key....

- TO PROTECT HUMAN LIFE
- TO PROTECT OUR ASSETS
- TO PROTECT OUR ENVIRONMENT
- TO PROTECT OUR REPUTATION
- TO ENSURE UNINTRUPPTTED PRODUCTION

HSE Management system



Leadership and Commitment

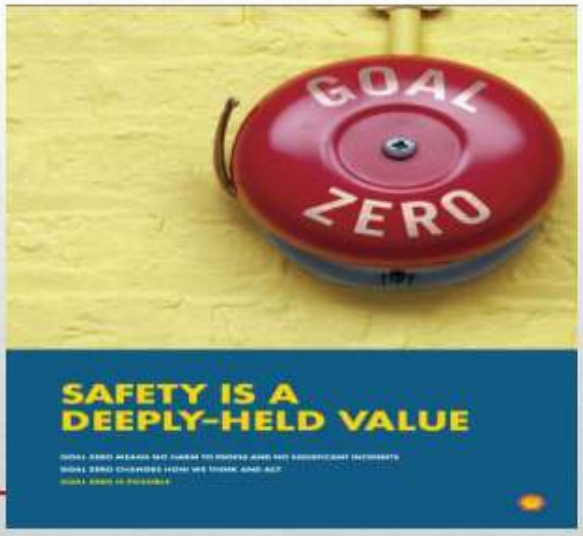
- A strong and visible leadership is important for promoting a healthy HSE culture within an organization.
- Top leadership shall provide needful and appropriate direction and steer towards constant HSE improvement through:
  - ✓ Visible leadership
  - ✓ Communicating the importance of HSE considerations in all business decisions
  - ✓ Communications with stakeholders

HSE Policies, Objectives and Plan

HSE POLICIES, OBJECTIVES AND PLANS

- **HSE Policies**
  - HSSE Policy.
  - Alcohol, Drugs & Tobacco Policy.
- **HSE Objectives**
  - Zero Injury
  - Zero legal non-conformance
  - Group HSSE Control Framework Compliance
  - Pro-active HSE culture
- **HSE Plan**
  - Yearly HSE Plan includes:
  - KPIs
  - Schedule of Management Walks
  - Schedule of Internal Audits.
  - Schedule of Contractor Audits.
  - Emergency Drills
  - HSE Days

Policies & Strategies



Life-Saving Rules – Mandatory compliance

Training & Development

Training & development

- Employees and contractor staff are provided comprehensive HSE Trainings as follows:
  - Basic HSE Induction
  - Overview of HSE Management System
  - Hazard Identification & Safe Supervision
  - Permit to Work (PTW) system
  - Emergency Response
  - NM / Potential Incident / Incident Reporting (having online HSE incident reporting system)
  - Environmental awareness
- Safe Supervision Training to all Supervisors.
- Training to contractor workmen is provided in Hindi / Gujarati.
- Firefighting & rescue training is provided to Specific target group

People's wellbeing

People's Well being

- Employees & contractors undergo mandatory risk based medical exam before start of job..
- Consultancy and counselling on health issues is provided free of cost.
- Medical treatment is provided All occupational reported cases are reported via incident reporting system and investigated by OH specialist.
- Fitness to work standards is applied to staff and contractors.
- Special drive on Tobacco Free Environment (TFE)
- HIV AIDs counselling and support.
- Exclusive "BE WELL" drive for employees.

I Promote TFE

Tobacco Free Environment (TFE).

BE WELL CHAMPION CONTEST - QUARTERLY

BE-WELL CHAMPION PARAMETERS

- WEIGHT : [kgs]
- WAIST CIRCUMFERENCE: [cms]
- BODY MASS INDEX: wt [kgs]/ht2 [m]
- WAIST HIP RATIO
- Body Fat %
- Total Cholesterol
- Blood Sugar

Strategic HSE Objectives

Management shall develop and document HSE objectives to reflect company's short and long-term HSE aspirations. These objectives shall provide direction and help in setting targets. Some examples of proactive HSE objectives are as follows:

- Obtaining ISO 9001, ISO 14001 & OHSAS 18001 certification for all major operating facilities.
- Zero Fatalities, Zero LTIs, Zero Injuries.....i.e. GOAL ZERO
- Protecting soil and groundwater through programs to reduce the potential for spills or leaks.
- Provide effective training to workmen to execute jobs safety.
- Fully equipped to effectively emergency response in place.

Organization and resources:

An organization and associated resources shall be developed to facilitate safety at all stages of business:
Responsibilities and Competency

- Within an organization, all HSE responsibilities shall be clearly indicated and all personnel will have adequate training to fulfill their responsibilities.
- HSE shall be directly the line responsibility with heads of each department made directly responsible for implementation.
- HSE professionals shall provide support and advice to facilitate qualitative and effective compliance.

Hazard and Effects Management Process (HEMP)

HEMP is a process of identifying risks and corresponding controls in any task / process.

Identify	Are people, environment, assets or company reputation exposed to potential harm?
Assess	What are the causes and consequences? How likely is loss of control? What is the risk and is it ALARP?
Control	Can the causes be eliminated? What controls are needed? How effective are the controls?
Recover	Can the potential consequences or effects be mitigated? What recovery measures are needed? Are recovery capabilities suitable and sufficient?

Risk Assessment Matrix (RAM)

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in the Industry	Heard of in the Industry	Has happened in the Organisation or more than once per year in the Industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact					
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact					
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

Light Blue

Dark Blue

Yellow

Red

Planning and procedures

The plans and procedures shall include process-related and management-related activities. Some good examples are:

- Organization, roles and responsibilities
- Communication requirements and guidelines.
- Competence and training requirements.
- Engineering controls.
- Asset integrity plan
- Change management guideline.
- SOPs etc etc

Implementation and monitoring

An Organization shall develop and maintain procedures for implementation and monitoring of relevant aspects of HSE performance as follows:

- Training plans for staff and workmen.
- Detailed HSE Plan and its monitoring (Risk Management, Drills, Inspections, Management walks, Audits etc)
- Progress against HSE management systems and review it's effectiveness.
- Proactive management reviews and identify Leaning's to facilitate a healthy PDCA cycle.
- Overall legal compliance and its monitoring.

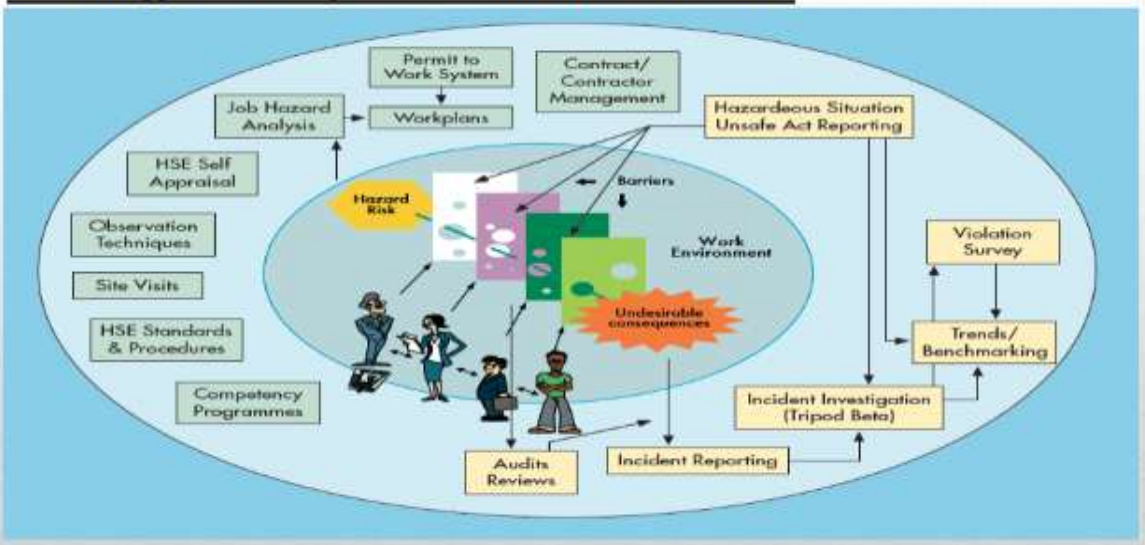
Operational Safety

Integrity Leadership is the pivotal point for the strong AIPSM (Asset Integrity and Process Safety Management) implementation and sustaining it through out the life cycle of a process plant

Gas Game: Ensure Safe Production

- A very basic, standardized, operational work process that ensures operation with in well-defined, well-understood limits, all the time"
- It is achieved through:
  A defined and well followed set of operational/organizational
  BEHAVIOURS at all levels

Sealing the loop holes in the barriers



Contractor HSE management

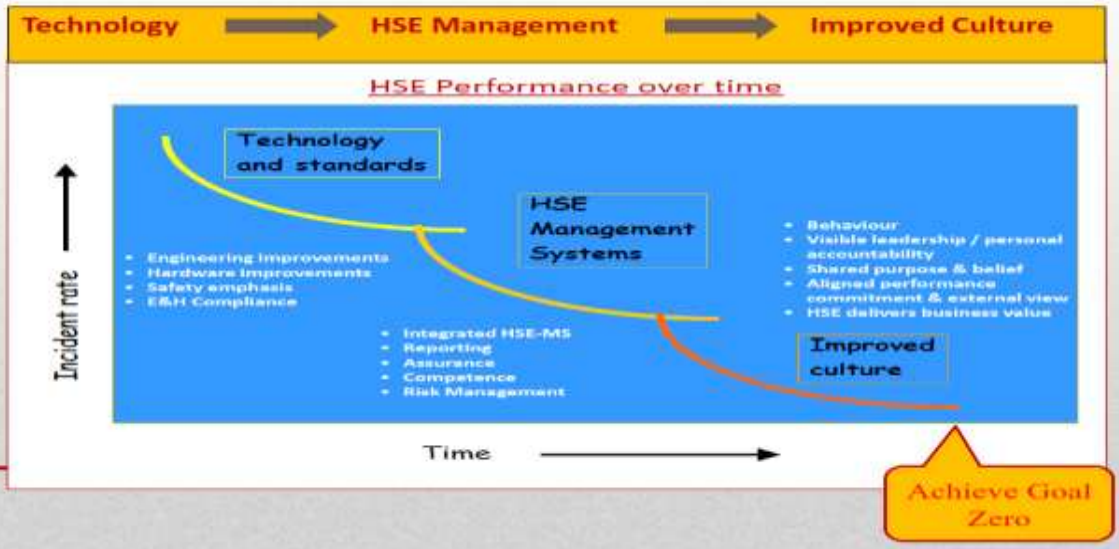
One major challenge in overall HSE compliance within an organization is ensuring successful Contractor HSE management.

The key steps of the process are:

- Pre - qualification
- Selection
- Pre-job activities
- Work management
- Post-job evaluation
- Systems review

Treat Contractors as Business Partners and Team Up for Success in HSE

Three stages of a successful HSE organization

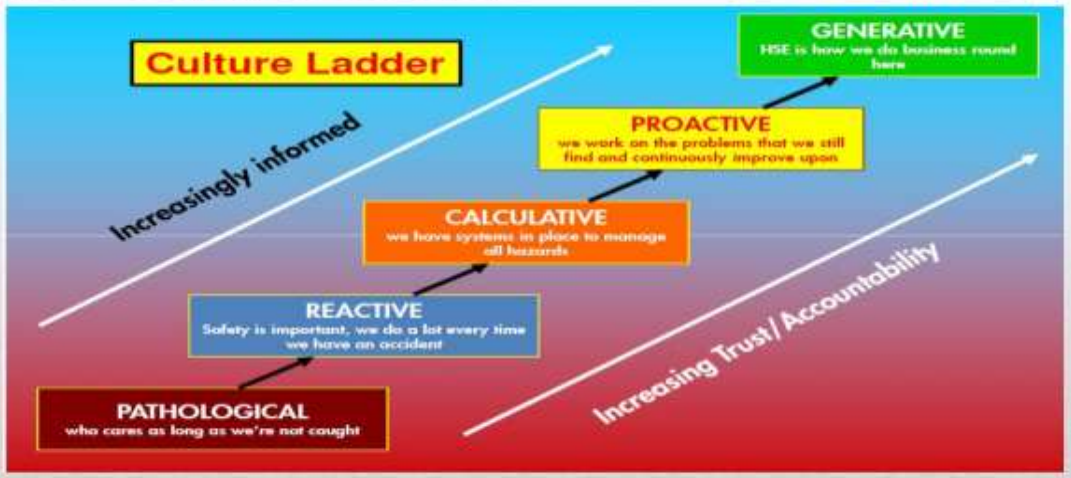


HSE culture

"HSE Culture" is a case of organizational culture, in which HSE has a special place in the concerns of those who work for the organization.

CULTIVATE A DEEP OWNERSHIP AND COMMITMENT THROUGH CULTURAL AND BEHAVIOURAL ASPECTS AND ESTABLISH CONTINUOUS IMPROVEMENT (PDCA).

HSE Cultural Ladder



"Structured and Sustainable HSE Management Systems and Culture in an Organization would facilitate Goal Zero....i.e. "Zero Injury, Zero Loss, Zero Leaks".

Health, Safety & Environment Issues in LNG Facilities

Health Safety & Environment Management Systems in a LNG Terminal…

By Devendra Bathija – Hazira LNG Pvt. Ltd

Hazira LNG Pvt. Ltd

5 MTPA LNG Storage and Regasification Plant

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- Location : South Gujarat
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Summary of presentation

- HSE Issues - Challenges v/s Opportunities
- HSE Management System
  - Leadership and Commitment
  - Policies & Strategic Objectives
  - Organization, Responsibilities, Resources and Standards
  - Hazards and Effects Management Process
  - Planning and Procedures
  - Implementation and Monitoring
  - Audits
  - Management Review
- Contractor HSE Management: Key aspect of a successful HSE Performance
- HSE Culture - Cultivate a deep ownership and commitment through Cultural and behavioral aspects.

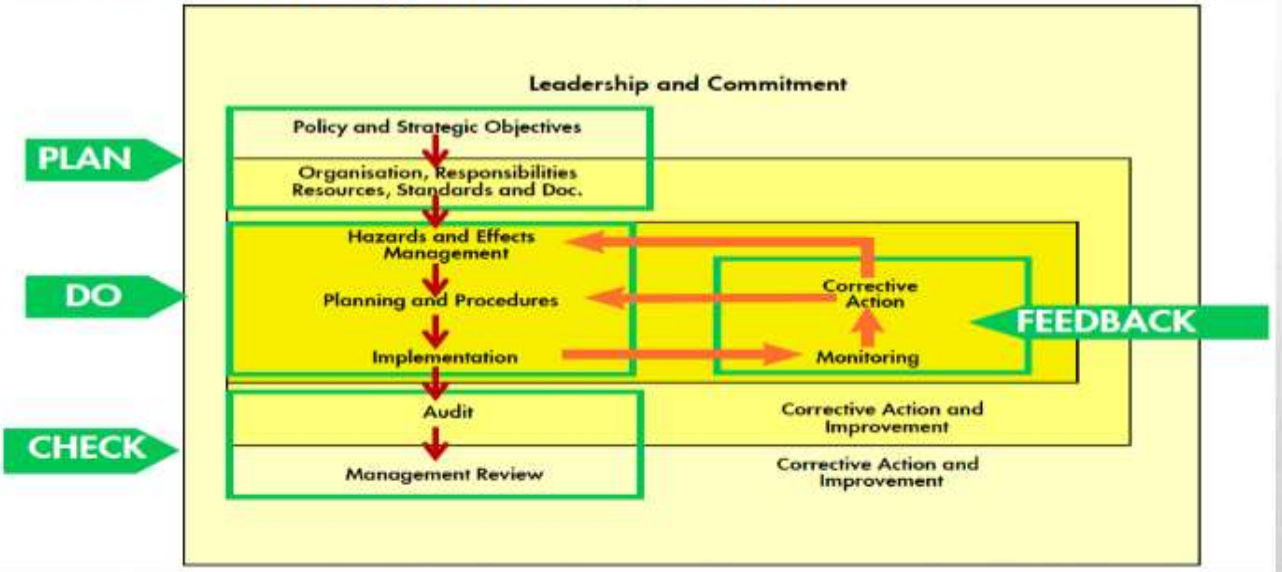
Health Safety & Environment (HSE)

With Systematic planning and controls, all accidents / incidents can be prevented.

HSE Is the Key....

- TO PROTECT HUMAN LIFE
- TO PROTECT OUR ASSETS
- TO PROTECT OUR ENVIRONMENT
- TO PROTECT OUR REPUTATION
- TO ENSURE UNINTRUPPTTED PRODUCTION

HSE Management system



Leadership and Commitment

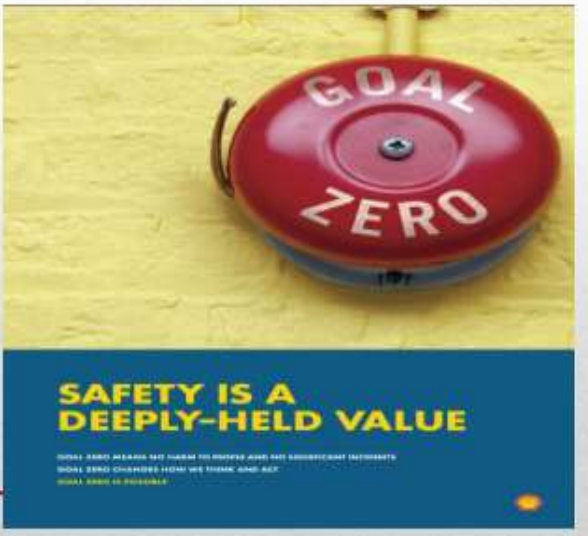
- A strong and visible leadership is important for promoting a healthy HSE culture within an organization.
- Top leadership shall provide needful and appropriate direction and steer towards constant HSE improvement through:
  - ✓ Visible leadership
  - ✓ Communicating the importance of HSE considerations in all business decisions
  - ✓ Communications with stakeholders

HSE Policies, Objectives and Plan

HSE POLICIES, OBJECTIVES AND PLANS

- **HSE Policies**
  - HSSE Policy.
  - Alcohol, Drugs & Tobacco Policy.
- **HSE Objectives**
  - Zero Injury
  - Zero legal non-conformance
  - Group HSSE Control Framework Compliance
  - Pro-active HSE culture
- **HSE Plan**
  - Yearly HSE Plan includes:
  - KPIs
  - Schedule of Management Walks
  - Schedule of Internal Audits.
  - Schedule of Contractor Audits.
  - Emergency Drills
  - HSE Days

Policies & Strategies



Life-Saving Rules – Mandatory compliance

Training & Development

Training & development

- Employees and contractor staff are provided comprehensive HSE Trainings as follows:
  - Basic HSE Induction
  - Overview of HSE Management System
  - Hazard Identification & Safe Supervision
  - Permit to Work (PTW) system
  - Emergency Response
  - NM / Potential Incident / Incident Reporting (having online HSE incident reporting system)
  - Environmental awareness
- Safe Supervision Training to all Supervisors.
- Training to contractor workmen is provided in Hindi / Gujarati.
- Firefighting & rescue training is provided to Specific target group

People's wellbeing

People's Well being

- Employees & contractors undergo mandatory risk based medical exam before start of job..
- Consultancy and counselling on health issues is provided free of cost.
- Medical treatment is provided All occupational reported cases are reported via incident reporting system and investigated by OH specialist.
- Fitness to work standards is applied to staff and contractors.
- Special drive on Tobacco Free Environment (TFE)
- HIV AIDs counselling and support.
- Exclusive "BE WELL" drive for employees.

I Promote TFE

Tobacco Free Environment (TFE).

BE WELL CHAMPION CONTEST - QUARTERLY

BE-WELL CHAMPION PARAMETERS

- WEIGHT : [kgs]
- WAIST CIRCUMFERENCE: [cms]
- BODY MASS INDEX: wt [kgs]/ht2 [m]
- WAIST HIP RATIO
- Body Fat %
- Total Cholesterol
- Blood Sugar

Strategic HSE Objectives

Management shall develop and document HSE objectives to reflect company's short and long-term HSE aspirations. These objectives shall provide direction and help in setting targets. Some examples of proactive HSE objectives are as follows:

- Obtaining ISO 9001, ISO 14001 & OHSAS 18001 certification for all major operating facilities.
- Zero Fatalities, Zero LTIs, Zero Injuries.....i.e. GOAL ZERO
- Protecting soil and groundwater through programs to reduce the potential for spills or leaks.
- Provide effective training to workmen to execute jobs safety.
- Fully equipped to effectively emergency response in place.

Organization and resources:

An organization and associated resources shall be developed to facilitate safety at all stages of business:
Responsibilities and Competency

- Within an organization, all HSE responsibilities shall be clearly indicated and all personnel will have adequate training to fulfill their responsibilities.
- HSE shall be directly the line responsibility with heads of each department made directly responsible for implementation.
- HSE professionals shall provide support and advice to facilitate qualitative and effective compliance.

Hazard and Effects Management Process (HEMP)

HEMP is a process of identifying risks and corresponding controls in any task / process.

Identify	Are people, environment, assets or company reputation exposed to potential harm?
Assess	What are the causes and consequences? How likely is loss of control? What is the risk and is it ALARP?
Control	Can the causes be eliminated? What controls are needed? How effective are the controls?
Recover	Can the potential consequences or effects be mitigated? What recovery measures are needed? Are recovery capabilities suitable and sufficient?

Risk Assessment Matrix (RAM)

SEVERITY	CONSEQUENCES				INCREASING LIKELIHOOD				
	People	Assets	Environment	Reputation	A	B	C	D	E
					Never heard of in the Industry	Heard of in the Industry	Has happened in the Organisation or more than once per year in the Industry	Has happened at the Location or more than once per year in the Organisation	Has happened more than once per year at the Location
0	No injury or health effect	No damage	No effect	No impact					
1	Slight injury or health effect	Slight damage	Slight effect	Slight impact					
2	Minor injury or health effect	Minor damage	Minor effect	Minor impact					
3	Major injury or health effect	Moderate damage	Moderate effect	Moderate impact					
4	PTD or up to 3 fatalities	Major damage	Major effect	Major impact					
5	More than 3 fatalities	Massive damage	Massive effect	Massive impact					

Light Blue

Dark Blue

Yellow

Red

Planning and procedures

The plans and procedures shall include process-related and management-related activities. Some good examples are:

- Organization, roles and responsibilities
- Communication requirements and guidelines.
- Competence and training requirements.
- Engineering controls.
- Asset integrity plan
- Change management guideline.
- SOPs etc etc

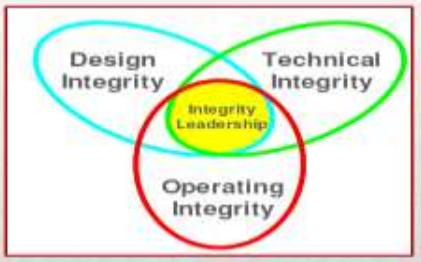
Implementation and monitoring

An Organization shall develop and maintain procedures for implementation and monitoring of relevant aspects of HSE performance as follows:

- Training plans for staff and workmen.
- Detailed HSE Plan and its monitoring (Risk Management, Drills, Inspections, Management walks, Audits etc)
- Progress against HSE management systems and review it's effectiveness.
- Proactive management reviews and identify Leaning's to facilitate a healthy PDCA cycle.
- Overall legal compliance and its monitoring.

Operational Safety

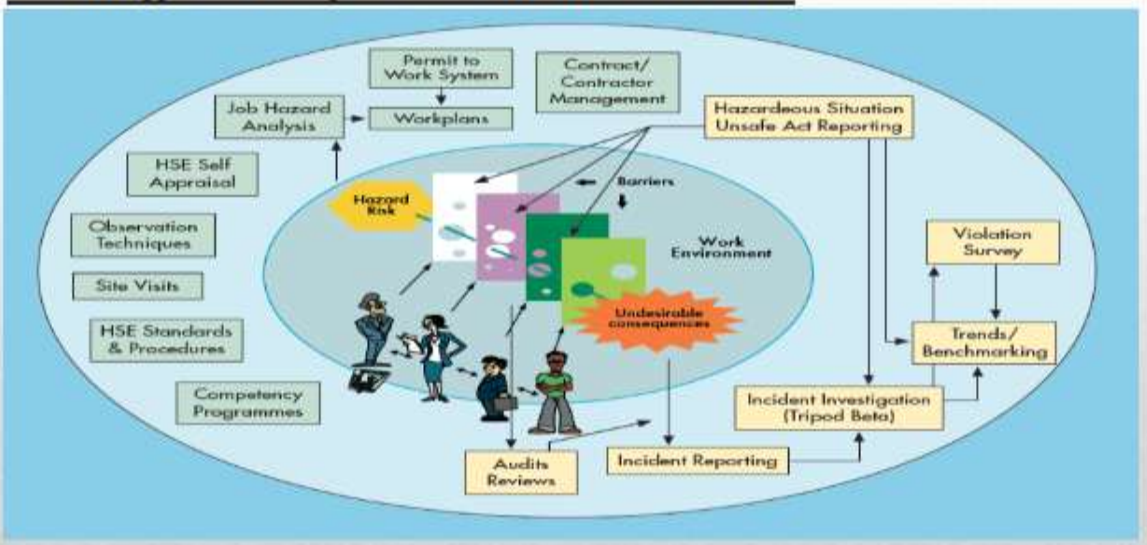
Integrity Leadership is the pivotal point for the strong AIPSM (Asset Integrity and Process Safety Management) implementation and sustaining it through out the life cycle of a process plant



Gas Game: Ensure Safe Production

- A very basic, standardized, operational work process that ensures operation with in well-defined, well-understood limits, all the time"
- It is achieved through:
  A defined and well followed set of operational/organizational
  BEHAVIOURS at all levels

Sealing the loop holes in the barriers



Contractor HSE management

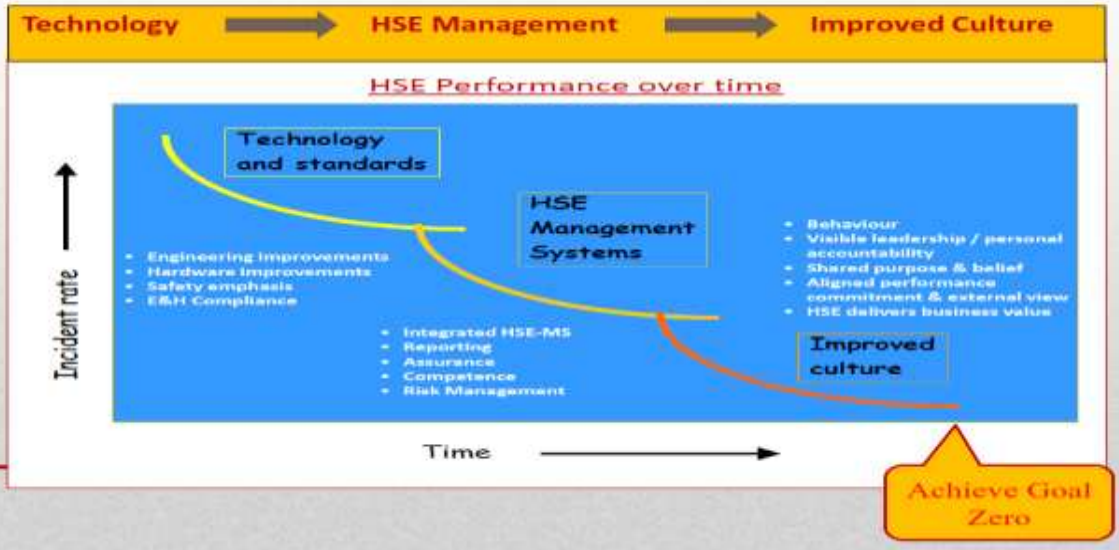
One major challenge in overall HSE compliance within an organization is ensuring successful Contractor HSE management.

The key steps of the process are:

- Pre - qualification
- Selection
- Pre-job activities
- Work management
- Post-job evaluation
- Systems review

Treat Contractors as Business Partners and Team Up for Success in HSE

Three stages of a successful HSE organization

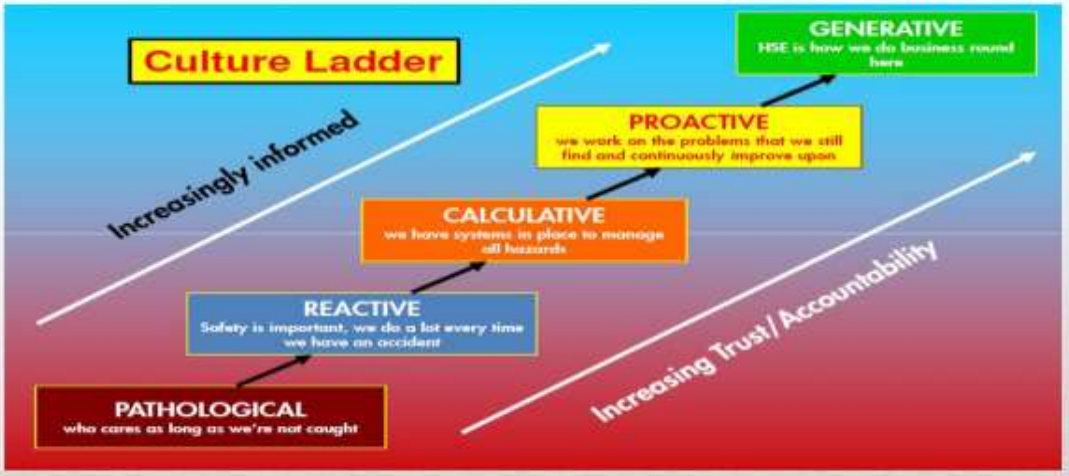


HSE culture

"HSE Culture" is a case of organizational culture, in which HSE has a special place in the concerns of those who work for the organization.

CULTIVATE A DEEP OWNERSHIP AND COMMITMENT THROUGH CULTURAL AND BEHAVIOURAL ASPECTS AND ESTABLISH CONTINUOUS IMPROVEMENT (PDCA).

HSE Cultural Ladder



"Structured and Sustainable HSE Management Systems and Culture in an Organization would facilitate Goal Zero....i.e. "Zero Injury, Zero Loss, Zero Leaks".