Pre-Feasibility Report

10th July 2018

Private and Confidential

Rev. 0

FSU/FSRU based LNG Terminal in Hooghly Estuary at Kukrahati, West Bengal

Document No.	BD/BCPL/WBIGP/EC/001

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1. EXECUTIVE SUMMARY

Bengal Concessions Private Limited (BCPL) is a subsidiary of H-Energy Renewables Private Limited (HREPL), a company established with a vision to contribute to the economic growth of the country by offering world class, environmentally safe and sustainable energy solutions. H-Energy Gateway Private Limited, an affiliate of BCPL, is currently developing an LNG Floating Storage and Regasification terminal at Jaigarh Port in Maharashtra and a cross-country pipeline connecting the source to the National Gas Grid. Other affiliates of BCPL are involved in the business of providing natural gas solutions including LNG Sourcing, re-gasification facilities, downstream deliveries based on customer preference through suitable evacuation pipelines.

H-Energy and its various affiliates endeavour to build world-class LNG infrastructure projects, which will ensure a regular and sustainable supply of clean, environment-friendly natural gas fuel at strategic locations on the east and west coast of India.

To this regard, BCPL is planning to set up a Floating LNG Storage and regasification terminal at Kukrahati, West Bengal with a maximum capacity of 4 MMTPA. As part of this project, BCPL intends to construct a jetty/ near shore Gravity based floating (GBF) structure to receive LNG by small-scale LNG carriers, store it in an FSU/FSRU/Storage tank provided inside the GBF structure and to re-gasify the LNG in the vaporizers provided on land/on jetty/on GBF/on board the FSRU at the project site in Kukrahati. The R-LNG thus produced shall be supplied to Customers in the vicinity through suitable evacuation pipelines. BCPL expects this project to be commissioned by Q4, 2020.

2. INTRODUCTION/BACKGROUND OF THE PROJECT

2.1. IDENTIFICATION OF THE PROJECT

In order to meet the gas demand in West Bengal and Western Bangladesh, BCPL proposes to develop an LNG storage and regasification terminal at Kukrahati in West Bengal. The project is envisaged keeping in mind the industrial and domestic consumers of the region. The project is strategic in nature and when implemented, will benefit not only the eastern states of India but also the neighboring country of Bangladesh. BCPL's project location is in close proximity to Industrial regions in Eastern India and in Bangladesh, which shall be the primary consumers of R-LNG from the project.

2.2. BRIEF DESCRIPTION OF THE PROJECT

BCPL is planning to set up an LNG storage and regasification terminal at Kukrahati, West Bengal with a maximum capacity of 4 MMTPA. As part of this project, BCPL intends to construct a jetty/ GBF structure to receive LNG by LNG carriers, store it in an FSU/FSRU/Storage tank provided inside the GBF Structure and re-gasify the LNG in the vaporizers provided on land/on jetty/on board the FSRU at the project site in Kukrahati. Re-gasified LNG will be supplied to end users in West Bengal and its vicinity including Bangladesh through suitable evacuation pipelines.

Fig 1: Project Location

One (01) number of either FSU/FSRU of upto 80,000 m3 shall be permanently moored at the proposed jetty at Kukrahati or an inbuilt storage of similar capacity shall be built inside the GBF structure.

The terminal will receive LNG from a suitable source through LNG Carriers of upto 30,000 m3 size. The LNG thus received will be re-gasified and transported to customers in West Bengal and Bangladesh through evacuation pipelines. The target date for commissioning of the project is Q4 2020.

2.3. NEED FOR THE PROJECT

Demand for natural gas in India is expected to increase manifold in the future given its competitive edge over other fuels in terms of environmental benefits, efficiency and pricing against liquid fuels. Historically, power and fertilizer sectors in India were the largest consumers of gas. Based on this and certain other factors, these sectors received priority in allocation of gas. Infrastructure was also developed considering the needs of these sectors. However, for the other sectors, the development of supply infrastructure has remained limited. These sectors are therefore still at a nascent stage of gas use but show a huge and growing appetite for the fuel.

Currently India has four regasification terminals with a total capacity of approximately 31.7 MMTPA. In addition to this, the proposed terminals and the ones under construction are likely to enhance the regasification capacity to the tune of another 37 MMTPA. Till date, over 87 Geographical areas have been authorized by PNGRB for City Gas Distribution (CGD) operations in various cities. Also, India currently has an operating natural gas pipeline for infrastructure of over 16470 kms and capacity of about 387 MMSCMD. This network is expected to expand around 29,369 kms of pipelines with a total design capacity of around 879 MMSCMD in next 5-6 years taking the country close to the formation of Natural gas grid connecting all major demand and supply centers in India. This will ensure wider and uniform availability of gas across all regions for social and economic progress. Overall utilization of LNG regasification capacity during year 2016-17 was around 75%. LNG Terminals are under construction/implementation stage across India and once functional would substantially increase the regasification capacity in the country.

With natural gas being the cleanest fossil fuel, LNG is the fuel of choice for the project. The main advantages in the use of LNG are listed below:

- Lower carbon footprint on substitution of liquid fuels;
- LNG sourcing at competitive price and on customized terms;
- Cheaper and Cleaner source of energy leading growth and revival of gas based industries;
- Reduced cost of industrial protection;
- Accelerated socio-economic development and Supplement to depleting economic growth;
- Help in CGD networks in major towns and cities, mainly benefitting vehicular transport& households

At present, there is a strong imbalance within the country with regard to consumption of natural gas. An affiliate of BCPL has carried out gas demand assessment for the following key sectors:

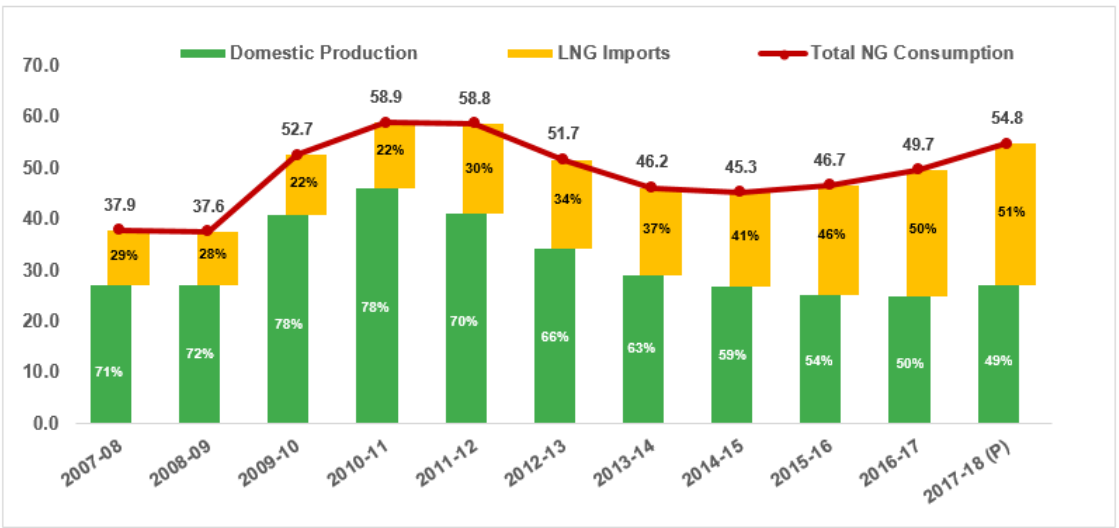
a) Large Industrial users

- Power Plants
- Fertilizer Plants
- Refineries and Petrochemicals
- Iron and Steel
- Cement

b) CGD Business

- Residential
- Transport
- Small industrial and commercial

Natural gas demand supply scenario of the nation over last decade has been depicted below in figure 2. Natural gas consumption of the country is met through domestic production (net of auxiliary consumption of producing companies and natural gas flared) and LNG imported from various countries. Of late, due to the decrease in the domestic production of Natural Gas in India, the shortfall thus created was satisfied through import of LNG. During 2016-17 out of total NG consumption in the country 50% of volume was imported LNG.



Source: PPAC 2017-18(P) extrapolated data from monthly data available

Fig 2: NG Consumption – Supply scenario – India (in BCM)

During year 2016-17, total natural gas consumption in the country was around 49.7 BCM. Maximum use of Natural Gas was in fertilizers sector (30%) followed by power generation (23%) and 14% natural gas was used for city or local distribution networks. Sector-wise distribution of natural gas off-take has been depicted in below figure 3.

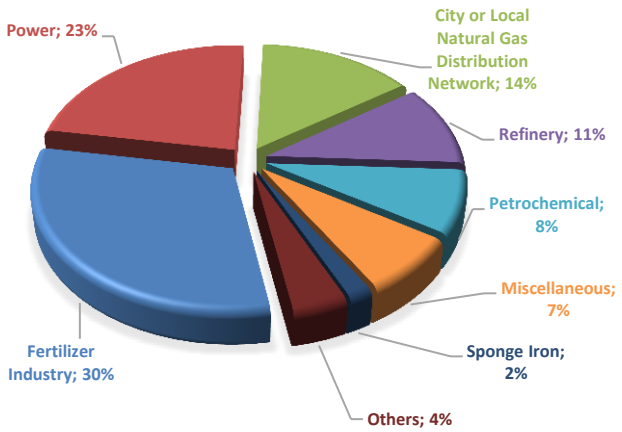


Fig 3: Sector wise Natural Gas Take off (2016-17)

Sectors identified for domestic gas allocation are listed here:

- Gas based fertilizer (urea) plants
- LPG Plants
- Power Plant Supplying to Grid / state utilities at regulated rates under PPA
- CGD network for domestic and transport sectors
- Steel, Refineries and Petrochemicals for feedstock purpose
- CGD network for Commercial and Industrial consumers
- Any other customers for captive & merchant power, feedstock or fuel purpose

Details of existing and proposed LNG terminals are given as table 1.

Table -1: LNG Terminal Capacity (in MMTPA)

Sr. No.	Location	Owner	Capacity (MMTPA)	Status
	Existing			
1.	Dahej, Gujarat	Petronet LNG 100%	15.0	Operating
2.	Hazira, Gujarat	Shell 74%; TOTAL 26%	5.0	Operating
3.	Kochi, Tamil Nadu	Petronet LNG 100%	5.0	Operating
4.	Dabhol, Maharashtra	GAIL 31.52%; NTPC 31.52%; Indian financial institutions 20.28%; MSEB Holding Co. 16.68%	1.7	Operating (in phase-1 without break water - to be increased to 5 MMTPA)
5.	Mundra, Gujarat	GSPC – Adani	5.0	Ready for commissioning
	Total Existing Capacity		**31.7**	
	Total Existing Capacity (BCM)*		**43.1**	
	Planning / Under Construction Stage			
1.	Pipavav (Jafrabad), Gujarat	Swan Energy	5.0	Planning / Advance stage of Financial closure. Letter of Intent has been issued to the EPC, Contractor for the topside during May 2017. – Annual Report of Swan Energy, 2016-17
2.	Jaigarh, Maharashtra	H-Energy – Phase I	4.0	Under Construction, Expected completion of construction by Mid of year 2018
3.	Ennore, Tamil Nadu	IOCL	5.0	Under Construction
4.	Chhara, Gujarat	HPCL Shapoorji Energy Ltd.	5.0	Under Construction

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Sr. No.	Location	Owner	Capacity (MMTPA)	Status
	Total Under Construction / Planning	**MTPA**	**19.0**	
	Total Under Construction / Planning	**BCM**	**25.8**	
	Other Proposed LNG Terminals			
1.	Dhamra, Orissa	Adani - IOCL	5.0	Planning stage
2.	Kakinada, Andhra Pradesh	GAIL	5.0	Planning
3.	Jaigarh, Maharashtra	H-Energy – Phase II	4.0	Planning, would be undertaken after completion of Phase I
4.	Digha, West Bengal	H-Energy	4.0	Planning, expected commissioning by Q4 2020
5.	Nana Layja in Kutch, Gujarat	GIMPCL (Gujarat Integrated Maritime Complex Pvt Ltd, a subsidiary of IL&FS Maritime Infrastructure Company Ltd.)	5.0	Proposed
6.	Krishnapatnam Port	KEI-ROSS Petroleum and Energy Private Ltd. (LNG Bharat)	5.0	Proposed
7.	Kakinada Deep Water Port	Krishna Godavari LNG Terminal Private Limited	7.2	Proposed
8.	Kakinada Deep Water Port	GMR Holdings Private Limited	1.8	Environment clearance received
	Total Proposed Capacity	**MTPA**	**37.0**	
	Total Proposed Capacity	**BCM**	**50.3**	

The energy security of a nation has an important role to play towards its growth. The demand for energy in developing nations continues to soar at an alarming rate with India being no exception to this. The primary energy consumption of India in 2015 was about 5% higher than 2014. The GOI (Government of India) has recently launched a #Gas4India campaign where it focuses to promote the use of Natural gas all over the country by conducting various social media engagement as well as hyper-local offline events and increase the total share of Natural gas in country's energy basket from 7% to 15% by year 2025.

However, the share of natural gas in the energy pool is likely to increase over the coming years, considering India's relentless efforts in reducing emissions and cost effectiveness of natural gas vis-à-vis other fuels. The recent policy reforms for natural gas usage in power and fertilizer sector clearly indicate the nation's strong desire to move towards a gas based economy. Keeping in mind the lack of availability of Natural Gas in the eastern part of India, there is a strong need to develop necessary Infrastructure in order to cater the natural gas demand. Considering the attractiveness of the location, huge untapped gas demand of nearby industries and low LNG prices, there is a strong case for development of a LNG regasification terminal at Kukrahati.

2.4. DEMAND – SUPPLY GAP

The increase in the usage of natural gas as fuel, feedstock and other industrial and domestic applications is highly dependent on creation of integrated natural gas infrastructure including LNG regasification terminals, CGD networks, cross-country pipelines etc. The region wise distribution of natural gas pipeline infrastructure is presented in the table below:

Table – 2: Region wise share in gas consumption and pipeline activity

Region	Approx. % of Total gas P/L network	% of consumption	States with infrastructure and consuming gas	States lacking or having inadequate pipeline infrastructure
Western	40%	53%	Gujarat, Maharashtra	
Northern	20%	26%	Delhi, UP, Haryana, Rajasthan	Punjab, J&K, Himachal Pradesh, Uttarakhand
Central	13%	3%	Madhya Pradesh	Chhattisgarh
Southern	16%	14%	Tamil Nadu, Andhra Pradesh	Kerala, Karnataka
Eastern	**0%**	**NIL**	**-**	**Bihar, West Bengal, Jharkhand, Orissa**
North Eastern	10%	4%	Assam, Tripura	Meghalaya, Sikkim, Arunachal Pradesh, Mizoram, Manipur, Nagaland

As it is evident from the details mentioned in Table-1, the pipeline infrastructure is highly skewed towards northern and western parts of the country and the state of West Bengal is deprived of natural gas infrastructure. The gap between supply and demand warrants a need to create infrastructure for gas supply from external resources particularly from the eastern coast of India to cater to the need of the region.

2.5. IMPORTS vs. INDIGENOUS PRODUCTION

LNG will be imported from suitable source through LNG carriers and this imported LNG will be regasified at the project site and transported to customers through evacuation pipelines. There is no indigenous production at the site.

2.6. EXPORT POSSIBILITY

Export possibility of Gas is high, considering the need emanating from the neighboring country of Bangladesh. BCPL intends to cater to the demand of Bangladesh.

2.7. DOMESTIC / EXPORT MARKETS

DOMESTIC MARKET:

Overall gas demand in West Bengal is expected to increase from 5.19 MMSCMD in 2020 to 18.17 MMSCMD in 2040 at CAGR of about 5%. Consumers in the catchment area of West Bengal are mainly categorized in two major heads viz.

a) Major Industrial Customers

The major industrial units were broadly categorized as per the usage pattern, i.e. feedstock, process and heating. The sectors considered were the following:

Feedstock

- Fertilizer
- Refinery & Petrochemical

Process and Heating

- Aluminum
- Iron & Steel

b) Potential CGD Networks

Expected consumption for the total demand of CGD sector has been forecasted into following subsectors:

- Residential
- Industrial & Commercial
- Transportation

Gas Demand summary (in MMSCMD) for consumers by 2020-21 with distance ranging from 0-25km from the project site at project site is shown in below table:

Table 3: Gas Demand Summary in India

Distance from BCPL project site (in kms)	Location Details	Total Demand for Natural Gas in 2020-21 (MMSCMD)
10.0	East Medinipur	0.44
		3.75
15.0		0.10
20.0	24-Paraganas	0.06
	Hooghly	0.09
Demand from GCGSCL (CGD)		0.75
Total Estimated Demand in West Bengal by 2020-21		5.19

EXPORT MARKET:

- Overall gas demand in Bangladesh is expected to increase from 75 MMSCMD in 2015 to 136 MMSCMD in 2030 at CAGR of 4%
- Maximum demand is likely to be from the power sector followed by the industrial segment and then domestic & commercial segments. Gas consumption of power sector is expected to increase from 46 MMSCMD in 2015 to 82 MMSCMD in 2030
- Present gas reserves, if fully exploited can meet the gas demand at best up-to 2025 with a demand growth rate of 5% per year
- Gas shortage and mushrooming of liquid-fuel plants provides thrust for greater fuel diversification – scope for LNG based plants

- Most of the Bangladesh's pipeline network is concentrated in the more populated and developed eastern zone of the country. The present infrastructure coverage is inadequate to service key market areas of the country, as most of the supply points are in north-eastern and central regions, while the delivery points are located in south and west
- Expansion of pipeline infrastructure and import of RLNG will ease the pressure on gas deficit. Better connectivity to gas grid and availability of RLNG will ensure stranded power and fertilizer plants utilize their capacity

The sector wise estimated demand (in the West Bengal & Bangladesh) by 2040 (near the proposed pipeline) has been provided below:

Table 4: Sector wise demand in West Bengal and Bangladesh

Demand in 2040	Fertilizer	Power	Iron & Steel	Petrochemical & Refinery	CGD	Estimated Demand
In MSCMD	8.44	7.20	3.10	8.35	5.86	32.95
In MMTPA	2.34	2.00	0.86	2.32	1.63	9.15

2.8. EMPLOYMENT GENERATION (DIRECT AND INDIRECT)

During the construction period, approx. 500 skilled/semi skilled/unskilled workers will be engaged by various contractors on temporary basis. During the operation phase, approximately 50 skilled persons of Indian/Foreign will be stationed by the O&M Contractor on the FSU/FSRU/GBF. At the site, approx. 50-100 skilled/semi skilled persons of Indian/Foreign origin would be required to operate the onshore facility. Further, natural gas, being a cleaner fuel, will replace some of FO, Naphtha and Diesel requirements as a fuel source. Industries dependent on LNG will develop in eastern India generating addition employment in the future.

3. PROJECT DESCRIPTION

3.1. TYPE OF PROJECT

BCPL is planning to set up a Floating LNG Storage and regasification terminal at Kukrahati, West Bengal with a maximum capacity of 4 MMTPA. As part of this project, BCPL intends to construct a jetty/ near shore Gravity based floating (GBF) structure to receive LNG by small-scale LNG carriers, store it in an FSU/FSRU/Storage tank provided inside the GBF structure and to re-gasify the LNG in the vaporizers provided on land/on jetty/on GBF/on board the FSRU at the project site in Kukrahati. The R-LNG thus produced shall be supplied to Customers in the vicinity through suitable evacuation pipelines. BCPL expects this project to be commissioned by Q4, 2020.

The proposed project falls under the 6(a) category - Oil & Gas Transportation Pipe Line (Crude And Refinery/ Petrochemical Products), Passing Through National Parks/Sanctuaries/Coral Reefs/Ecologically Sensitive Areas Including LNG Terminal.

3.2. SITE LOCATION

The selection of the proposed site location is of great importance to BCPL, as BCPL is committed to identify solutions that minimize potential impacts on the environment and population. The proposed layout for development of LNG storage and regasification terminal at Kukrahati, considering both the jetty/GBF structure and onshore facilities at the site, is shown below in figure 4. BCPL intends to commission this project with an initial regasification capacity of 0.3-2.5 MMTPA, which will be expanded up to 4 MMTPA in future.

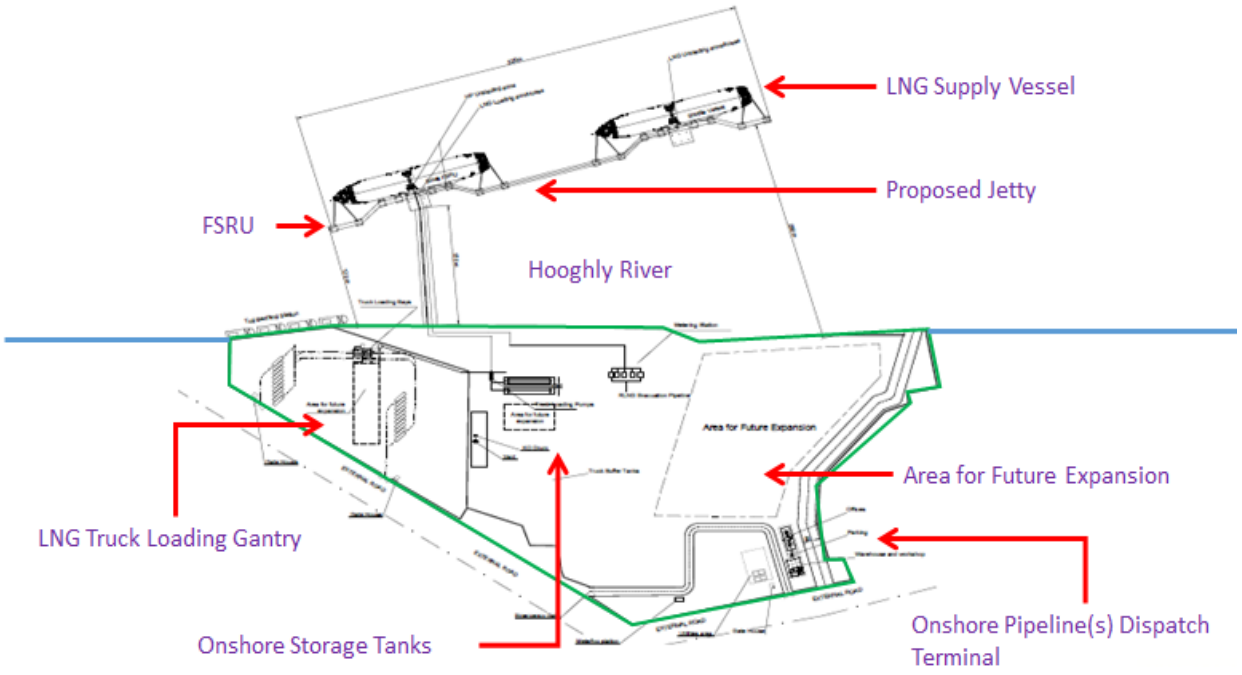

Fig. 4: Option 1 – FSRU and LNG Carrier moored at the proposed Jetty at Kukrahati

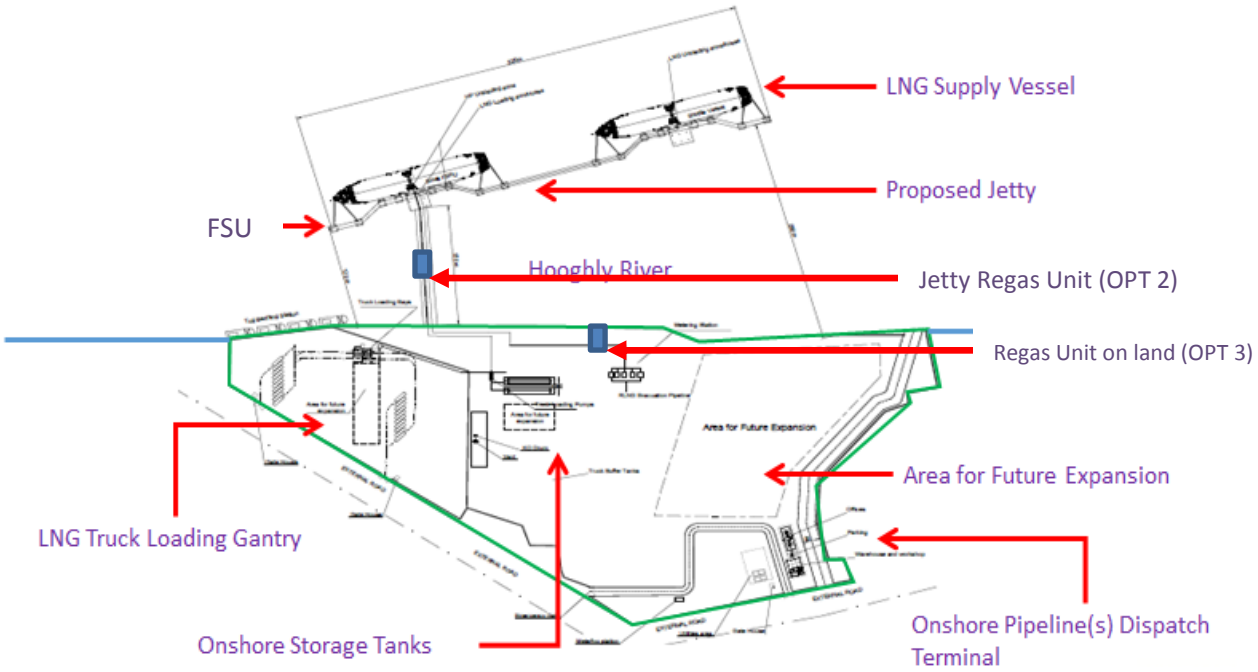

Fig. 5: Option 2 & 3 – FSU and LNG Carrier moored at the proposed Jetty at Kukrahati, with Regas Unit on Jetty/Land

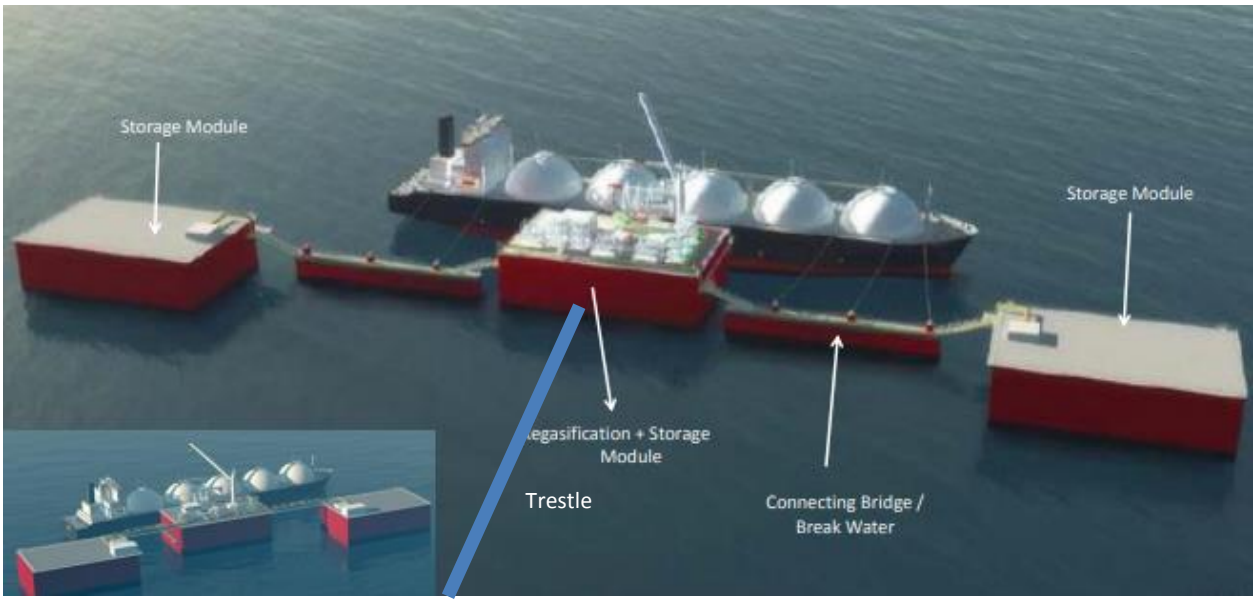

Fig. 6: Option 4 - LNG Carrier moored at the proposed GBF Structure at Kukrahati

3.3. DETAILS OF ALTERNATE SITES

BCPL had also identified few other sites for construction of jetty to berth FSRU/FSU within a radius of 25km from Haldia in order to cater to the demand in the area. Approximate location details of a few of the land sites are as follows:

Site 1: Latitude: 22° 4'21.99"N, Longitude: 88°14'8.13"E

Site 2: Latitude: 22° 1'11.70"N, Longitude: 88°12'50.69"E

Site 3: Latitude: 22°10'23.92"N, Longitude: 88°11'57.67"E

Site 4: Latitude: 22°12'15.87"N, Longitude: 88° 8'22.31"E

Site 5: Latitude: 22°11'21.20"N, Longitude: 88° 6'34.64"E

The above sites had been identified for the proposed project. However, the proposed site at Kukrahati (Site 5) located at Latitude: 22°11'21.20"N, Longitude: 88° 6'34.64"E has been found to be the most suitable for the project. The site will be used for constructing a jetty/GBF structure to berth FSU/FSRU with LNG Carrier for the project.

3.4. SIZE OF OPERATION

BCPL intends to develop a small scale project at the proposed site at Kukrahati. Based upon

future requirements, suitable additions or modifications may be done in terms of building additional infrastructure and miscellaneous facilities. The terminal is envisaged to handle 0.3 to 2.5 MMTPA of RLNG during the first 5-6 years of operation. During this operational period, an FSU/FSRU/LNG Carrier is planned to berth at the proposed jetty/GBF structure. LNG Carriers of 30,000 m^3 size will bring the LNG for regasification at suitable intervals based on throughput. Multiple pipelines are envisaged to emanate from the site to deliver Re-gasified LNG (R-LNG) to the end users. Also, a truck loading facility shall be constructed to deliver LNG to nearby customers. It is also envisaged that the demand may ramp up to 2.5 – 4 MMTPA after the initial 5 years of operation.

3.5. PROCESS DETAILS

BCPL is evaluating 4 options of which the final option shall be selected based on viability and timely availability of LNG Vessels for purchase/charter to ensure project commissioning by Q4, 2020 (Refer Fig. 4-6). The options are as below:

- Option 1 – FSRU and LNG Carrier moored at the proposed Jetty at Kukrahati
- Option 2 – FSU and LNG Carrier moored at the proposed Jetty at Kukrahati, with Regas Unit on Jetty
- Option 3 – FSU and LNG Carrier moored at the proposed Jetty at Kukrahati, with Regas Unit on Land
- Option 4 - LNG Carrier moored at the proposed GBF Structure at Kukrahati

Project facilities to be developed at the regasification terminal will primarily include the following components:

- **Jetty/GBF Structure:** BCPL plans to construct a jetty/GBF Structure near the shore to accommodate an FSU/FSRU/Incoming LNG Carrier (Max. draft of 7m). This FSRU/FSU shall receive LNG from LNG Carriers of suitable size. The jetty/GBF shall have facilities for handling LNG such as LNG Storage tank, marine unloading arms, cryogenic pipelines etc. The jetty/GBF structure shall also have means for mooring the FSU/FSRU /incoming LNG Carrier. Additional equipment and safety features shall be installed based on risk assessment studies. The jetty would normally be located at a depth suitable to moor the FSRU/FSU/LNG Carrier to the jetty. The prevailing depths near the project site in the river channel is >10m and there may not be any dredging

required. However, if the jetty is to be located at shallower depths < 7m, based on recommendation from the Kolkata Port Trust (KoPT) dredging would be required and dredge material would be safely disposed as per existing practices of KoPT

A Trestle shall connect the jetty/GBF to the project site. Both LNG and R-LNG Unloading Arms and pipelines shall be mounted on the trestle. The Vaporizers for LNG regasification shall be open loop with water and Glycol as Intermediate Fluids and shall be installed either on the jetty or on the project site.

- **Marine Unloading arms:** Marine unloading arms will be designed based on the LNG transfer rate of LNG carriers. Three Liquid with one vapour return manifolds would be arranged on both starboard and port side of the FSRU/FSU/LNG Carriers. However, the configuration and design of marine unloading arms shall be determined based on detailed engineering.

- **Onshore Facilities:** The terminal will have various onshore facilities for smooth operation of the project. A probable list of main equipment at the facility includes:

    - Control room;
    - Pressure Reduction Facilities,
    - cold vent system/flare;
    - filters;
    - compression skid;
    - Pig launcher/ receiver;
    - power generation system;
    - ESD valves station;
    - metering skid;
    - valves station;
    - firefighting system;
    - truck loading bay;
    - Storage tanks;
    - Underground and above ground piping system
    - Diesel/Gas Gen-sets,
    - UPS,
    - Security room,

- SCADA
- Driver's Room
- Pumps,

Headers for evacuation pipeline(s), emergency response systems, fire protection systems, provision of utilities etc. shall also be included in the facilities at the project site.

LNG will be imported via LNG Carriers and will be stored, re-gasified through vaporizers provided onboard the FSRU or on jetty/GBF/land and the R-LNG will be sent to customers through evacuation pipelines. Below block diagram represents a standard process flow of a regasification plant.

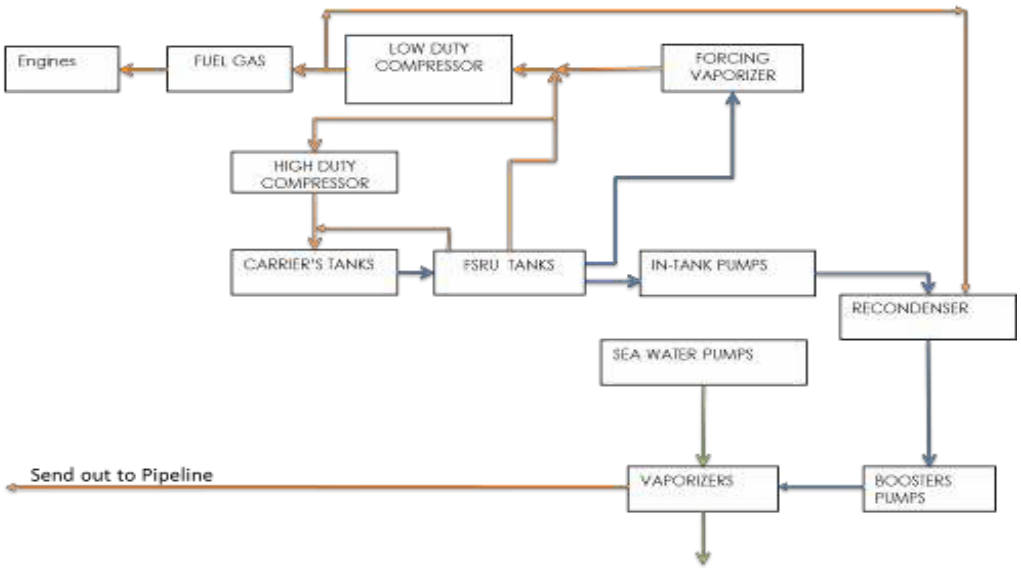

Fig 7: Typical Block Layout – FSRU Option

3.5.1. LNG OFFLOADING

LNG offloading shall be carried out by hard/soft unloading arms. Once the LNG Carrier is berthed alongside the FSU/FSRU/GBF structure, the LNG unloading arms are moved and connected to the manifold flange. The pressure of the LNG Carrier and that of the FSU/FSRU/GBF's storage tanks shall be balanced via the vapour return line with a slight differential pressure in order to enhance vapour return.

Cool-down of unloading arms shall then be started from the LNG Carrier and from the FSU/FSRU/GBF structure. Cool-down shall be carried out by pumping a small flow of LNG into

the arms using the LNG carrier spray pumps. The Cargo pumps shall be started and the LNG transfer rate gradually increased until the design-loading rate is reached. LNG shall be loaded through the manifolds and transferred simultaneously into all the FSU/FSRU/GBF structure.

During the loading operation, sufficient natural gas shall be returned to the LNG Carrier via the vapour return line and vapour arm in order to maintain the LNG Carrier storage tank pressure.

In case the differential pressure is not sufficient to ensure the natural gas flow, High Duty (HD) compressors shall be employed. When the loading operation is complete, prior to disconnection, the arms shall be emptied and purged using nitrogen. The onboard nitrogen generators shall be mainly used for this scope. When loading is not in progress, the loading lines shall be kept in cryogenic conditions by circulating a small amount of LNG in the lines. This shall be achieved by pumping LNG to the loading lines using the Spray Pumps and returning it to the LNG storage tanks.

3.5.2. LNG STORAGE

LNG will be stored in cargo tanks of FSU/FSRU/GBF structure provided at the project site. Each cargo storage tank shall be equipped with block valves on the filling lines, which allow isolating the tank in case of emergency. Moreover, in case of failure of the tank pressure control system, each tank shall be protected against over pressure by independent safety valves discharging directly to the atmosphere via a dedicated vent mast. Tanks will be provided with one radar type level instrument to monitor the level and give high and low level alarms. In addition, an independent high-level switch will be fitted to initiate the shutdown of the LNG Carrier loading operation to protect the tank from overfilling in case all other preventive actions fail. Each tank will be also supplied with a Level Temperature Density (LTD) measurement instrument, which allows measuring of liquid level, tank temperature profile and tank density profile. This instrument will be used to monitor tank stratification and as a backup for the radar level instrument. Cargo tanks will be equipped with submerged electric LNG In-tank pumps used to lift LNG from storage tanks to the regasification plant. The cooling of the electric motor and bearings and bearings lubrication is ensured by pumped LNG. The start/stop of each LNG in-tank pump will be controlled by the operator who shall ensure that enough pumps are in operation to fulfill the gas send out flow rate.

Each pump discharge will be equipped with:

- A minimum flow recirculation, which ensures that the pumps never operate below their minimum flow. The minimum flow recirculation will also be used for pump start-up.
- A vent to tank. During pump start-up sequence the vent will be opened to allow venting the gas contained in the pump well. The vent opening will be controlled by a timer. After an adjustable time, the vent will close.

Tanks will be equipped with spray pumps. Each pump discharge will be equipped with a control valve, which enables to control the pump electrical current. Moreover, a return line to tank with an additional control valve will be provided in order to control the spray nozzles inlet pressure.

3.5.3. LNG REGASIFICATION

Regasification system shall be river water and glycol based IFVs (Intermediate Fluid Vaporizers). After heat exchange the water will be discharged back to the river at temperature lower than the ambient. Cooling water from the power generation system will be discharged after meeting discharge norms. Ballast water will be discharged at the same temperature. Bilge water will be treated onboard the FSRU/FSU before discharge. The sewage generated will be treated before discharge.

The LNG regasification system will be provided with either shell and tube vaporizer or by water based Intermediate Fluid Vaporizers (IFVs) provided on the land/jetty/FSRU/GBFS. High-pressure LNG booster pumps will be provided in the regasification area for feeding LNG to the IFVs to the expected send out pressure. The LNG Booster Pumps will suck LNG from the Re-condenser.

Each booster pump will be designed in order to guarantee the maximum send-out flow rate and the best flexibility and maintainability without production interruption of limitation.

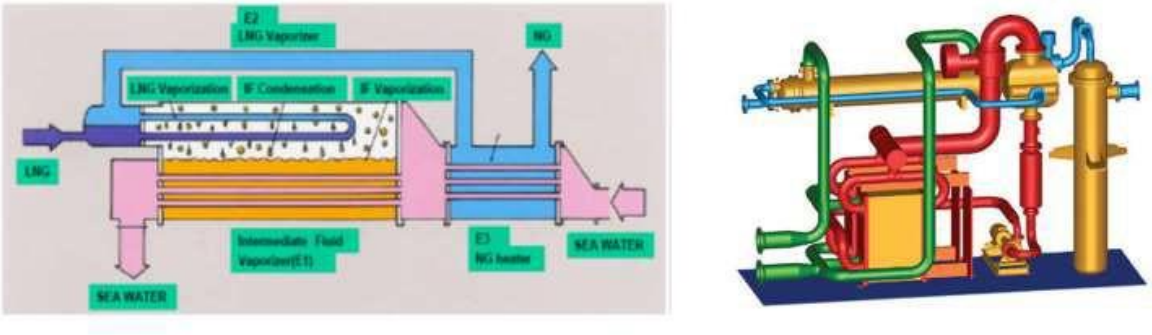

Fig 8: Example of IFV

Each pump will be equipped with a dedicated recirculating flow line to the Re-condenser to prevent pump operation below minimum flow. Intermediate Fluid Vaporizers will be used to vaporize the send-out LNG. Two examples of IFVs are presented above in figure 6

IFVs will be counter-current heat exchanger and will use water as a heat source and propane or water glycol as an intermediate heating medium between water and LNG. The intermediate fluid in the IFVs will be circulated in closed loop with no requirement for makeup or pumping during normal operation. In case of over pressure in the propane/water glycol vaporizer, a safety relief valve will be provided which discharges in a dedicated propane vent header. The LNG flow rate to the IFVs will be under flow control. The valve will be actuated by the ESD. Propane will be stored in steel pressure cylinders, while glycol in steel tanks.

3.5.4. BOG HANDLING AND FUEL GAS SYSTEM

The boil off gas produced both by natural cargo heating and by operations will be handled by the BOG handling system, which is made up of the following main equipment:

- LD Compressors;
- HD Compressors;
- Scrubber and Heater.

The BOG handling system will manage the BOG production in two ways:

- Providing fuel gas to the fuel gas header;
- Sending the BOG to the Re-condenser for re-condensation.

The main source of fuel gas is the boil off that is compressed by LD Compressor up to the

required pressure.

3.5.5. WATER SYSTEM

A water system will be provided to supply the required water to the LNG Vaporizers for vaporization. Water system is made up of:

- water intakes;
- water pumps;
- water filters installed upstream water pumps provided for protecting pumps;
- water filters provided for protecting LNG Vaporizers

The water will pass through water filters and will be pumped by the water pumps to the LNG Vaporizers. Water filters will be provided on discharge header to protect LNG Vaporizers. Water will then be routed overboard through gooseneck and, then, to the water discharge line.

Almost 5000 m^3/ hr of water shall be required for 1 MMTPA LNG to vaporize. For the ultimate capacity of annual throughput of 4 MMTPA, total –20,000 m^3 / hr of water would be required for regasification.

3.5.6. VENTING SYSTEM

The FSRU/FSU shall be constructed with no venting philosophy. However, the FSRU/FSU will have the venting system which in case of emergency will aim to discharge any flammable vapour release to atmosphere at safe location, thus minimizing any potential risk to involved personnel.

For the onshore facility, it is proposed to install cold flare venting system. This venting system shall be used for normal operations and maintenance of the onshore facility, including but not limited to pipelines, vaporizers, metering system etc. All the venting outlets in the onshore facility will be connected to the common venting point.

3.5.7. NITROGEN SYSTEM

A nitrogen system will be available for the following types of services:

- Purging of unloading arms: vapour and liquid unloading arms shall be purged after any loading;
- Intermittent services (tank barriers, sealing system between compressors and relevant

motors, other seals, vent system purging);

- Continuous (essential) services (tank barriers, purging of the vent mast (first purge) and of unloading arms, continuous services).

The system will be made up of:

- Two redundant nitrogen generation packages;
- A buffer tank;

3.5.8 A nitrogen distribution system**Evacuation Pipeline system**

- Horizontal Direction Drilling method will be used for laying underground pipeline across the river Hooghly
- Horizontal directional drilling (HDD) is a steerable trenchless method of installing underground pipelines in a shallow arc along a prescribed bore path by using a surface-launched drilling rig, with minimal impact on the surrounding area. HDD is used when trenching or excavating or digging is not practical. In this methodology the drilling rig is placed on one bank of the river (Kukrahati side) and the pipe to be installed across river crossing would be stringed at the other end of the bank near Mukandapur, left side of Raichalk. On making requisite hole beneath the scour depth of the river the pipe would be pulled in the designated profile.
- Installation of a pipeline by HDD is generally accomplished in three stages: (1) Pilot hole drilling, (2) Boring/reaming operation of the pilot hole, (3) Pulling the pipeline in the reamed hole
- River crossing by R-LNG pipeline shall be at least 5.0 m below the riverbed and shall be done using Horizontal Directional Drilling Method. This process will not impact any road/rail/river traffic during construction or operation.
- The main advantages in carrying out pipeline installation by horizontal directional drilling methodology are (1) it will involve installation of Three Layer Polyethylene (3LPE) coated pipes. No measures are required to be taken for ensuring anti-buoyancy of the pipes such as concrete coating. (2) It is comparatively more environment friendly. Requirement for cutting of mangroves or any other environment friendly tress across the river will not be required. (3) It will pass well below the river bed (scour depth) such that no impact on river water and its flora fauna

3.6. RAW MATERIAL REQUIRED

Considering the nature of the envisaged project, the primary raw material required will be LNG, which will be sourced by BCPL from a suitable source. Other miscellaneous raw material will be sourced locally or from outside sources as per the requirement, depending upon its availability. Construction materials will be transported to site through existing road network / water ways along Hooghly river. During operational phase, LNG will be transported using LNG vessel through Hooghly River to the LNG Storage Tanks situated in the FSU/FSRU/GBF.

3.7. RESOURCE OPTIMIZATION

BCPL has charted out a comprehensive roadmap, which shall be meticulously followed in order to obtain the desired project progress. To this regard, BCPL has plans to expand its available resources (Human, Machinery and Financial) to achieve Resource Optimization.

3.8. AVAILABILITY OF WATER, ITS SOURCE, ENERGY REQUIREMENT

River water is abundantly available in the vicinity of the proposed project location. BCPL intends to utilize these sources responsibly for carrying out operations. Approx. 100 KLD river water will be required for civil construction work. For Horizontal directional Drilling, bentonite mixed with water shall be used as the Floating medium and shall be sourced separately via road tankers. For Hydro testing of the pipeline and equipment, approx. 10000 m3 water shall be required.

10,000 m3 / hr of river water would be required for regasification in the initial stage of the project. When demand ramps up, Maximum of 20,000 m3/hr of river water would be required for regasification (@5000 m3/hr/1 MMTPA LNG). After meeting the discharge standards, these waters will be discharged back into the river. Further, 150 m3/hr of groundwater shall be used for fire water storage system, 2000 m3/hr river water will be required for auxiliary cooling system and a maximum of 1500 m3/hr river water shall be required as ballast water. 2-3 KLD groundwater will be required for domestic requirement of operational workers.

Power requirement during construction phase will be approximately 3 MW and shall be sourced from the local electricity grid. In case of non availability of power from the local grid/disruption of power, temporary DG sets with cumulative capacity of 3 MW shall be used. The FSRU/FSU shall be self sufficient and will have on board Power Generation of upto 40 MW, which shall be used to meet all power requirement onboard the FSU/FSRU including those required for the LNG

Handling facility onboard the vessel.

The power requirement for the facilities on the jetty and the project site shall be met by the power supplied from the West Bengal State Electricity Board (WBSEB) or from the power generated onboard the FSRU/FSU or through gas/diesel gensets at project site. The boil off gas from the FSU/FSRU/GBF shall be utilized for generation of power in case gas gensets are used.

3.9. WASTE PRODUCTION & DISPOSAL

Onshore Terminal:

The construction phase of the project is the one when most waste is likely to be generated. EGAS/GASCO Standards shall be followed for waste management. During the construction phase of the project, approximately 20-25 kg/day and during operational phase 25-30 kg/day of solid waste will be generated. The MSW will be disposed in the nearby municipal dumping ground. Some used oil will also be generated from equipment and machineries and DG set. These will be disposed as per Hazardous and Other Wastes (Management and Transboundary Movement) Rules 2016.

Impacts on local population, land, surface and subsurface waters, air quality, and animal and plant species, including habitat, shall be considered.

Production and water handling facilities shall be planned to utilize the smallest practical surface area consistent with safe, prudent, and economic operations. Special care shall be taken to minimize the possibility of environmental damage due to equipment upsets, spills, and leaks.

Equipment and facilities shall be located and designed to minimize the wastes generated by operations and maintenance activities. Recyclable products shall be used, where possible.

Appropriate methods of collecting and recycling or disposing of waste generated during construction, operation, and maintenance of the facility shall be considered as per the approved standards in place.

A sound waste management plan is important to protect human health and the environment and minimize long-term liabilities to the operator. Accordingly, a waste or residual

management plan shall utilize one or all of the options listed below, in order of preference, to protect human health and the environment.

a) Source Reduction—Minimize or eliminate the volume and/or toxicity of the waste generated.

b) Recycling—Reclaim or reuse the maximum amount of waste possible.

c) Treatment—Utilize techniques to minimize the amount and the toxicity of waste after it is generated, thereby minimizing the amount that has to be disposed.

d) Disposal—Employ environmentally sound and approved methods to properly dispose of generated wastes.

The Waste Management Plan shall specify the types of wastes that will be generated as part of the construction process as follows:

• Aqueous waste (comprising hydro test water, drainage water, untreated sewage water);

• Non-hazardous waste; solid and liquid (domestic refuse, industrial refuse, sewage sludge);

• Gaseous wastes (vents, exhausts, fire-fighting agents, refrigerants).

Considerations that shall be evaluated when choosing either an on-site or an off-site commercial disposal method are as follows:

a) general site review of the topographical and geologic features,

b) groundwater review to determine the presence of groundwater and aquifers,

c) area weather patterns to estimate rainfall and flooding potential,

d) general soil conditions,

e) natural drainage areas,

f) identification of environmentally sensitive conditions,

g) air quality.

It is pertinent to note that notwithstanding the above, only minor quantities of wastes (mainly

due to maintenance operation) are foreseen. These quantities are negligible if compared to the ones produced by the FSRU.

FSRU/FSU/GBFS

The operation will involve waste production, mainly due to:

- Maintenance operation;
- Presence of personnel (medicines, kitchen wastes, etc.);
- Sewage;
- Electronic equipment and batteries maintenance;
- Packaging.

Table 5 below includes a list of waste typologies related to the FSRU/FSU/GBFS operation.

Table 5: Waste Typologies

Waste	**Waste Physical State**
Plastic, papers, glass, wood	Solid
Oil sludge (from maintenance operation)	Liquid
Paints, varnishes and thinners	Liquid
Rags and filter materials	Solid
Metals	Solid
Medicines	Solid
Exhausted vegetable oil and fats, other kitchen wastes	Liquid/Solid
Sewage	Liquid
Oil filters	Solid
Waste non contaminated by hydrocarbons	Solid
Electronic equipment and batteries	Solid
Packages containing hazardous wastes (i.e.: drums for oil and diesel fuel)	Solid
Not hazardous inorganic wastes	Solid
Solvents	Liquid

All the waste shall be temporarily stored on the vessel, where proper dedicated areas shall be

identified. Waste will be further sent to an onshore reception facility for final disposal. Quantities of waste shall be defined during the project development. Related waste will be handled by a MARPOL compliant Shipboard incinerator capable of handling burning of allowed waste (Sludge Oil and Solid) generated onboard. Disallowed items as per MARPOL will be collected in separate bins and landed ashore to shore reception facility.

3.10. SCHEMATIC REPRESENTATION OF THE FACILITY

Refer Fig.4-6

3.11. NOISE EMISSIONS

Noise emissions are related to:

- FSRU/FSU/GBFS equipment;
- Facilities on Jetty, if any
- On land facilities

For FSRU/FSU/GBFS, main emission sources include the following:

- Water process pumps;
- Water cooling pumps;
- Hypochlorite dosing system;
- Generation system;
- Sanitary discharge pumps;
- Booster pumps;
- Cooling water unit and Compressors
- Diesel Gensets
- Gas Gensets/ Engines
- Fire water Pumps (motor based/ Engine based)

For onshore facilities, in normal operating conditions noise emissions mainly refer to power generation system and gas compression skid. Sound pressure levels (at 1 m from the source) can be preliminarily assumed between 75 and 95 dB(A) each. This will be confirmed at later stage of the project. If necessary, noise reduction measures will be provided.

Noise will be generated during construction from the operation of equipment and machinery. The machinery used will adhere to national standards and emissions are shall be within

stipulated limits. For FSU/FSRU, main emission sources include River water process pumps; River water cooling pumps; Hypochlorite dosing system; Power Generation system; Sanitary discharge pumps; Booster pumps; Cooling water unit and Compressors; Diesel Gensets; Gas Gensets, engines; Fire water Pumps, HDD Machine. Noise level will be maintained to 75 dB.

During operational phase, noise will be generated from pump house and other onshore facilities.

Piling activities are envisaged during construction of jetty, trestle and facilities on site. Approximately 75 to 95 dB(A) of noise is expected during piling.

ORF sound pressure levels will be monitored and respect of national regulations in force ("The Noise Pollution (Regulation and Control) Rules", 2000) will be guaranteed.

3.12. EMISSION DATA

Project development might involve potential effects on the environment, due to:

- Emissions of pollutants to atmosphere;
- Water discharges;
- Waste production; and
- Noise emissions.

Land facilities shall meet the state pollution control board norms. The LNG Regasification terminal and the FSRU/FSU shall meet the relevant MARPOL and applicable flag requirements. In detail, the FSRU/FSU will respect environmental limits indicated in the "International Convention for the Prevention of Pollution from Ships" (MARPOL). MARPOL is one of the most important international marine environmental conventions. It was designed to minimize pollution of the seas, including dumping, oil and exhaust pollution. Its stated object is to preserve the marine environment through the complete elimination of pollution by oil and other harmful substances and the minimization of accidental discharge of such substances.

The original MARPOL Convention was signed on 17 February 1973, but did not come into force. The current Convention is a combination of 1973 Convention and the 1978 Protocol. It came into force on 2 October 1983. As of 31 December 2005, 136 countries (including India),

representing 98% of the world's shipping tonnage, are parties to the Convention. Following is an overview on main emission data associated with the project:

3.12.1. EMISSIONS TO ATMOSPHERE

The FSRU operation will involve the following emissions to atmosphere:

- "Conveyed" emissions due to gas combustion for FSRU power generation;
- "Conveyed" emissions from unit incinerator;
- "Fugitive" emissions of Total Organic Compounds (TOC) from FSRU:
- Joints and valves (due to LNG receiving system),
- Joints, pumps and compressors (due to LNG regasification and send-out),
- Joints and oil storage tanks (due to energy production).

During normal operating conditions, the FSRU will be fed by boil-off gas. Exhausts of the combustion will be represented by NOx and CO emissions. In case dual fuel engines are used, potential additional emissions of Sulphur oxides and particulate might occur. Emissions will be conveyed through a stack positioned in the aft part of the FSRU. The FSRU unit shall respect emission limits presented on the Annex VI of the "International Convention for the Prevention of Pollution from Ships" (Maritime Pollution – MARPOL). With reference to nitrogen oxides, MARPOL only presents the following maximum NOx emission rates at the stack for diesel engines:

- 14.4 g/kWh when rated engine speed n is less than 130 rpm;
- 44.0 * n (-0.23) g/kWh when rated engine speed n is 130 or more but less than 2,000 rpm;
- 7.7 g/kWh when rated engine speed n is more than 2,000 rpm.

With reference to Sulphur oxides and particulate matter emissions, MARPOL states that these emissions on ships will in general be controlled by setting a limit on the Sulphur content of marine fuel oils as follows. The Sulphur content of any fuel oil used on board shall not exceed the following limits:

- 4.50% m/m prior to 1 January 2012;
- 3.50% m/m on and after 1 January 2012;
- 0.50% m/m on and after 1 January 2020.

Incinerators installed on board a unit after 1st January 2000 shall meet the requirements contained in Appendix IV of Annex VI of the MARPOL, presented below:

- Percentage of CO_2 in combustion chamber: 6-12%;
- CO in flue gas maximum average: 200 mg/MJ;
- Soot number maximum average: Bacharach 3 or Ringelman 1 (20% opacity);
- Unburned components in ash residues: maximum 10% by weight;
- Combustion chamber flue gas outlet temperature range: 850-1,200 °C.

Additional more limits that are restrictive might be requested by national and local Authorities during the permitting phase. With reference to fugitive emissions, on the basis of available information from similar FSRUs, it is possible to estimate a yearly overall TOC emission equal to 1 ton per year. Maximum NOx concentration for a new gas turbine having a capacity less than 100 MW is equal to 100 ppm (as per Environmental Protection Rules).

With reference to the onshore receiving facility, the only emissions are related to:

- exhausts from vaporizers (NOx and CO), if necessary;
- exhaust from power generation system;
- gas emission from the cold vent. These emissions are non-continuous and will only occur in case of need;
- emissions of volatile compounds from joints and valves (these emissions are almost negligible).

During construction period, heavy machineries like crane, digging equipment, piling equipment is likely to give rise to emission from combustion of fossil fuel. During commissioning and Maintenance activities, some amount of venting of R-LNG would be required to ensure readiness of plant and equipment.

During normal operation, some emission is expected from operation of heavy/light vehicles. Vehicles would be used for transportation of materials and shall have valid PUC certificate. The FSRU/FSU operation will involve the following emissions like from Gas combustion forduring generation of power in the FSRU/FSU/Gas/Diesel Gensets on the site.

During commissioning and Maintenance activities, some amount of venting of R-LNG would be

required to ensure readiness of plant and equipment. Fugitive emissions comprising of grease, lubricating oil, diesel, methane, other combustibles, dust etc. from Joints, mechanical seals, bearings, flanges, valves, instrumentation tubings, pumps, exchangers, gensets, compressors, filters, pig receiver/launchers etc.during handling, storage and transportation of LNG/R-LNG Some emission is expected from operation of heavy/light vehicles. Vehicles would be used for transportation of storage materials/LNG and shall have valid PUC certificate.

3.12.2. DISCHARGE TO WATER

Water discharges are mainly related to the FSRU/Jetty Regasification Unit (JRU)/Land based Regasification Unit (LRU) operation if the regasification is provided on board the FSRU/on jetty or on land. Potential discharges might be involved by the following:

- Regasification; if the regasification system is water based Intermediate Fluid Vaporizer (IFVs) with propane or water glycol solution as intermediate fluid. In IFVs the LNG and water flow in separated beams, both in contact with the same intermediate fluid. In this type of vaporizer, a double heating process is performed. Water is primarily used to heat the intermediate fluid. The intermediate fluid then transfers its heat to the LNG (which vaporizes). After having transferred heat to the intermediate fluid, water is discharged back to the sea at a temperature lower than the ambient one; the maximum difference of temperature between the inlet and the outlet will be equal to 5°C.
- Power generation system cooling;
- Ballast; water will be withdrawn and discharged at the same temperature. FSRU will be provided with 2 to 3 ballast pumps having a total capacity of approximately 2,000 m3/h
- Sewage: The FSRU/FSU will have a sewage treatment system in order to guarantee environmental maximum concentration of pollutants and parameters included in the “International Convention for the Prevention of Pollution From Ships” (Maritime Pollution – MARPOL);
- Bilge;
- Auxiliary cooling system;

FSRU/FSU will be provided with a sewage treatment plant meeting the MARPOL

requirements. The sewage will collect:

- Grey water;
- Black water.

Black water will be treated; sludge content will be held on-board for transfer to shore reception facilities. Concentration of pollutants and chemicals at the discharge shall not exceed limits indicated by the "International Convention for the Prevention of Pollution from Ships" (Maritime Pollution – MARPOL).

With reference to the onshore receiving facility, it has to be highlighted that, during normal operation:

- the only discharge refers to cooling water for the power generation system and grey water for the presence of an office; water shall be collected and discharged according to limits from regulations in force;

- the ORF will be provided with a drainage facility for rain water and a septic tank storage for handling generated sewage.

During construction domestic wastewater will be treated through septic tank and soak pit. During operational phase, water used for regasification, ballast water, cooling water for power generation system will be discharged in the river after meeting the discharge standard. The bilge water, sewage will be treated and then will be discharged into river or in to the municipal sewage system. Discharge of treated water may not cause significant impact on receiving surface water body.

The emission from power generation system, flaring and fugitive emissions from storage and handling of LNG to air during operational phase are not expected to be significant. The risk of contamination of land or water from such emissions is therefore low to none.

4. SITE ANALYSIS

4.1. CONNECTIVITY

Kukrahati is a small town in Medinipur district of West Bengal. It is located around 150km from Kolkata, and stands on the bank of the Hooghly River, opposite Raichak in South 24 Parganas. It is the gateway to the port and Industrial city of Haldia.

There is a ferry service across the Hooghly between Raichak and Kukrahati and there is good road connectivity between Kukrahati and Haldia.

4.2. LAND FORM AND LAND OWNERSHIP

The proposed site at Kukrahati is at the bank of river Hooghly. It is an unleveled ground and has a mild downward slope towards the river. The proposed land for the project site can be divided into two parts. One part is a vacant land which was earlier allotted for the manufacture of shipyard project. However, no construction activity was initiated. The same land is planned to be taken by BCPL on long term lease. The construction of FSRU/FSU based LNG Terminal will have the same land use, ie. industrial activity.

The second part of the land is currently being used as a brick-kiln. The construction of FSRU/FSU based LNG Terminal shall increase the intensity of land use of this land.

There is a small canal in between the two parts of land proposed for the site. The same shall be retained in an as-is condition and no changes are proposed.

However since the project site is on either side of this small canal, required above ground piperack shall be built to transport LNG/R-LNG/other utilities between the two project sites. Further, required overground cable tray shall be laid to connect both the plots for electrical / instrumentation cables.

4.3. TOPOGRAPHY

Detailed Topography map is not available with BCPL. This will be provided at a later stage. Survey of India's topography sheet is attached along with Form 1.

4.4. EXISITING LAND USE PATTERN

The proposed project site can be divided into two parts. One part is not being used for any activity (neither agriculture nor non agriculture) currently. The other part is currently being used as a brick kiln. The project site also does not have any mangroves or endangered plants. The location of the site is also upstream of the Southern Municipal limit of Diamond Harbour.

4.5. EXISTING INFRASTRUCTURE

The proposed site at Kukrahati is an empty land with no existing infrastructure in one part and a brick kiln in the other part.

4.6. SOIL CLASSIFICATION

Project site has very soft to medium silt clay / clayey silt with lenses or lamination of silt up to 33.0 m depth below the existing level and extended beyond the termination depth.

4.7. CLIMATIC DATA FROM SECONDARY SOURCES

4.7.1. DRAFT AT SITE

All the identified sites have draft restriction of ~7m in the channel. However, BCPL is planning to dredge near the site for safe navigation of LNG Carriers inside the channel and excavate the land at Kukrahati for a water depth of ~10m to bring LNG Carriers safely for berthing at the jetty/GBFS.

4.7.2. RAINFALL

Rainfall in Purba Medinipur district occurs primarily during the south-west monsoon months i.e. June to September and constitutes about 74% of the total annual rainfall. Some rainfall, mostly as thunder showers, is received in the latter half of the summer season and in

October. Based on the data available in District Statistical Hand Book of Purba Medinipur, the area receives reasonable rainfall during the wet months of June to September. The highest average rainfall of 365 mm has been recorded for the month of August, followed by September (322 mm) and July (298 mm). The total annual rainfall has been 1586mm. The month wise distribution of mean rainfall during 2010-2014 has been presented in below figure.

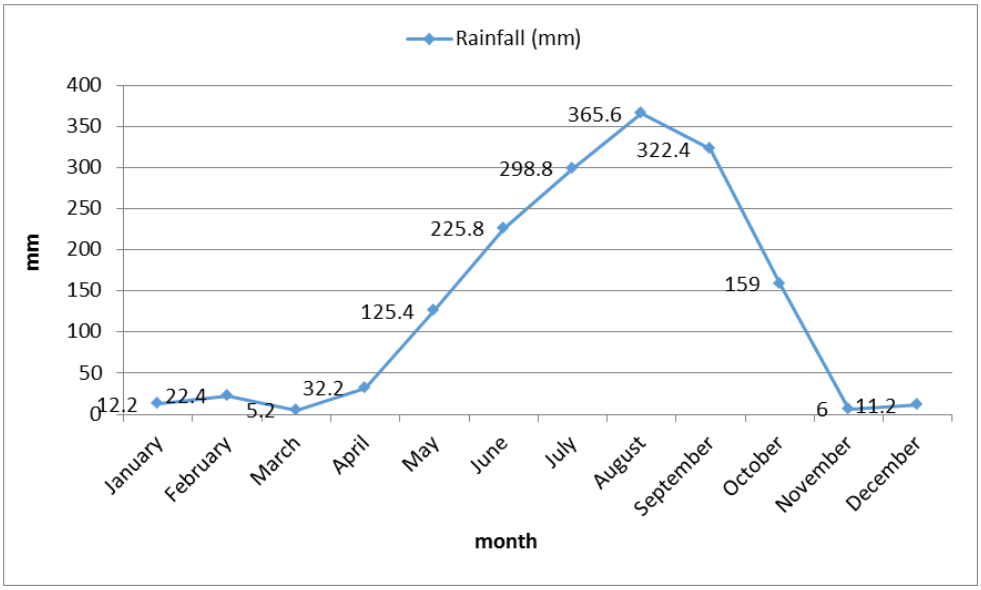

Fig 7: Monthly Rainfall Distribution (2010 – 2014)

4.7.3. WAVE

The rise in water level in Hooghly estuary is due to the tidal influence The Mean High Water level goes up to 4.64 -5.20 m at Kukrahati during spring tide.

4.7.4. CURRENT

The major seasonal current in the west Bengal region is EICC (East India Coastal Current), which is the strongest in the transition period from March to May flowing towards NE and weakest during SW monsoon period.

4.7.5. SEA SURFACE TEMPERATURE

Water temperature ranges between 18°C and 33°C, during the year generally without any appreciable difference between the different regions. The maximum difference between the surface and bottom temperatures has been found to be 1.5°C.

4.7.6. pH

The range of variation in pH of water in the estuary is generally between 7.9 and 8.4 during the year.

4.7.7. SALINITY

The most characteristic feature of salinity is the wide range of variation from season to season. It increases to about 30% in the pre-monsoon season and comes down to almost fresh water (1.6%) during monsoon months.

4.8. SOCIAL INFRASTRUCTURE

No social infrastructure is available near the project site.

5. PLANNING BRIEF

5.1. PLANNING CONCEPT

BCPL, through this proposed project, intends to supply LNG and R-LNG to various Customers in West Bengal and nearby states/Countries. These industries include, but are not limited to Fertilizers sector, Refining sector, Power Plants and CGDs. Site has already been identified as Kukrahati in West Bengal. The Project components have also been clearly identified, and their requirements in lieu of the timelines have also been fixed. The Project Schedule shall be prepared keeping in mind various factors like timelines for completion of project, project milestones etc. BCPL also has a system in place for slippage monitoring. Slippages shall be meticulously monitored and suitable corrective actions shall be performed by BCPL ensuring that the project timelines are being strictly adhered to.

5.2. POPULATION PROJECTION

A detailed demand assessment report shall be prepared by BCPL through a Consultant. This Report shall contain the Population Projection along with demand figures in the Geographical area. BCPL shall provide this report along with the figures at a later date.

5.3. LAND USE PLANNING

BCPL intends to use the selected land for setting up an LNG Storage and regasification terminal. The land based facilities shall form an integral part of the proposed LNG Storage and regasification terminal. The facilities on the land may include, but shall not be limited to storage tanks, pumps, truck loading facility, other miscellaneous like pipes, valves, metering devices, fire-fighting system etc. Areas for each facility shall be clearly demarcated as per the applicable standards. Green belt will be developed in the peripheral of the project site around the on land facilities and other areas.

5.4. ASSESSMENT OF INFRASTRUCTURE DEMAND

BCPL has identified the Infrastructure that shall be built as part of the proposed project. These have been explained in the Project Description section.

5.5. AMENITIES/FACILITIES

BCPL intends to build a greenfield LNG Storage and regasification terminal at Kukrahati. In addition to containing the all the standard facilities which may be required in a project of this magnitude (like tanks, pipes, valves etc.), BCPL intends to provide amenities like drinking water supply, sanitary spaces etc. for the personnel working onshore.

On the vessel, in order to face operative conditions, a number of people shall be housed on board the vessel as per the DG Shipping guidelines, inclusive of technical personnel dedicated to typical terminal operations (actual value will be defined in the later stage of the project).

Based on the actual number of people, accommodations may include the following:

• public spaces: officers' dining room, officers' lounge, crew mess, crew lounge, duty mess, hospital/dispensary, gymnasium;

• service spaces: galley, officer and crew pantries, pantry at cargo control room, officer, FSRU and crew laundries, storage lockers, linen (clean, dirty) lockers, incinerator room, waste handling room;

• sanitary spaces: public toilets, officer and crew changing rooms;

• operational spaces: combined wheelhouse with chart and radio room, engine control room, cargo control room with related meeting room, conference room, main administration office, one (1) office each for Captain, C/Engineer and Senior Officers, document store, central fire control station, fire equipment rooms;

• Provisions stores: Dry provision (18°C), meat (-25 °C), fish (-25°C), vegetable (2°C), lobby (4°C), bonded store.

6. PROPOSED INFRASTRUCTURE

6.1. INDUSTRIAL AREA

The proposed project site at Kukrahati is unlevelled ground. Before commencement of the project, BCPL shall level the land. Once land levelling is completed, BCPL shall start activities as per the project schedule. Once the requisite civil activities at the site are completed, BCPL shall bring in the other project components like Vaporizers, tanks, pumps etc. and install the same as per the planned layout. All season access roads, if needed, might be built by BCPL to facilitate movement of vehicles from the main road till the project site.

6.2. RESIDENTIAL AREA

The terminal will have minimal working staff and the occupancy shall be limited to few skilled / semi skilled (<50) and security personnel. All staff would work in shifts and apart from a control room and rest room, no residential areas are planned within the terminal. The Vessel shall have experienced crew onboard (as per DGS Manning requirements).

6.3. GREEN BELT

Green belt will be developed in the peripheral of the project site around the on land facilities and other areas. Development will be finalized based on CCoE approval/ and considering the safety aspects & PESO regulations.

6.4. SOCIAL INFRASTRUCTURE

As per of the Corporate Social Responsibility plan, BCPL is committed to provide Social Infrastructure in the area of operations. An interaction is required to understand the community infrastructure needs of the area. BCPL will understand these needs better, through further interactions. Based on the EIA Study which is being carried out for the project, BCPL as a responsible corporate citizen will support either directly or through the district administration – development of social infrastructure for the local communities. The impact of the support will be reviewed periodically, monitored, and assessed.

6.5. CONNECTIVITY

The identified project site at Kukrahati, lies in the Purba Mednipur district of West Bengal and is well connected to the nearest Industrial hubs of Haldia and Falta, through roads and ferry services, respectively.

The site is well-connected through rail/road network for transporting materials to the site. As the site is adjacent to Hooghly estuary, river route will be utilized for transport of construction materials as well as LNG vessels.

6.6. DRINKING WATER MANAGEMENT

BCPL will enable provision for drinking water management system at the site. After completion of detailed engineering studies, BCPL shall finalize the number of tanks and other specifications required for the construction of drinking water management system.

6.7. FIRE WATER STORAGE SYSTEM MANAGEMENT

Fire Protection facilities for the ORF will be designed primarily in accordance with OISD-226, supplemented by OISD-117. Main components of fire water system include fire water storage, fire water pumps and firewater spray system (deluge).

Water for firefighting will be stored in two aboveground steel tanks/Underground Steel RCC Tanks of each having 50% of required capacity above the level of suction point. The effective firewater storage will be designed to cater 4 hours aggregate rated capacity of the firewater pump. Two x 100% diesel driven firewater pumps (1 duty + 1 stand-by) will be provided to meet the required fire water flow rate and head. Pumps will be quick starting type and start automatically on pressure drop in the firewater network. Also provision of local push button and remote actuation of firewater pumps from control room will be provided. Firewater

pumps (including jockey pump) will be designed in accordance with NFPA-20.

6.8. SEWERAGE SYSTEM

BCPL will enable provision for sewage system at the site. After completion of detailed engineering studies, BCPL shall finalize the number of sump pits and other specifications required for the construction of sewerage system. Either a septic tank-soak pit system or, a potable sewage treatment will be installed for treatment of sewage generated at the project site in Kukrahati

The FSRU/FSU will have a sewage treatment system to treat and discharge waste and meet the MARPOL standards. Similarly, treatment facilities for bilge water will be provided on the FSRU.

6.9. INDUSTRIAL & SOLID WASTE MANAGEMENT

Various kinds of solid and industrial wastes that will be generated on the vessel, will be either safely incinerated or safely brought to site location and disposed in onshore waste facilities available at Kukrahati. Food wastes generated on board the vessel where all plastic materials have been removed will be comminuted or ground to a particle size capable of passing through a screen with openings of 25mm and then discharged.

Both solid and industrial wastes from onshore facilities will be collected and either recycled or safely disposed in nearby approved waste handling facility.

6.10. POWER REQUIREMENT & SUPPLY/SOURCE

Power requirement during construction phase will be approximately 3 MW and shall be sourced from the local electricity grid. In case of non availability of power from the local grid/disruption of power, temporary DG sets with cumulative capacity of 3 MW shall be used.

The FSRU/FSU shall be self sufficient and will have on board Power Generation of upto 40 MW, which shall be used to meet all power requirement onboard the FSU/FSRU including those required for the LNG Handling facility onboard the vessel.

The power requirement for the facilities on the jetty and the project site shall be met by the power supplied from the West Bengal State Electricity Board (WBSEB) or from the power generated onboard the FSRU/FSU or through gas/diesel gensets at project site. The boil off gas from the

FSU/FSRU/GBF shall be utilized for generation of power in case gas gensets are used.

7. REHABILITATION AND RESETTLEMENTS (R&R) PLAN

One part of the land belongs to Haldia Development Authority and is fully surrounded by boundary wall. The land is free from any settlement and hence does not require any kind of rehabilitation and resettlements.

The other part of the land is being used as a brick kiln and is being acquired directly from the current owners.

8. PROJECT SCHEDULE AND COST ESTIMATES

8.1. SCHEDULE

Project Schedule for commissioning of Phase I of the project is majorly divided in to following sections as follows:

- Identification of suitable project site
- Conduct major studies and surveys
- Required clearances and permissions for the site and the project
- Chartering of FSRU/FSU
- RoU acquisition for onshore pipeline
- FEED and Detailed engineering for project facilities and onshore pipeline
- Procurement of long lead items and other materials
- Construction of site and onshore pipeline including civil works, electrical, mechanical, instrumentation, control room, SCADA, communication and customer installation readiness
- Site readiness
- Pre-commissioning of project facilities
- Commissioning of the project

Considering all the above activities, project shall be implemented within shortest possible time once all the permissions and clearance from state and central statutory bodies are obtained. It is estimated that since the start of construction work it will take 24 months to commission the project. Project is expected to commission by Q4 2020

8.2. PROJECT COST

Estimated CAPEX of the project is ~Rs. 2000 Crores that shall comprise of the following components:

- Land and Land Development
- Studies
- Jetty/GBF Structure
- On land facilities
- LNG Transfer system including unloading arms, pipeline etc.
- Cryogenic pipelines, loading bay, metering, pumps etc.
- Floating assets
- LNG storage facilities/ Tanks/ Pumps/ Truck Loading Bay
- Firefighting system
- Onshore Facilities/ Pipeline
- IDC
- Contingency

9. ANALYSIS OF THE PROPOSAL

As part of the proposed project development, following employment and goods/service sourcing requirements can be locally met:

- Unskilled/semi-skilled workers required as part of constructing onshore facilities and laying the onshore pipeline – for short term
- Land transport and local accommodation requirements for both construction and operational personnel
- Security and patrolling requirements during operation of terminal and onshore pipeline

10. HEALTH, SAFETY, ENVIRONMENT AND COMMUNITY

The Project development will give highest consideration to the preservation of human life, the minimization of environmental impacts and the mitigation of adverse effects on community. The main risk for safety and environment are related to the handling of liquefied natural gas (LNG) and pressurized natural gas (NG).

The main risk for safety and environment are related to the handling of LNG and pressurized natural gas (NG). LNG hazards result from three of its properties: cryogenic temperatures, dispersion characteristics, and flammability characteristics. In order to cope with these risks, International Maritime Organization (IMO) issues the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (normally referred as IGC Code).

The Project Site falls under Seismic Zone IV classified as damage risk zone as per IS 1893-2002. The design of the facility will be in accordance with relevant IS code. Suitable seismic coefficients in horizontal and vertical directions respectively, would be adopted while designing the structures as per NBC/ IS codes and other statutory norms.

LNG is natural gas that has been refrigerated into a cryogenic liquid so that it can be shipped long distances in dedicated carriers. Once an LNG carrier reaches a receiving terminal, the LNG is unloaded and stored in FSRU/FSU until it is regasified and has been sent to customers through natural gas pipeline. LNG is a hazardous liquid, because of its cryogenic properties and combustibility (as natural gas). LNG hazards result from three of its properties: cryogenic temperatures, dispersion characteristics, and flammability characteristics. The extremely cold LNG (about -163°C) can directly cause injury or damage (brittle fracture). A vapour cloud, formed by an LNG spill, could drift downwind into populated areas. It can lead to ignition if the concentration of natural gas is between 5% and 15% in air in the presence of an ignition source.

The natural gas generated by the LNG vaporization is a flammable gas mostly made up of methane. The hazard related to NG releases is due to its highly flammability and the potential formation of jet fires or flammable vapour clouds.

In order to cope with these risks, International Maritime Organization (IMO) issues the International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk (normally referred as IGC Code). The IGC Code is an international mandatory code that defines all the safety provisions to be foreseen and made available on board LNG Carrier as well as regasification units.

The IGC Code defines the minimum safety requirements for the ships handling liquefied gases

with particular reference to:

- Ship survival capabilities;
- Ship arrangement;
- Cargo containment, pressure and temperature control and venting;
- Process pressure vessels and piping;
- Material selection;
- Electrical installations;
- Fire protection / fire extinction;
- Personnel protection; etc.

In addition to IGC Code, Class Rules are applied providing additional safety features related to structure design, testing, fabrication and ship survivability.

As far as the pollution risks are concerned, the terminal shall comply with the Intervention Convention for the Prevention of Pollution from Ships (MARPOL). The MARPOL Convention was adopted in 1973 and covers the pollution of the sea by oil, noxious substances carried by ships, sewage and garbage produced on board. In particular, MARPOL requires the preparation and implementation of a Shipboard Marine Pollution Emergency Plan (SMPEP) that consist of a management and response plan in case of any spill into the water.

As far as on land facility safety is concerned, Indian laws as well as international standards will be applied to minimize risks and ensure a safe work environment. Onshore safety strategy is made up of:

- Application of engineering standards;
- Assessment of the risk.

The first step to ensure plant safety is the application of recognized engineering standards that allow developing a design that has safety consideration built in. Since engineering standards cannot cover and deal with all potential risks, the design will pass through a risk assessment process that will aim to:

- Identify hazards;
- Identify potential incidental scenarios;
- Evaluate their potential likelihood;

- Assess consequences for each scenario;
- Calculate the resulting risk.

For those risks that result higher than the acceptable level, additional actions shall be undertaken including:

- Assessment of risk reduction measures to lower the risk level both acting on the probability of occurrence (prevention) or acting on the expected consequences (mitigation);
- Defining an inspection and monitoring program;
- Inform personnel on the risk identified and train personnel to manage it.

11. CODES AND STANDARDS

FSRU/FSU

The FSRU/FSU will be designed and realized according to main maritime rules and regulations, including the following:

- The International Convention for the Safety of Life at Sea SOLAS (Consolidated Edition, 2009) and SOLAS Amendments 2010 - 2011;
- The International Code for Construction and Equipment of Ships carrying Liquefied Gases in Bulk "IGC Code" 1993 Edition and following Amendments up to Contract signing;
- International Convention on Load lines 1966, as amended by IMO Resolutions A513 (XIII) and A514 (XIII), inclusive of Protocol of 1988 Relating to the International Load Lines, as modified by the 2003 Amendments and 2004 Amendments including MSC.172(79) resolution (2005 Edition);
- IMO International Ship and Port Facility Security Code ISPS (2012 edition) and following Amendments up to Contract signing;
- International Telecommunication Convention (Malaga - Torremolinos 1973) with Annex and Revisions (Geneva, 1974 and Nairobi 1982) and following;
- International Convention for the Prevention of Pollution of seas from ships 1973 as modified by the Protocol of 1978 relating thereto (MARPOL 73/78) Consolidated Edition 2011;
- International Conference on Tonnage measurement of Ships, 1969 as amended by

IMO Resolutions A493 (XII) and A494 (XII);

- International Convention for the Prevention of Collision at Sea (COLREG), 1972, as amended by IMO Resolution A464 (XIII) and following (consolidated Edition 2003);
- International Maritime Dangerous Goods Code (IMDG Code), 2012 Edition;
- International Code for Application of Fire Test Procedures, FTP Code (2012 Edition)
- ILO Maritime Labour Convention, MLC 2006 (2006 Edition);
- Suez Canal Authority: Tonnage Measurements and Navigating Rules;
- IMO Anti-Fouling Convention, 2005;
- IMO Code on Alerts and Indicators, 1999 (2010 Edition) and following Amendments up to Contract signing;
- IMO Code on Intact Stability, 2008 (2009 Edition);
- IMO Noise Levels on Board Ship (1982 Edition);
- IMO Resolution A343 (IX) Recommendation on Method of Measuring Noise Levels at Listening Posts;
- IMO Resolution A468 (XII) Code Noise Levels on board Ships;
- IMO Resolution A 708 Navigation Bridge Visibility and Function;
- International Life-Saving Appliance Code LSA Code (2010 Edition);
- IMO Publication No.978 - Performance Standards for Navigational Equipment (1988 Edition);
- IMO Recommendations of Equipment for the towing of disabled tankers (1981 Edition);
- IMO Recommendations Concerning Regulations for Machinery and Electrical Installations in Passenger and Cargo Ships (Resolution A. 325 (IX) - 1976 Edition);
- IMO Graphical Symbols for Fire Control Plans (2006 Edition);
- IMO Guidelines for the Provisional Assessment of Liquids Transported in Bulk (2006 edition);
- IMO Navtex Manual (2005 Edition);
- Ballast Water Management Convention (2004 Edition);
- IMO Ballast Water Management Convention and the Guidelines for its implementation (2009 Edition);
- International Aeronautical and Maritime Search and Rescue Manual (IAMSAR Manual) 2010 Edition;
- Global Maritime Distress and Safety System Manual, GMDSS Manual (2010 Edition);
- NACE Standard for Shipbuilding;

Furthermore, the following guidelines will be taken into account:

- IACS REC No.47 Part A Shipbuilding and Repair Quality Standard for New Construction (To be kept as minimum reference);
- ILO Codes of Practice n.152, Safety and Health in Dockwork, 1977 as amended 1979 and following (1996 Edition);
- Equipment and fittings required by O.I.L. rules 147, Minimum Standard Criteria for Merchant Ships (1997 Edition);
- ISO Standards – All the applicable ones;
- ISO 6954 (1984) Guidelines for the overall evaluation of vibration in merchant ships;
- ISO 8468 = 1990 (E) - Ship Bridge layout and associated - Requirements and Guidelines (1990-11-01);
- ISO 6578 - Refrigerated Light Hydrocarbon Fluids - Static Measurement - Calculation procedure;
- ISO 8311 - Refrigerated Light Hydrocarbon Fluids - Calibration of membrane tanks and independent prismatic tank in ships - Physical measurement;
- ISO 8309 - Refrigerated Light Hydrocarbon Fluids - Measurement of liquid levels in tanks containing Liquefied gases - Electrical Capacitance Gauges;
- ISO 8310 - Refrigerated Light Hydrocarbon Fluids - Measurement of temperature in tanks containing Liquefied gases - Resistance Thermometers and Thermocouples;
- ISO 10574 - Refrigerated Light Hydrocarbon Fluids - Measurement of liquid levels in tanks containing Liquefied gases - Float Type Level Gauges;
- ISO 13398 - Refrigerated Light Hydrocarbon Fluids - Liquefied Natural Gas - Procedure of Custody Transfer System;
- G.I.I.G.N.L. - LNG Custody Transfer Handbook 3rd Edition 2011;
- I.E.C. Publication No.92 (electric part);
- ISGOTT - International Safety Guide for Oil Tankers and Terminal (5th Edition, 2006);
- ICS Bridge Procedures Guide (4th Edition);
- ICS Tankers Safety Guide (Liquefied Gas) (2nd Edition, 1996);

- ICS Guide to Helicopter/Ship Operations (4th Edition);
- ICS Safety in Liquefied Gas Carrier (1980);
- ICS/OCIMF/SIGTTO LNG Ship to ship Transfer guide (Edition, 2011);
- OCIMF/SIGTTO Manifolds Recommendation Liquefied Natural Gas Carriers (LNG) (Edition 2011);
- OCIMF Mooring Equipment Guidelines (3rd Edition, 2011);
- OCIMF Effective Mooring (3rd Edition 2008);
- OCIMF Recommendations on Equipment for the Towing of Disabled Tankers (2nd Edition, 1996);
- OCIMF Safety Guide for Terminals Handling Ships Carrying Liquefied Gases in Bulk (2nd Edition, 1993);
- OCIMF Prediction of Wind and Current Loads on VLCC's (2nd Edition, 1995);
- OCIMF Recommendations for the Tagging/Labelling, Testing and Maintenance, Documentation/Certification for Ships' Lifting Equipment (2005);
- OCIMF/SIGTTO Prediction of Wind Loads on Large Liquefied Gas Carrier (1985);
- SIGTTO Liquefied Gas Handling Principles on Ships and in Terminals (3rd Edition, 1999);
- SIGTTO Cargo fire-fighting on liquefied gas carrier (2nd Edition, 1996);
- SIGTTO Guidelines for the alleviation of excessive surge pressure on ESD - 1987.
- SIGTTO Recommendation for the Installation of Cargo Strainers on LNG Carriers - January 1984;
- SIGTTO Recommendation and Guidelines for Linked Ship/Shore Emergency Shut-Down of Liquefied Gas Cargo Transfer - July 1987;
- SIGTTO Introduction to the Design and Maintenance of Cargo System Pressure Relief Valves on Board Gas Carrier, 2nd Edition (1998);
- SIGTTO Guidelines for Automatic Cargo Tank Overfill Protection Aboard Gas Carrier (1993);
- SIGTTO Guidelines for Ship to Shore Access for Gas Carrier;

- SIGTTO Information Paper No5: Ship/Shore Interface Communications (2nd Edition 1997);
- OCIMF/SIGTTO Inspection Guidelines for Ships Carrying Liquefied Gases in Bulk (3rd Edition 2005);
- I.M.P.A. Shipmaster's guide to Pilot Transfer by Helicopter (1990);
- I.M.P.A. (International Maritime Pilot's Associations) Pilot Ladders;
- SNAME T&R No.3-39 "Guide for Shop and Installation Test", 1985;
- SNAME T&R No.3-47 "Guide for Sea Trials", 1989;
- SNAME T&R 5-2 "Gas Trials Guide for LNG Vessels".

Onshore Facility and Pipelines

The following standards will be followed for the design, construction and installation of Onshore facility and Pipelines:

- ASME – American Society of Mechanical Engineers:
- ASTM – American Society for Testing and Materials;
- API – American Petroleum Institute;
- IS – Indian Standards;
- NFPA – National Fire Protection Agency;
- IEC – International Electro technical committee;
- ISO – International Standardization;
- PNGRB Standards and Regulations