PRE-FEASIBILITY REPORT

PROPOSED SMALL SCALE LNG IMPORT, STORAGE & DISTRIBUTION FACILITY WITH TARGETED THROUGHPUT CAPACITY OF 1 MMTPA WITHIN THE INDUSTRIAL ZONE OF HALDIA DOCK COMPLEX AT HALDIA, WEST BENGAL, INDIA

Project Proponent

M/s. Venerable LNG Private Limited
Delhi, India
<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Title</th>
<th>Page No.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Executive Summary</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>Introduction Of The Project</td>
<td>2</td>
</tr>
<tr>
<td>3</td>
<td>Project Description</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Site Analysis</td>
<td>22</td>
</tr>
<tr>
<td>5</td>
<td>Planning Brief</td>
<td>24</td>
</tr>
<tr>
<td>6</td>
<td>Proposed Infrastructure</td>
<td>24</td>
</tr>
<tr>
<td>7</td>
<td>Rehabilitation And Resettlement (R &amp; R) Plan</td>
<td>26</td>
</tr>
<tr>
<td>8</td>
<td>Project Schedule &amp; Cost Estimates</td>
<td>27</td>
</tr>
<tr>
<td>9</td>
<td>Analysis Of Proposal (Final Recommendations)</td>
<td>27</td>
</tr>
</tbody>
</table>
1. EXECUTIVE SUMMARY

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Description</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Name of the Project</td>
<td>Small Scale LNG import, storage and distribution facilities</td>
</tr>
<tr>
<td>2.</td>
<td>Location of the Facility</td>
<td>Industrial Zone of Haldia Dock Complex at Haldia, West Bengal</td>
</tr>
<tr>
<td>3.</td>
<td>Product</td>
<td>LNG (Liquefied Natural Gas)</td>
</tr>
<tr>
<td>4.</td>
<td>Total land requirement for the project</td>
<td>4.65 ha (11.48 acres)</td>
</tr>
<tr>
<td>5.</td>
<td>Total Water requirement &amp; Source</td>
<td>About 4 m³/day of water is required for the domestic purpose. Water requirement will be sourced from Haldia Dock Complex.</td>
</tr>
<tr>
<td>6.</td>
<td>Manpower</td>
<td>During construction phase, about 300 persons will be transported and during operational phase, 100 persons movement is envisaged.</td>
</tr>
<tr>
<td>7.</td>
<td>Estimated Cost of the Project</td>
<td>INR. 700 Crores</td>
</tr>
</tbody>
</table>

2. INTRODUCTION OF THE PROJECT

(i) Identification of project and project proponent.

M/s. Venerable LNG Pvt. Ltd. (VLNG) is developing the gas distribution network in East India which is currently deprived of any access to natural gas. The states that will get benefited from this project are West Bengal, Orissa, Jharkhand, Bihar, Assam and Uttar Pradesh. Distribution of LNG is planned by transporting and distributing LNG across the chain in liquid form in cryogenic tanks over trucks, railway wagons and inland waterway barges in addition to distributing gas through captive pipeline network and connection to the gas grid (once gas grid connection is established upto Haldia).

VLNG proposes to setup LNG terminal for LNG import, storage & distribution facility with targeted throughput of 1 MMTPA capacity within the industrial zone of Haldia Dock Complex at Haldia, West Bengal, India. VLNG is engaged with TGE Gas Engineering GmbH (TGE) as the technical partner to develop this facility. TGE is a world leader in providing engineering, procurement and construction services, and have already developed more than twenty such facilities in Europe and Asia.

VLNG in consortium with TGE have already secured land at Haldia Dock Complex, Kolkata Port Trust through a tendering process to setup this facility.

(ii) Brief description of nature of the project

VLNG proposes to setup a small scale LNG terminal for LNG import, storage & distribution facility with targeted throughput of 1 MMTPA capacity within the industrial zone of Haldia Dock Complex at Haldia, West Bengal, India.

The land that has been allotted to setup LNG terminal is already well connected by road and railways network, and no construction of any new road and railways link to
land will be required. It also proposed to use the existing oil jetties of Haldia Dock Complex, and thus no jetty construction is required for the project. The terminal will require construction of LNG storage tank and associated processing and distribution facilities to store, re-gasify and distribute LNG/Gas to customers.

As per Environmental Impact Assessment Notification dated 14th September, 2006 and 01.12.2009, the proposed project falls under schedule 6(a) of Category ‘A’.

(iii) Need for the Project

The project involves building a Small Scale LNG Distribution Value Chain in the eastern and north-eastern part of India. This supply chain network provides an end to end flexible supply solution of supplying LNG/Gas to its consumers with the application of Hub and Spoke and multi-modal transportation concepts.

Small scale LNG is rapidly becoming a very popular concept in China, USA, and Europe as a viable supply solution to displace more polluting liquid fuels such as Diesel, Naphtha, furnace Oil and LPG in Industries, Refineries, Long Haul Trucking, Inland Waterways Barges and Heavy Mining Machinery. There is great potential in India as well to follow the same path, as it is both more economical and environmentally friendly to displace these liquid fuel consumption with LNG. LNG can bring in fuel savings of above 25% when it displaces liquid fuels like Diesel and LPG.

More than 20 Million Tonnes of liquid fuels are consumed by Industries and Transport Sector in East India. The burning of liquid fuel such as Diesel, Naphtha, Furnace Oil, Gasoline is one of the major source of particulate matter, CO₂ and SOx emissions. Eastern India has some of the most polluted cities globally.

The proposed LNG terminal and the flexible supply chain will be able to supply LNG/Gas to Industrial and Transportation Sector and support in displacement of these more pollution fuel with more cleaner and economical Gas.

In the initial phase, the project will support average daily demand of 2000-3000 scm of LNG to a large base of potential LNG consumers along the Eastern and North-Eastern part of India. It is expected the demand will grow steeply once the reliable LNG fuel availability is demonstrated in the region, and daily demand shall reach over 5,000 SCM in less than five years.

Demand is primarily targeted on distributing the LNG to the following end consumers:

- Non - Traditional market of Natural Gas as a replacement of Diesel, LPG, HFO and Naphtha:
  - Transportation – Inland waterways vessel (marine), Long Haul Trucking (Road), State Public Transport and Railways.
  - Mining and Oil & Gas Drilling - Heavy Machineries.
  - Industries – Chemical, Pharmaceutical, Ceramic, refractories, Automobile, Glass etc.
  - Small Engines for Power Generation – From 1 MW to 50 MW.

- Off pipeline takers & remote areas where the access to the Natural gas is a challenge, supporting them with LCNG station and City Gas distribution or grid network.
Nearby bulk customers such as Refinery and Petrochemical complexes requiring R-LNG through captive pipeline network.

To gas grid connected customers through pipeline, when the gas grid connection is established till Haldia.

The LNG will be sourced to the Haldia terminal from different LNG Import terminals located inside or outside India via long term chartering of Small Scale LNG ship of capacity 7,500 to 45,000 SCM. From the terminal LNG will be distributed in small volumes, 20 to 120 SCM to the end consumers via LNG cryogenic tankers on trucks, railway wagons and inland river barges, and as R-LNG to bulk customers as and when any pipeline connectivity is established to the terminal.

The proposed terminal will be able to cover a catchment area of upto 750 km from Haldia in the states of West Bengal, Orissa, Jharkhand, Bihar, Uttar Pradesh and Assam.

The economic and environmental benefits for the end consumers due to the proposed LNG terminal are ostensibly quite strong. Road Transport sector in the eastern part of the country will be able to achieve annual savings of USD 100 Million each if even only 10% of the total fleet adopts LNG as a fuel.

1 MMTPA LNG consumption as displacement of Diesel will bring in CO₂ savings of more than 1.1 MMTPA, strongly supporting the carbon emissions reduction program of the country.

The project shall also support the BBIN (Bhutan, Bangladesh, India and Nepal) Initiative of the Government of India by supplying LNG to these countries, and help
them bring savings in Fuel Expenditure and also support in their Climate Change programs.

(iv) Demand- Supply Gap

In 2016-17, India consumed 193.745 MMT of petroleum products. In 2017-18, up to December, the figure stood at 152.266 MMT. India was 3rd largest consumer of crude oil and petroleum products in the world in 2016. LNG imports into the country accounted for about one-fourth of total gas demand, which is estimated to further increase by two times, over next five years. To meet this rising demand the country plans to increase its LNG import capacity to 50 million tonnes in the coming years. India increasingly relies on imported LNG; the country is the fourth largest LNG importer and accounted for 5.68 per cent of global imports. India imported 18.787 MMT of LNG during 2016-17, in comparison to 16.217 MMT in 2015-16. LNG imports in 2017-18, up to November, were 13.10 MMT.

India is the world’s 4th largest energy consumer; oil and gas account for 35.61 per cent of total energy consumption in India. Demand for primary energy in India is to increase 3-fold by 2035 to 1,516 million tonnes of oil.

India’s gas consumption has increased at a CAGR of 2.3 per cent between 2007 and 2016. Demand is not likely to simmer down anytime soon, given strong economic growth and rising urbanization. Gas consumption is projected to reach 216 bcm by 2021-22. The demand, supply and imports of Gas in India for last two years is provided in Table-1.

<table>
<thead>
<tr>
<th>TABLE-1</th>
<th>2016-17</th>
<th>2017-18</th>
</tr>
</thead>
<tbody>
<tr>
<td>(a) Gross production</td>
<td>31,897</td>
<td>32,648</td>
</tr>
<tr>
<td>(b) Net availability</td>
<td>30,848</td>
<td>31,731</td>
</tr>
<tr>
<td>(c) LNG import</td>
<td>24,686</td>
<td>26,328</td>
</tr>
<tr>
<td>(d) Total consumption including internal consumption</td>
<td>55,534</td>
<td>58,059</td>
</tr>
</tbody>
</table>

*all figures in mmmscm

*Source: PPAC, Ready Reckoner December 2018*

Domestic production accounts for more than three-quarter of the country’s total gas consumption. Demand is expected to increase due to higher economic growth, ensure less dependency on imported crude and a desire to use cleaner fuel. India’s LNG imports increased at a CAGR of 9.55 per cent during FY08-FY17. Domestic gas production in India stood at around 30.84 billion cubic meters in FY17. Production during April-November 2017 reached 21.4 bcm.

(v) Imports vs. Indigenous production

As on today, LNG need to be imported as India does not have indigenous resources.

(vi) Employment Generation (Direct and Indirect) due to the Project

During construction phase, about 500 persons will be employed for the construction activity and during operational phase, about 50 persons will be directly employed due to the proposed LNG terminal.
During the construction phase, skilled and unskilled people on daily average will be employed. VLNG will give preference to the local population during construction and operation phase of the project depending upon the skill, job requirement and capability. Several other indirect employment opportunities such as transport, business, vehicle drivers and attendants, workshops, grocery and retails, medical, etc. will be created in the surrounding areas.

3. PROJECT DESCRIPTION

(i) Types of project including interlinked and interdependent project, if any

VLNG proposes small scale LNG terminal for LNG import, storage & distribution facility with targeted throughput of 1 MMTPA capacity within the industrial zone of Haldia Dock Complex at Haldia, West Bengal, India. The land that has been allotted to setup LNG terminal is already well connected by road and railways network, and no construction of any new road and railways link to land will be required. It also proposed to use the existing oil jetties of Haldia Dock Complex, and thus no jetty construction is required for the project.

Following are the facilities required for setting up of small scale LNG terminal:

1. Receiving Section:
   - Setting up of unloading arm on the existing Oil jetty 1 and 2 of the Haldia Dock Complex
   - Cryogenic pipeline to connect the unloading arms with the terminal

2. Storage Section:
   - Full containment LNG storage tank with pumps
   - Associated utilities

3. Send Out Section:
   - BOG compressor system
   - Truck loading system
   - High Pressure send out system including Vaporisers

The process flow diagram for the proposed small scale LNG terminal is shown in Figure-2.
The terminal will receive LNG from bulk carriers. The LNG will be stored near atmospheric pressure. The stored product will be discharged from the storage tank, to the truck loading and/or the HP send-out. The HP send-out will be pumped using the in-tank pumps and contacted with excess BOG in the re-condenser, before passing to the HP pumps and vaporized to the HP pipeline. The HP send-out will be metered before entering into the pipeline network.

The LNG terminal includes the following unit operations:

- LNG unloading system
- LNG storage tank
- In-tank pumps
- BOG compressor system
- Truck loading system
- High Pressure send out system

**LNG Transfer System**

The small-scale LNG Terminal at Haldia will be capable of receiving LNG Carriers (LNGCs) at the existing oil jetties of Haldia Dock Complex. The terminal is proposed to be connected to two existing multiproduct oil jetties namely Oil Jetty 1 and Oil Jetty 2.

Both the jetties are multiproduct jetties and are currently handling petroleum products such as Furnace Oil, Naphtha and LPG. The terminal is proposed to be connected to both the Oil Jetties 1 and 2 to avoid congestion on any single jetty. However, only one LNG unloading operation will be performed from either jetty at a
given time. Oil Jetty 1 can accept vessels upto maximum LOA of 236m, and Oil Jetty 2 can handle vessels upto maximum LOA of 277m, and draught available at both the jetties is upto 7.8m. LNG carriers with capacities ranging from 7,500 m³ to 45,000 m³ will be able to berth at either of the jetties and discharge LNG to terminal.

When the ship is safely moored and ship to shore communications are established, the vapour return arm and the LNG unloading arm will be connected. Subsequently cool down of the ship’s transfer piping and the LNG unloading arm will be started with a small LNG flow from the carrier.

LNG will be discharge during the ship unloading pumps. The LNG discharged from the LNGC will flow via the LNG unloading arm, through the ship unloading line, and then through the tank riser to the LNG storage tank. The unloading system is designed based on a minimum of 120 mLC pressure at the ship’s manifold flange for an unloading rate of up to 2,500 m³/h to the LNG storage tank.

One LNG unloading arm with a riser, inboard/outboard arms, equipped with a Powered Emergency Release Coupler (PERC) and a Quick Connect/Disconnect Coupler (QCDC) will be installed at the jetties to unload LNG from ship to the onshore storage tank.

The unloading rate will be determined based on the level indications in the LNG storage tank. The quality of LNG being unloaded from the LNGC will be monitored via an on-line analyzer located at the process area. The purpose of this analysis is to supplement the cargo certificates provided with the incoming CIF (Carriage, Insurance & Freight) documentation.

Metering of the quantity of LNG unloaded from the ship will be performed based on “tank-dip” surveys of the LNGC.

Prior to the ship’s arrival at the terminal, the operating pressure of the storage tank will be maintained as low as possible but 50-70 mbar above ship’s cargo tank pressure. This will minimize the quantity of flash gas entering the tank.

The cool down of the unloading arm, the arm riser and unloading line up to the transfer arm isolation valve is accomplished by directing cold NG. During the arm cool down operation, the storage tank’s pressure may increase slightly. If necessary the LNG storage tank pressure will be maintained by running the BOG compressors. On completion of the arm cool down operation, the ship unloading operation will be started.

During the ship unloading operation, the storage tank pressure will be controlled at a higher pressure than the saturation pressure of the ship’s cargo. Throughout the unloading period the pressure in the ship’s cargo tank will be maintained at a constant value by allowing displaced vapour from the tank to flow to the ship via the vapour return arm. The pressure in the ship’s tank will be controlled by the ship’s pressure control system.

For ships arriving with higher saturation pressures (a.k.a.”Hot Ship”), excessive flash gas will be generated in the storage tank. The BOG compressor system may be unable to handle this excess gas from the tank, therefore the LNG may have to be unloaded at reduced rates to avoid flaring the excess vapour.
As the ship cargo tanks approach low level, the unloading rate will be reduced, and the ship pumps stopped one by one. At the end of ship unloading, the LNG will be purged out of the unloading arm with nitrogen connected at the top of the arm. The LNG will be driven back into the ship and into the unloading header from the arm and then QCDC will be disconnected.

**LNG Storage Tank**

A full containment LNG Storage Tank, constructed from pre-stressed reinforced concrete, a concrete roof and a 9 % nickel inner tank, will be provided. The storage tank capacity up-to60,000 m³ is considered.

The annular space between the inner and outer tank, the tank base and the suspended deck will be equipped with thermal insulation that will limit the maximum LNG boil-off rate of a full tank under design ambient conditions to 0.1% of tank contents per day based on pure methane. The tank will be equipped with bottom heating to prevent freezing of the ground resulting in “frost heave”. All fill and withdrawal connections are top entry through the outer tank roof. LNG tank will be equipped with a top splash plate for distributing the liquid during top-filling operations and a perforated standpipe for bottom filling.

The vapour space of the tank is connected to the BOG header. The BOG header is connected to the BOG Compressors the ship vapour return line and the flare system.

The LNG storage tank will have a design pressure of -10 mbarg to 290 mbarg. Typically the normal vapour space operating pressure of the LNG storage tank will range between 100 mbarg (low pressure set point for the BOG compressor) and 220 mbarg (high pressure set point for the BOG compressor), and this pressure will generally be controlled by stepwise operations of the BOG compressors. During LNGC unloading, the tank’s pressure is assumed steady at a relatively high level of 220 mbarg.

The LNG storage tank will be provided with protection systems in order to prevent:

- **Tank over-filling**: by redundant level gauging, multi-level alarming, interlocks for equipment shutdown and finally activation of Unloading Emergency Shutdown.

- **Overpressure**: primarily via stepwise operation of BOG compressors, followed by an interlock that isolates the tank and a pressure control valve releasing excess gas to the flare. A discretionary vent valve is installed on top of the tank which the operator may open from the control room to avoid lifting the tank relief valves if tank pressure increases further. The ultimate protection of the tank against overpressure will be achieved by a set of Pressure Safety Valves (PSVs), mounted on the tank roof to relieve excess pressure to the atmosphere. The overpressure protection covers various upset scenarios e.g. atmospheric pressure drop, tank rollover, vacuum breaker control valve’s failure, displacement due to filling, external fire etc.

- **Vacuum conditions**: under normal send out, the control of vacuum conditions is achieved by: (1) shutdown of BOG compressors; (2) shutdown of send out pumps. Under abnormal conditions and after shutdown of BOG compressors and in-tank pumps, the ultimate protection of the tank against vacuum will be
achieved by a set of air vacuum breakers, mounted on the tank roof to admit air into the tank.

- LNG stratification: the tank will be provided with LTD type of level gauging (level, temperature and density) for detection of stratification and initiation of corrective measures. The corrective measures include: selection of top and bottom filling mode during ship unloading (“Lean” and “Rich” LNG will be loaded by the bottom filling and top filling respectively); regular renewal of tank contents and circulation of LNG using LP LNG send-out pumps in kickback mode. The LTD will be equipped with a high differential temperature alarm (TDAH) and a high differential density alarm (DDAH) to alert the operator to the possible onset of stratification.

Truck loading from the LNG storage tank will be achieved with the operation of two truck loading in-tank pumps. Low pressure in-tank pumps (send out pumps) will be used for pumping out LNG from tank, which will be further pressurised using HP pumps and then vaporised using ambient air vaporisers. The HP pumps will be submerged, column mounted, fully enclosed centrifugal type.

Nitrogen injection arrangements in both the inner and annular spaces as well as vent lines are provided for tank drying, purging and inerting. A cool down spray ring will be provided along with bottom temperature sensors for initial cool-down to put the tank into service.

**Heat Leakage / LNG Recirculation System**

*LNG Send-out Recirculation*

The heat input into the entire cryogenic system will include ambient temperature heat-in leak into the equipment and piping insulated surfaces. The heat generated due to pumping will be carried away by the flowing streams towards the NG sendout system, unless the in-tank pumps are operating in kickback mode or in recirculation mode.

Flows of LNG will be circulated through LNG lines as follows:

- LP pump kickback lines, back to the tank
- Non-running LP pump column, back to the tank
- HP pumps’ discharge header, to recirculation header
- Truck loading header, to recirculation header

The recirculation flow ensures the lines are always flooded with LNG and maintained at a cold temperature. At times of no sendout the recirculation streams are returned to the storage tank.

With this routing, all of the sendout liquid lines will be maintained at their normal cold operating temperatures. However, this mode of operation adds heat to the storage tank thus the tank pressure will gradually rise over time until the BOG compressors are put into operation, failing that, the tank’s pressure control system will vent the excess gas being generated to the flare system.
Unloading Line Recirculation/Drainage

The terminal is designed to maintain the unloading line under cold conditions by LNG recirculation.

During unloading line recirculation, ambient heat ingress into the unloading line and recirculation line will be continuously removed by circulating LNG from the in-tank pumps. The re-circulating stream will be directed from the ship unloading line from the terminal to the jetty, then returned though the recirculation line and back to the tank. If required for maintenance purposes the unloading line is capable of being fully drained.

Handling of Boil-Off and Displaced Vapours

BOG is generated inside the LNG tank by ambient heat in-leak to the tank, flashing and displacement during tank filling. During sendout, heat generated by the in-tank pumps is mostly rejected to the pump discharge stream and not to the tank contents. BOG from the LNG storage tank is routed via the boil-off gas header, partly back to the ship’s cargo tank, and the remainder to the boil-off gas (BOG) compressors. In the event when the BOG compressors are overloaded or unavailable, excess BOG will be vented to the flare system by the tank’s pressure control system. During normal operation, no flaring is expected.

The BOG compressors will be reciprocating compressors with stepwise capacity controls to permit flexibility in coping with varying BOG quantities. Start/stop and capacity controls will be performed either automatically by the control system or manually by the operator.

The absorber re-conditions the BOG under pressures ranging from 6 to ~10 barg by contacting the sub-cooled send-out LNG and boil-off gas in a packed bed. The absorber also acts as liquid buffer volume, suction drum, for the LNG high-pressure pumps located downstream. Sub-cooled LNG flow to the packed bed is controlled by split flow control while the remaining flow will by-pass the packing by means of flow control. This provides assurance that the LNG entering the HP pumps is sufficiently sub-cooled ensuring that cavitation cannot occur.

Ship Unloading

During ship unloading, the level in the on-shore LNG storage tank increases causing an increase in pressure in the tank due to positive displacement effect. Simultaneously, the level in the LNGC tank decreases, causing a pressure decrease due to negative displacement effect.

To prevent under pressure in the LNGC tank, a part of the displaced vapour from the on-shore LNG storage tank will be routed via the BOG header to the ship through the ship vapour return line.

The balance of the BOG will be handled by the BOG compressors. During ship unloading operation BOG(s) compressor will be required to handle the boil-off gas rate. The compressed BOG will re-condensed in the absorber.

For an abnormal operating condition, when there is no discharge route for the BOG compressors, or compressors are not available, the pressure within the LNG tank will
gradually rise, and if this situation prevails, the boil-off gas will be relieved to the flare system, under pressure control. This is an abnormal operating condition, and flaring will be inevitable.

Normal Operation

Normal operation for the terminal is with product storage and send out, with no ship unloading occurring. If there is low send out requirement, a single BOG compressor may be required to handle the boil-off gas from the storage tank.

In the event that the BOG generation rate is less than the negative vapour displacement created by the LNG send out rate, the storage tank pressure will decrease and send out gas can be injected to the boil-off gas header to maintain the tank pressure and prevent vacuum in the storage tank.

Boil-Off Compressors

The LNG storage tank boil-off gas will be compressed by the Boil-Off Gas Compressors. A BOG de-super heater upstream of the BOG Compressors Suction KO Drum will be provided, to ensure the compressor suction temperature is below -110°C, at low boil-off gas flows or during start-up, thus improving the efficiency of the BOG compressors and limiting the discharge temperature. The compressor suction KO drum will be fitted with a demister pad to remove any liquid carryover from the gas stream to the BOG compressors. Accumulated LNG will be drained by gravity into the LNG collection pipe at the bottom of the suction KO drum. Normally liquid is not expected in the LNG collection pipe. However, if liquid is collected, the liquid will be drained by nitrogen pressure to the LNG Drain Pipe and routed back to the LNG storage tank.

In-tank LNG Pumps

LNG send-out liquid from the LNG storage tank will be pumped by the in-tank LNG pumps. The operator will select which pump and the number of pumps based on the operating requirement. In general, the in-tank LNG pumps have the following functions:

- for send-out and recirculation flows.
- for truck loading

The in-tank LNG pumps are of submerged vertical type mounted in a dedicated column. Each pump will be provided with its own column venting and automatic minimum flow lines returning back to the LNG storage tank.

Send-out System

The HP LNG pumps are of the vertical canned type and are mounted in individual cans with support structures for surrounding piping. These pumps are equipped with facilities for automatic venting of cans and minimum flow protection. All venting flows return to the re-condenser.

The HP LNG pumps will discharge LNG at approximately 60 barg via the HP discharge header to the vaporizers. LNG will be vaporized to meet the design send-out rate.
The vapour exiting these units is controlled to a temperature of approximately +5 °C.

A set of ambient air vaporisers with combined peak re-gasification capacity of 3.5 mmcmd will be used to vaporise LNG. Ambient air vaporisers are vertical heat exchange tubes that utilise ambient air in either a natural draft mode or a forced draft mode to vaporise LNG. In winters when ambient air temperature is too low supplementary heating may be required to meet the outlet gas temperature.

Defrosting of ambient air vaporisers will be required due to dense ice build-up on the surface of the heat exchanger tubes. The ice build-up occurs due to the condensation and freezing of water vapour in the air. To defrost the exchanger, it has to be placed on a standby mode. In standby mode defrosting will be performed either by natural draft convection or force draft air fans. The use of force draft fans can reduce the defrosting time but would require additional power for fan.

A high integrity pressure protection system (HIPPS) may be required downstream of the metering station to ensure the pipeline design pressure (HOLD) is not exceeded. The HIPPS activation will shut down the terminal send-out. The margin between the maximum operating pressure of the terminal and the pipeline design pressure is set to minimize spurious HIPPS actuation during normal operation.

**Truck Loading**

Truck loading facilities are provided for ten truck loading bays. The truck loading facilities consist of a loading bay, with loading and vapour return arms, metering and control of loaded quantities. A weighing computer system allows the truck driver to receive the "bill of loading".

LNG will be loaded onto the LNG road trucks (each 18 tons)/ ISO containers (each 40 feet and LNG carrying capacity of 17 tons). These LNG road trucks/ISO containers will be then weighed on a weigh bridge for measurement and moved by road to customer locations. Similarly ISO containers will be weighed and moved by trailers to the railway siding within the port.

The displaced vapour is returned (by pressure differential) to the terminal boil-off gas header. LNG recirculation is provided to maintain the lines in a cold condition and to avoid excess flash vapour into the truck during the initial loading. An LNG sample point will be provided in the truck loading header to allow manual sampling and analysis of the LNG loaded in to trucks.

**Vent, Flare and Relief System**

A flare system will be provided for safe disposal from the tank’s pressure control system. This system will be configured such that any excess gas from the tank will be routed to the flare system for safe disposal before the LNG storage tank safety valves lift.

PSV discharges from equipment within low pressure systems including: BOG compressors, BOG compressor suction KO drum, LNG collection pipes and LNG drain pipe will be routed to the tank BOG header to recover discharge gas to the storage tank. The high pressure discharges from the PSV at the ambient air vaporizers outlet lines will be directed to atmosphere.
Vent, drains and relief from thermal expansion valves within the process area will be collected in the LNG Collecting Pipe. Vapour and liquid phases are recovered to the LNG storage tank.

**Utilities**

The terminal will also be provided with utilities including:

- External power supply will be secured which will be supported by emergency diesel generator and UPS systems for the critical items.
- Potable and industrial water used for plant internal needs.
- Fire water distribution system to protect the equipment against heat radiation in the unlikely event of a fire. The fire fighting facilities on the jetties are already existing and not required to be installed by VLNG.
- Gaseous nitrogen and instrument air production and distribution systems.

**(ii) Location map showing general location, specific location, and project boundary & project site layout with coordinates**

VLNG proposes LNG terminal for LNG import, storage & distribution facility with targeted throughput of 1 MMTPA capacity within the industrial zone of Haldia Dock Complex at Haldia, West Bengal, India.

The index map of the proposed LNG terminal is given in **Figure-3**. The study area map of 10 km radius from the project boundary is shown in **Figure-4**. The project LNG Handling Facility Layout with boundary coordinates is shown in **Figure-5**.
FIGURE-3
INDEX MAP SHOWING THE LNG TERMINAL PROJECT SITE
FIGURE-4
10 KM STUDY AREA OF LNG TERMINAL LOCATION
FIGURE-5 (A)
LNG TERMINAL - MASTER LAYOUT
The project area falls in Survey of India (SOI) Toposheet No. 79B/4 & 79C/1. The indicative project site coordinates are given Table-2.

**TABLE-2**

**BOUNDARY COORDINATES OF THE LAND AREA**

<table>
<thead>
<tr>
<th>Sr.No</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td><strong>Project Site Corner Coordinates</strong></td>
<td></td>
</tr>
<tr>
<td>A</td>
<td>22° 2'5.89&quot;N</td>
<td>88° 5'53.28&quot;E</td>
</tr>
<tr>
<td>B</td>
<td>22° 2'6.76&quot;N</td>
<td>88° 6'8.03&quot;E</td>
</tr>
<tr>
<td>C</td>
<td>22° 2'5.97&quot;N</td>
<td>88° 6'8.54&quot;E</td>
</tr>
<tr>
<td>D</td>
<td>22° 1'56.38&quot;N</td>
<td>88° 5'54.43&quot;E</td>
</tr>
<tr>
<td>E</td>
<td>22° 1'59.62&quot;N</td>
<td>88° 5'52.02&quot;E</td>
</tr>
<tr>
<td></td>
<td><strong>Jetty-1 Coordinates</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>22°01'50.98&quot; N</td>
<td>88°05'58.23&quot; E</td>
</tr>
<tr>
<td></td>
<td><strong>Jetty-2 Coordinates</strong></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>22°01'34.65&quot; N</td>
<td>88°05'32.40&quot; E</td>
</tr>
</tbody>
</table>
(iii) Details of alternate sites considered and the basis of selecting the proposed site, particularly the environmental considerations gone into should be highlighted

No alternative sites were envisaged as Kolkata Port Trust (KoPT) has come out with a tender and earmarked a land of approx. 11.48 acres along with the right to use an existing multiproduct liquid cargo handling jetties for setting up a Small Scale LNG terminal at the port of Haldia within the premises of Haldia Dock Complex.

The land was to be awarded to the entity/consortium that qualifies and wins the tender issued by the KoPT specifically for setting up the LNG terminal, which has been now allotted to consortium of VLNG and TGE after winning the tender.

The selection of Haldia port as a preferred location for setting up the small scale LNG terminal has been justified based on the following criteria:

- The most cost-effective option at this stage as the port has availability of existing permanent multi product jetties.
- Close to the existing and upcoming gas market of the east and north – eastern India thus reducing the cost of connectivity which will have a significant share of the overall capital expenditure.
- Relatively maintained drafts limit condition for the yearlong activities with less cyclonic activities than other areas of eastern India.
- Well connected with the National Highways, Golden quadrilateral, dedicated freight corridors and major railway routes.
- Availability of Power and Water.
- Road/Rail connectivity to Eastern as well as North eastern Indian states.
- Low population areas around port.
- Absence of Natural Forests and ecologically sensitive areas within the port premises.
- The project is non-polluting as there is no processing or manufacturing involved.

Salient Features of Haldia Port

Haldia Port is a part of Kolkata Port, the only riverine major port in India situated on the bank of the Hooghly River, 126 miles from the sea. The port is located on the east coast of West Bengal at latitude 22.11667’North and longitude of 88.18334’ East. It is situated at 104 km downstream of Kolkata (West Bengal, India), 130 km upstream from Sand heads and 45 km upstream from Pilotage station. It comprises 3 riverine Oil Jetties, 12 berths inside an impounded dock, two riverine barge jetties and Haldia Anchorage for LASH vessels.

- All-weather port.
- Lock Gate: 985 feet x 130 feet
- Turning basin: 1800 feet in diameter
- Land Area: 6367 acres
- Supports, encourages and facilitates growth of Port-based and Port-oriented industries.
- Ample land availability for prospective port-based industries and port users.
- Average draft availability is 7.5 meters, which is regularly being improved by further 1 meter.
- State of the art radar surveillance through Automatic Identification System (AIS) and Vessel Traffic Management System for effective and safe guidance to vessels.
(iv) **Raw material required along with estimated quantity, likely source, marketing area of final products/s, mode of transport of raw material and finished product.**

VLNG along with its partners proposes to source and market LNG as LNG and R-LNG through network of captive pipeline, connection to Gas Grid and in cryogenic tanks over road, railways and inland river barges, LNG will be sourced to terminal via a long term chartering of small scale LNG ship with a capacity of 7,500 to 45,000 SCM

Annual throughput capacity of terminal: 0.2 – 1.0 MMTPA
Capacity of the small scale LNG ship: 7,500 to 45,000 scm.

(v) **Resources optimization/ recycling and reuse envisaged in the project, if any, should be brief outlined.**

LNG can compete with liquid fuels such as Diesel, LPG, HFO and Naphtha, not just on the merits of being a more clean fuel but also on strong economic benefits. Currently average retail price of Diesel in the country is around INR 65/litre (January, 2019) which translates to USD 25/MMBTU. In comparison, the prevailing LNG spot prices is close to USD 7-8/MMBTU, and with this project it can be delivered to the end consumer at a price below USD 12/MMBTU, bringing in more than 40% savings in operating fuel expenses to consumers from shifting Diesel to LNG fuel.

(vi) **Availability of water its sources, Energy /power requirement and sources should be given,**

**Water requirement**

Provision of uninterrupted water supply should be provided by the Haldia port, along with that port should assist in developing/mapping the outlets of sewage drainage and rain water harvesting outlets. Also, the fire water supply at the jetties should be made available round the clock.

About 4 m³/day of water is required for domestic purposes and no water is required for process.

**Power requirement**

During the construction phase of the proposed LNG terminal the power requirement is envisaged to be 1.3 MW which will be sourced from Haldia port.

The power requirement for both jetty and on shore site during operation phase is envisaged to be 3.5 MW which will be sourced from Haldia port which will assist in providing the required approvals for the provision of electricity from WBSEDCL up to the battery limits of proposed terminal site as well as upto the Haldia Oil Jetty 1 and 2.

DG set of 1500 KVA capacity will be used during the operation phase as a backup during emergency conditions and about 500 KVA will be required during the construction phase. The proposed DG set will be provided with appropriate stack height and will be provided with proper acoustic enclosures.
(vii) **Quantity of wastes to be generated (liquid and solid) and scheme for their management/disposal.**

Domestic wastewater to be generated will be discharged through municipal sewage system.

Waste generated during construction and operation stage will be collected by local municipal authorities. A small quantity i.e. about 0.5 KL/year of hazardous oily waste will be generated from the proposed LNG terminal during periodic maintenance. Hazardous waste will be collected and stored at specific identified area at site. Authorized agency will be hired to dispose the collected Hazardous waste.

(viii) **Schematic representations of the feasibility which give information of EIA purpose.**

Detailed schematic representations of the feasibility covering the purpose of EIA will be given in the Environmental Impact Assessment report.

4. **SITE ANALYSIS**

(i) **Connectivity**

The National Highway 41 (Port Connectivity) connects the port city with National Highway 6 (part of Golden Quadrilateral) at Kolaghat. From Kolaghat NH-6 connects Orissa, Jharkhand, Kharagpur, Bankura and Purulia and also Durgapur, through NH-34 to North Bengal, Bangladesh via Petrapole and Bhojadanga Land Custom Stations. A State Highway also connects Haldia with Kolaghat via Tamluk town which is the district headquarters as an alternate connectivity. Besides the major Highways the Haldia township has an extensive network of roads that serve the different parts of the city and the industrial area.

(ii) **Land form, land use and land ownership**

The land in which VLNG proposes to set LNG terminal is located within the industrial zone of Haldia dock complex and the land is already under industrial zone and hence there will not be any change in land use.

(iii) **Topography (along with map)**

Topography of the proposed LNG terminal project site is already an industrial area where there are building and storage tanks exists within the project site. The location map is shown in Figure-7 and 8.

(iv) **Existing land use pattern (agriculture, non-agriculture, forest, water bodies(including area under CRZ)), shortest distances from the periphery for the project to periphery of the forests, national park, wild life sanctuary, eco-sensitive areas, water bodies (distance form the HFL of the river), CRZ. In case of notified industrial area, a copy of the Gazette notification should be given)**

The land in which VLNG proposes to set LNG is already an industrial area where there are building and storage tanks already existing. The project site is located within the notified industrial zone of Haldia dock complex.
(v) **Existing infrastructure**

The land in which VLNG proposes to set LNG terminal is located within the industrial zone of Haldia dock complex and the land is already under industrial zone.

(vi) **Soil classification**

The soils of the study area are formed through alluvial deposits and overlain by more recent back swamp deposition. The soils are light to dark colored and poor in calcareous materials. Considerable quantity of decayed vegetation is reported to occur particularly in the silty clay strata.

Soils in the area are mostly clay loam and silt or clay in texture and contain large percentage of silt and clay and hence possess high water holding capacity and good fertility status. Only in areas close to rivers, soils are sandy clay which is typical of river banking areas.

(vii) **Climatic data from the secondary sources**

The secondary climatic data has been collected from IMD Sagar Island, which is nearest IMD station to the project site. The data collected from IMD includes wind speed, wind direction, (recorded in sixteen directions), temperature, relative humidity, atmospheric pressure; rainfall and cloud cover over a period of 30 years. The monthly maximum, minimum and average values are collected. The collected data is tabulated in below.

The total annual rainfall in the region based on the IMD data is 1794.8 mm. The maximum number of rainy days occur in the months of July, August and September. Predominant winds are from Southwest and South. Annual and monthly variations in the rainfall are given in Table-3.

<table>
<thead>
<tr>
<th>Month</th>
<th>Atmospheric Pressure (Mb)</th>
<th>Temperature (°C)</th>
<th>Relative Humidity (%)</th>
<th>Rainfall (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0830</td>
<td>1730</td>
<td>Max.</td>
<td>Min.</td>
</tr>
<tr>
<td>January</td>
<td>1016.3</td>
<td>1012.9</td>
<td>25.1</td>
<td>16.2</td>
</tr>
<tr>
<td>February</td>
<td>1014.1</td>
<td>1010.8</td>
<td>27.0</td>
<td>19.5</td>
</tr>
<tr>
<td>March</td>
<td>1011.4</td>
<td>1007.8</td>
<td>29.9</td>
<td>23.8</td>
</tr>
<tr>
<td>April</td>
<td>1007.9</td>
<td>1004.2</td>
<td>31.4</td>
<td>26.0</td>
</tr>
<tr>
<td>May</td>
<td>1004.6</td>
<td>1001.4</td>
<td>32.2</td>
<td>27.0</td>
</tr>
<tr>
<td>June</td>
<td>1000.0</td>
<td>997.5</td>
<td>31.8</td>
<td>27.3</td>
</tr>
<tr>
<td>July</td>
<td>1000.2</td>
<td>997.6</td>
<td>30.6</td>
<td>27.0</td>
</tr>
<tr>
<td>August</td>
<td>1001.0</td>
<td>998.6</td>
<td>30.6</td>
<td>26.8</td>
</tr>
<tr>
<td>September</td>
<td>1005.5</td>
<td>1002.6</td>
<td>30.9</td>
<td>26.7</td>
</tr>
<tr>
<td>October</td>
<td>1010.5</td>
<td>1007.3</td>
<td>30.8</td>
<td>25.3</td>
</tr>
<tr>
<td>November</td>
<td>1014.2</td>
<td>1010.8</td>
<td>28.8</td>
<td>21.6</td>
</tr>
<tr>
<td>December</td>
<td>1016.8</td>
<td>1013.3</td>
<td>25.7</td>
<td>17.4</td>
</tr>
</tbody>
</table>

*Source: Indian Meteorological Data, Pune*
(viii) Social Infrastructure Available

All infrastructure facilities such as education, health facilities and other social facilities are adequate at district headquarter.

5. PLANNING BRIEF

(i) Planning Concept (types of industries, facilities, transportation etc) Town and Country planning/Development authority Classification

The project is envisaged to employ 50 direct employees during operation phase and 100 indirect employees. The basic infrastructure facilities like medical facilities, schools, playground, drinking facilities, bank, post offices etc. are already available.

(ii) Population projection

The proposed LNG facility at Haldia industrial zone would aid in the overall social and economic development of the region. The facility will give direct employment to about 50 people, in addition there will be indirect employment to many more people in the form of out sourcing jobs, business opportunities, service facilities etc. This will enhance the economic status of the local region.

Apart from the jobs, the company will provide medical and educational facilities to the employees which can also be availed by the people around the facility.

(iii) Landuse planning (breakup along with green belt etc)

The land of about 11.48 acres is required for the proposed LNG terminal. The proposed project site is already under industrial use.

(iv) Assessment of Infrastructure Demand (physical & social)

Adequate physical and social facilities are available in this area.

(v) Amenities/ Facilities

All infrastructure facilities such as education, health facilities and other social facilities are adequate which makes the region adequate in amenities.

6. PROPOSED INFRASTRUCTURE

(i) Industrial Area (Processing Area)

The development of the LNG storage and distribution terminal involves following associated infrastructure facilities:

Availability of Jetty for unloading of cargo:

Haldia port will ensure availability of Jetties for the unloading of LNG, at least once in ten days for the first two years of operation and henceforth in conjunction with the LNG flows actual and projected as per the terminal utilization.
**Space availability at the Jetty:**

Ensure suitable space on Jetty to setup LNG unloading arms/hoses and associated infrastructure facility.

**Right of Way:**

Haldia Port will provide the right of way for laying cryogenic and utility pipeline network at the existing pipeline corridor at the Haldia Oil Jetty – 1 and 2. In addition to the jetty, the right of way will also be provided in the pipeline corridor existing at the land connecting the Haldia Oil Jetty - 1 and 2 and proposed on shore terminal site location.

**Security at the Jetty and Terminal:**

Haldia port will provide around the clock security at the jetties and up to the battery limits of the project site.

**Small Captive Barge Jetty:**

Haldia port shall construct a small captive barge jetty for performing regular unloading & loading operations of LNG at the barge jetty on a small scale basis into the river barges. With the support of small scale captive barge jetty, the Haldia port will be able to provide LNG as a bunker fuel to the upcoming LNG powered barges.

The feasibility of the jetty lies into the fact that the availability of the draft in the vicinity of jetty which is around 4 meter at the protrusion of jetty to around 150 meter. This supports the requirement of draft for placing the barges at the time of loading/unloading.

(ii) **Residential Area (Non Processing Area)**

No residential area is proposed for the facilities.

(iii) **Green belt**

Greenbelt will be developed in the peripheral of the land site around the storage facilities and other areas. Development plan will be finalized based considering the safety aspects & PESO regulations and guidelines.

(iv) **Social infrastructure**

VLNG shall undertake socio-economic development projects to enhance education, healthcare, and overall community development of the surrounding villages. A well defined CSR policy will be followed by VLNG.

(v) **Connectivity (Traffic and Transportation Road/ Rail/Metro/ Water ways etc)**

The National Highway 41 (Port Connectivity) connects the port city with National Highway 6 (part of Golden Quadrilateral) at Kolaghat. From Kolaghat NH-6 connects Orissa, Jharkhand, Kharagpur, Bankura and Purulia and also Durgapur, through NH-34 to North Bengal, Bangladesh via Petrapole and Bhojadanga Land Custom Stations. A State Highway also connects Haldia with Kolaghat via Tamluk town which is the district headquarters as an alternate connectivity. Besides the major Highways the
Haldia township has an extensive network of roads that serve the different parts of the city and the industrial area. Haldia is also the starting point of National Waterway 1 and 2.

(vi) **Sewerage system**

Domestic wastewater to be generated will be discharged through municipal sewerage system. There is no process wastewater generation envisaged from the proposed LNG terminal.

(vii) **Industrial waste management**

No industrial waste from the process of LNG import, storage and distribution facility is envisaged.

(viii) **Solid waste management**

Hazardous oil waste of about 0.5 KL/year is envisaged. This will be collected and stored at a specified area at the site and will be collected by authorized agency for safe disposal.

(ix) **Power Requirement & Supply / Source**

During the construction phase of the proposed LNG terminal the power requirement is envisaged to be 1.3 MW which will be sourced from Haldia port.

The power requirement for both jetty and on shore site during operation phase is envisaged to be 3.5 MW which will be sourced from Haldia port which will assist in providing the required approvals for the provision of electricity from WBSEDCL up to the battery limits of proposed terminal site as well as upto the Haldia Oil Jetty 1 and 2.

7. **REHABILITATION AND RESETTLEMENT (R & R) PLAN**

(i) **Policy to be adopted (Central/ State) in respect of the project affected persons including home oustees, land oustees and landless laborers (a brief outline to be given).**

Not applicable, since there is no R& R Issue involved.

8. **PROJECT SCHEDULE & COST ESTIMATES**

(i) **Likely date of start of construction and likely date of completion (time schedule for the project to be given).**

Project is scheduled to be completed within 18 - 24 months (tentatively July, 2021) from the start of the construction which is targeted by Oct 2019 after obtaining necessary clearances.

(ii) **Estimated project cost along with analysis in terms of economic viability of the project.**

The proposed LNG Terminal cost is estimated to be about INR. 700 Crores.
9. ANALYSIS OF PROPOSAL (FINAL RECOMMENDATIONS)

(i) Financial and social benefits with special emphasis on the benefit to the local people including tribal population, if any in the area

The proposed LNG terminal will have following benefits on the socio and financial aspects:

- Enhance National Energy Security and Sustainability.
- Support Ministry of Shipping’s initiative of promoting LNG as a fuel for barges running along inland waterways and ships along the coast of India.
- Support Government’s initiative to increase the percentage of gas utilization in India from current 6% to 12% and primarily promoting Natural gas in the eastern and north eastern part of India.
- Support Industries in Eastern and North Eastern parts of the country in transition to a cheaper and cleaner fuel.
- Support City Gas Distribution programs in the cities not yet connected to Gas Pipeline – Kolkata, Haldia, Howrah etc.
- Support Government Policy towards reducing CO₂ emissions and air pollution.
- Support Government of India’s major initiatives of development in India – Swachh Ganga Abhiyan, Sagar Mala Project, and Indian Railways – Alternative fuels Initiative, JalMargVikas, Development of Inland Waterways of India, Green Corridors.
- Support BBIN (Bhutan, Bangladesh, India, Nepal) initiative by making Gas accessible to these countries.
- Making Mining sector more competitive and greener.

Employment: Preference will be given for locals for employment based on qualifications & requirement.

Medical facilities: Medical facilities will be provided for employees as well as people of nearby villages.

Educational facilities: Basic educational and vocational facilities will be provided for the children of employees as well as nearby villagers

****