



LNG Easy Private Limited

## **HEALTH, SAFETY, SECURITY & ENVIRONMENTAL PROTECTION (HSSE) POLICY**

LNG Easy (Private) Limited (LNGe) is committed to the health, safety, security and wellbeing of its staff and of those people that could be affected by its business. Enhanced safety work culture, protection of environment and avoidance of any adverse impact on the environment (marine or otherwise) including property and the protection of company's assets.

**The main objectives of company's HSSE Policy are as follows:**

- Provide a safe and healthy workplace for all employees and workers in company facilities.
- Ensure that HSSE considerations are integrated into all activities.
- Encourage participation and consultation of employees and contractors to promote a culture where everyone takes responsibility for HSSE.
- Prevent any accident including process safety accidents, that may result in bodily injury, ill health or damage to the property and environment.
- Improve continually the HSSE management system.
- Confirm that all reasonably practicable efforts are made to safeguard visitors, contractors and members of the public, who could be affected by its activities.
- Protect the environment and respond appropriately to any emergency.

LNGe will meet or exceed all of Pakistan's relevant statutes, regulations and codes of practice, and will take following appropriate steps within its authority;

- Frequently inspects, audits and ensures maintenance of plant and equipment which is safe and minimizes risks to health and the environment.
- Assure safety and reduction of risks to health and wellbeing in relation to the use, handling, storage and transportation of articles and substances.
- Maintenance of a safe place of work, and provision of a safe means of access and egress from it.

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## LNG Easy Private Limited

- Provision and maintenance of adequate welfare facilities; Provision of sufficient information, instruction, training and supervision as is necessary to ensure the health and safety of employees at work.
- Continuous improvement of the environmental and health impact of operations by minimizing pollution and waste, and resource consumption, and using energy efficiently.
- Setting measurable objectives, leading indicators and targets aimed at controlling higher risk activities and increasing awareness of health, process and occupational safety.
- Manage and respond to all security threats, including terror threats by identifying all potential threats and implementing corresponding control/mitigating measures.
- Ensure that the quality of its products is safe for use by customers.
- Be prepared to respond effectively during an emergency.
- Regular review of HSSE Policy.

To realize these objectives, LNGe shall make available adequate resources to promote and maintain best practices in Health, Safety, Security & Environmental Management.

The company requires and will ensure full participation and involvement of all employees and contractors engaged by LNGe to manage and execute its HSSE initiatives in line with this Policy.



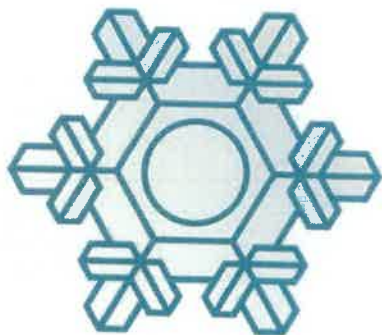
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**LNG Easy Private Limited**

**Final Report  
March 2021**

# **ENVIRONMENTAL IMPACT ASSESSMENT (EIA)**

## **SMALL SCALE LNG DISTRIBUTION THROUGH VIRTUAL PIPELINE**



Environmental & Analytical Solutions

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## Abbreviations

Symbol	Description
LNG	Liquefied Natural Gas
MFP	Mobile Filling Platform
KPT	Karachi Port Trust
Regas	Regassification
FSU	Floating Storage Unit
DES	Delivery Ex-Ship
JKM	Japan Korea Marker
SSLNGC	Small-Scale LNG Carrier
FSRU	Floating Storage and Regasification Unit
BOG	Boil-Off Gas
CNG	Compressed Natural Gas
DG	Dangerous Good
PCI	PetroChina International (Middle East) Company Limited
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
RLNG	Regasified LNG
EBIDTA	Earnings Before Interest, Taxes, Depreciation and Amortization
IRR	Internal rate of return
CPEC	China-Pakistan Economic Corridor
MN	Methane Number
PSO	Pakistan State Oil
SSGCL	Sui Southern Gas Company Limited
SNGPL	Sui Northern Gas Pipeline Limited
L-CNG	LNG supply solution for CNG stations

## Units

Symbol	Description
mtpa	Million tons per annum
scf	Standard Cubic Feet
mmscfd	Million Standard Cubic Feet Per Day
BTU	British Thermal Unit
MMBtu	Million BTU
Cbm	Cubic meter
°C	Degree Celsius
Lbs	Pounds
Kg	kilogram



## Executive Summary

Pakistan has become one of the top emerging markets for the super-chilled fuel in recent years as domestic gas production has plateaued, forcing the nation to import cargoes. The nation has also auctioned a record 20 oil and gas blocks to encourage exploration activity. Pakistan, which imported its first cargo five years ago, currently has two LNG terminals. It's running the two terminals at capacity to meet peak winter demand. Two more LNG terminals, Energas and Mitsubishi's Tabeer Energy, are expected to start in the next few years<sup>1</sup>. Significant growth of RLNG usage in energy mix has helped in improved supply to various power plants like Bhikki, Haveli Bahadur Shah, Balloki, Halmore, Orient, Rousch, KAPCO, Saif and Sapphir being supplied to fertilizer plants, industrial and transport sectors. The comparison of share of different sources of electricity generation is given below:

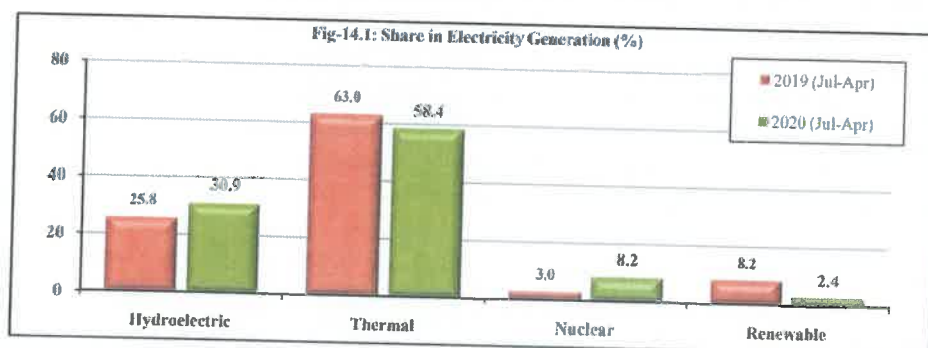


Figure EX-1: Share in Electricity Generation (%)

Source: 14-Energy 02-06-2020 (finance.gov.pk)

LNG Easy (Pvt) Limited, a Consortium of LNG Easy Pte. Limited Singapore, who are pioneers in Small Scale LNG Distribution through Virtual Pipeline concept along with PetroChina International Middle East (PCI) are developing Pakistan's first Virtual Pipeline for supply of Small-Scale LNG in ISO Cryogenic Tanks mostly to OFF-GRID clients nationwide.

M/s LNG Easy Singapore is already in this business of "Small Scale LNG through Virtual Pipeline" and is successfully operating similar projects in China, Malaysia, Myanmar and Vietnam while PCI is the largest LNG importer in China with revenues over several billion dollars. LNG Easy's world's first Plug & Play LNG Mobile Filling Platform (MFP) will directly transfer LNG from ships to Cryogenic tanks through proprietary MFP. Subsequently ISO tanks will be

<sup>1</sup> Pakistan's new pipeline with Russia to increase LNG import capacity (worldoil.com)

transported to the destination by road and rail. LNG Easy will re-gasify the LNG at end user premises and will also provide gas storage units.

No dedicated berth is required for off-loading at KPT. The berth will be available for use once the off-loading operations are complete. The berth on the average will only be occupied for about 12 days in a month. No permanent structure is required to be built on the berth and the MFP will moved away after completion of operations. Arrangements are also being made for transportation of these ISO tanks to up country through Pakistan Railways which will further enhance the revenue stream and expertise of Pakistan Railways. This project will result of inflow of millions of dollars in FDI and creation of new jobs in Oil & Gas, Transportation and Construction Sectors of the country.

Quantitative Risk Analysis (QRA) and HAZOP/HAZID conducted by world renowned classification and risk management company M/s. DNV GL Singapore. EHS Services has been commissioned by LNGE to conduct a Environmental Impact Assessment (EIA). LNG Easy is in the final stages of completion of all regulatory formalities for grant regulatory approvals from respective departments / agencies / authorities for first ever Small-Scale LNG Virtual Pipeline project. It is planned to bring much needed LNG by 3<sup>rd</sup> Qtr 2021.

- LNGe has identified three possible locations in Pakistan for LNG importation, storage and breakbulk operations, namely Gwadar Port, Port Qasim and Karachi Port.
- LNGe's Singapore HQ has proprietary equipment in the form of MFP which can be used to receive LNG and perform break-bulking operations.



- The MFP is essentially an LNG receiving and offloading pontoon, which can be moored by anchor and chains, or by piles. Alongside jetties, the MFP is a manifold tower to receive LNG from LNG carriers. At locations without jetty, the MFP is a prefabricated jetty.
- Some small investment is required around the MFP jetty, such as a container yard, parking lot for trucks, and some buffer storage (optional).
- Bulk LNG can be imported into Pakistan by means of SSLNGCs. This imported LNG can then be filled into ISO tank containers, and thereafter



distributed by trucks. This system of liquid-to-liquid virtual pipeline delivery will not compete against “system gas” as it effectively caters to a different clientele.

- This EIA shall focus on the proposed development at Karachi Port.
- Karachi port will allow unloading of LNG cargos, including LNG ISO Containers / Cryogenic Bowsers, at their berths No.18, 19 and 23. It is proposed to undertake unloading/loading of LNG ISO Containers / Cryogenic Bowsers pre-filled at source ports overseas and also by using mobile LNG container filling system through which LNG will be filled in 40 feet ISO Containers/LNG Bowsers on trailers parked on the berth.



Figure EX-2: Proposed LNG Filling Operations at Berth 18/19 (Alternate 1)



Figure EX-3: Proposed LNG Filling Operations at Berth 19 (Alternate 2)



Figure EX-4 Proposed LNG Filling Operations at Berth 23 (Alternate 3)

- Initially small-scale LNG vessels of 10,000 to 30,000 cubic meter size will be used which will discharge LNG into ISO Containers/Cryogenic Bowsers at the allocated berths at Karachi port through Mobile Filling Platform (MFP) moored at the berth. The LNG vessel will be moored on the outside of the MFP. The MFP will be removed from the berth immediately upon completion of discharge activity.

#### GENERAL FLOW DIAGRAM

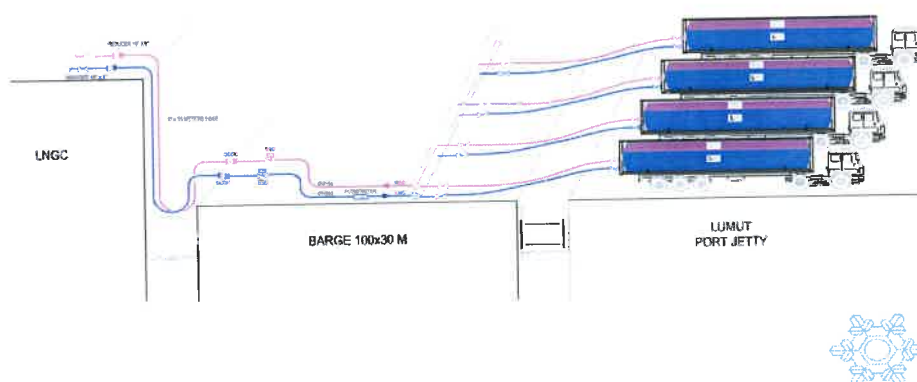
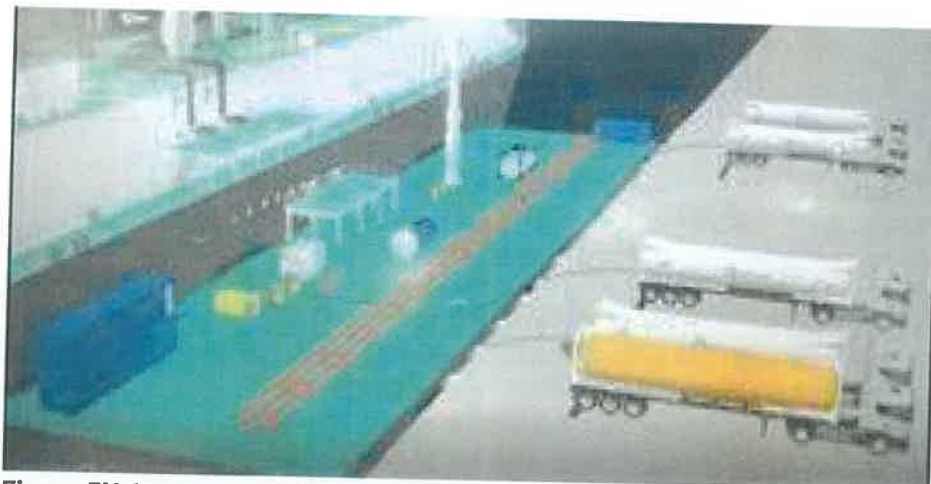


Figure EX-5: General Process Flow Diagram

- The MFP will be moored alongside the LNGC and jetty for LNG ISO Containers and Cryogenic LNG Bowser/Road Truck will be on the other side, as shown in Figure 3.6.



**Figure EX-6: Layout of LNGC, MFP and LNG ISO Container or Cryogenic LNG Bowser/Road Truck**

- LNG from the LNGC will be unloaded to the LNG ISO containers or Cryogenic LNG Bowser/Road Truck will be filled via the Mobile Filling Platform (MFP) at the jetty. Operators will need to connect the filling hose and vapour return hose to each ISO Container or Cryogenic LNG Bowser / Road Truck. Vapour return from the ISO containers will be sent to LNG buffer tank where the gas will be heated and sent as fuel gas to the gas generators.
- Up to 18 ISO containers or Cryogenic LNG Bowser/Road Truck can be filled simultaneously. Once filling is completed, operators will disconnect the hoses and the ISO containers/trucks will leave the jetty.
- The filling rate to each ISO containers is  $40\text{m}^3/\text{hr}$ . It is anticipated that it will take 1hr to fill the ISO containers. For offshore operation, flowrate of up to  $720\text{m}^3/\text{hr}$  ( $40\text{m}^3/\text{hr} \times 18$  ISO tanks) is envisaged.
- LNG from LNGC will be pumped from cargo tank to fill the 40' LNG ISO containers. The in-tank main cargo pump design flowrate is  $1400\text{m}^3/\text{hr}$  and since the pumping capacity is much higher than the flowrate into the ISO containers, throttling is necessary from the LNGC. The flowrate can be reduced to  $420\text{m}^3/\text{hr}$  with throttling. Boil off gas (BOG) will be generated and returned to the LNGC via the vapour return line and needs to be handled on the LNGC. Spray pump on the LNGC will be used during start-up/ initial filling to cool down the whole system before starting the LNG transfer via the main cargo pump.
- Unloading of ISO Containers/Cryogenic Bowsers pre-filled at sources overseas can commence immediately followed by unloading/filling through MFP, which will be deployed within 60 days of receiving Licenses and approval permits. LNG Easy will also facilitate provision of LNG ISO containers/Cryogenic Bowsers for transport of LNG and the regasification facilities required at the customer locations.

- Initially the cargo volumes will be around 350,000 tons per annum and will be increased subsequently. Traditional pipelines have a high capital cost and are usually only viable to those who consume high volumes. Building the infrastructure also takes time and it frequently encounters “right-of-way” and squatting issues. The proposed system makes it possible to deliver LNG anywhere with road or rail access. The parcels can also be delivered in much smaller quantities, making it economically feasible to serve retail demands.
- For handling of 350,000 tons per annum of LNG cargo the designated berth will be occupied only for up to a maximum of twelve days in a month. Up to seven 10,000 cubic meter LNG vessels will be unloading cargo per month, each ship capable of filling 244 forty (40) feet LNG ISO Containers/Cryogenic Bowsers in about 39 hours through MFP.
- The berth will remain unoccupied for more than 18 days a month as MFP will be towed away from the berth immediately upon completion of filling operation and will be redeployed at the berth only on the arrival of next ship for facilitating unloading operations.
- The comments expressed by the institutional stakeholders at the scoping session as well as the participants at public consultation and focus group discussions were noted. These comments have been analyzed as socioeconomically viable statements of the participants and have been reflected in the detailed engineering design as much as possible. Since these consultation meetings / FGDs were an open forum for all, there was a representation from all groups by language, age and income levels. This is a continuous process and will be continued until the issues pertaining to the project are settled to the reasonable satisfaction of stakeholders, especially the affected local communities, if any. The result of the consultation was a clear identification of the issues perceived to be important by the community and stakeholders and the need to respond to those issues in the EIA. Mitigation of potential environmental effects of concern to the community and other stakeholders has been incorporated into the project planning and will occur throughout the implementation of the project.
- **The entire operation will not require construction of any permanent/fixed structure, re-gasification or storage at the port and is confined only to unloading of pre-filled LNG ISO Containers/Cryogenic Bowsers and/or from LNG Vessel through MFP to the LNG ISO Containers/Cryogenic Bowsers on 40 feet trailers on the berth.**
- **Thus, this project would not require any site preparation works (dredging and/or reclamation activities) and would therefore have ‘No’ impact on the marine ecosystem in particular the mangroves and benthic ecology.**

The following are conclusions derived from the QRA study:

- For public risk, the intolerable risk for public, which is  $1\text{E-}04$  per year, does not extend beyond the MFP, and the broadly acceptable risk level of  $1\text{E-}06$  per year is contained within the jetty area. As such, the risk to public is considered to be within the ALARP region.
- The Individual Risk Per Annum (IRPA) for an individual working on the MFP is estimated to be  $2.15\text{E-}05$  per year. This is calculated based on the risk for an arbitrary person working at a particular location (in this case personnel is assumed to be positioned at the main pipe rack area of the MFP), with a 12 hours work shift per day (split of 70% of time spent outdoor, 30% indoor). The filling operation is assumed to take place 12 days in a month. This risk result shows that the IRPA for workers on the MFP falls within the ALARP region (i.e. between  $1\text{E-}07$  per year to  $1\text{E-}04$  per year).
- The furthest radial distance extended by the  $1\text{E-}06$  per year risk contour from the centre of the MFP is approximately 120m in length. 120m is thus recommended as the minimum distance between centre of the MFP and any on-shore/off-shore facilities, if applicable.
- The Ignition Exclusion Zone (IEZ) has been determined to be approximately 120m from centre of the MFP (potential release at LNG filling hose connection at the filling bay). The marine exclusion zone distance set for LNGC is calculated to be 60m. This is the minimum distance for any passing vessels or marine vessels plying the area (except authorized vessel with appropriate ignition control measures in place) during LNG filling operations.
- Within the defined IEZ / MEZ radius, the following restrictions must be in place:
  - Unauthorized entry must be restricted within the IEZ / MEZ radius. Only dedicated personnel are allowed in the area.
  - On water, this restriction will include small boats, fishing vessels and other marine vessels that are unlicensed for harbour work and are carrying open air ignition sources.
  - No activities can be performed which can introduce ignition sources (e.g. hot work, hot surfaces, etc.).

The detailed report of QRA and HAZID / HAZOP is attached as Annex.

#### Conclusion:

OGRA forecasts an inexorable decline in domestic gas production. OGRA accepts that "IP and TAPI seem to be taking their time" and says that "in the coming five years, LNG imports seem to secure the maximum contribution in



the energy mix". Opportunity exists to develop private sector LNG projects for the supply of affordable and competitive gas to:

- Fertilizer plants
- Anticipated captive power plants
- CNG Sector
- New power plants and the private sector (industry, textile, IPPs)

The Oil and Gas Regulatory Authority (Ogra) on has recently granted the provisional licenses of virtual liquefied natural gas (LNG) pipeline to LNG Easy (Private) Limited for supply of the fuel through bowzers to consumers outside the gas network. These would be first of its kind projects in Pakistan to facilitate the supply of natural gas mainly to off-grid consumers. Provisional License' have been issued on completion of all formalities under the Ogra Ordinance 2002, LNG Policy 2011 and LNG Rules 2007 to allow for carrying out regulated activities in the LNG business.

The demand and supply gap provides comfort that clearly there is enough demand to justify the setting up a Liquefied Natural Gas (LNG) receiving and offloading facility for LNG ISO containers or Cryogenic LNG Bowser/Road Truck filling. Pakistan has an excellent basis for virtual pipeline with an extensive highway system been built over the last six years. Pakistan also has world's most extensive network of CNG-filling stations built over twenty years ago.

LNG Easy is introducing this new system of LNG supply in Pakistan through involvement of private sector in the development of natural gas infrastructure and take the burden away from the government for providing people their basic energy needs. To summarize, the following markets will be served through LNG Easy ISO Containers/Cryogenic Bowzers:

- L-CNG.
- Industrial boiler and furnaces.
- Back-up and distributed power.
- LNG refueling stations.
- City/rural gas distribution franchises.

The new concept of supply of LNG through ISO Containers/Cryogenic Bowzers will go a long way in provision of much needed energy to the commercial and industrial sectors of the country resulting in widespread benefits to the population and overall social and economic uplift and development of Pakistan.

The cumulative impact on the National economy will be strongly positive. Significant additional resources will be realized by the nation as a result of this project, which is consistent with the government's long-term development plan. The additional licensing income, among other sources of additional income, will add to the government revenues and economic growth resulting from expanded and diversified business development in Pakistan in future.

A series of mitigation and monitoring measures have been included to address the risks involved in the handling of LNG/RLNG. Environmental Management and Monitoring Plan as well as safety and security measures would ensure that the Project will not create adverse environmental impacts that have not been mitigated or leave the safety and security concerns of the stakeholders unmitigated.

The Environmental Impact Assessment (EIA) study finds that the establishment of proposed LNG project is compatible with the aims and objectives of sustainable development in making available a sustainable energy source and thus contributing to economic development.

The Study therefore recommends that the Environmental Impact Assessment (EIA) report should be approved with the provision that the suggested mitigation measures will be adopted and the Environmental Management Plan (EMP) will be followed in letter and spirit.



## 1.0 Introduction

LNG Easy (Pvt) Limited, a Consortium of LNG Easy Pte. Limited Singapore, who are pioneers in Small Scale LNG Distribution through Virtual Pipeline concept along with PetroChina International Middle East (PCI) are developing Pakistan's first Virtual Pipeline for supply of Small-Scale LNG in ISO Cryogenic Tanks mostly to OFF-GRID clients nationwide.

M/s LNG Easy Singapore is already in this business of "Small Scale LNG through Virtual Pipeline" and is successfully operating similar projects in China, Malaysia, Myanmar and Vietnam while PCI is the largest LNG importer in China with revenues over several billion dollars. LNG Easy's world's first Plug & Play LNG Mobile Filling Platform (MFP) will directly transfer LNG from ships to Cryogenic tanks through proprietary MFP. Subsequently ISO tanks will be transported to the destination by road and rail. LNG Easy will re-gasify the LNG at end user premises and will also provide gas storage units.

No dedicated berth is required for off-loading at KPT. The berth will be available for use once the off-loading operations are complete. The berth on the average will only be occupied for about 12 days in a month. No permanent structure is required to be built on the berth and the MFP will moved away after completion of operations. Arrangements are also being made for transportation of these ISO tanks to up country through Pakistan Railways which will further enhance the revenue stream and expertise of Pakistan Railways. This project will result of inflow of millions of dollars in FDI and creation of new jobs in Oil & Gas, Transportation and Construction Sectors of the country.

Quantitative Risk Analysis (QRA) and HAZOP/HAZID conducted by world renowned classification and risk management company M/s. DNV GL Singapore. EHS Services has been commissioned by LNGE to conduct a Environmental Impact Assessment (EIA). LNG Easy is in the final stages of completion of all regulatory formalities for grant regulatory approvals from respective departments / agencies / authorities for first ever Small-Scale LNG Virtual Pipeline project. It is planned to bring much needed LNG by 3<sup>rd</sup> Qtr 2021.

### 1.1 Energy Demand Forecast

Successive discoveries of large natural gas reserves have shaped Pakistan's energy history since the 1950s. These sparked, in the 1960s, the growth of the domestic fertilizer industry and large public-sector gas distribution utilities. Between the mid-1970s and the 1990s, all the major power plants that the government set up were based on dual fuel, with natural gas as the primary



fuel. The share of gas in Pakistan's primary energy mix stood at approximately 50% in 2005. Since then, in the absence of major gas field additions, gas production has plateaued, and imported oil has begun to take on a greater burden of the energy demand. More recently, higher coal and LNG imports have offset the decreasing share of local gas supplies.

At the beginning of last decade, Pakistan experienced widespread power and gas shortages. Many parts of the country, particularly the rural areas, suffered 8-12 hours of blackout every day during the peak summer months and low gas pressure or supplies during the peak winter months. Then, in 2013, a new government came into power, winning on a mandate to eliminate energy shortages. Over the next 05 years, Pakistan invested heavily in its energy infrastructure, adding at least 10 GW in new power generation capacities (including about 02 GW of coal) and commissioning 1.3 billion cubic feet per day of LNG-importing infrastructure.

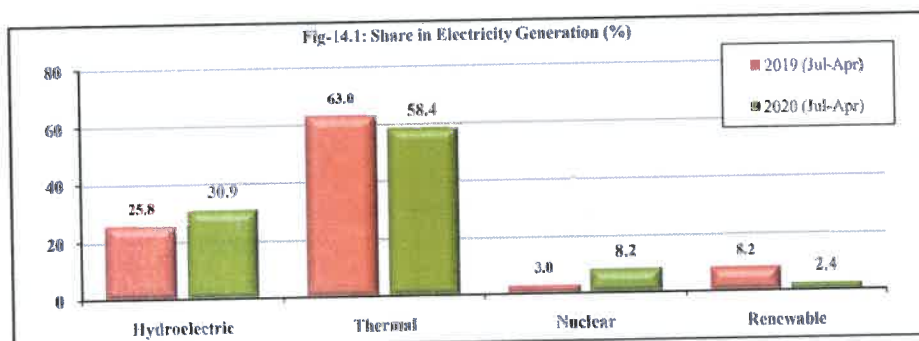
The share of natural gas in Pakistan's primary energy mix stood at approximately 50% in 2005. Since then, in the absence of major gas field additions, gas production has plateaued. Today, natural gas makes up around 35% of the country's primary energy mix. Overall, Pakistan imports nearly a third of its energy supplies in the form of oil, coal, and recently LNG. The expectation is that this share of imports will grow drastically as the local gas reserves deplete. Oil & Gas Regulatory Authority projects that local gas production will fall from ~4 billion cubic feet per day currently to about 2 billion cubic feet per day by 2025. Over the same period, it expects the demand for gas to increase by 1.5 billion cubic feet per day. If energy imports were to replace this additional 3.5 billion cubic feet per day of gas shortfall, Pakistan's energy imports would have to increase by more than double (in tonnes of oil equivalent).<sup>2</sup>

Pakistan is successfully overcoming energy crisis, which has direct and indirect impact on all sectors of the economy, through increase in generation as well as in transmission capacity of the system. Presently, Energy Sector is confronted with demand supply gap, which needs to be filled up along with improvement in energy-mix for its supply at lower cost. In terms of energy-mix, Pakistan's reliance on thermal which includes imported coal, local coal, RLNG and natural gas has been decreasing over last few years. Pakistan's dependence on natural gas in the overall energy mix is on decline and the reduction of its share in the energy mix may be attributed to declining natural gas reserves as well as to the introduction of LNG since 2015. The share of renewable has steadily increased over the years (% share, however, in July-April 2020 has declined as compared to same period in 2019). The shares of Hydro and nuclear in energy-mix have

<sup>2</sup> Energy Security in Pakistan: A Quantitative Approach to a Sustainable Energy Policy (adb.org)

also increased in FY2020 as compared to FY 2019. Such historical variability for each energy source in the energy mix of the country has been used to formulate the Integrated Energy Plan. The Integrated Energy Plan will not only help in envisioning the energy demands and respective supply paths of the future but also to formulate evidence based long term policy options.

Pakistan has become one of the top emerging markets for the super-chilled fuel in recent years as domestic gas production has plateaued, forcing the nation to import cargoes. The nation has also auctioned a record 20 oil and gas blocks to encourage exploration activity. Pakistan, which imported its first cargo five years ago, currently has two LNG terminals. It's running the two terminals at capacity to meet peak winter demand. Two more LNG terminals, Energas and Mitsubishi's Tabeer Energy, are expected to start in the next few years<sup>3</sup>. Significant growth of RLNG usage in energy mix has helped in improved supply to various power plants like Bhikki, Haveli Bahadur Shah, Balloki, Halmore, Orient, Rousch, KAPCO, Saif and Sapphir being supplied to fertilizer plants, industrial and transport sectors. The comparison of share of different sources of electricity generation is given below:



**Figure: Share in Electricity Generation (%)**

Source: 14-Energy 02-06-2020 (finance.gov.pk)

Natural Gas is a clean, safe, efficient and environment friendly fuel. Its indigenous supplies contribute about 38 percent in total primary energy supply mix of the country. Pakistan produces around four (4) Billion Cubic Feet Per Day (Bcfd) of indigenous natural gas against an unconstrained demand of over six (6) Bcfd. To meet the shortfall, the GoP has initiated the import of LNG. Pakistan has an extensive gas network of over 12,971 Km Transmission 139,827 KM Distribution and 37,058 Services gas pipelines to cater the requirement of more than 9.6 million consumers across the country. Government of Pakistan is pursuing its policies for enhancing indigenous gas production as well as

<sup>3</sup> Pakistan's new pipeline with Russia to increase LNG import capacity ([worldoil.com](http://worldoil.com))

imported gas to meet the increasing demand of energy in the country. At present, the capacity of two Floating Storage and Re-gasification Unit (FRSU) to Re-gasified Liquefied Natural Gas (RLNG) is 1200 MMCFD and accordingly RLNG is being imported to mitigate gas demand-supply shortfall.

GoP introduced LNG Policy for potential investors to facilitate the successful implementation of LNG import projects. As per the said Policy, the project structures can be (i) integrated, in which the terminal developer arranges LNG imports as well as arrange its own buyers and (ii) unbundled, in which the terminal developer, LNG importer and LNG buyers are different.

In pursuance of LNG Policy, 2006 and OGRA Ordinance, 2002, OGRA notified LNG Rules, 2007 to bring the anticipated LNG activity under regulatory regime. LNG Policy encourages prospective project developers to enter into LNG Market after fulfillment of requisite formalities as per LNG Rules.

OGRA forecasts an inexorable decline in domestic gas production. OGRA accepts that "IP and TAPI seem to be taking their time" and says that "in the coming five years, LNG imports seem to secure the maximum contribution in the energy mix". Opportunity exists to develop private sector LNG projects for the supply of affordable and competitive gas to:

- Fertilizer plants
- Anticipated captive power plants
- CNG Sector
- New power plants and the private sector (industry, textile, IPPs)

The Oil and Gas Regulatory Authority (Ogra) on has recently granted the provisional licenses of virtual liquefied natural gas (LNG) pipelines to two private companies — Daewoo Gas and LNG Easy — for supply of the fuel through bowsers to consumers outside the gas network.

These would be first of its kind projects in Pakistan to facilitate the supply of natural gas mainly to off-grid consumers. Provisional License' have been issued on completion of all formalities under the Ogra Ordinance 2002, LNG Policy 2011 and LNG Rules 2007 to allow for carrying out regulated activities in the LNG business, the regulator said.

LNG Easy Pte Ltd, to be based at Karachi Port, and Daewoo Gas Pvt Ltd, to be located at Gwadar Port, would pursue LNG virtual pipeline project for supply of gas through cryogenic bowsers. At respective ports, the two companies

would import LNG cargoes, fill, transport, market and distribute the fuel under the 'Integrated LNG Project Structure' as per the LNG Policy 2011.<sup>4</sup>

The above analysis provides comfort that clearly there is enough demand to justify the setting up a Liquefied Natural Gas (LNG) receiving and offloading facility for LNG ISO containers or Cryogenic LNG Bowser/Road Truck filling. Pakistan has an excellent basis for virtual pipeline with an extensive highway system been built over the last six years. Pakistan also has world's most extensive network of CNG-filling stations built over twenty years ago.

The major shareholding of LNG Easy is held by LNG Easy Pte Ltd of Singapore which has experience in break bulking of LNG into ISO containers and cryogenic bowzers for further distribution to customers.

The company plans to use berth No 18 to 20 at Karachi Port Trust (KPT) for import of LNG cargoes and then use a Mobile Filling Platform (MFP) to fill ISO containers/cryogenic bowzers for further distribution.

## 1.2 Environmental Impact Assessment

### 1.2.1 Need for EIA

The EIA study of proposed Project responds to:

- Section 17 of Sindh Environmental Protection Act 2014 which requires that every new development project in Sindh has to be preceded by an Initial Environmental Examination (IEE) or Environmental Impact Assessment (EIA) depending on the nature and severity of impacts anticipated on commissioning of the project;
- Procedures set out in Sindh Environmental Protection Agency (Review of IEE/EIA) Regulations 2014 which categorizes projects requiring IEE and EIA in Schedules I & II respectively.
- LPG and LNG Projects (including LNG Terminals, re-gasification units) are covered by Schedule-II, list of projects requiring EIA.
- Accordingly, an EIA study has been conducted and the report will be submitted to Sindh EPA for review & approval.

### 1.2.2 Objectives of EIA

The main purpose of this EIA Study is to respond to provisions of Sindh Environmental Protection Act 2014 and the rules & regulations framed

<sup>4</sup> Provisional licenses of virtual LNG pipelines granted - Newspaper - DAWN.COM



thereunder, and to provide information on the nature and extent of environmental impacts arising from developing Pakistan's first Virtual Pipeline for supply of Small-Scale LNG in ISO Cryogenic Tanks mostly to OFF-GRID clients nationwide. that would take place concurrently or subsequently. The EIA study has been conducted for the purpose of:

- Describing the environmental baseline of the project area.
- Describing the activities pertaining to the Project.
- Ascertaining applicability of relevant rules and regulations to the site and operations.
- Identifying the environmental consequences of siting the project and inception of associated activities; QRA will assess the risks due to the LNG filling operations at these three berths in support of the selecting the LNG filling location at Karachi Port.
- Undertaking the environmental assessment from the perspective of environmental & social aspects in the project area & suggesting mitigation measures for sustained development.
- Ensuring the adequacy of proposed mitigation measures to deal with residual impacts after implementation of the Project.

### 1.2.3 Approach to the EIA

A brief overview of the conceptual components of an EIA Process that meets both Sindh, Pakistan and international standards is given below:

Table 1.4 - Conceptual Components of an EIA process		
Components	Main Purpose	Activities related to Stakeholder Consultation
Scoping	<ul style="list-style-type: none"> <li>▪ Identify the issues on which the EIA should focus</li> <li>▪ Identify the project alternatives that should be evaluated during the course of the EIA.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Identify institutional and community stakeholders</li> <li>▪ Engage stakeholders and record issues raised</li> <li>▪ Provide feedback to the EIA team to incorporate stakeholders concern in baseline investigations and impact assessment</li> </ul>
Baseline investigations	<ul style="list-style-type: none"> <li>▪ Collect background information on the environmental and social setting of the project</li> </ul>	<ul style="list-style-type: none"> <li>▪ Incorporate additional issues raised during the baseline survey</li> </ul>
Impacts assessment studies	<ul style="list-style-type: none"> <li>▪ Define the potential impacts of the project</li> <li>▪ Undertake specialist investigations to predict</li> </ul>	<ul style="list-style-type: none"> <li>▪ Assess issues raised by stakeholders</li> </ul>

Table 1.4 - Conceptual Components of an EIA process

	<p>changes to the environment due to the project</p> <ul style="list-style-type: none"> <li>▪ Determine the significance of the potential impacts</li> <li>▪ Identify measures for the management of the impacts</li> <li>▪ Determine the residual impacts of the project after incorporation of the management measures</li> <li>▪ Evaluate the overall acceptability of the project (from environmental and social perspectives).</li> </ul>	
Mitigation Measures and management plan	<ul style="list-style-type: none"> <li>▪ Environmental mitigation and monitoring plan will describe the measures proposed to ensure implementation of the mitigation measures identified during the impact assessment. It will include, for example, specific designs and plans, training requirements, resources requirement, monitoring details (sampling locations, methodology and frequency). Review and reporting requirements and budget.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Assess the acceptability and practicability of the proposed mitigation measures</li> </ul>
EIA Report Preparation	<ul style="list-style-type: none"> <li>▪ After the studies, the EIA team will put together the detailed assessment of impacts and mitigation measures. This may involve liaison with various specialists to ensure correct interpretation of information and compile EIA report.</li> </ul>	<ul style="list-style-type: none"> <li>▪ Provide stakeholders with a feedback on the EIA specifically communicate how the project proposes to address the issues raised by the stakeholders</li> </ul>
EIA submittal to regulatory authorities and decision making	<ul style="list-style-type: none"> <li>▪ Submittal and review of the EIA report by regulatory authorities and other interested stakeholders. The reviewers will inform about the decision on the acceptability of the project from environmental and social perspectives and the condition of approval for the development</li> </ul>	<ul style="list-style-type: none"> <li>▪ Attend the public hearings and respond to the issues raised during the public hearings.</li> </ul>

#### 1.2.4 Methodology Adopted for EIA

This study has covered all major areas of concern as per regulatory requirements. Scope of the EIA study included collection of data from different sources, development of baseline of the current physical, ecological and social baseline of the area through surveys. In general, the study has been conducted in accordance with the Sindh Environmental Protection Agency (Review of EIA and IEE) Regulations, 2014 & guidelines provided therein.

Following screening of potential environmental impacts, the requirement for mitigation measures to address the adverse impacts is presented. The Report includes the Environmental Management and Monitoring Program that will be implemented during the different phases of the project. This environmental impact assessment was conducted in the following manner:

#### 1.2.5 Scoping

A scoping exercise was undertaken to identify the potential issues that are to be considered in the environmental impact assessment.



The scoping exercise included the following tasks:

**Data Compilation:** A generic description of the proposed activities relevant to this environmental assessment was compiled with the help of the Project proponent.

**Review of Published literature:** All available published and unpublished information pertaining to the micro and macro environment of the study area was obtained and reviewed. It included the earlier studies conducted in the study area, environmental and social baseline and impact assessment studies conducted by different consultants in past. Secondary data was very helpful in understanding the issues that were identified by other consultants.

**Review of applicable Legislation:** Information on relevant legislation, regulations, guidelines, and standards was reviewed and compiled.

**Identification of potential impacts:** The information collected in the above procedures was reviewed and potential environmental issues identified.

**Initial site visit:** An initial site visit was conducted to get an overview of site conditions and the surrounding areas.

**Stakeholder consultation:** Stakeholder consultation was undertaken to document the concerns of the stakeholders, and to identify issues that may require additional assessment in order to address these concerns. Stakeholder consultation was conducted during the survey with following objectives:

- To inform the stakeholders about the project and gather feedback
- To identify relevant potential environmental & social issues of the project, and corresponding mitigation measures.

#### 1.2.6 Review of Legislation and Guidelines

National & Provincial legislations, international agreements, environmental guidelines, and best industry practices were reviewed to set environmental standards that Project Proponents will be required to follow during different stages of the project. Review of legislations included but not limited to the following:

- Policies and Legislation relevant to LNG.
- Complementary legislation applicable to project for sustainable management of the environment covering land, water resources & water quality, solid waste management, atmospheric emissions.
- Administration: identification of relevant organization with its role and responsibility and make clear the approval process with its average time schedule though visit to relevant organization and reviewing documents.

The SEPA 2014 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. A number of rules and regulations have been promulgated under the SEPA 2014. These are:

- Environmental Samples Rules, 2014
- Pollution Charge for Industry (Calculation and Collection) Rules, 2014
- Provincial Sustainable Development Fund Board (Procedure) Rules



- The Sindh Environmental Quality Standard (Self-Monitoring & Reporting by Industry) Rule, 2014
- Sindh Environmental Protection Agency (Review of IEE and EIA), Regulations 2014
- Sindh Environmental Quality Standards.

There is a long list of legislation that falls in the category of or is relevant to environmental law. Some of the more important ones are:

- LNG Policy 2011
- International maritime treaties and environmental conventions
- London convention on the prevention of marine pollution by dumping of wastes and other matter 1972
- MARPOL 1973 (modified in 1978)
- The convention on biological diversity
- IFC Environment, Health and Safety guidelines on LNG
- Sindh wildlife protection ordinance, 1972
- The Antiquities Act, 1975
- Sindh Cultural Heritage (Preservation) Act, 1994

#### 1.2.7 Baseline Data Collection

Detailed environmental baseline surveys were conducted to collect primary data on the Project Area to help identify sensitive receptors. The primary data were examined and compared with secondary data available from earlier environmental studies in the region. The scope of survey included collection of information on following key aspects:

(1) To confirm baseline data including Biophysical of the Project Area including the following items with their seasonal variability:

- |                        |                  |
|------------------------|------------------|
| ▪ Climate and Rainfall | ▪ Geology        |
| ▪ Air Quality          | ▪ Geomorphology  |
| ▪ Noise Quality        | ▪ Hydrology      |
| ▪ Topography           | ▪ Flora & Fauna  |
| ▪ Soil                 | ▪ Marine Ecology |

(2) To confirm baseline data including Socio Economic Environment of the Project Area including the following items with their seasonal variability

- Administrative Division
- Demography and Settlement
- Socio-Economic Activities



- Land use and National Resources Management in the Project area
- Existing Infrastructure and Social Services
- Current socioeconomic issues

#### **1.2.8 Identification of Aspects**

Identification of environmental aspects and their significance is fundamentally important for determination of severity of incidence of impacts at different stages of the project. This step is aimed at obtaining an inventory of the aspects. The aspects identified during this step cover all activities in order to determine those which, have or can have significant impact on the environment.

#### **1.2.9 Impact Assessment & EMP**

Environmental experts at EHSS analyzed and assessed the anticipated impacts that are likely to arise due to the identified aspects. Each of the potential impacts identified during the scoping session was evaluated using the environmental, socioeconomic, and project information collected. In general, the impact assessment discussion covers the following aspects:

- Present baseline conditions
- Potential change in environmental parameters likely to be affected by Project-related activities
- Prediction of potential impacts
- Evaluation of the likelihood and significance of potential impacts
- Defining of mitigation measures to reduce impacts to as low as practicable
- Prediction of any residual impacts, including all long- and short-term, direct and indirect, and beneficial and adverse impacts. QRA was conducted to systematically assess the likelihood and consequence of all credible potential process hydrocarbon risks of the proposed facilities, and:
  - Ascertain if such risks are tolerable in accordance to 'UK HSE and DNV GL Recommended Practice Individual Risk Criteria; and
  - Recommend the Ignition Exclusion Zone (IEZ) and Marine Exclusion Zone (MEZ)
  - The boundary of the study is limited to the following:
    - LNG Vessel
    - Filling operation of ISO containers or Cryogenic LNG Bowser/Road Truck and;
    - Departure of the trucks from the jetty (excluding the transportation risk).
  - QRA is limited to normal operations, with the focus on Major Accident Hazards (MAHs) identified from the HAZID

- Monitoring of residual impacts

An environmental management plan (EMP) was developed to oversee the environmental performance of the project and adoption of proposed mitigation measures. A monitoring plan has also been incorporated in the EMP to monitor impact of all activities and performance of mitigation measures and to identify the residual impact if any, and also the positive/negative changes in the physical, and socioeconomic environment.

#### 1.2.10 Documentation & Review

This is the final step of the EIA study. The data generated during and for the study are compiled and examined by experts of the respective field. Sections of this report were prepared as the study progressed, by EHSS office staff in consultation with experts. The report was finally reviewed by Team Leader, who analysed the information, assessed the potential environmental impacts in the light of national and international guidelines, examined the alternatives in the light of observations on the field as well as meetings with the stakeholders, before organizing the Report in the present form.

## **2.0 Policy, Legal & Regulatory Framework**

This section of the EIA study covers all the applicable National and Provincial legal requirements in the context of the environmental protection & sustainable development, and the institutions that exist in the country that may influence the environmental management of the proposed Project. In addition to the local laws and regulations, Pakistan is also signatory to a number of International environmental conventions which have been ratified by the government. In carrying out this Environmental Assessment, relevant international guidelines have duly been followed.

### **2.1 The 18<sup>th</sup> Amendment in Constitution of Pakistan**

Prior to the 18<sup>th</sup> Amendment to the Constitution of Pakistan in 2010, the legislative powers were distributed between the federal and provincial governments through two 'lists' attached to the Constitution as Schedules. The Federal list covered the subjects over which the federal government had exclusive legislative power, while the 'Concurrent List' contained subjects regarding which both the federal and provincial governments could enact laws. The subject of 'environmental pollution and ecology' was included in the Concurrent List and hence allowed both the national and provincial governments to enact laws on the subject. However, as a result of the 18<sup>th</sup> Amendment this subject is now in the exclusive domain of the provincial government.

As a result, the Ministry of Environment at the federal level has been abolished. Its functions related to the national environmental management have been transferred to the provinces. The international obligations in the context of environment will be managed by the Ministry of Climate Change. Administration on environment has been divided into federal and provincial government. International issues such as the environmental policy and regulation has been managed by Ministry of Climate Change. On the other hand, national environmental matter has been managed by provincial government. In Sindh province, Sindh EPA has been responsible for the provincial matters. All of the environmental technical issues such as EIA, monitoring, enforcement of law/environmental quality standards are headed by Director General of Sindh EPA.

SEPA is a regulatory agency with the following main functions:

- Enforcement of Sindh Act 2014
- Prepare environmental policies for approval of the GoS
- Implement environmental policies
- Publish annual state of the environment report for Sindh



- Prepare or revise SEQS
- Ensure implementation of SEQS
- Establish systems and procedures for environmental management
- Promote research and studies on environmental issues
- Issue license for handling of hazardous substance
- Certify environmental laboratories
- Initiate legislation for environmental protection
- Provide assistance to government agencies in case of environmental accidents
- Providing advice to the government on issues related to environment
- Assist governments agencies in implementation of waste management schemes
- Provide guidance to public on environmental matters
- Assist education institutions in prescribing environmental curricula
- Undertake measures to enhance awareness on environment among general public
- Disseminate knowledge on environment
- Specify safeguards for the prevention of accidents which may cause pollution
- Review and approve mitigation plans and give guidance for clean-up operations
- Encourage the formation and working of nongovernmental organizations, community organizations and village organizations for environmental protection
- Carry out any other task related to environment assigned by the government.
- SEPA has the authority to review and issue approval of the EIA of the proposed Project.

## 2.2 Sindh Environmental Protection Act, 2014

The SEPA 2014 is the basic legislative tool empowering the government to frame regulations for the protection of the environment. The act is applicable to a broad range of issues and extends to air, water, soil, marine, and noise pollution, as well as to the handling of hazardous wastes. This act is applicable to a broad range of issues that extends to air, water, industrial liquid effluent, marine, and noise pollution as well as to the handling of hazardous wastes. The applicable sections of the act to this project are:

- *Section 11(1): Subject to the provisions of this Act and the rules and regulations, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely to cause pollution or adverse environmental effects, as defined*



in section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards; or, where applicable, the standards established under Section 6(1)(g)(i); or direction issued under Section 17, 19, 20 and 21 of this Act; or any other direction issued, in general or particular, by the Agency.

- Section 11(2): All persons, in industrial or commercial or other operations, shall ensure compliance with the Environmental Quality Standards for ambient air, drinking water, noise or any other Standards established under section 6(1)(g)(i); shall maintain monitoring records for such compliances; shall make available these records to the authorized person for inspection; and shall report or communicate the record to the Agency as required under any directions issued, notified or required under any rules and regulations.
- Section 11(3): Monitoring and analysis under sub-section (1) and (2), shall be acceptable only when carried out by the Environmental Laboratory certified by the Agency as prescribed in the rules.
- Section 12: No person shall import hazardous waste into Sindh province or its coastal, internal, territorial or historical waters, except acquiring prior approval of the Agency.
- Section 13: Subject to the provisions of this Act, no person shall import, generate, collect, consign, transport, treat, dispose of, store, handle or otherwise use or deal with any hazardous substance except- Handling of hazardous substances. (a) under a license issued by the Agency; or (b) in accordance with the provisions of any other law, rule, regulation or notification for the time being in force, or of any international treaty, convention, protocol, code, standard, agreement or other instrument to which Government is a party.
- Section 17(1): No proponent of a project shall commence construction or operation unless he has filed with the Agency an initial environmental examination or environmental impact assessment and has obtained from the Agency approval in respect thereof.
- Section 17(3): Every review of an environment impact assessment shall be carried out with public participation and, subject to the provisions of this Act, after full disclosure of the particulars of the project.
- Section 31(1): The Agency shall cause relevant details of any proposed project regarding which an Environmental Impact Assessment has been received to be published, along with an invitation to the public to furnish their comments

thereon within a specified period. (2) In accordance with such procedure as may be prescribed, the Agency shall hold public hearings to receive additional comments and hear oral submissions. (3) All comments received under sub-sections (1) and (2) shall be duly considered by the Agency while reviewing the environmental impact assessment or strategic impact assessment, and decision or action taken thereon shall be communicated to the persons who have furnished the said comments.

- A number of rules and regulations have been promulgated under the SEPA 2014. These are:
  - Environmental Samples Rules, 2014
  - Pollution Charge for Industry (Calculation and Collection) Rules, 2014
  - Provincial Sustainable Development Fund Board (Procedure) Rules, 2001
  - The Sindh Environmental Quality Standard (Self-Monitoring and Reporting by Industry) Rule, 2014
  - Sindh Environmental Protection Agency (Review of IEE and EIA), Regulations 2014
  - Sindh Environmental Quality Standards.
  - Hazardous Substances Rules 2014

### 2.3 Sindh EPA Review of IEE And EIA Regulations 2014

The Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 define Schedules (I & II) of projects falling under the requirement of IEE or EIA. This EIA Study has, for environmental classification of the Project, taken account of the requirements of the Sindh Environmental Protection Agency (Review of EIA/IEE) Regulations 2014 which define Schedules (I & II) as follows:

**Schedule I:** A project falls in Schedule I if it is likely to have adverse environmental impacts, but of lesser degree or significance than those for category 'A' and all the mitigation measures to handle the impact is manageable. Such types of projects need IEE report including EMP.

**Schedule II:** Projects are categorized in Schedule II if they generate significant adverse environmental impacts that require a comprehensive management plan, or if the project is located within or passes through: a) Areas declared by the Government of Pakistan as environmentally sensitive (National Parks/Sanctuaries/Game Reserve), b) Areas of international significance (e.g. protected wetland as designated by the RAMSAR Convention), or c) Areas designated by the United Nations Educational, Scientific, and Cultural Organization (UNESCO) as cultural heritage sites.



According to Sindh Environmental Protection Agency Regulation, 2014, a proponent of a project falling in any category listed in Schedule II shall file an EIA with the Sindh Environmental Protection Agency, since the listed projects are generally major projects and have the potential to affect a large number of people.

The proposed project therefore requires an EIA. Accordingly, an EIA study has been conducted and the report will be submitted to Sindh EPA for review and approval.

## 2.4 Sindh Environmental Quality Standards

The proposed Project is legally required to comply with the SEQS (Sindh Environmental Quality Standards). In addition to SEQS, the Project's environmental performance will also assess compliance with relevant international guidelines on emissions & effluent discharge.

Article 11(1) of the Sindh Act 2014 states that: 'Subject to the provisions of this Act and the rules and regulations, no person shall discharge or emit or allow the discharge or emission of any effluent, waste, pollutant, noise or any other matter that may cause or likely to cause pollution or adverse environmental effects, as defined in Section 2 of this Act, in an amount, concentration or level which is in excess to that specified in Sindh Environmental Quality Standards...'

The Sindh EPA has promulgated several standards, the SEQS, which were applicable to the entire province of Sindh. These include:

- Ambient air quality (9 parameters)
- Drinking water (32 parameters)
- Ambient noise
- Industrial effluents (32 parameters)
- Industrial gaseous emissions (16 parameters).

**Table 2.1: Sindh Environmental Quality Standard for Ambient Air**

Pollutant	Time-weighted average	Concentration in Ambient Air	Method of measurement
Sulfur Dioxide (SO <sub>2</sub> )	Annual Average*	80µg/m <sup>3</sup>	Ultraviolet Fluorescence Method
	24 hours**	120µg/m <sup>3</sup>	
	Annual Average*	40µg/m <sup>3</sup>	Gas Phase Chemiluminescence



Oxides of Nitrogen as (NO)	24 hours**	40µg/m <sup>3</sup>	
Oxides of Nitrogen as (NO <sub>2</sub> )	Annual Average*	40µg/m <sup>3</sup>	Gas Phase Chemiluminescence
	24 hours**	80µg/m <sup>3</sup>	
O <sub>3</sub>	1 hour	130µg/m <sup>3</sup>	Non dispersive UV absorption method
Suspended Particulate Matter (SPM)	Annual Average*	360µg/m <sup>3</sup>	High volume Sampling, (Average flow rate not less than 1.1m <sup>3</sup> /minute)
	24 hours**	500µg/m <sup>3</sup>	
Respirable Particulate Matter (PM <sub>10</sub> )	Annual Average*	120µg/m <sup>3</sup>	B Ray absorption method
	24 hours**	150µg/m <sup>3</sup>	
Respirable Particulate Matter (PM <sub>2.5</sub> )	Annual Average*	40µg/m <sup>3</sup>	B Ray absorption method
	24 hours**	75µg/m <sup>3</sup>	
	1 hour	15µg/m <sup>3</sup>	
Lead (Pb)	Annual Average*	1µg/m <sup>3</sup>	ASS Method after sampling using EPM 2000 or equivalent Filter paper
	24 hours**	1.5µg/m <sup>3</sup>	
Carbon Monoxide (CO)	8hours**	5mg/m <sup>3</sup>	Non Dispersive Infra Red (NDIR) method
	1hours	10mg/m <sup>3</sup>	

\*Annual arithmetic mean of minimum 104 measurements in a year taken twice a week 24 hourly at uniform interval.

\*\*24 hourly / 8 hourly values should be met 98% of the in a year. 2% of the time, it may exceed but not on two consecutive days.

Table 2.2: Sindh Environmental Quality Standard for Noise

S. No.	Category of Area / Zone	Limit it in dB(A) Leq*	
		Day Time	Night Time
1	Residential area (A)	55	45
2	Commercial area (B)	65	55
3	Industrial area (C)	75	65
4	Silence Zone (D)	50	45

Note: 1 Day time hours: 6.00 a. m to 10.00 p. m

2	Night time hours: 10.00 p. m to 6.00p. m
3	Silence zone; Zone which are declared as such by competent authority. An area comprising not less than 100 meters around hospitals, educational institutions and courts.
4	Mixed categories of areas may be declared as one of the four above-mentioned categories by the competent authority.
*dB(A)Leq	Time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

**Table 2.3: Sindh Environmental Quality Standard for Municipal & Liquid Industrial Effluents**

S. #	Parameter	Into Inland Waters	Into Sewage Treatment	Into Sea	unit
1	Temperature or Temp. increase	<3	<3	<3	°C
2	pH value (H <sup>+</sup> )	6-9	6-9	6-9	
3	Biological Oxygen Demand (BOD) <sub>5</sub> at 20°C	80	250	80	mg/l
4	Chemical Oxygen Demand (COD)	150	400	400	mg/l
5	Total Suspended Solids (TSS)	200	400	200	mg/l
6	Total Dissolved Solids (TDS)	3500	3500	3500	mg/l
7	Oil and Grease	10	10	10	mg/l
8	Phenolic Compounds (as Phenol)	0.1	0.3	0.3	mg/l
9	Chloride (as Cl <sup>-</sup> )	1000	1000	SC	mg/l
10	Fluoride (as F <sup>-</sup> )	10	10	10	mg/l
11	Cyanide (as CN <sup>-</sup> )total	1.0	1.0	1.0	mg/l
12	An-ionic detergents (as MBAS)	20	20	20	mg/l
13	Sulphate(SO <sub>4</sub> <sup>2-</sup> )	600	1000	SC	mg/l
14	Sulphide (S <sup>2-</sup> )	1.0	1.0	1.0	mg/l
15	Ammonia (NH <sub>3</sub> )	40	40	40	mg/l
16	Pesticides	0.15	0.15	0.15	mg/l
17	Cadmium	0.1	0.1	0.1	mg/l
18	Chromium (trivalent and hexavalent)	1.0	1.0	1.0	mg/l
19	Copper	1.0	1.0	1.0	mg/l
20	Lead	0.5	0.5	0.5	mg/l
21	Mercury	0.01	0.01	0.01	mg/l



22	Selenium	0.5	0.5	0.5	mg/l
23	Nickel	1.0	1.0	1.0	mg/l
24	Silver	1.0	1.0	1.0	mg/l
25	Total toxic metals	2.0	2.0	2.0	mg/l
26	Zinc	5.0	5.0	5.0	mg/l
27	Arsenic	1.0	1.0	1.0	mg/l
28	Barium	1.5	1.5	1.5	mg/l
29	Iron	8.0	8.0	8.0	mg/l
30	Manganese	1.5	1.5	1.5	mg/l
31	Boron	6.0	6.0	6.0	mg/l
32	Chlorine	1.0	1.0	1.0	mg/l

Table 2.4 - Sindh Environmental Quality Standards for Drinking Waters (mg/l)

Table 4.1: Sanitation Environmental Quality Standards for Drinking Waters (mg/l)					
S.#	Properties/ Parameters	Standard Values for Pakistan	S.#	Properties / Parameters	Standard Values for Pakistan
Bacterial			Chemical		
1	All water intended for drinking (E.Coli or Thermo tolerant Coliform bacteria)	Must not be detectable in any 100 ml sample	Essential Inorganics (mg/liter)		
			13	Aluminum (Al) mg/l	≤ 0.2
			14	Antimony (Sb)	≤ 0.005
2	Treated water entering the distribution system (E.Coli or thermo tolerant coliform and total coliform bacteria)	Must not be detectable in any 100 ml sample	15	Arsenic (As)	≤ 0.05
			16	Barium (Ba)	0.7
			17	Boron (B)	0.3
3	Treated water in the distribution system (E.coli or thermo tolerant coliform and	Must not be Detectable in any 100 ml sample. In case of large supplies, where sufficient samples are examined, must not be resent in 95%	18	Cadmium (Cd)	0.01
			19	Chloride (Cl- )	< 250
			20	Chromium (Cr)	≤ 0.05
			21	Copper (Cu)	2
			Organic (mg/L)		

Table 2.4 - Sindh Environmental Quality Standards for Drinking Waters (mg/l)					
	total coliform bacteria)	of the samples taken throughout any 12-month period.	22	Phenolic compounds	<0.0002
				Toxic Inorganics (mg/liter)	
			23	Cyanide (CN) <sup>-</sup>	≤ 0.05
			24	Fluoride (F)	≤ 1.5
			25	Lead (Pb)	≤ 0.05
			26	Manganese (Mn)	≤ 0.5
	Physical		27	Mercury (Hg)	≤ 0.001
4	Color	< 15 TCU	28	Nickel (Ni)	≤ 0.02
5	Taste	Non-objectionable/ Acceptable	29	Nitrate (NO <sub>3</sub> ) <sup>-</sup>	≤ 50
6	Odor	Non-objectionable/ Acceptable	30	Nitrite (NO <sub>2</sub> ) <sup>-</sup>	≤ 3
7	Turbidity	< 5 NTU	31	Selenium (Se)	≤ 0.01
8	Total Hardness as CaCO <sub>3</sub>	< 500 mg/l	32	Residual Chlorine	0.2-0.5 At consumer end
9	TDS	<1000			0.5-1.5 at source
10	pH	6.5-8.5			
	Radioactive				
11	Alpha Emitters bq/L	0.1	33	Zinc (Zn)	5.0
12	Beta emitters	1			

## 2.5 Self-Monitoring and Reporting by Industry Rules 2014

The self-monitoring and reporting system (SMRS) define the priority parameters for each industry that falls in either of the schedules of liquid and gaseous emissions. It takes into account the resources and interests of both the EPA and industry.

Schedule I is for industries and establishments producing effluents and places them into categories (A), (B), and (C), each corresponding to a specified reporting frequency; category (A) being the most polluting. The category (A) industries are bound to report their effluents and emission levels every month while category (B) industry quarterly and category (C) industry biannually. Schedule II categorizes the gaseous emission producing industries. It has two



categories (A) and (B) wherein category (A) again represents industries that are prone to produce more pollutants as compared to category (B).

The industries must have their effluents tested by an EPA certified/accredited laboratory and enter the results in the electronic forms (as well as a hard copy) included in the software package. The data must be sent to the respective provincial EPA via email or on a floppy disk. Sampling and analysis requirements and procedures and the charges have evolved through the process of coordination among representatives of industry, government, environmental NGOs and academic researchers. Appreciable progress has been made towards operationalizing the process.

Project Proponent will be required to submit regular environmental performance monitoring reports to SEPA as per the requirements/conditions laid down in the EIA approval.

## 2.6 The Hazardous Substances Rules 2014

The Hazardous Substances Rules 2014 define the hazardous substances in schedule 1 and make it compulsory for any proponent who is filing an EIA to apply for a license for transporting any hazardous substance that it has in its plans. The rules also stipulate a waste management plan to be in place in such a facility holding hazardous materials. Further SEP Act 2014 also requires the proponent to obtain a license to store any such hazardous substance.

The Hazardous Substances Rules, 2014 define the hazardous substances in schedule 1 and make it compulsory for any proponent who is filing an EIA to apply for a license for transporting any hazardous substance that it has in its plans. The rules also stipulate a waste management plan to be in place in such a facility holding hazardous materials. Further SEP Act 2014 also requires the proponent to submit Environmental Impact Assessment (EIA) of the project or industrial activity involving generation, collection, consignment, transport, treatment, disposal, storage, handling or import of a hazardous substance

The Proponent of proposed Project will follow the provisions of hazardous substances rules in letter and spirit.

## 2.7 Labor and Health and Safety Legislation

The Constitution of Pakistan contains a range of provisions concerning labor rights, in particular:



- Article 11 of the Constitution prohibits all forms of slavery, forced labor and child labor;
- Article 17 provides for a fundamental right to exercise the freedom of association and the right to form unions;
- Article 25 lays down the right to equality before the law and prohibition of discrimination on the grounds of sex alone; and
- Article 37(e) makes provision for securing just and humane conditions of work, to ensure that children and women are not employed in vocations unsuited to their age or sex, and to provide maternity benefits for women in employment.

The Labor law regulates at both provincial and national levels with compulsory employment agreements containing the terms set out by the labor laws. There are various laws containing health and safety requirements including: Mines Act 1923; Factories Act 1934; Factories Rules; Hazardous Occupations Rules 1963; Provincial Employees Social Security Ordinance 1965; and Workmen's Compensation Act 1923.

Recently the Sindh Government has approved Sindh Occupational Safety and Health Act, 2017 to make provisions for occupational safety and health conditions at all workplaces in the province for the protection of workers during work.

## 2.8 Sindh Wildlife Protection Ordinance 1972

The Sindh Wildlife Protection Ordinance 1972 empowers the government to declare areas of ecological significance as protected. The law provides three different types of such areas, the national park, the wildlife sanctuary and the game reserve. Responsible authority for each classification is Sindh Forest & Wildlife Department. According to guidelines for sensitive and critical areas 1997, thirty (30) wildlife sanctuaries (532,582ha), one (1) national park (308,733ha) and eleven (11) game reserves (127,020ha) are designated.

The project falls in the jurisdiction of Karachi Port Trust. The project site is located outside of any wildlife protected area therefore the project will not contravene with any provisions of this Act.

**Table 2.5: Classification of Protected area in Sindh Province**

Classification	Responsible Authority	Contents
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Wildlife sanctuary	Sindh Forest & Wildlife Department	<ul style="list-style-type: none"> <li>o undisturbed breeding ground</li> <li>o prohibited or regulated public areas</li> <li>o non-exploitation of forest</li> </ul>
National park		<ul style="list-style-type: none"> <li>o protection and preservation of scenery, flora and fauna in its natural state</li> <li>o an area of outstanding scenic merit and natural interest</li> </ul>
Game reserves		Hunting and shooting of wild animals is not be allowed, except under a specific permit, which may specify the maximum number of animals or birds that may be killed or captured and the area and duration for which such permits shall be valid.

Source: Guidelines for sensitive and critical areas, 1997

## 2.9 Sindh Fisheries Ordinance 1980

This ordinance mainly regulates fishing in any public waters for any purpose. The regulated waters include the coastal areas and rivers. The section 8 of this ordinance specifically prohibits the dumping of untreated industrial or domestic sewage waste into a water body in Sindh, unless treated and made harmless for fish and other aquatic life.

The proposed project will not be allowed to release any harmful and untreated effluent in any water body, hence fulfilling the stipulated requirement.

## 2.10 Sindh Forest Act 1927

The act empowers the provincial forest departments to declare any forest area reserved or protected. The act also empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling, and lopping. The act empowers the provincial forest departments to declare any forest area reserved or protected. The act also empowers the provincial forest departments to prohibit the clearing of forests for cultivation, grazing, hunting, removing forest produce, quarrying, felling, and lopping.

The Sindh Forestry Department manages official forestry reserves (including mangroves) and has expressed concern about the level of woodcutting, camel breeding which has taken place in the port areas.

## **2.11 The Sindh Factories Act 2015**

The Sindh Factories Act, 2015, deals with any premises which falls in the category of a Factory i.e., where any manufacturing work is carried out employing ten or more persons. Inspectors, appointed under this act, are empowered to enforce the provisions of this Act.

Section 11(1) of the Act “Registration and Deregistration of Factory” states that:

‘Provided also that the registration documents be supported by No Objection Certificates from Industries Department, approval of Sindh Environmental Protection Agency (SEPA) and any other document or forms in the prescribed manner.’

Chapter III of this Act titled “Health & Safety” comprising of Section 15-53, describes various Occupational Health and Safety measures that any Factory has to follow. The provisions of this chapter include clean working environment, arrangements for disposal of wastes and effluents on regular basis, provision of adequate ventilation, prevention from accumulation of dust and fumes generated during manufacturing process, avoidance of overcrowding and ensuring of sufficient lighting arrangements. This chapter also requires availability of amenities such as drinking water, canteen, safety against fire hazards and appointment of welfare officer and measures for prevention from diseases. This Act also prescribes penalties for violation of provisions of the Act.

The proponent will adhere to the applicable provisions of the act.

## **2.12 The Sindh Factories Rules 1975**

These Rules provide for inspection of factory premises at any time by inspectors authorized under these rules. Section 13 & 14 discusses health and safety requirements. Section 15, 16 & 17 requires that the working areas should be properly ventilated with tolerable levels of dust, fumes and artificial humidification. Section 25 prescribes sound precautions against fire. Protection of persons attending machinery or boilers is also provided. Section 33-K provides precautions against dangerous fumes.

The proponent will adhere to the applicable provisions of the rules.



### 2.13 Land Acquisition Act (LAA) 1984

Land Acquisition Act (LAA) 1984 is generally used to establish the rights on the land being acquisitioned for public purposes. The LAA describes the detailed procedures for acquisition of private properties but does not appropriately cover resettlement and rehabilitation. Additionally, LAA 1984 treats land acquisition as a provincial subject, and allows each province to use it in different ways based on their own interpretation. Federal EPA has prepared the National Resettlement Policy 2002, which describes the ways relating to calculation of compensation, public participation and consultation, formulation of resettlement action plan, and provisions for transparency and accountability.

As No private land will be acquired for the proposed project, the provisions of LAA therefore do not apply.

### 2.14 Pakistan Penal Code

The Pakistan Penal Code (1860) authorizes fines, imprisonment or both for voluntary corruption or fouling of public springs or reservoirs so as to make them less fit for ordinary use.

- Section 277: Fouling water of public spring or reservoir: Whoever voluntarily corrupts or fouls the water of any public spring or reservoir, so as to render it less fit for the purpose for which it is ordinarily used.

Project Proponent shall strictly monitor activities & shall restrain from disposing off any kind of waste/effluent in the sea.

### 2.15 Sindh Antiquities Act 1974

The protection of cultural resources in Pakistan is ensured by the Antiquities Act of 1975. The law prohibits new construction in the proximity of a protected antiquity and empowers the Government of Pakistan to prohibit excavation in any area which may contain articles of archaeological significance. Under the Act, the project Proponent is obligated to:

- Ensure that no activity is undertaken in the proximity of a protected antiquity
- If an archaeological discovery is made during the course of the project, it should be reported to the Department of Archaeology, Government of Pakistan.



The Act is designed to protect these antiquities from destruction, theft, negligence, unlawful excavation, trade, and export. The law prohibits new construction in the proximity of a protected antiquity and empowers the GOP to prohibit excavation in any area that may contain articles of archaeological significance.

The Proponent of proposed project is obligated to ensure that no activity is undertaken within 61 m (200 Ft) of a protected antiquity and to report to the GOP's Department of Archaeology of any archaeological discovery made during the course of the project.

So far, none of the sites protected under Sindh Antiquities Act 1974 has been identified in the immediate vicinity of the proposed Project site in KPT.

#### **2.16 Sindh Cultural Heritage (Preservation) Act 1994**

The Sindh Cultural Heritage (Preservation) Act, 1994 is the provincial law for the protection of cultural heritage. Its objectives are similar to those of the Antiquity Act, 1975.

#### **2.17 The Biodiversity Action Plan**

The key to protect the biological heritage of Pakistan lies in the involvement of local people and in the support provided by a competent institution for conservation and sustainable use. The Government of Pakistan has recognized the importance of these measures in the preparation of the National Conservation Strategy and in becoming a signatory to, and ratifying, the Convention on Biological Diversity (CBD) in 1994.

Developing the Biodiversity Action Plan (BAP) for Pakistan is the first attempt to meet the planning requirements of the NCS. It rolls into one the three processes called for under the Convention. Pakistan's BAP provides a brief assessment of the status and trend of the nation's biodiversity, outlines strategic goals and objectives, and identifies a plan of action that includes coordination arrangements and implementation measures. The development of the BAP has been the most significant direct steps towards addressing the biodiversity loss in Pakistan.

The overall goal of the BAP is to promote the conservation and sustainable use of Pakistan's biodiversity, and the equitable sharing of benefits arising thereof, for the wellbeing and security of the nation.



Some of the key objectives from the BAP which are relevant to the project include:

- Objective 3: Enhance the enforcement of biodiversity-related laws;
- Objective 5: Develop and institutionalize systems to monitor key elements of biodiversity;
- Objective 7: Conserve biodiversity outside protected areas;
- Objective 11: Protect & encourage community-based biodiversity management systems;
- Objective 21: Institutionalize and strengthen EIA procedures for projects, programmes & policies; and
- Objective 24: Develop national funding mechanisms to support priority biodiversity conservation and management programmes.

## 2.18 National Climate Change Policy

The National Climate Change Policy provides a framework for addressing the issues that Pakistan faces or will face in future due to the changing climate.

The main objectives of Pakistan's climate change policy include:

- To pursue sustained economic growth by appropriately addressing the challenges of climate change;
- To integrate climate change policy with other interrelated national policies;
- To focus on pro-poor gender sensitive adaptation while also promoting mitigation to the extent possible in a cost-effective manner;
- To ensure Water Security, Food Security and Energy Security of the country in the face of challenges posed by climate change;
- To minimize the risks arising from expected increase in frequency and intensity of extreme weather events: floods, droughts, tropical storms etc.;
- To strengthen inter-ministerial decision making and coordination mechanism on climate change;
- To facilitate effective use of the opportunities, particularly financial, available both nationally and internationally;
- To foster the development of appropriate economic incentives to encourage public and private sector investment in adaptation measures;
- To enhance the awareness, skill and institutional capacity of relevant stakeholders;
- To promote conservation of natural resources and long-term sustainability.

## **2.19 Climate Change Act 2017**

Pakistan Climate Change Act, 2017 was passed in March 2017 by the parliament. The new law establishes a Pakistan Climate Change Council, Pakistan Climate Change Authority and Pakistan Climate Change Fund. The council will be a decision-making body chaired by either the prime minister or a person nominated by him. The government will appoint federal and provincial ministers, chief ministers and chief secretaries as members of the council. Other members of the body, which will total around 30 people, will be scientists and researchers, representatives of business and industry, and experts from non-governmental organizations concerned with climate change.

The Climate Change Authority will be an autonomous government department, housed in Islamabad and led by scientists, academics, industrialists, agriculturalists and serving and retired government servants, with a chairperson appointed by the prime minister. It will formulate adaptation and mitigation policies and projects designed to meet Pakistan's obligations under international climate accords like the recent Paris Agreement. Projects are to be implemented by the provinces. The Climate Change Fund will support adaptation and mitigation schemes, and other measures including research.

## **2.20 National Forest Policy 2015**

The goal of the National Forest Policy is the expansion of National Coverage of Forests, Protected Areas, Natural Habitats and Green Areas for restoration of ecological functions and maximizing economic benefits while meeting Pakistan's obligations to international agreements related to Forests. Policy objectives under the forest policy include enhancing public awareness, implementing a national level mass afforestation programme to expand and to maintain forest cover to meet international standards and to promote standardized and harmonized scientific planning of forests, research and education.

## **2.21 Disaster Management Act, 2010**

This Act was enacted to provide for the establishment of a National Disaster Management System for Pakistan. Sindh Disaster Management Authority enforces the Act. The Act defines 'disaster' as a catastrophe or a calamity in an affected area, arising from natural or man-made causes or by accident which results in a substantial loss of life or human suffering or damage to, and destruction of, property. Disaster management includes preparedness and response. The Act provides establishment of disaster management authorities



at national, provincial and district levels. The authorities require preparing and implementing disaster management plan for their area.

## 2.22 Building Code of Pakistan, Fire Safety Provisions 2016

The Building Code of Pakistan-Fire Safety Provisions-2016 provide rules for fire prevention, life safety in relation to fire and fire protection of building and structures as prescribed. All the federal and provincial governments, organizations, authorities, both public and private are mandated to adopt and implement Building Code of Pakistan-Fire Safety Provisions-2016, as notified. Any construction and modification of buildings in violation of Building Code of Pakistan (Fire Safety Provisions-2016) shall be considered as violation of professional engineering works as specified under clause (xxv) of section 2 of the Act.

The implementation and enforcement of this byelaw shall vest with the Authority Having Jurisdiction (AHJ) within their respective jurisdictions and circles as follow:

- 1) Building Control, Housing and Development Authorities
- 2) District Administration
- 3) Tehsil or Town Administration
- 4) Municipal Administration
- 5) Station Headquarters (Army, Air Force and Navy)
- 6) Cantonment Administration
- 7) Union Council Administration
- 8) Autonomous Bodies
- 9) Industrial Estates
- 10) Directorates of Civil Defense
- 11) Export Processing Zones
- 12) Other Federal/Provincial Authorities as and when notified

This Byelaw shall come into force upon being notified and all the concerned AHJs shall implement the same immediately in the prescribed manner.

All relevant AHJs shall ensure compliance and implementations of this Code and accordingly adopt or amend their relevant regulations, Byelaws or rules as the need be.

This Byelaw shall apply to both new and existing buildings.

- a) buildings permitted for construction after the adoption of these Provisions shall comply with the provisions stated herein for new buildings forthwith.



- b) existing buildings constructed prior to adoption of these provisions shall comply with the provisions stated herein as soon as possible but not later than three years of notification of these provisions; and
- c) minimum fire protection requirements such as provision of fire alarm and detection system, fire extinguishers, emergency response plans and fire drills shall however be in place as soon as possible but not later than one year of notification of these provisions.

Any person who fails to comply with this Byelaw or fails to carry out an order made pursuant to these provisions, or violates any condition attached to a permit, approval, or certificate shall be subject to the penalties in accordance with the regulations of AHJ.

### **2.23 Karachi Ports Trust Act 1886 as amended in 1994**

Section 90: Port to be pollution free etc.

(90.1) The Board shall be responsible for maintaining the environment in the areas under the jurisdiction of KPT on land and within Port limits seaward, free from pollution.

(90.2) No discharge of solid, liquid and gaseous waste; or oily, noxious, radioactive and hazardous industrial effluents in concentrations exceeding NEQS or oily bilge, sludge, garbage, residues and mixtures containing noxious solid and liquid wastes from ships or de-ballasting of unwashed cargo tanks, tank washings from oil tankers or garbage, organic matter; or other pollutants as may be specified by the Board shall be made in the areas under jurisdiction of KPT on land and within Port limits Seaward.

(90.3) Any person contravening the provisions of sub -section (2) shall be liable to penalty not exceeding ten million rupees for each contravention in addition to the charges for cleaning of the Port and removal of pollution there from.

### **2.24 The Sindh Occupational Safety and Health Act, 2017**

This Act aims to make provision for occupational safety and health conditions at all workplaces for the protection of persons at work against risk of injury arising out of the activities at workplaces and for the promotion working environment adapted to eth physical, physiological and psychological needs of all persons at work.



## 2.25 World Bank Guidelines on Environment

The principal World Bank publications that contain environmental guidelines are listed below:

- Environmental Assessment-Operational Policy 4.01. Washington, DC, USA. World Bank 1999
- Environmental Assessment Sourcebook, Volume I: Policies, Procedures, and Cross-Sectoral Issues. World Bank Technical Paper Number 139, Environment Department, the World Bank, 1991
- Environmental Assessment Sourcebook, Volume III: Guidelines for Environmental Assessment of Energy and Industry Projects. World Bank Technical Paper No. 154, Environment Department, the World Bank, 1991
- Pollution Prevention and Abatement Handbook: Towards Cleaner Production, Environment Department, the World Bank, United Nations Industrial Development Organization and the United Nations Environment Program, 1998

The first two publications listed here provide general guidelines for the conduct of an IEE/EIA and address the IEE/EIA practitioners themselves as well as project designers. While the Sourcebook in particular has been designed for the Bank projects and is especially relevant for the impact assessment of large-scale infrastructure projects, it contains enormous information which is useful to environmentalists and project proponents.

## 2.26 IFC Performance Standards

International Finance Corporation (IFC) applies the Performance Standards to manage social and environmental risks and impacts and to enhance development opportunities in its private sector financing in its member countries eligible for financing. The Performance Standards may also be applied by other financial institutions electing to apply them to projects in emerging markets. Together, the eight Performance Standards establish standards that the Proponent is to meet throughout the life of an investment by IFC/WB or other relevant financial institution. The objectives of Performance standards are given below:

- To identify and assess social and environment impacts, both adverse and beneficial, in the project's area of influence



- To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them
- To promote improved social and environment performance of companies through the effective use of management systems.

**Performance Standard-1: Social & Environmental Assessment & Management System:** This Performance Standard seeks to:

- a) Identify and assess social and environment impacts in the project's area of influence;
- b) Avoid, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment;
- c) Ensure that affected communities are appropriately engaged on issues that could potentially affect them; and
- d) Promote improved social and environment performance of the project through the effective use of management systems.

Under this Standard, the project is required to establish and maintain a social and environmental management system appropriate to the nature and scale of the project and in accordance with the level of social and environmental risks and impacts. The management system is required to incorporate the following elements:

- Social and Environmental Assessment;
- Management program;
- Organizational capacity;
- Training;
- Community engagement;
- Monitoring; and
- Reporting

This EIA study has been conducted to respond to requirements of national legislation and international Guidelines and just as well fulfils the above requirements of the IFC Performance Standards PS1.

**Performance Standard-2: Labor and Working Conditions:** This PS seeks to establish, maintain and improve the worker-management relationship; promote fair treatment, non-discrimination and equal opportunity for workers, and compliance with national labor and employment laws; protect the workforce by addressing child labor and forced labor issues; and promote safe



and healthy working conditions, and to protect and promote the health of workers.

**Performance Standard-3: Pollution Prevention and Abatement:** The PS 3 seeks to avoid or minimize adverse impacts on human health and the environment by avoiding or minimizing pollution from project activities, and to promote the reduction of emissions that contribute to climate change. The Standard requires the project to consider during its entire lifecycle ambient conditions and apply pollution prevention and control technologies and practices that are best suited to avoid or, where avoidance is not feasible, minimize or reduce adverse impacts on human health and the environment while remaining technically and financially feasible and cost-effective.

**Performance Standard-4: Community Health, Safety and Security:** The PS 4 seeks to avoid or minimize risks to and impacts on the health and safety of local community during the project lifecycle from both routine and non-routine circumstances, and to ensure that the safeguarding of personnel and property is carried out in a legitimate manner that avoids or minimizes risks to the community's safety and security. The PS requires the project to evaluate the risks and impacts to the health and safety of the affected community during the different phases of the project and establish preventive measures to address them in a manner commensurate with the identified risks and impacts.

**Performance Standard-5: Land Acquisition and Involuntary Resettlement:** This PS aims to address the adverse impacts associated with land acquisition and involuntary resettlement caused by the project. The PS seeks to:

- avoid or at least minimize involuntary resettlement wherever feasible by exploring alternative project designs
- mitigate adverse social and economic impacts from land acquisition or restrictions on affected persons' use of land by: (i) providing compensation for loss of assets at replacement cost; and (ii) ensuring that resettlement activities are implemented with appropriate disclosure of information, consultation, and the informed participation of those affected
- improve or at least restore the livelihoods and standards of living of displaced persons
- improve living conditions among displaced persons through provision of adequate housing with security of tenure at resettlement sites.

Performance Standard-6: Biodiversity Conservation & Sustainable Natural Resource Management



The PS 6 seeks to protect and conserve biodiversity and promote sustainable management and use of natural resources through adoption of practices that integrate conservation needs and development priorities.

**Performance Standard-7: Indigenous Peoples:** The PS 7 seeks to address the impacts of the project on the indigenous people. Specifically, the objectives of the PS are to:

- ensure that the development process fosters full respect for the dignity, human rights, aspirations, cultures and natural resource-based livelihoods of Indigenous Peoples
- avoid adverse impacts of projects on communities of Indigenous Peoples, or when avoidance is not feasible, to minimize, mitigate, or compensate for such impacts, and to provide opportunities for development benefits, in a culturally appropriate manner
- establish and maintain an ongoing relationship with the Indigenous Peoples affected by a project throughout the life of the project
- foster good faith negotiation with and informed participation of Indigenous Peoples when projects are to be located on traditional or customary lands under use by the Indigenous Peoples
- respect and preserve the culture, knowledge and practices of Indigenous Peoples

No indigenous people - with a social and cultural identity distinct from the existing dominant society that makes them vulnerable to being disadvantaged in the development process of the Project are known to exist in and around the proposed site. No such people were found in the area during the present study either. Therefore, this PS is not applicable for the proposed project.

**Performance Standard-8: Cultural Heritage** objectives have been set in the IFC performance standards to achieve sustainable development.

The objectives of this PS are to protect cultural heritage from the adverse impacts of project activities and support its preservation, and to promote the equitable sharing of benefits from the use of cultural heritage in project activities.

No sites of cultural heritage are known to exist at or in the immediate vicinity of the Project location. There are also no indications of any old settlement in the area, nor is there any site covered under the listing of cultural heritage sites.



## 2.27 IFC- Environment, Health & Safety Guidelines for LNG

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry. These EHS Guidelines are applied as required by their respective policies and standards. EHS guidelines for LNG facilities are designed to be used together with the General EHS Guidelines document, which Provides guidance to users on common EHS issues potentially applicable to all industrial sectors.

The applicability of EHS Guidelines for Crude Oil and Petroleum Product Terminals include information relevant to land and shore-based petroleum storage terminals receiving and dispatching bulk shipments of crude oil, gasoline, middle distillates, aviation gas, lube oil, residual fuel oil, compressed natural gas (CNG), liquid petroleum gas (LPG), and specialty products from pipelines, tankers, railcars, and trucks for subsequent commercial distribution. This guideline covers Industry-Specific Impacts and Management and Performance Indicators and Monitoring.

The EHS Guidelines for Liquefied Natural Gas (LNG) Facilities include information relevant to LNG base load liquefaction plants, transport by sea, and re-gasification and peak sharing terminals. For coastal LNG facilities including harbors, jetties and in general coastal facilities (e.g. coastal terminals marine supply bases, loading/offloading terminals), additional guidance is provided in the EHS Guidelines for Ports, Harbors, and Terminals. For EHS issues related to vessels, guidance is provided in the EHS Guidelines for Shipping. Issues related to LPG/Condensate production and storage in liquefaction plants are not covered in this Guideline.

Certain objectives have been set in IFC performance standards to achieve sustainable development. Those objectives are given below:

- To identify and assess social and environment impacts, both adverse and beneficial, in the area of influence of LNG project
- To avoid, or where avoidance is not possible, minimize, mitigate, or compensate for adverse impacts on workers, affected communities, and the environment
- To ensure that affected communities are appropriately engaged on issues that could potentially affect them
- To promote improved social and environment performance of companies through the effective use of management systems.



## 2.28 International Treaties and Conventions

Pakistan is signatory/member to various international treaties and conventions on conservation of environment and protection of wildlife. The country is obliged to adhere to the commitments specified in these treaties. The United Nations Conference on Environment and Development (UNCED), 1992 emphasized on Protection, rational use and development of resources; preventing further degradation and reducing the risk of long-term irreversible effects; conservation of biodiversity, and sustainable use of genetic resources.

**World Heritage** Convention obligates the states to ensure identification, protection and transmission of natural heritage to future generations. A world heritage site is a site (natural or cultural) recognized by the international community (World Heritage Convention founded by the General Conference of UNESCO in 1972) as possessing universal value and coming under a collective responsibility.

Other international conventions and programs to which Pakistan is a party relate to biodiversity conservation, for all of which there is a national legislation. Three conventions dealing with species are:

- a) Convention on Conservation of Migratory Species of Wildlife Animals, adopted in Bonn, Germany in 1979 which Pakistan ratified in 1987;
- b) Convention of International Trade in Endangered Species of Wild Fauna and Flora (CITES), signed in Washington in 1973 of which Pakistan became a party in 1976;
- c) Convention on Biodiversity (CBD), signed in Rio de Janeiro in 1992 which Pakistan ratified in 1994.
- d) Convention on Wetlands of International Importance especially as Waterfowl Habitat, signed in Ramsar in Iran in 1971, to which Pakistan became a party in 1978; and
- e) Convention Concerning the Protection of the World Culture and Natural Heritage, signed at United Nations Educational, Scientific and Cultural Organization (UNESCO), Paris in 1972.

## 2.29 International Convention on Biodiversity

The International Convention on Biodiversity was adopted during the Earth Summit of 1992 at Rio de Janeiro. The Convention requires parties to develop national plans for the conservation and sustainable use of biodiversity, and to integrate these plans into national development programmes and policies. Parties are also required to identify components of biodiversity that are



important for conservation, and to develop systems to monitor the use of such components with a view to promoting their sustainable use.

### 2.30 Convention on Wetlands of International Importance, (RAMSAR) 1971

Pakistan is a signatory to the RAMSAR Convention. The principal obligations of contracting parties to the Convention are:

- To designate wetlands for the List of Wetlands of International Importance
- To formulate and implement planning so as to promote wise use of wetlands
- To carry out Environmental Assessment before transformations of wetlands, and to make national wetland inventories
- To establish nature reserves on wetlands and provide adequately for their wardening and through management to increase waterfowl populations on appropriate wetlands
- To train personnel competent in wetland research, management and wardening
- To promote conservation of wetlands by combining far-sighted national policies with coordinated international action, to consult with other contracting parties about implementing obligations arising from the Convention, especially about shared wetlands and water system
- To promote wetland conservation concerns with development aid agencies
- To encourage research and exchange of data

So far 18 sites in Pakistan have been declared as wetlands of International Importance or RAMSAR Sites. Of these, there are about 45 game sanctuaries and reserves spread over an area of 0.90 million hectares in Sindh. None of these wetlands have been included within or close to the project area. Haleji Lake and Kinjhar (Kalri) Lake are the two lakes designated as Wildlife Sanctuary. These freshwater lakes are internationally important areas for breeding, staging and wintering water birds. They are however >100 km distance from Project site in KPT.

### 2.31 IUCN Red List

It has been about 50 years now when IUCN first established the Red List. It is the world's most comprehensive source of information for conservation status of animals, fungi and plant species. The list categorizes the species as:



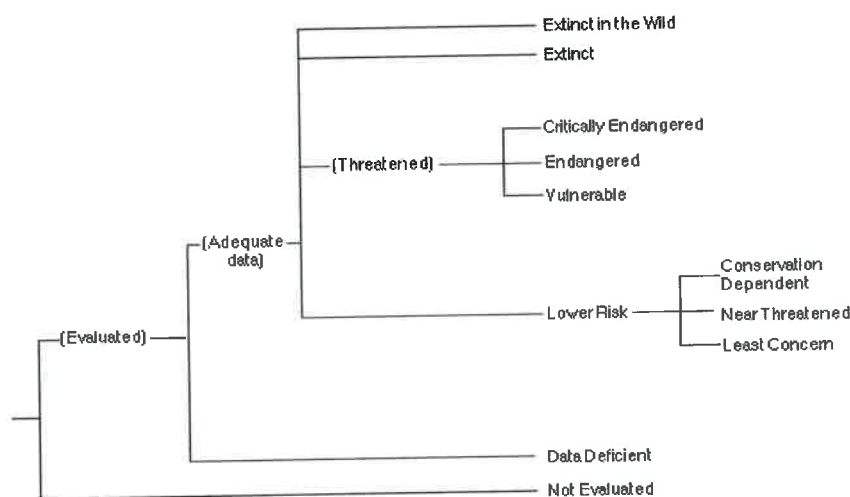


Figure 2.1 – IUCN Categorization of Threatened Species (source [www.iucnredlist.org](http://www.iucnredlist.org))

No faunal species that fall under the IUCN Red List category were observed during the surveys at the site for the EIA study.

### 2.32 Liquefied Natural Gas (LNG) Policy, 2011

The LNG Policy 2011 aims to facilitate the potential investors in LNG sector, by bringing more clarity and predictability for investors, on the basis of their experience and the bottlenecks pointed out by the potential investors during various interactions with OGRA. The LNG Policy, 2011 covers Import Project Structure, LNG Procurement, Ownership & Operation of the LNG Terminal, RLNG Marketing & Transportation, and Regulatory Framework during construction period and operational period, Government Incentives, Pricing of RLNG, Government Guarantee, Freedom to Participate in the LNG Business, Technical Codes and Standards, Shipping of LNG, Other Permits and Licenses. Prior permission of GoP for Spot purchase of LNG will not be required. SSGCL/SGNPL will not sell gas priced under weighted average cost of gas mechanism, to industries, which are selected by GOP to use RLNG from time to time. Licensees will be required to furnish guarantee against their delivery commitment. In case of failure of the licensee to deliver LNG by stipulated date, its first right to 3rd Party Access will stand waived off. The involvement of Coast Guards or any other agency to control activities of entry and exit of shipping traffic and requirement of security escort through Coast Guards at the expense of LNG developer, LNG Terminal Owner/Operator and LNG Buyer will no longer be necessary.



Port authorities have been obligated to convey their decision on acceptance of site within one month of submittal of NOC from Sindh Environmental Protection Agency, Quantitative Risk Assessment Study and Navigational Simulation Study.

Pakistan's policy for the sustainable development of the energy sector, including the provision of reliable and competitively-priced energy is based on the following objectives:

- a) Optimization of the primary energy mix, based on economic and strategic considerations;
- b) Maximizing the utilization of indigenous energy resources;
- c) Enhancing private sector participation in the energy sector by strengthening the regulatory framework and institutional capacity;
- d) Developing energy infrastructure; and
- e) Developing human resources with emphasis on energy sector-specific technical skills and expertise

Natural gas plays a key role in Pakistan's energy balance which is currently around 50% of the country's primary energy supplies. With accelerating economic growth, the demand for gas is projected to increase sharply and the country's recoverable indigenous gas reserves will be insufficient to meet this demand. Gas shortages have already emerged and shall increase substantially in the following years if indigenous supply is not supplemented through imports. In order to address the shortage, strong emphasis is being laid on importing gas from neighbouring gas-producing countries through cross-border gas pipelines and also in the form of liquefied natural gas ("LNG"). Necessary measures are being taken for installation of LNG receiving, storage, re-gasification facilities and expansion of gas transmission infrastructure, for the distribution and sale of Regasified LNG ("RLNG") in the domestic market.

The LNG Policy aims to facilitate expeditious implementation of the LNG Projects. It has laid out the following framework for the Ownership & Operation of LNG Terminals:

The LNG Developer or LNG TO/O, as the case may be, will obtain a license to design, construct, operate and own a LNG terminal from OGRA under the Oil and Gas Regulatory Authority Ordinance, 2002 subject to satisfying the following criteria:

**(a) Technical:** At least one member of the consortium of LNG Developer or LNG TO/O, as the case may be, should have experience in developing and operating a liquefaction plant or a regasification terminal. The LNG terminal will be

constructed based on technical standards as prescribed by the OGRA from time to time, in consultation and approval of Department of Explosives, including internationally acceptable industry technical standards as stipulated in Appendix-1.

**(b) Financial:** The LNG Developer or LNG TO/O consortium (on a several or joint and several basis) should have liquidity, revenues, net income and net worth above prescribed minimum thresholds (to be set by OGRA taking into consideration the financial obligations associated with the development and operation of the LNG import terminal).

**(c) Health, Safety & Environment. (“HSE”) Standards:**

1. The LNG Developer, LNG TO/O or LNG Buyer as the case may be, will ensure that the project complies with World Bank HSE Guidelines, Pakistan’s Environmental Protection Act 1997 rules, regulations and guidelines made there under, National Environmental Quality Standards, Pakistan’s health, environment and safety standards and is consistent with the best international LNG industry practices.
2. The LNG Developer or LNG TO/O will undertake a comprehensive environmental impact assessment of the design, construction and operational aspects of the project including impact assessment of shipping associated with the project, in accordance with international standards and practices. The studies and approvals required at the planning, construction, commissioning and operating phases are defined in the Pakistan Environmental Protection Act, 1997.
3. All LNG terminals shall be surrounded by safety zones which shall meet the industry standards set forth in safety codes of the National Fire Protection Association of USA and as per the risk assessment studies so as to ensure protection of neighbouring communities and shipping traffic.
4. Site approval: The site (either land-based terminal or offshore terminal of any type) for setting up an LNG terminal shall be selected by LNG Developer or LNG TO/O, as the case may be, taking into account the following factors:
  - Existing and projected population and demographic characteristics of the location;
  - Existing and proposed land use near the location;
  - Physical aspects of the location;



- Medical, law enforcement and fire protection capabilities near the location that can cope with a risk caused by the facility;
- Exclusion zone distances from the terminal to property and population as per international standards are complied with;
- Proximity to existing gas infrastructure and market;
- Need to encourage remote sitting;
- Any other significant community concerns; and
- Environmental considerations.

In applying for the license, the LNG Developer or LNG TO/O will have the onus of demonstrating compliance with the above criteria through risk assessment and simulation studies. Port Authorities will convey their decision on acceptance of site within one month of submission of NOC from SEPA, QRA study and navigational simulation study.

The licensee shall:

- Ensure delivery of LNG on fast-track basis.
- Furnish guarantee against its commitment.

In case of licensee's failure to deliver LNG by stipulated date its right to Third Party Access will be subject to cancellation/review by OGRA.

### **2.33 Ports Act 1908 & Pakistan Territorial Waters & Maritime Zones Act 1976**

The Ports Act 1908 ensures safe shipping in the sea and prevention of pollution in waters. Pakistan Territorial Waters and Maritime Act 1976 regulates the exploration, development, conservation, and management of living and nonliving resources in Pakistan's Exclusive Economic Zone (EEZ), which extends up to 200 miles from the country's coastal zone.

Ports Act 1908 and Pakistan Territorial Waters and Maritime Zones Act 1976 will both apply to the Project. The Project proponent will be mandated to ensure safe shipping of the LNG Carriers (LNGCs) and to adopt measures for prevention of pollution of the sea and the resources in Pakistan's Exclusive Economic Zone (EEZ), which extends up to 200 miles from the country's coastal zone.

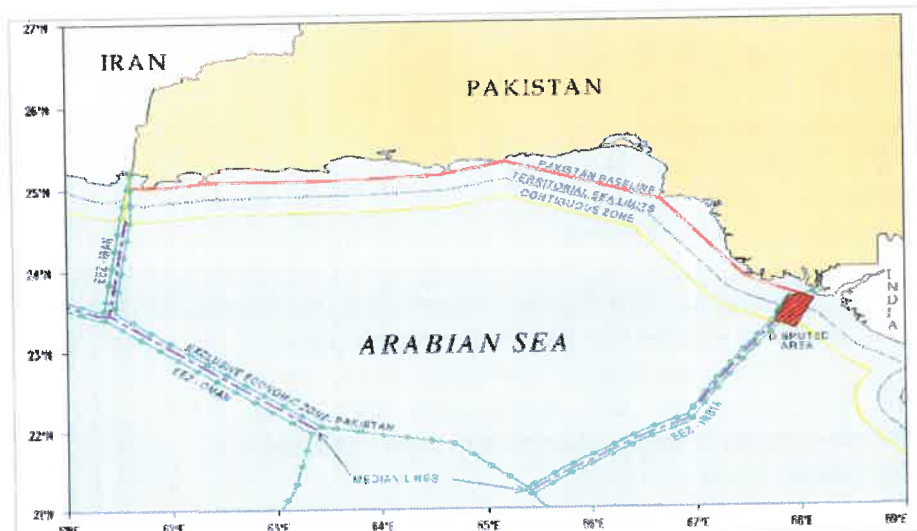


Figure 2.2: Pakistan's Exclusive Economic Zone

### 2.34 United Nations Convention on the Law of the Sea

The United Nations Convention on the Law of the Sea lays down a comprehensive regime of law and order in the world's oceans and seas establishing rules governing all uses of the oceans and their resources. It enshrines the notion that all problems of ocean space are closely interrelated and need to be addressed as a whole.

The Convention was opened for signature on 10 December 1982 in Montego Bay, Jamaica. This marked the culmination of more than 14 years of work involving participation by more than 150 countries representing all regions of the world, all legal and political systems and the spectrum of socio/economic development. At the time of its adoption, the Convention embodied in one instrument traditional rules for the uses of the oceans and at the same time introduced new legal concepts and regimes and addressed new concerns. The Convention also provided the framework for further development of specific areas of the law of the sea.

The Convention entered into force in accordance with its article 308 on 16 November 1994, 12 months after the date of deposit of the sixtieth instrument of ratification or accession. Today, it is the globally recognized regime dealing with all matters relating to the law of the sea.

The Convention (full text) comprises 320 articles and nine annexes, governing all aspects of ocean space, such as delimitation, environmental control, marine

scientific research, economic and commercial activities, transfer of technology and the settlement of disputes relating to ocean matters.

Some of the key features of the Convention are the following:

- Coastal States exercise sovereignty over their territorial sea which they have the right to establish its breadth up to a limit not to exceed 12 nautical miles; foreign vessels are allowed "innocent passage" through those waters;
- Ships and aircraft of all countries are allowed "transit passage" through straits used for international navigation; States bordering the straits can regulate navigational and other aspects of passage;
- Archipelagic States, made up of a group or groups of closely related islands and interconnecting waters, have sovereignty over a sea area enclosed by straight lines drawn between the outermost points of the islands; the waters between the islands are declared archipelagic waters where States may establish sea lanes and air routes in which all other States enjoy the right of archipelagic passage through such designated sea lanes;
- Coastal States have sovereign rights in a 200-nautical mile exclusive economic zone (EEZ) with respect to natural resources and certain economic activities, and exercise jurisdiction over marine science research and environmental protection;
- All other States have freedom of navigation and over flight in the EEZ, as well as freedom to lay submarine cables and pipelines;
- Land-locked and geographically disadvantaged States have the right to participate on an equitable basis in exploitation of an appropriate part of the surplus of the living resources of the EEZ's of coastal States of the same region or sub-region; highly migratory species of fish and marine mammals are accorded special protection;
- Coastal States have sovereign rights over the continental shelf (the national area of the seabed) for exploring and exploiting the shelf can extend at least 200 nautical miles from the shore, and more under specified circumstances;
- Coastal States share with the international community part of the revenue derived from exploiting resources from any part of their shelf beyond 200 miles;
- The Commission on the Limits of the Continental Shelf shall make recommendations to States on the shelf's outer boundaries when it extends beyond 200 miles;
- All States enjoy the traditional freedoms of navigation, over flight, scientific research and fishing on the high seas; they are obliged to adopt, or cooperate with other States in adopting, measures to manage and conserve living resources;

- The limits of the territorial sea, the exclusive economic zone and continental shelf of islands are determined in accordance with rules applicable to land territory, but rocks which could not sustain human habitation or economic life of their own would have no economic zone or continental shelf;
- States bordering enclosed or semi-enclosed seas are expected to cooperate in managing living resources, environmental and research policies and activities;
- Land-locked States have the right of access to and from the sea and enjoy freedom of transit through the territory of transit States;
- States are bound to prevent and control marine pollution and are liable for damage caused by violation of their international obligations to combat such pollution;
- All marine scientific research in the EEZ and on the continental shelf is subject to the consent of the coastal State, but in most cases they are obliged to grant consent to other States when the research is to be conducted for peaceful purposes and fulfils specified criteria;
- States are bound to promote the development and transfer of marine technology "on fair and reasonable terms and conditions", with proper regard for all legitimate interests;
- States Parties are obliged to settle by peaceful means their disputes concerning the interpretation or application of the Convention;
- Disputes can be submitted to the International Tribunal for the Law of the Sea established under the Convention, to the International Court of Justice, or to arbitration. Conciliation is also available and, in certain circumstances, submission to it would be compulsory. The Tribunal has exclusive jurisdiction over deep seabed mining disputes.

### **2.35 National Maritime Policy of Pakistan**

The National Maritime Policy of Pakistan has recently been approved and notified (16th October 2002). Among other matters, the Policy advocates "Management of assets in a judicious manner with conscientious regard to the environment and international law". It also incorporates, "Ports, shipping, fisheries, offshore resource, petroleum, environment, tourism, R&D, human resource development and protection of maritime interest".

One of the Policy Objectives is for the "Protection & Conservation of the marine environment/ ecosystem".

Section IV of the Policy, among other institutions, holds the Port Authorities responsible under legislation to protect the marine environment within their prescribed limits. This includes tasks such as monitoring and combating spills.



### 2.36 International Maritime Conventions

Project Proponent and its suppliers will comply with International Maritime Conventions. These will include the conventions of the International Maritime Organization, International Labor Organization, United Nations, World Health Organization and others as appropriate.

The primary International Maritime Organization (IMO) safety standard governing the marine transport of LNG is the "International Code for the Construction and Equipment of Ships Carrying Liquefied Gases in Bulk," (IGC Code – 1993 Edition).

**MARPOL 1973 (modified in 1978):** Ship-generated waste is regulated globally as part of the implementation of the International Convention for the prevention of pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78). The requirement of MARPOL 73/78 is established in 20 Articles, two Protocols and five annexes; these include contamination by oil, noxious liquid substances carried in bulk, harmful substances, sewage and garbage. Pakistan is signatory to all five annexes. Nevertheless, pollution prevention practices consistent with MARPOL requirements will be adhered to during all the phases of project. The Project proponent will be mandated to ensure safe shipping of the LNG Carriers (LNGCs) and besides adopting measures for prevention of pollution of the sea, will follow the International Convention for the prevention of pollution from Ships 1973 as modified by the Protocol of 1978 (MARPOL 73/78).

**The Society of International Gas Tankers and Terminal Operators (SIGTTO 1997)** and The International Navigation Association (PIANC 1997) guidelines for LNG Docking facilities will be referred to during project design and construction.

**London Convention 1972:** In 1972, The London Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter defines a Black List of toxic substances, and a Grey List of less hazardous substances that may only be dumped under a prior special permit, the dumping of any other wastes not specified in these lists requires a prior general permit. In 1990 this Convention was amended to require signatory countries to consider whether an adequate scientific basis exists for assessing the environmental impact of a substance (i.e. dredged material) before issuing a permit for dumping. Pakistan is signatory to the London Convention and a Notification came into force on 8th April 1995.



Under Article-IV, Annex-I the following substances are included in the "Blacklist".

*Blacklist*

- Organohalogen Compounds;
- Mercury and Mercury Compounds;
- Cadmium and Cadmium Compounds;
- Persistent Plastics and other persistent synthetic materials;
- Crude oil and petroleum products;
- High level radioactive wastes; and
- Materials produced for biological and chemical warfare.

Note (1): Item-viii gives exemption to the above listed substances which are "rapidly rendered harmless" provided they do not make edible organisms unpalatable or endanger human health or that of domestic animals.

Note (2): Item-xi gives exemption to dredged material containing the above substances as trace contaminants but subject such materials to Grey List status.

Under Article 4, Annex-2 the following less harmful substances are included in the 'Grey List' "or special care substances. These substances can only be dumped into the sea after a special permit has been issued:

*Grey List*

- Wastes containing significant amounts of arsenic, lead, copper, zinc, organosilicon compounds, cyanides, fluorides, pesticides and their by-products.
- Additional list in the case of disposal of large quantities of acids and alkalis: beryllium, chromium, nickel, vanadium;
- Generally bulky wastes, which may cause a hazard to fishing or shipping;
- Radioactive wastes (other than high level);
- Incineration of waste at sea is also controlled; and
- Substances which, though non-toxic, may become harmful due to the quantities in which they are dumped.

The Project Proponent will follow the procedures adopted by the other units based in KPT area for dumping the wastes on guidelines of KPT.



**Laws of Seas:** The UN Convention on the Law of the Sea was adopted and opened for signature in 1982. On November 16<sup>th</sup>, 1994, it entered into force for 68 countries. Pakistan is signatory to the convention. It establishes a basic structure of obligations, objectives and principles covering all sources of marine pollution that include:

- Pollution by vessels (operational and accidental discharges from ships), and
- Dumping (the deliberate disposal of wastes at sea by ships, aircrafts, platforms, or other manmade structures).

KPT will be mandated to ensure safe shipping of the LNG Carriers (LNGCs) and follow the Laws of Seas for prevention of pollution by vessels, besides taking measures to avoid dumping of ship wastes into the seas.

**Ballast water management convention:** The International Convention for the Control and Management of Ships Ballast Water and Sediments was adopted by consensus at a Diplomatic Conference at IMO in London on Friday 13 February 2004.

General obligations of the Convention (Article 2) state that parties give full and complete effect to the provision of the Convention and the Annex in order to prevent, minimize and ultimately eliminate the transfer of harmful aquatic organisms and pathogens through the control and management of ships' ballast water and sediments.

Under Article 5 (Sediment Reception Facilities) parties undertake to ensure that ports and terminals where cleaning or repair work of ballast tanks occurs have adequate reception facilities for the reception of sediment.

The **National Fire Protection Association (NFPA)** develops fire safety codes and standards drawing upon the technical expertise of persons from diverse professional backgrounds that form technical committees. These committees address concerns about specific activities or conditions related to fire safety. The members of these committees use an open consensus process to develop standards for minimizing the possibility and effects of fire. NFPA has adopted two comprehensive standards, NFPA 59A that relate to LNG.

NFPA 59A Standard for the Production, Storage and Handling of Liquefied Natural Gas (LNG) 2009 Edition describes the basic methods of equipment fabrication as well as LNG installation and operating practices that provide for protection of persons and property. It also "provides guidance to all persons concerned with the construction and operation of equipment for the



production, storage, and handling of liquefied natural gas." This comprehensive standard contains detailed technical requirements to ensure safety of LNG facilities & operations, including general facility considerations, process systems, stationary LNG storage containers, vaporization facilities, piping systems & components, instrumentation and electrical services.

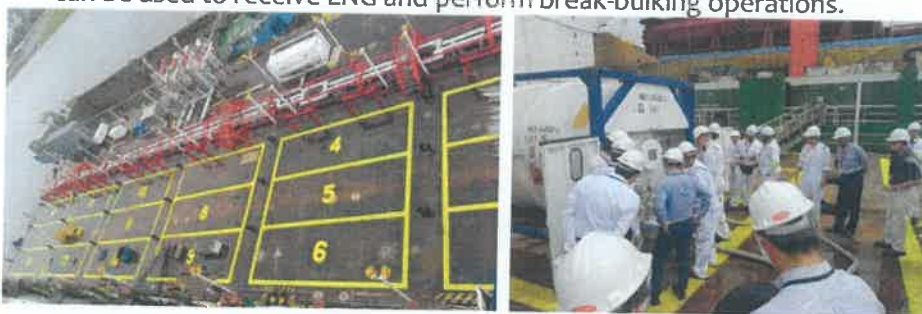
The standard also incorporates, by reference, technical standards developed by a number of other professional organizations, such as American Society of Mechanical Engineers (ASME), the American Society of Civil Engineers (ASCE), the American Petroleum Institute (API), the American Concrete Institute (ACI), and the American Society for Testing and Materials (ASTM).

The European codes and standards used would be explicitly mentioned in the detailed design. The technical design would be based on best industry practices and the technical standards and guidelines provided in LNG policy 2011 and guidelines provided along with the NOC issued by KPT, where applicable. Any international codes, guidelines and standards used will be justified based on international practices currently applicable at the time of design and it is the intention of the proponent to design the terminal using European standards.

### 3.0 Description of Project

#### 3.1 Overview

- LNGe has identified three possible locations in Pakistan for LNG importation, storage and breakbulk operations, namely Gwadar Port, Port Qasim and Karachi Port.
- LNGe's Singapore HQ has proprietary equipment in the form of MFP which can be used to receive LNG and perform break-bulking operations.



- The MFP is essentially an LNG receiving and offloading pontoon, which can be moored by anchor and chains, or by piles. Alongside jetties, the MFP is a manifold tower to receive LNG from LNG carriers. At locations without jetty, the MFP is a prefabricated jetty.
- Some small investment is required around the MFP jetty, such as a container yard, parking lot for trucks, and some buffer storage (optional).
- Bulk LNG can be imported into Pakistan by means of SSLNGCs. This imported LNG can then be filled into ISO tank containers, and thereafter distributed by trucks. This system of liquid-to-liquid virtual pipeline delivery will not compete against "system gas" as it effectively caters to a different clientele.
- This EIA shall focus on the proposed development at Karachi Port.

#### 3.2 Proposed Development at Karachi Port

- The concept of a virtual pipeline for downstream distribution of LNG has been growing rapidly in China over the past few years. The normal driving distance is usually within 500 km (but some road tankers travel as much as 3,000km).
- This distribution of LNG using land transportation can be performed in Pakistan from Karachi Port (operated by KPT) to serve the neighboring cities. For instance, Gwadar is about 627km away, connected by the Makran Coastal highway with a speed limit about 100km/hr.
- Supply of LNG can be sourced from a few locations. There are a few LNG reload terminals in the vicinity, namely Oman LNG Terminal, Kochi Terminal

and Dahej Terminal, and there is a FSRU operating in Dubai by Dubai Supply Authority (Dusup). Some of the storage tanks in Dahej and Kochi LNG Terminals are bonded and controlled by international tenants such as Trafigura and Gunvor. If one procures small parcels from reload terminals, typically there is a “small scale premium” charged, compared to conventional size cargoes.

- Currently LNGe have estimated the shipping using Unicom Spirit and her sister. They are 12,000 cbm LNG capable multi-gas carriers operated out of Singapore.
- It is envisaged that the project will be developed in two phases, by first having an interim fast track solution for 0.3 -0.325 mtpa (Phase 1), followed by a permanent solution to ramp up throughput volume to 1.7 mtpa (Phase 2).

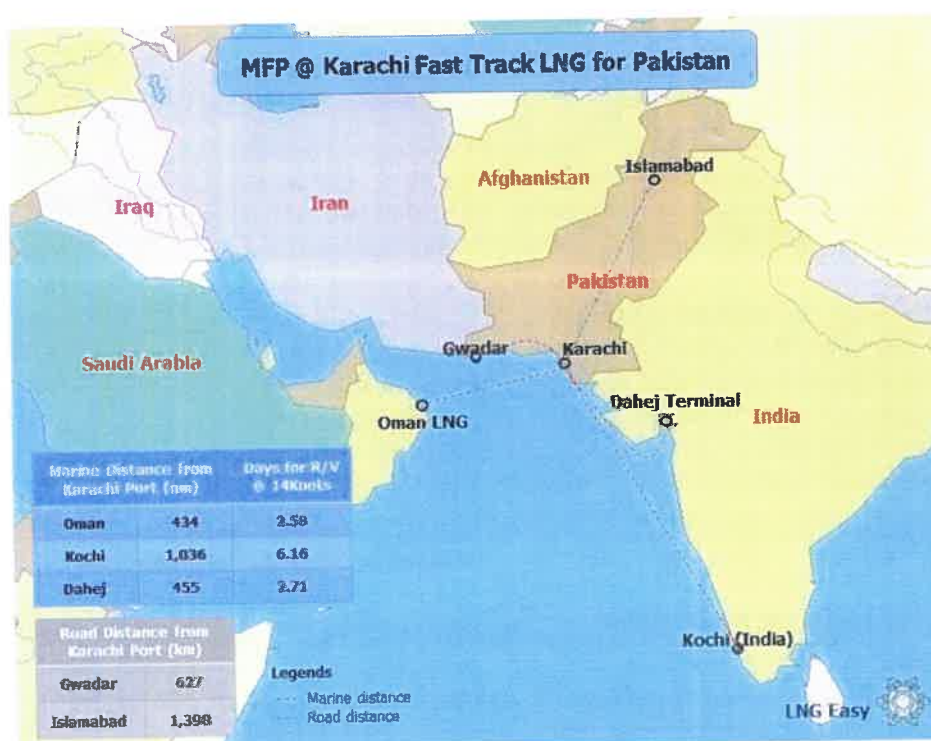


Figure 3.1: Potential sites

### 3.3 Operation

- Karachi port will allow unloading of LNG cargos, including LNG ISO Containers / Cryogenic Bowsers, at their berths No.18, 19 and 23. It is proposed to undertake unloading/loading of LNG ISO Containers / Cryogenic Bowsers pre-filled at source ports overseas and also by using

mobile LNG container filling system through which LNG will be filled in 40 feet ISO Containers/LNG Bowsers on trailers parked on the berth.



Figure 3.2: Proposed LNG Filling Operations at Berth 18/19 (Alternate 1)



Figure 3.3: Proposed LNG Filling Operations at Berth 19 (Alternate 2)



Figure 3.4 Proposed LNG Filling Operations at Berth 23 (Alternate 3)

- Initially small-scale LNG vessels of 10,000 to 30,000 cubic meter size will be used which will discharge LNG into ISO Containers/Cryogenic Bowsers at the allocated berths at Karachi port through Mobile Filling Platform (MFP) moored at the berth. The LNG vessel will be moored on the outside of the MFP. The MFP will be removed from the berth immediately upon completion of discharge activity.

#### GENERAL FLOW DIAGRAM

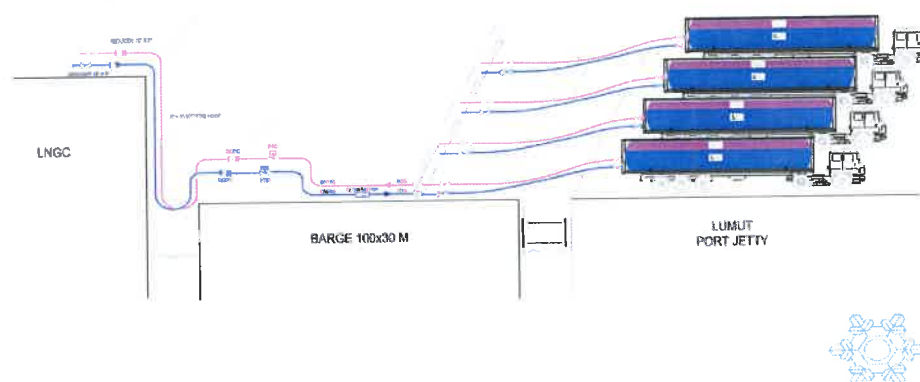


Figure 3.5: General Process Flow Diagram

- The entire operation will not require construction of any permanent/fixed structure, re-gasification or storage at the port and is confined only to unloading of pre-filled LNG ISO Containers/Cryogenic Bowsers and/or

from LNG Vessel through MFP to the LNG ISO Containers/Cryogenic Bowsers on 40 feet trailers on the berth.

- The MFP will be moored alongside the LNGC and jetty for LNG ISO Containers and Cryogenic LNG Bowser/Road Truck will be on the other side, as shown in Figure 3.6.



**Figure 3.6: Layout of LNGC, MFP and LNG ISO Container or Cryogenic LNG Bowser/Road Truck**

- LNG from the LNGC will be unloaded to the LNG ISO containers or Cryogenic LNG Bowser/Road Truck will be filled via the Mobile Filling Platform (MFP) at the jetty. Operators will need to connect the filling hose and vapour return hose to each ISO Container or Cryogenic LNG Bowser / Road Truck. Vapour return from the ISO containers will be sent to LNG buffer tank where the gas will be heated and sent as fuel gas to the gas generators.
- Up to 18 ISO containers or Cryogenic LNG Bowser/Road Truck can be filled simultaneously. Once filling is completed, operators will disconnect the hoses and the ISO containers/trucks will leave the jetty.
- The filling rate to each ISO containers is  $40\text{m}^3/\text{hr}$ . It is anticipated that it will take 1hr to fill the ISO containers. For offshore operation, flowrate of up to  $720\text{m}^3/\text{hr}$  ( $40\text{m}^3/\text{hr} \times 18$  ISO tanks) is envisaged.
- LNG from LNGC will be pumped from cargo tank to fill the 40' LNG ISO containers. The in-tank main cargo pump design flowrate is  $1400\text{m}^3/\text{hr}$  and since the pumping capacity is much higher than the flowrate into the ISO containers, throttling is necessary from the LNGC. The flowrate can be reduced to  $420\text{m}^3/\text{hr}$  with throttling. Boil off gas (BOG) will be generated and returned to the LNGC via the vapour return line and needs to be handled on the LNGC. Spray pump on the LNGC will be used during start-up/ initial filling to cool down the whole system before starting the LNG transfer via the main cargo pump.

### 3.4 Schedule for implementation

- Unloading of ISO Containers/Cryogenic Bowsers pre-filled at sources overseas can commence immediately followed by unloading/filling through MFP, which will be deployed within 60 days of receiving Licenses and approval permits. LNG Easy will also facilitate provision of LNG ISO containers/Cryogenic Bowser for transport of LNG and the regasification facilities required at the customer locations.

### 3.5 Annual Cargo volumes

- Initially the cargo volumes will be around 350,000 tons per annum and will be increased subsequently. Traditional pipelines have a high capital cost and are usually only viable to those who consume high volumes. Building the infrastructure also takes time and it frequently encounters “right-of-way” and squatting issues. The proposed system makes it possible to deliver LNG anywhere with road or rail access. The parcels can also be delivered in much smaller quantities, making it economically feasible to serve retail demands.

### 3.6 Berth Occupancy for loading/unloading/filling operations

- For handling of 350,000 tons per annum of LNG cargo the designated berth will be occupied only for up to a maximum of twelve days in a month. Up to seven 10,000 cubic meter LNG vessels will be unloading cargo per month, each ship capable of filling 244 forty (40) feet LNG ISO Containers/Cryogenic Bowsers in about 39 hours through MFP.
- The berth will remain unoccupied for more than 18 days a month as MFP will be towed away from the berth immediately upon completion of filling operation and will be redeployed at the berth only on the arrival of next ship for facilitating unloading operations.

### 3.7 Potential Market for Supply of LNG through ISO Containers / Cryogenic Bowsers

- The following sectors are the main potential users for LNG distributed by LNG Easy through LNG ISO Containers/Cryogenic Bowsers.

#### Combined Heat Power/Combined Heat Cold Power

- Back-up/distributed power generation deals with the issue of availability of electricity. But there is also a case for distributed generation for efficiency reasons. These technologies are called Combined Heat Power or Combined Heat Cold Power. The typical efficiency for centralized power generation is



whatever the power plants generate (about 62% for CCGT) less the grid loss (which can be very substantial/double digits in a country like Pakistan. But through CHP or CCHP, if the business in question can find the users for heat and cold, the efficiency can typically be raised to 85%+. This will give dual benefit of fuel replacement (LNG replacing more expensive fuel such as LPG and diesel), but also the efficiency gains from utilizing the heat energy obtained from the power generation process, which is normally wasted by centralized power plants.

#### Residential sector

- China has most successfully transformed LNG from a very large B2B (business-to-business), LNG-to-power fuel to a small B2B and B2C (business-to-consumer) fuel. Over 500 million Chinese customers are connected to the city or rural gas distribution network using natural gas. The success in China is achieved through a franchise system under which the operators invest in gas-consuming infrastructure in return for rights to supply exclusively to a defined area. This franchise normally lasts for 30 years. LNG Easy intends to apply for franchises in many areas of Pakistan. The current consumption is about 0.5mtpa in LNG equivalent which has priority over other sectors in the winter, however, there are other unserved demand for "off-grid" areas. Defense Housing Authority (DHA) and Bahria Town in Karachi alone are building new projects for over 2 million residents.

#### Transport sector

- The company plans to promote green energy in Pakistan by facilitating provision of cleaner fuel for heavy duty trucks and heavy buses. LNG will replace very expensive diesel on which most of these vehicles are running. Currently Pakistan spends about USD 1.5 billion on import of diesel for the transport sector alone. Conversion of heavy-duty trucks and bus fleet to LNG, will result in savings for customers and less burden on country's foreign exchange reserves.
- CNG: LNG Easy will provide LNG to off-line CNG stations** which are currently starved of pipeline gas. There are about 1200 CNG stations stranded in Punjab and over 700 in Sindh which constitutes a huge market for the product.
- LNG trucking: The biggest demand is in** the LNG-fueled sector for which it is proposed to develop and set up LNG refueling stations. There are over 472,000 heavy duty trucks and heavy buses in Pakistan, using diesel which can be conveniently converted to LNG and dispensed through a network of LNG refueling stations. LNG Easy will set up its own LNG fueling stations in collaboration with PetroChina to facilitate provision of cheaper and cleaner fuel for heavy duty vehicles.





- **Railway:** Pakistan has a very large and widely spread railway network. Pakistan Railway can also be an alternate choice for transporting LNG to the Northern consuming area.

#### Industries – Boiler and Furnaces

- A large number of industrial units are using LPG or diesel to fire their boilers and furnaces, typically using LPG, furnace oil or diesel as fuel. Many industries in Pakistan have access to pipeline gas but for various reasons do not receive steady gas supply. LNG Easy can provide steady gas of the required quantity and specifications to them and as a fuel distributor will go to the plant gate of these industrial customers, install regasification and storage equipment and flowmeter and charge the customers accordingly.



**Power Generation**

- Pakistan currently faces the issue of unsteady supply of natural gas, forcing many businesses and industries to have their own power generation as backup. Some of these installations are connected to the pipeline but for known reasons, the pressure in the pipeline is low, sometimes outright outage.
- LNG Easy would provide LNG to their doorstep as a backup arrangement. Similarly, LNG supply could be provided to remote locations (for instance mining areas), where they are not covered by the electricity grid. Here also, the businesses would want to have LNG as fuel to generate power.

**Residential sector**

- China has most successfully transformed LNG from a very large B2B (business-to-business), LNG-to-power fuel to a small B2B and B2C (business-to-consumer) fuel. Over 500 million Chinese customers are connected to the city or rural gas distribution network using natural gas. The success in China is achieved through a franchise system under which the operators invest in gas-consuming infrastructure in return for rights to supply exclusively to a defined area. This franchise normally lasts for 30 years. LNG Easy intends to apply for franchises in many areas of Pakistan. The current consumption is about 0.5mtpa in LNG equivalent which has priority over other sectors in the winter, however, there are other unserved demand for “off-grid” areas. Defense Housing Authority (DHA) and Bahria Town in Karachi alone are building new projects for over 2 million residents.



ISO tank container-based mini-grid for village and housing colonies



Small scale regasification for LNG cylinders

### 3.8 ISO Tanks/Cryogenic Bowser Transportation in Pakistan

- LNG is being transported in ISO Tank Containers/Cryogenic bowsters the world over under relevant Standards and Codes including IMO, US and British Standards. Transportation of Liquefied Gases in Cryogenic ISO Tanks/Bowsers is currently taking place in Pakistan also.
- Companies like Pakistan Oxygen Limited are using ISO Tanks/Cryogenic Bowsers for transportation of their Liquefied gases to the customer sites all over Pakistan.



- Transportation of LNG in ISO Tanks/Cryogenic Browsers in Pakistan will be carried out under international IMO, US and British and/or equivalent / corresponding Chinese Standards to ensure safe and hazard free transportation. M/s. DNV GL of Singapore, one of the leading internationally recognized classification and risk management companies of the world have undertaken Quantitative Risk Assessment (QRA) of the operations including trucking of LNG ISO Tanks/Cryogenic Browsers. The report has confirmed that entire operation does not pose any significant risk or hazard either to the port or any related transportation activity.

### 3.9 Import of Liquefied Gases

- These Liquefied gases are being Imported in ISO Tanks/Cryogenic Browsers by the following Companies:

1	M/S FATIMA FERTILIZER COMPANY LIMITED
2	MULTAN CHEMICALS LIMITED (Head office & Factory)
3	PAKISTAN OXYGEN LIMITED
4	M/S. FATAMNA CORPORATION
5	H.E.J. RESEARCH INSTITUTE OF CHEMISTRY
6	Ghani Glass Limited
7	AKBARI STORES (PVT.) LTD.,
8	MARTIN DOW MARKER SPECIALITIES (PRIVATE) LIMITED
9	M/S ARCHROMA PAKISTAN LIMITED
10	MULTICHEM ENTERPRISES
11	GMSA INTERNATIONAL CO



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5. Pakistan Environmental Protection Agency has decided to accord its approval under Section 14 of PEP Act 1997, on Environmental Management subject to the following conditions:-

- i. Company will ensure the compliance of National Environmental Quality Standards during transportation of LNG and no adverse impact would be on environment and proper monitoring system for LNG treatment set up for any leakage.

The transportation of the LNG should strictly carried out in accordance with Port Qasim Authority issued SOPs for operating conventional LNG carriers PQA Notice SOP/Conv 001/16 dated 30th April, 2016 (Amended 2018).

- ii. Ministry of maritime Affairs approval is mandatory in terms of compliance of MARPOL regulation which aimed at preventing and minimizing pollution from ships.
- iii. Company will abide by all the relevant laws including explosive Act 2010, particularly.
- iv. In the event of an accidental release/leakage during operation/storage, the permitted party should be immediately informed by the designated official by telephone and fax. The incident and any corrective action taken should be recorded.
- v. This approval does not absolve the proponent of the duty to obtain any other approval including the provincial and local Government or clearance that may be required under any other law in force.
- vi. The company will be submitting quarterly report with all detail of LNG operation, quantity, and distribution network in country.
- vii. Company will appoint Health, Safety, and Environment officer for the project safety and leads all efforts to enhance environment protection.
- viii. The company shall be participate in activities for the protection of environment in Islamabad capital territory (ICT) or as the case may to be planned in collaboration with Pak EPA under their CSR on annual basis.
- ix. Any time Pak EPA will conduct the site inspection and company shall also intimate at the time of landing/barging of containers.
- x. This approval shall be treated, as null and void if the conditions mentioned above are not complied with.

*Mohsina*

(Dr. Mohsina Zubair)  
Deputy Director (Lab/NEQS)

**DR. MOHSINA ZUBAIR**  
Deputy Director (Lab/NEQS)  
Government of Pakistan  
Pakistan Environmental Protection Agency  
Ministry of Climate Change  
Islamabad

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**PAKISTAN ENVIRONMENTAL PROTECTION AGENCY**  
**PLOT NO # 42, STREET NO # 6, SECTOR H/8-2,**  
**Islamabad**

F No 3(9)/2019-Dir(Lab/NEQS)

Dated: 16<sup>th</sup> June, 2021

**APPROVAL FOR IMPORT & TRANSPORTATION OF LNG THROUGH VIRTUAL PIPELINE**

- |                                     |   |
|-------------------------------------|---|
| 1 Name of proponent                 | Mr. Yasir Hameed (C.E.O)  |
| 2 Description of Company            | M/s LNG Easy (Pvt.) Ltd Pakistan,<br>Office -6A, Serena Business Complex,<br>Khayaban-e- Suhrawardy, G-5,<br>Islamabad. |
| 3 Date of Admission of application: | 4 <sup>th</sup> March, 2021.  |
| <b>Transport Details:</b>           |   |
| a) Country/State of Origin          | Qatar   |
| b) Name of Contractor               | M/s LNG Easy (Pvt.) Ltd Pakistan  |
| c) Port of arrival                  | Karachi Port Trust, Sindh   |
| d) OGRA Case number                 | OGRA-LNG-18 (31)/2020; Licence number-<br>11/2021   |
| e) Mode of Transportation           | Cryogenic bowzers by road and railway<br>network after reaching country of import                                       |
| f) Primary container                | Cryogenic bowzers ( -163 °C )   |
| g) Validity Limit                   | Date of issue till 30 <sup>th</sup> June 2022   |

4. OGRA awarded the Provisional License in favour of M/s LNG Easy (Pvt) Limited for operation and transportation of LNG and entails obtaining approval/NOCs from various Govt. Offices including Pak-EPA before the start of the business operations. Mr. Yasir Hameed, C.E.O. of M/s LNG Easy (Pvt) Limited Submitted the request for Environmental approval and Mobile filling platform fill ups the ISO tanks directly from LNG ship at KPT. The regasification of LNG will be carried out at the client's site.

PTO

*Mohsin*  
**DR. MOHSINA ZUBAIR**  
Deputy Director (Lab/NEQS)  
Government of Pakistan  
Pakistan Environmental Protection Agency  
Ministry of Climate Change  
Islamabad

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**Name:** He, Yi Yong

**Name:** Zhang, Lei

**Title:** Chief Executive Officer

**Title:** Deputy General Manager

*Witness*

**By:**

**By:**

**Name:**

**Name:**

**Title:**

**Title:**

張磊

12/1/2020

2020/12/1



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unreasonably withheld.

- (e) This MOU may be executed in any number of counterparts and by the Parties on separate counterparts, each of which will be deemed an original but which together shall constitute one agreement, with the same effect as if the signatures on the counterparts were upon a single engrossment of this MOU.
- (f) Notwithstanding anything contained to the contrary in this MOU, no Party shall be liable to the other Party under this MOU for or in respect of (i) any loss of profits or revenue, (ii) any indirect, incidental, punitive or exemplary damages or (iii) any consequential losses and/or damages arising or alleged to arise out of such Party's failure to properly carry out its obligations under this MOU.

**(9) Business Ethics**

No Party shall engage in acts or transactions in violation of or inconsistent with the applicable laws or the anti-bribery or anti-money laundering laws, regulations, rules or requirements of any relevant jurisdiction, including the relevant legislation of the country where this MOU is being performed. Any non-compliance with this clause during the performance of the activities to be carried out under this MOU, connected to possible implications involving liabilities, will represent a material breach of this MOU. In any such event, the non-breaching Party shall be entitled to undertake any and all measures it considers appropriate to protect its interests, including to terminate this MOU for default of this provision.

**(10) Compliance**

- (a) Each Party agrees to co-operate with the due diligence process of the other Party, and hereby agrees to comply with all applicable laws including applicable anti-corruption laws in pursuing the cooperation under this MOU.
- (b) Each Party shall respect and comply with all applicable competition laws.

**(11) Applicable Law and Jurisdiction**

This MOU shall be governed by, and construed in accordance with the laws of England with arbitration in Singapore.

**IN WITNESS WHEREOF**, the Parties have executed this MOU in two (2) original copies by and through their respective authorized representatives on the date first above written.

By: LNG EASY PTE LTD

By: ZHANGJIAGANG FURUI CIT CO.,LTD



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Email: zhanglei@cit.furuise.com

### (7) Confidentiality

- (a) For the purpose of this MOU, Confidential Information shall mean any and all information (whether marked confidential or otherwise) including but not limited to data, reports, records, correspondence, notes, compilations, studies, forecasts, analyses, renderings, sketches, trade secrets, operations, processes, plans, intentions, product information, prices, know-how, designs, customer lists, market opportunities, transactions, affairs and/or business of one Party and/or its Affiliates, and/or relating to their respective directors, officers, employees, shareholders, customers, suppliers, clients, analysts, consultants, business associates or Affiliates in or on any medium or format, whether in writing or oral, whether disclosed and/or obtained prior to, on, or after the date of this MOU, for the purpose of, or in the course of, considering, negotiating, advising or furthering the subject matter thereof.
- (b) Confidential Information in all cases excludes information that (i) is already in the public domain or enters the public domain other than through the act or omission of the receiving Party; or (ii) can be demonstrated to be already known by the receiving Party before the date the information is disclosed to the receiving Party by the disclosing Party or is lawfully obtained by the receiving Party from a third party which is not otherwise subject to any obligation of confidentiality; or (iii) is independently developed by the receiving Party without reference to, use of or access to the Confidential Information of the disclosing Party, as evidenced by its written records.
- (c) Except to the extent required by law or any legal or regulatory authority of competent jurisdiction, no Party shall at any time disclose to any person (other than its or its Affiliates' employees, directors or professional advisers, on a strictly need to know basis, and provided there are in place confidentiality undertakings to protect the Confidential Information) the terms of this MOU or any trade secret or other Confidential Information relating to any of the other Parties, or make any use of such Confidential Information other than to the extent necessary for the purpose of, or in the course of, considering, negotiating, advising or furthering the subject matter of this MOU.
- (d) Except for the requirement of disclosure by a government authority, the MOU shall not be publicly disclosed except where prior written consent has been received from the other Party.
- (e) This confidentiality provision shall endure during the term of the MOU and for a period of two (2) years after the termination or expiry thereof.

### (8) Miscellaneous

- (a) No amendments, changes or modifications of this MOU shall be effective unless such amendment is signed by a duly authorized representative of each Party.
- (b) Each Party shall bear its own costs and expenses in connection with this MOU, or any other activities contemplated hereunder. No Party shall have any right to any reimbursement or compensation of any kind from the other Party under this MOU.
- (c) Unless the right of enforcement is expressly granted, it is not intended that any provision of this MOU shall be enforceable by virtue of the Contracts (Rights of Third Parties) Act 1999 by any person who is not a party to this MOU.
- (d) Subject to paragraph 5 above, this MOU shall not be assignable by any Party, and no Party may delegate without the other Party's prior written consent, which consent shall not be

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Any binding agreement between the Parties with regard to the matters contained in this MOU will be evidenced only by the execution by the Parties of a Definitive Agreement. In addition, nothing in this MOU shall create, or be deemed to create, a partnership, joint venture or legal relationship of any kind between the Parties that would impose liability upon one Party for the acts or omissions of any other Party, or authorize any Party to act as agent for the other Parties.

**(3) Term**

This MOU shall come into force on the Effective Date and shall remain in effect until the earlier of: (i) execution of the Definitive Agreement, (ii) 2 years from the Effective Date, or (ii) until termination under clause 6 below (the "Term"). The Term can be extended by mutual agreement of the Parties. Such extension agreement shall be in writing.

**(4) Termination**

- (a) Each Party is entitled to terminate this MOU and withdraw from negotiations at any time by giving written notice to the other Party and for any reason whatsoever and this MOU shall be considered terminated upon such withdrawal.
- (b) In the event of termination of this MOU, save for paragraphs 4 and 6 to 14 inclusive which shall survive, all rights and obligations of the Parties shall cease to have effect immediately upon such termination.

**(5) Assignment**

Each Party may assign this MOU to its Affiliate(s) upon reasonable notice to the other Party, provided and subject to the Affiliate not being a "restricted party" (i.e. being an entity which is subject to applicable sanctions or listed on a restricted persons list promulgated by the US, EU and its member states and the UN). No Party may assign this MOU in whole or in part to any third-party other than its Affiliate(s) without the prior written consent of the other Party.

**(6) Notices**

Any notices to be given under this MOU shall be in writing and be sent by post with a copy by email to the address shown below:

**(a) To LNGe:**

Address: 12 Tuas Avenue 1, Singapore 639497  
 Attention: Mr He Yi Yong, Chief Executive Officer  
 Tel : +65 6222 8605; Fax : +65-6222 3812  
 Email : [projects@lngeasv.com](mailto:projects@lngeasv.com)

**(b) To Furui:**

Address: No 19, Chenxin Road, Yangshe Town, Zhangjiagang City, Jiangsu Province, China  
 Attention: Ms. Zhang Lei, Deputy General Manager  
 Tel: +86-512 5874 6112

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## **Memorandum of Understanding**

This Memorandum of Understanding (the "**MOU**") is made and entered into on 17<sup>th</sup> March 2020 (hereinafter the "**Effective Date**"), by and among:

1. **LNG EASY PTE LTD** (Reg. No. 201508962C) a private limited company incorporated in Singapore and having its registered address at 12 Tuas Avenue 1 Singapore 639497 (hereinafter referred to as "**LNGe**") of the second part.
2. **ZHANGJIAGANG FURUI CIT CO.,LTD** (License No. 913205827764237992), a company incorporated in People's Republic of China and having its registered address in No 19, Chenxin Road, Yangshe Town, Zhangjiagang City, Jiangsu Province, China (hereinafter be referred to as "**Furui**").

The parties hereto may hereinafter be referred to as "**Party**" and collectively as "**Parties**".

### **WHEREAS:**

- I. **LNGe** will start to import and distribute LNG in Pakistan by virtual pipeline, where it will require a large number of Iso Tank Containers for the transportation and storage of LNG.
- II. **Furui** is in the business of manufacturing T75 Iso Tank Containers (hereinafter called Containers) and other cryogenic equipment.

**NOW THEREFORE**, the Parties agree as follows:

#### **(1) The Parties intend to develop the LNG market in Pakistan together in the following steps:**

- (i) **Furui** will provide a few Containers for safety approval by Pakistani authorities, notably Oil & Gas Regulatory Authority (OGRA);
- (ii) Once the containers are approved, **LNGe** will purchase a certain number of Containers for its needs;
- (iii) **LNGe** will discuss long-term lease a larger number of Containers as the business expands;
- (iv) **LNGe** may acquire a dealership relationship from **Furui** for the distribution of its Containers.

#### **(2) Relationship**

For the avoidance of doubt, this MOU does not create a legally binding obligation to sell, purchase, exchange Containers.

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No Party shall engage in acts or transactions in violation of or inconsistent with the applicable laws or the anti-bribery or anti-money laundering laws, regulations, rules or requirements of any relevant jurisdiction, including the relevant legislation of the country where this MOU is being performed. Any non-compliance with this clause during the performance of the activities to be carried out under this MOU, connected to possible implications involving liabilities, will represent a material breach of this MOU. In any such event, the non-breaching Party shall be entitled to undertake any and all measures it considers appropriate to protect its interests, including to terminate this MOU for default of this provision.

**13. Compliance**

(a) Each Party agrees to co-operate with the due diligence process of the other Party, and hereby agrees to comply with all applicable laws including applicable anti-corruption laws in pursuing the cooperation under this MOU.

(b) Each Party shall respect and comply with all applicable competition laws.

**14. Applicable law and jurisdiction**

This MOU shall be governed by, and construed in accordance with the laws of England and Wales and with the exclusive jurisdiction of the English courts.

**IN WITNESS WHEREOF**, the Parties have executed this MOU in two (2) original copies by and through their respective authorized representatives on the date first above written.

By: LNG EASY PTE LTD

Name: HE YI YONG

Title: CEO

Witness

By:

Name: Ling Si Hua

Title: Accountant

By: PETROCHINA INTERNATIONAL  
(MIDDLE EAST) COMPANY LIMITED

Name: Wang Xingjany

Title: General Manager

By:

Name: Lu Ti

Title: Deputy Genl.

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considering, negotiating, advising or furthering the subject matter thereof.

- (b) Confidential Information in all cases excludes information that (i) is already in the public domain or enters the public domain other than through the act or omission of the receiving Party; or (ii) can be demonstrated to be already known by the receiving Party before the date the information is disclosed to the receiving Party by the disclosing Party or is lawfully obtained by the receiving Party from a third party which is not otherwise subject to any obligation of confidentiality; or (iii) is independently developed by the receiving Party without reference to, use of or access to the Confidential Information of the disclosing Party, as evidenced by its written records.
- (c) Except to the extent required by law or any legal or regulatory authority of competent jurisdiction, no Party shall at any time disclose to any person (other than its or its Affiliates' employees, directors or professional advisers, on a strictly need to know basis, and provided there are in place confidentiality undertakings to protect the Confidential Information) the terms of this MOU or any trade secret or other Confidential Information relating to any of the other Parties, or make any use of such Confidential Information other than to the extent necessary for the purpose of, or in the course of, considering, negotiating, advising or furthering the subject matter of this MOU.
- (d) Except for the requirement of disclosure by a government authority, the MOU shall not be publicly disclosed except where prior written consent has been received from the other Party.
- (e) This confidentiality provision shall endure during the term of the MOU and for a period of two (2) years after the termination or expiry thereof.

#### 11. Miscellaneous

- (a) No amendments, changes or modifications of this MOU shall be effective unless such amendment is signed by a duly authorized representative of each Party.
- (b) Each Party shall bear its own costs and expenses in connection with this MOU, or any other activities contemplated hereunder. No Party shall have any right to any reimbursement or compensation of any kind from the other Party under this MOU.
- (c) Unless the right of enforcement is expressly granted, it is not intended that any provision of this MOU shall be enforceable by virtue of the Contracts (Rights of Third Parties) Act 1999 by any person who is not a party to this MOU.
- (d) Subject to paragraph 7 above, this MOU shall not be assignable by any Party, and no Party may delegate without the other Party's prior written consent, which consent shall not be unreasonably withheld.
- (e) This MOU may be executed in any number of counterparts and by the Parties on separate counterparts, each of which will be deemed an original but which together shall constitute one agreement, with the same effect as if the signatures on the counterparts were upon a single engrossment of this MOU.
- (f) Notwithstanding anything contained to the contrary in this MOU, no Party shall be liable to the other Party under this MOU for or in respect of (i) any loss of profits or revenue, (ii) any indirect, incidental, punitive or exemplary damages or (iii) any consequential losses and/or damages arising or alleged to arise out of such Party's failure to properly carry out its obligations under this MOU.

#### 12. Business Ethics

- (b) In the event of termination of this MOU, save for paragraphs 4 and 6 to 14 inclusive which shall survive, all rights and obligations of the Parties shall cease to have effect immediately upon such termination.

#### 7. Assignment

Each Party may assign this MOU to its Affiliate(s) upon reasonable notice to the other Party, provided and subject to the Affiliate not being a "restricted party" (i.e. being an entity which is subject to applicable sanctions or listed on a restricted persons list promulgated by the US, EU and its member states and the UN). No Party may assign this MOU in whole or in part to any third-party other than its Affiliate(s) without the prior written consent of the other Party.

#### 8. Notices

Any notices to be given under this MOU shall be in writing and be sent by post with a copy by email to the address shown below:

(a) **To LNGe:**

Address: 12 Tuas Avenue 1, Singapore 639497  
Attention: Mr He Yi Yong, Chief Executive Officer  
Tel : +65 6222 8605; Fax : +65-6222 3812  
Email : [projects@lngeasy.com](mailto:projects@lngeasy.com)

(b) **To PCIME:**

Address: Suites 102-104, Gate Village 04, Dubai International Financial Centre, Dubai, UAE,  
PO: 506728  
Attention: Oleg Che, LNG Marketing Manager  
Tel: +971 588657683  
Email: [Oleg-Che@petrochina.com.sg](mailto:Oleg-Che@petrochina.com.sg)

#### 9. Assessment of the Proposal

Each of the Parties acknowledges that it is the exclusive responsibility of each Party in considering participation in this MOU to make its own independent assessment of the merits or otherwise of participation and the commercial and legal consequences of so doing.

#### 10. Confidentiality

- (a) For the purpose of this MOU, Confidential Information shall mean any and all information (whether marked confidential or otherwise) including but not limited to data, reports, records, correspondence, notes, compilations, studies, forecasts, analyses, renderings, sketches, trade secrets, operations, processes, plans, intentions, product information, prices, know-how, designs, customer lists, market opportunities, transactions, affairs and/or business of one Party and/or its Affiliates, and/or relating to their respective directors, officers, employees, shareholders, customers, suppliers, clients, analysts, consultants, business associates or Affiliates in or on any medium or format, whether in writing or oral, whether disclosed and/or obtained prior to, on, or after the date of this MOU, for the purpose of, or in the course of,

### 3.3 LNG sales, transportation and distribution in Pakistan ("Downstream"):

The Parties shall market LNG to Downstream LNG customers in Pakistan and develop infrastructure in Pakistan if required for the Project development and execution. The Parties jointly shall meet Downstream LNG customers, including but not limited to CNG associations, power plants, textile associations, and highway authorities. The Parties shall update each other on any progress with any customer. Each Party shall act in good faith and shall not take any undiscussed decisions that will jeopardize the development of the Project. The Parties shall sign MOUs with Downstream LNG customers.

PCIME will bring its experience from similar projects into the Downstream LNG market and equipment. The Parties shall work jointly to develop commercial proposals for Downstream LNG customers.

### 3.4 Project Structure and Operation

The Parties shall discuss and agree the structure and ownership of the Project. The Parties shall work on a transparent joint plan of investment into the Project. The Parties intend to develop the Project jointly, in good faith and in a timely manner.

LNGe shall provide an initial proposal of the structure and ownership of the Project to PCIME by March 2020.

## 4. Relationship

For the avoidance of doubt, this MOU does not create a legally binding obligation to sell, purchase, exchange LNG or enter into any logistics or operations agreement or any other agreements on either Party.

Any binding agreement between the Parties with regard to the matters contained in this MOU will be evidenced only by the execution by the Parties of a Definitive Agreement. In addition, nothing in this MOU shall create, or be deemed to create, a partnership, joint venture or legal relationship of any kind between the Parties that would impose liability upon one Party for the acts or omissions of any other Party, or authorize any Party to act as agent for the other Parties.

## 5. Term

This MOU shall come into force on the Effective Date and shall remain in effect until the earlier of: (i) execution of the Definitive Agreement, (ii) 2 years from the Effective Date, or (ii) until termination under clause 6 below (the "Term"). The Term can be extended by mutual agreement of the Parties. Such extension agreement shall be in writing.

## 6. Termination

- (a) Each Party is entitled to terminate this MOU and withdraw from negotiations at any time by giving written notice to the other Party and for any reason whatsoever and this MOU shall be considered terminated upon such withdrawal.

Easy (PVT) Limited and intended to supply downstream companies with LNG.

## 2. Process

2.1 The Parties agree to meet and to have calls from time to time to discuss:

- (i) the development of a definitive cooperation agreement and/or other appropriate form of agreement (the "**Definitive Agreement**"); and
- (ii) the implementation mechanics necessary to facilitate the cooperative measures reflected in this MOU or in any of their ongoing discussions.

2.2 Any further agreement(s) resulting from discussions between the Parties shall be memorialized in such form as the Parties deem appropriate. Until such time as such agreement(s) is/are executed, the Parties may use the principles set forth in this MOU as a guideline for the discussion.

## 3. Business Objectives of the Parties

The Parties intend to develop the Project jointly and agree the principal terms and conditions in good faith and in the timely manner. The Parties shall evaluate any potential legal, operational or commercial impediments to the development of the Project and shall disclose any discovered impediments to the other Party in the timely manner.

The business objectives for the Parties entering into this MOU are as follows:

### 3.1 Delivery of LNG to the Project ("Upstream"):

PCIME will deliver LNG by small-scale LNG ships in Phase 1 of the Project and later by conventional LNG ships in Phase 2 of the Project. PCIME will be responsible for the LNG supply and LNG shipping. LNGe will assist PCIME in contracting LNG supply and LNG ships for the Project. LNGe will provide all requested information to PCIME if such information is available and in possession of LNGe.

The timing and all details of Phase 1 and Phase 2 of the Project shall be discussed and agreed between the Parties in order to align LNG supply and LNG shipping with the Project development. LNGe shall take crucial decisions in regards to Phase 1 and Phase 2 of the Project together with PCIME.

### 3.2 LNG Imports into Pakistan and licensing ("Midstream"):

LNGe will be responsible for providing Mobile Filling Platform ("MFP"), which will be the key facility for importing LNG and discharging LNG into the trucks or/and ISO containers from LNG Ship.

LNGe and LNG Easy (PVT) Limited will be responsible for securing all necessary permits in Pakistan for LNG importing, discharging, operation, sales, distribution and any other permits that are required for the Project. PCIME will provide support and information to LNGe and/or LNG Easy (PVT) Limited if such information is requested, available and in possession of PCIME. LNGe and LNG Easy (PVT) Limited shall disclose the progress and documents submitted for the permits in Pakistan to PCIME.

## Memorandum of Understanding

This Memorandum of Understanding (the "**MOU**") is made and entered into on 05-MAR 2020 (hereinafter the "**Effective Date**"), by and among:

1. **LNG EASY PTE LTD** (Reg. No. 201508962C) a private limited company incorporated in Singapore and having its registered address at 12 Tuas Avenue 1 Singapore 639497 (hereinafter referred to as "**LNGe**") of the second part.
2. **PETROCHINA INTERNATIONAL (MIDDLE EAST) COMPANY LIMITED** (License No. CL0902), a company incorporated in Dubai, United Arab Emirates and having its registered address in Suites 102-104, Gate Village 04, Dubai International Financial Centre, Dubai, UAE, PO: 506728 (hereinafter be referred to as "**PCIME**").

The parties hereto may hereinafter be referred to as "**Party**" and collectively as "**Parties**".

### **WHEREAS:**

- I. The Parties would like to collaborate and jointly develop a small-scale LNG project in Pakistan. The Parties intend to discuss and agree the principal terms and conditions of the cooperation between the Parties for the Project in good faith.
- II. This MOU reflects the Parties' initial view on cooperation for the Project that can be taken together by the Parties and is solely intended to provide a basis for further dialogue between the Parties.
- III. This MOU does not create a legally binding obligation to sell, purchase, exchange LNG or enter into any logistics or operations agreement or any other agreements on either Party.

**NOW THEREFORE**, the Parties agree as follows:

### **1. Definitions**

The following words and phrases shall have the following meanings unless the context otherwise requires: -

"**Affiliate**" shall mean, with respect to a Party, any company or legal entity which controls, or is controlled by such Party or is controlled by a company or legal entity that also controls such Party. "**Control**" means the right to, directly or indirectly, exercise more than fifty percent (50%) of the voting rights in the appointment of directors of such company or legal entity, or the power to direct or cause the direction of the management and policies of such company or legal entity.

"**LNG**" shall mean Liquefied Natural Gas.

"**Project**" shall mean small-scale LNG project, which is currently developed in Pakistan by LNG

Tel No.99214311  
Fax No.99214329-30



## KARACHI PORT TRUST

No.S-20/1722  
Dated 13 AUG 2020

From: **Shafique Ahmed Faridi**  
Secretary

Mr. Imrani Akhtar  
Executive Director (LNG),  
Oil & Gas Regulatory Authority,  
Islamabad.

SUB:- APPLICATION FOR ISSUANCE OF OGRA LNG PROVISIONAL LICENCE FOR LNG BREAK BULKING AND LOADING / UNLOADING OF LNG CARGO FROM SMALL LNG CARRIER.

Ref:- Oil & Gas, Regulatory Authority, Islamabad's letter No. OGRA-LNG-18(31)/2019 dated 04.08.2020.

With reference to above, I am directed to state that M/s. LNG Easy (Pvt) Ltd., has applied to obtain a permission for the subject purpose and they are in a process to submit the Pre-requisites to KPT. It is pertinent to mention here that KPT has already allotted Berth No. 18 to 20 for handling of their upcoming LNG vessels calling at Karachi Port subject to the completion of all formalities / requirements.

M/s. LNG Easy (Pvt) Ltd., is in the process of completion of documents & obtaining NOC from other related departments. Therefore, OGRA is requested to consider this letter as provisional NOC. However handling of LNG vessel is subject to the submission of KPT specific QRA, Environment Impact Assessment (EIA), HAZOP / HAZID, Safety Integrity Level (SIL) Layer Protection Analysis (LOPA) & Security Risk Assessment from internationally reputable firms for the subject purpose.

Karachi Port strongly supports the said project and will cooperate for successful commencement of proposed project under the jurisdiction of KPT.

  
SECRETARY

Copy to:-

Secretary  
Ministry of Maritime Affairs  
Government of Pakistan  
Islamabad

o/c 13/8/2020  
ul 13/8/2020



**NATIONAL HIGHWAY AUTHORITY**  
**Road Assets Management Division**

No. 1110/GM(RAMD)/NHA/2020/ 457

28-Mauve Area,  
Sector G-9/1,  
Islamabad, April 26, 2020

**Mr. Yasir Hameed**  
Chief Executive Officer,  
LNG Easy (Pvt.) Ltd. Pakistan  
Office – 6A, Serena Business Complex,  
Khayaban-e-Suhrwardy, G-5,  
Islamabad


**Subject: No Objection Certificate for Transportation of LNG through Virtual Pipeline**

**Ref:** Your letter No. PMU/R3/INF/1-12/26 dated 1<sup>st</sup> April 2020

It is to inform that competent authority has been pleased to accord No Objection Certificate (NOC) for transportation of LNG in ISO Cryogenic Tanks through Virtual Pipeline in Pakistan using NHA network with following arrangement as provided by the transporter.

Item	Gross Weight	Dimensions ISO Cryogenic Container – 40 feet Flat Bed		
		Length	Width	Height
ISO Cryogenic Container (40 feet)	30 Tons	12.2 meters	2.4 meters	2.6 meters

2. The NOC shall be valid for a period of one year from the date of issuance subject to fulfilling following conditions.
  - a) The gross weight of vehicle including cargo should be within permissible load limits as specified in Sixth Schedule of National Highway Safety Ordinance 2000.
  - b) The overall dimensions of vehicle including cargo must conform to the specifications stipulated in National Highways and Motorways (Dimensions of Goods Transport Vehicles) Rules, 2017.
  - c) In case of any damage to NHA property due to passage of vehicles of M/s LNG Easy (Pvt.) Ltd. Pakistan, its restoration as per NHA Specifications shall entirely be the responsibility of M/s LNG Easy (Pvt.) Ltd. Pakistan. The restoration works (if required) shall be executed under the supervision of NHA field offices.
3. Further, NHA shall not be responsible for any kind of incident (fire, explosion etc. or any occurrence) due to vehicular fault during the transportation of ISO Cryogenic Container (40 feet flatbed) of M/s LNG Easy (Pvt.) Ltd. Pakistan on NHA's network.
4. This issues with the approval of Chairman NHA, please.

  
**MUHAMMAD NASEEM KHATTAK**  
General Manager (RAMD)

**Copy for Information:**

1. Chairman NHA, Islamabad
2. Member (Engineering Coordination), NHA
3. Director (Legal) NHA

623

**GOVERNMENT OF PAKISTAN  
MINISTRY OF ENERGY  
(PETROLEUM DIVISION)  
DEPARTMENT OF EXPLOSIVES  
\*\*\*\*\***

NO. 10-30/LNG/1368

Basement Local Government  
Complex, G-5/2, Islamabad.  
Dated: 25-02-2021

To, ✓

Mr. Yasir Hamid,  
M.s LNG Easy Private Limited,  
Head Office, 726, 7<sup>th</sup> Floor, Executive Tower,  
Dolmen Clifton, Karachi.

SUBJECT: - **APPLICATION FOR NOC OPERATION OF LNG FILLED ISO CONTAINERS  
ON ROADS OGRA CASE NO. OGRA-LNG-18(31)122020**

REF: Your letter No. Nil Dated 25-02-2021.

Dear Sirs,

With reference to your above referred letter, on the subject cited above, you are hereby, informed that Department of Explosives, have no objection to M/s LNG Easy Pvt. Ltd, for operation and transportation of LNG through virtual pipelines to include LNG bulk breaking, unloading / loading of cargo from small LNG carriers and supply of LNG mainly to Off-grid customers through cryogenic bowzers/ ISO containers, subject to the fulfillment of Mineral and Industrial Gases Safety Rules, 2010 and to the following pre-requisites:

1. That you will have to apply for the LNG storage premises, of filled ISO containers of LNG at port premises.
2. That end user of LNG should also be license holder of Department of Explosives.
3. That manufacturer of LNG ISO containers, should be enlisted with Department of explosives, if its manufacturing standard is other than ASME Sec VIII Division I.
4. That for transportation of LNG ISO containers, you will have to apply to Department of Explosives, for grant of license in form 'R' under Mineral and Industrial Gases Safety Rules, 2010.

This letter issued with the approval of Director General.

  
(SAMAD KHAN KAKAR)  
DIRECTOR

آئل اینڈ گیس  
ریگولیٹری اتھارٹی



Oil & Gas  
Regulatory Authority

The Islamic Republic of Pakistan

Case No. OGRA-LNG-18(31) /2020

License No. LNG-11/2021

## PROVISIONAL LICENCE

FOR THE PURPOSE OF FACILITATING COMPLETION OF ALL FORMALITIES FOR LNG VIRTUAL PIPELINES, LNG BULK BREAKING, UNLOADING/ LOADING OF CARGO FROM SMALL LNG CARRIERS AND SUPPLY OF LNG MAINLY TO OFF-GRID CUSTOMERS THROUGH CRYOGENIC BOWZERS

TO

LNG EASY (PRIVATE) LIMITED

UNDER

OIL AND GAS REGULATORY AUTHORITY ORDINANCE, 2002

AND

OIL AND GAS REGULATORY AUTHORITY

(LNG) RULES, 2007

Za

GRIP



OGRA-LNG-18(31)/2021  
08<sup>th</sup> January, 2021

**Mr. Mian Yasir Hamid,**  
**Chief Executive Officer,**  
LNG Easy (Private) Limited,  
Head office, 726, 7<sup>th</sup> Floor,  
Executive Tower, Dolmen Clifton  
Karachi.

**Subject: PROVISIONAL LICENCE**

For the purpose of facilitating completion of all formalities for LNG virtual pipelines, LNG Break Bulking, Unloading/Loading of Cargo from Small LNG Carriers and supply of LNG mainly to Off-Grid customers through cryogenic bowzers

Dear Sir,

This refers to your application No. Nil dated July 13, 2020 on the subject cited matter.

2. After completion of the required formalities under Rule 33 of LNG Rules 2007, the Authority is pleased to grant you a '*Provisional Licence*' to enable completion of all formalities required under LNG Rules 2007 to apply for a licence for carrying out regulated activities. The license is enclosed herewith please.

Yours faithfully,

**Imran Akhtar**  
Executive Director (LNG)

## About DNV GL

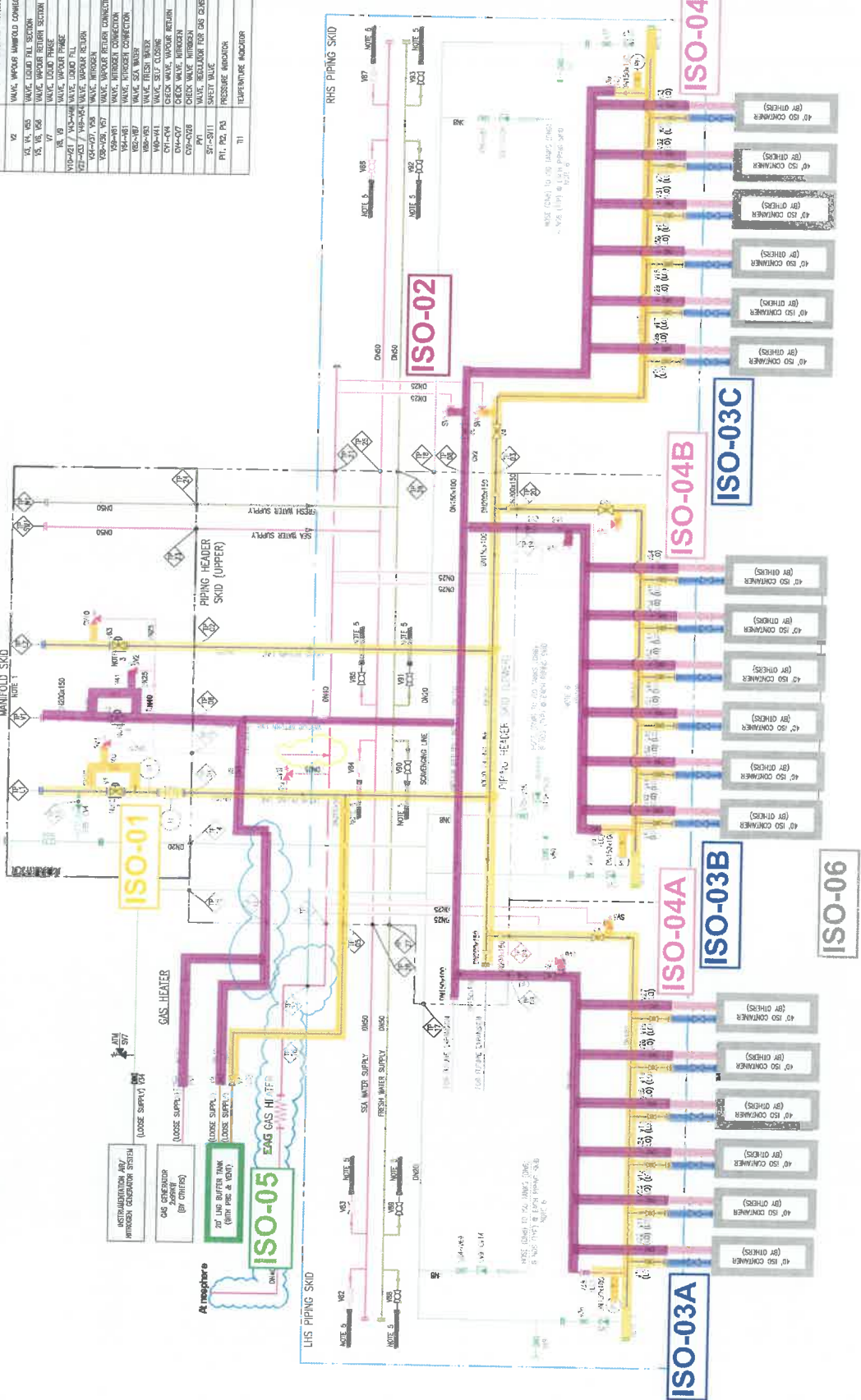
Driven by our purpose of safeguarding life, property and the environment, DNV GL enables organizations to advance the safety and sustainability of their business. We provide classification and technical assurance along with software and independent expert advisory services to the maritime, oil & gas and energy industries. We also provide certification services to customers across a wide range of industries. Operating in more than 100 countries, our professionals are dedicated to helping our customers make the world safer, smarter and greener.



8/9

yangmao

VALVE AND INSTRUMENTS LIST		
NO	FUNCTION	SIZE
V1, V3	VALVE, LIQUID MANIFOLD CONNECTION	DN200
V5	VALVE, ISO-01 MANIFOLD CONNECTION	DN150
V6, V7, V8	VALVE, LIQUID TANK SECTION	DN150
V9, V10, V11	VALVE, LIQUID TANK SECTION	DN150
V12	VALVE, LIQUID TANK SECTION	DN150
V13	VALVE, LIQUID TANK SECTION	DN150
V14	VALVE, LIQUID TANK SECTION	DN150
V15	VALVE, LIQUID TANK SECTION	DN150
V16	VALVE, LIQUID TANK SECTION	DN150
V17	VALVE, LIQUID TANK SECTION	DN150
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V92	VALVE, LIQUID TANK SECTION	DN150
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V94	VALVE, LIQUID TANK SECTION	DN150
V95	VALVE, LIQUID TANK SECTION	DN150
V96	VALVE, LIQUID TANK SECTION	DN150
V97	VALVE, LIQUID TANK SECTION	DN150
V98	VALVE, LIQUID TANK SECTION	DN150
V99	VALVE, LIQUID TANK SECTION	DN150
V100	VALVE, LIQUID TANK SECTION	DN150



张家港富瑞源科技有限公司 ZHANGJIANG FURUI CIT CO., LTD.			
流程图			
阶段	标记	比例	备注
A		1:1	
第 1 页 共 1 页			
版次	版次		



**Appendix A**  
**Marked up P&ID**

### 5.3 Flammable Parameters

General note – the LFL fraction to finish is set to 1.0 – this means that 1.0 of LFL concentration will be applied as the definition of the flash fire hazard zone.

The deterministic approach as per ISO/TS 18683 defines the ignition exclusion zone (safety zone) as the area within the distance to LFL, as determined for the maximum credible release as defined as part of the hazard identification.

Effect on Analysis:

This means that the LFL concentration will be applied as the definition of the flash fire hazard zone and safety zone.

Source:

## 5.2 General Parameters

### Height For Calculation Of Flammable Effects

Generally DNV GL applies a value of 1 m to reflect the height of a typical human.

### Surface roughness

User-defined length should be adjusted considering the field condition.

From PHAST Risk Help, the following typical values for the surface roughness should be used, depending on the field condition:

Type of Surface	Roughness Length (m)
Open water, at least 5 km	0.0002
Mud flats, snow, no vegetation, no obstacles	0.005
Open flat terrain; grass, few isolated objects	0.03
Low crops; occasional large obstacles, $x/h > 20$	0.10
High crops; scattered large obstacles, $15 < x/h < 20$	0.25
Parkland, bushes; numerous obstacles, $x/h < 15$	0.5
Regular large obstacle coverage (suburb, forest)	1
City centre with high- and low-rise buildings	3

Roughness length of 0.1m for dispersion over large obstacles (e.g. from piping header skid on filling barge towards the Containers).

#### Effect on Analysis:

This will impact the risk results as this will tend to give more conservative results for personnel risk, considering that it is more likely for the release scenarios at the 1 m height (i.e. fire or explosion) to impact personnel.

Affect the dispersion of pool releases and plumes.

#### Source:

1. DNV GL Software Phast documentation

## 5 SOFTWARE MODELLING PARAMETERS

### 5.1 Software

This QRA will be constructed using the Safeti (PHAST Risk 7.21) Quantitative Risk Analysis software package which allows the integration of numerous individual consequence analysis models with vulnerability criteria, release frequencies and ignition probability estimates.

To allow such analysis, numerous default assumptions are made by the Safeti (PHAST Risk 7.21) software package including assumptions with respect to:

1. Dispersion;
2. Discharge;
3. Jet Fires;
4. Pool Fires;
5. Fireballs and BLEVEs;
6. Flammability;
7. Explosions;
8. Pool Vaporisation;
9. Toxicity;
10. Weather;
11. Event Tree probabilities; and
12. Human Vulnerability.

For brevity, these default assumptions have not been described. Instead the PHAST Risk 7.21 software package and associated technical documentation should be consulted for the details and rationale behind these default assumptions.

#### Effect on Analysis:

These default assumptions are particularly influential to the consequence analysis of loss of containment events including the calculation of the gas cloud size and the calculation of the thermal radiation that may be generated from an ignited release.

#### Source:

Effect on Analysis:

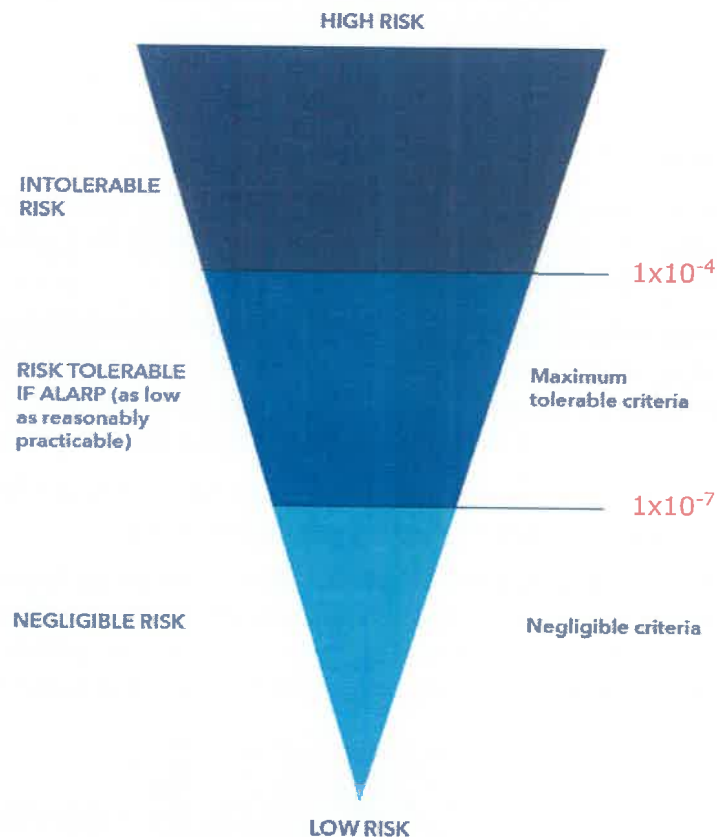
Determine the criteria for "acceptable risk level" for individual risk

Source:

1. UK HSE, [https://www.hse.gov.uk/foi/internalops/hid\\_circs/permissioning/spc\\_perm\\_37/](https://www.hse.gov.uk/foi/internalops/hid_circs/permissioning/spc_perm_37/)
2. UK HSE, Reducing Risk, Protecting People (R2P2), 2001.
3. DNV GL, Technical Note T17, Risk Criteria, Rev 1.

As per DNV GL technical note, the recommended criteria for individual risks (workers) from new activities are [3]:

- Maximum tolerable risk for workers:  $10^{-4}$  per year;
- Negligible risk:  $10^{-7}$  per year.



**Figure 4-2 Framework for Three-band Risk Criteria**

The risks are divided into three hierarchy levels, as below:

- The upper band is where the risks are usually considered intolerable irrespective of the benefits the activity may bring, and risk-reduction measures are essential whatever their cost.
- The middle band is where risk-reduction measures are desirable but may not be implemented if their cost is high relative to the benefit gained (i.e. the ALARP principle should be demonstrated).
- The lower band is where risks are negligible, or so small that no risk-reduction measures are needed.

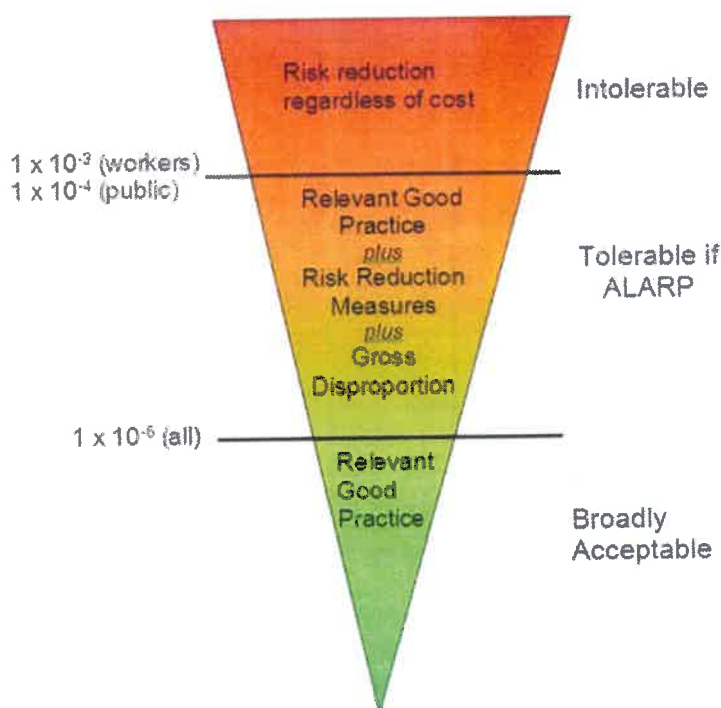
The number of hours exposed to the risks depends on the number of filling operations and duration. It is assumed that each personnel will spend 12 days in a month on the barge, working for 12 hours daily (70% outdoor and 30% indoor). Hence,  $IR = (LSIR \text{ outdoor} \times 0.7 + LSIR \text{ indoor} \times 0.3) \times (12/24) \times (144/365)$ .

## 4.2 Individual Risk Criteria

A determination of individual risks to the public, and to employees, forms the basis for risk-decision making. It provides an overall assessment of the level of risk to the exposed population and highlights the major contributors to the risk. Individual risk assessments combine the results of the consequence modeling, with a detailed assessment of frequencies, utilizing event tree analysis and failure frequency and databases.

- Individual risk criteria have been developed based on the principle that involuntary risks due to industrial developments should not significantly increase the level of risk to individuals living or working near such industry.
- Location Specific Individual Fatality Risk (LSIFR) is the risk of death to an individual person, if present 24 hours per day (in the open) at a particular location for a whole year. It takes no account of the number of people affected by an event.
- LSIR is normally represented in the form of risk contours. This is achieved by plotting and connecting all points (locations) of similar individual risk, thus forming risk contours (not dissimilar to isobars on a weather map). These contours can then be overlaid onto a land-use map to show the level of individual risk in the various land-use planning areas.
- Individual risk criteria may be applied, and measures taken to ensure that no single individual living near to a hazardous activity bears an undue level of risk.

According to UK HSE [1], an individual risk of death of one in a million per annum ( $10^{-6}$  per year) for both workers and the public corresponds to a very low level of risk and should be used as a guideline for the boundary between the broadly acceptable and tolerable regions. In this assessment, a risk level of  $1 \times 10^{-4}$  per year is taken to be intolerable – for both general public and workers.



**Figure 4-1 UK HSE Framework for the tolerability of risk [1]**

## 4 IMPACT ASSESSMENT AND RISK CRITERIA

### 4.1 Human Vulnerability

Personnel exposure to high levels of thermal radiation, high explosion overpressures may result in fatalities.

The following impact criteria in Table 4-1 below is applied in the QRA.

**Table 4-1 – Impact Criteria**

Hazardous effect	Criteria	Type of Damage
Thermal radiation	35kW/m <sup>2</sup>	Likely to cause fatalities in 100% of population exposed to thermal radiation of 35kW/m <sup>2</sup>
	12.5kW/m <sup>2</sup>	Likely to cause fatalities in 70% of outdoor personnel and 10% of indoor personnel exposed to thermal radiation of 12.5kW/m <sup>2</sup>
	4kW/m <sup>2</sup>	Likely to cause fatalities in 1% of all population exposed to thermal radiation of 4kW/m <sup>2</sup>
Flammable gas dispersion	LFL	100% fatality rate for all population within a flash fire i.e. within the LFL distance of the released material at a specific weather state
Overpressure	0.1 bar	Likely to cause fatalities in 2.5% of indoor population exposed to overpressure of 0.1 bar. No fatality for outdoor population.
	0.3 bar	Likely to cause fatalities in 100% of population (for both indoors and outdoors) exposed to overpressure of 0.3 bar

Consequence distance to the above tabulated vulnerabilities will be provided.

Effect on Analysis:

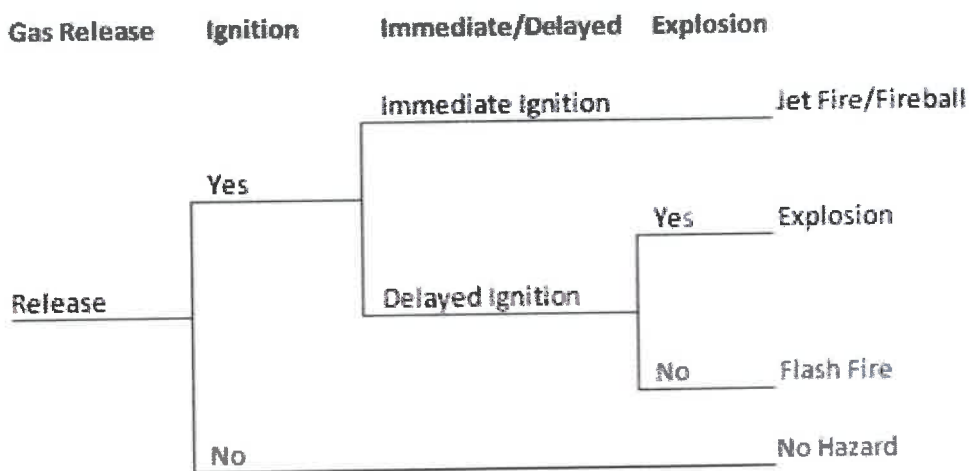
Required to calculate of the frequency at which personnel become fatalities whilst outside.

Source:

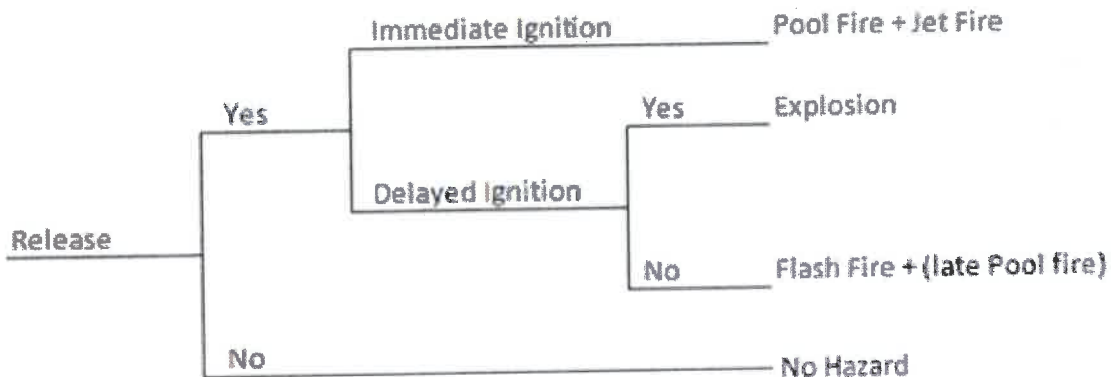
2. CPR – Guideline for Quantitative Risk Assessment ("Purple Book"), CPR 18E.
3. DNV GL Technical Note 16, SAFETI Parameters, Rev. 02.

### 3.10 Event Tree

The event frequency to be used in the QRA is presented in Figure 3-1 and Figure 3-2.



**Figure 3-1 Event Tree - Release of Flammable Gas**



**Figure 3-2 Event Tree - Release of Flammable Liquid**

Effect on Analysis:

Required to determine the risks due to release of LNG and NG.

Source:

1. DNV GL internal technical documentation

### 3.9 Isolation and Detection time

The vessel is manned during the LNG filling operations. There will be manual local supervision by an operator during transfer and emergency button can be actuated within a short time in the event of a leak.

For calculation of the mass of the LNG leaked during STS operations, the following response time (to detect and successful isolation) is estimated, regardless of any release sizes.

- 3 minutes (180 seconds)

Effect on Analysis:

Required to determine isolation time and thus, release duration and inventory.

Source:

1. LNG Operational experience.

For instantaneous release from **Cryogenic LNG Bowser/Road Truck**, the ignition probability (direct ignition probability) is extracted from "Purple Book" (/3/), Table 4.5 for material of substance type "Gas, low reactivity":

**Table 3-7 Probability of direct ignition for stationary installations**

Source		Substance		
Continuous	Instantaneous	K1-liquid	Gas, low reactive	Gas, average/high reactive
< 10 kg/s	< 1000 kg	0.065	0.02	0.2
10 - 100 kg/s	1000 - 10,000 kg	0.065	0.04	0.5
> 100 kg/s	> 10,000 kg	0.065	0.09	0.7

Based on the inventory of a **Cryogenic LNG Bowser/Road Truck**, an ignition probability of 0.09 will be used for early ignition probability.

#### **Immediate (Early) and delayed (late) ignition**

A 30:70 split between early and late ignition is assumed in line with industry and typical QRA approach (/1/).

#### **Explosion fraction**

Following the ignition of a free gas cloud, an incident occurs demonstrating characteristics of both a flash fire and an explosion. This is modeled as two separate events: as a pure flash fire and a pure explosion. The fraction that is modeled as an explosion,  $F_{\text{explosion}}$ , is equal to 0.4 (/3/).

#### **Effect on Analysis:**

Required for input to event trees within the QRA model, the ignition probability has a significant effect on the risk profile associated with each failure case, as ignited hydrocarbon releases were assumed to result in the potential for fatalities.

The differentiation between flash fire and explosion probability influences the potential for fatalities.

#### **Source:**

1. IP Research Report, Ignition Probability Review, Model Development and Look-up Correlations, Energy Institute, London, Jan 2006
2. Ignition Probabilities, Report No. 434-6.1, September 2019, issued by IOGP, Risk Assessment Data Directory.
3. CPR – Guideline for Quantitative Risk Assessment ("Purple Book"), CPR 18E – Table 4.5.

### 3.8 Ignition Probabilities

Ignition probabilities were calculated using the UKOOA correlations.

Curve 5 from the UKOOA correlations, which are for Small Plant Gas LPG (Gas or LPG release from small onshore plant), is used (/2/):

**Table 3-6 Ignition Probability (Curve 5)**

5 - Small Plant Gas LPG	
Gas or LPG release from small onshore plant	
Releases of flammable gases, vapour or liquids significantly above their normal (NAP) boiling point from small onshore plants (plant area up to 1200m <sup>2</sup> , site area up to 35,000m <sup>2</sup> )	
Release Rate (kg/s)	Ignition Probability
0.1	0.0011
0.2	0.0014
0.5	0.0020
1	0.0025
2	0.0074
5	0.0204
10	0.0339
20	0.0564
50	0.1107
100	0.1842
200	0.3065
500	0.6000
1000	0.6000

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### 3.7 Material

The LNG composition used for modeling in this study is 86 mol% of methane, 12 mol % of ethane and 2 mol % of propane.

For NG, 100% of methane is used.

Effect on Analysis:

Consequence of fire or explosions will be dependent on material.

Source:

1. CIMC Enric Energy Engineering (S) Pte Ltd, Design Brief for LNG Filling Manifold, Doc No. CEE-PR-1001, Rev A, 27 April 2018.

### 3.6 Leak Frequencies – Cryogenic LNG Bowser/Road Truck

The leak frequencies of the road truck is given by (/1/):

- $5.0E-7$  per annum (Instantaneous release of entire contents)

*Loading frequency of road trucks:*

The loading frequency of ISO containers is assumed to be applicable for Cryogenic LNG Bowser/Road Truck, i.e. 150 trucks are expected to be filled per day and there are about 12 days filling in operation per month.

Effect on Analysis:

Leak frequency estimates have a direct effect on the risk profile associated with leak of Cryogenic LNG Bowser/Road Truck, and thus, the overall risk profile of the facility.

Source:

1. Committee for the Prevention of Disasters (Commissie voor de Preventie van Rampen-CPR) – Guideline for Quantitative Risk Assessment ("Purple Book"), CPR 18E – Table 3.19.

### 3.5 Leak Frequencies – Hose and Coupling

The leak frequencies of the hose and coupling while LNG transfer is taking place is given by:

- 1.27E-7 per transfer operation

This frequency is based on ship-shore in port for liquefied gas transfer. For a given type of material the leak frequency is not strongly affected by whether the transfer uses hoses or arms.

As per input from LNGE, 150 number of ISO tanks are expected to be filled within 24 hours and there are about 12 days filling in operation per month. Hence, leak frequency from connecting hose and coupling (which is based on per transfer operation) will be multiplied by factor of  $150 \times 12 \times 12 = \mathbf{21,600}$  **filling operation in a year**. The filling system can fill 18 ISO containers at any one time.

#### Effect on Analysis:

Leak frequency estimates have a direct effect on the risk profile associated with leak of hose and coupling, and thus, the overall risk profile of the facility.

#### Source:

1. UK HSE – Failure rate and Event Data for use within Risk Assessments (28/6/2012) – Item FR 1.2.3.

### 3.4 Leak Frequencies – ISO Containers

Based on leak frequency data of ISO Tanks from UK HSE, leak frequencies of ISO Containers are as reported in Table 3-5 below.

**Table 3-5 – Leak Frequency for ISO Tanks (/1/)**

Representative Hole Size (mm)	Leak Frequency (per vessel year) for Representative Hole Size Range	Remarks
10	3.60E-4	This includes releases due to the valve being left open by the operator
25	3.00E-5	
50	3.00E-5	
Catastrophic failure	3.00E-6	With a pressure relief system

However, it is to be noted that rupture of the ISO containers in service caused by the inherent integrity of the containers is considered not credible, given that the ISO Containers are double skin tanks and in addition the following:

- The pressure takes time to build up in one tank, operator would have stopped the filling operation before the pressure is significant enough to cause a tank failure.
- Even if the pressure in the tank increase due to inadvertently closing the vapor return valve, this would speed up the filling in other tanks (common manifold), but is not expected to result in catastrophic rupture / leakage of the tank. The design pressure of the tank (8 barg) is much higher than the working pressure (less than 1 barg) and it would take a very long period for the pressure to reach above its design pressure, during which the action would have been taken.

#### *Loading frequency of Iso Containers:*

150 number of ISO tanks are expected to be filled within 24 hours and there are about 12 days filling in operation per month, with 18 ISO containers loading per time at the loading station (i.e. 18 loading stations). This gives an average number of **1,800 ISO containers being filled per month**.

The QRA will be based on filling of ISO container as the base case, and thus the loading frequency of ISO containers will be used and is assumed to be applicable for **Cryogenic LNG Bowser/Road Truck**.

#### **Effect on Analysis:**

Leak frequency estimates have a direct effect on the risk profile associated with ISO Containers failure case, and thus, the overall risk profile of the facility.

#### **Source:**

1. UK HSE - Failure rate and Event Data for use within Risk Assessments (28/6/2012) - Item FR 3.2.1.

### 3.3 Leak Frequencies – Cargo Tank

Based on leak frequency data of LNG Refrigerated Tanks from UK HSE, the leak frequencies are as reported in Table 3-4 below.

**Table 3-4 – Leak Frequency for LNG Refrigerated Tanks (/1/)**

Leak Category	Representative Hole Size	Leak Frequency (per vessel year)
Minor	225mm	3.00E-6
Major	750mm	1.00E-6
Catastrophic	Rupture	5.00E-8

The berths in consideration are located at end of the channel, thus the size of vessels in the vicinity of the berths is limited to tugboats or small size vessels only. In addition, speed limit of vessel in traffic is limited to 3-5 knots. As such, these would limit the impact energy in the event of an errant vessel colliding with the LNGC resulting in breach or leak of LNGC cargo tank.

**Effect on Analysis:**

Leak frequency estimates have a direct effect on the risk profile associated with LNG Cargo Tanks failure case, and thus, the overall risk profile of the facility.

**Source:**

1. UK HSE (2019). Failure Rate and Event Data for use within Risk Assessments (02/02/19) – Item FR 1.1.2.1.

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Effect on Analysis:

Leak frequency estimates have a direct effect on the risk profile associated with each failure case/inventory, and thus, the overall risk profile of the facility.

Source:

1. Singapore QRA Technical Guidance, Revision No. 3, 9th November 2016.
2. Leak v3.3. documentation

Actuated non-pipeline valve, all diameters	7.69E-04	2.00E-05	-1.11E+00	1.40E+00	9.99E-06
Small Bore Fitting	5.05E-04	0.00E+00	-8.20E-01	0.00E+00	0.00E+00

Based on the parameters above, the leak frequencies associated with each equipment are as presented below:

**Manual Valves (Full pressure leak frequencies per valve year):**

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)
1-3	5.3E-05	6.8E-05	1.4E-04	3.1E-04	5.9E-04
3-10	2.3E-05	2.9E-05	6.2E-05	1.3E-04	2.6E-04
10-50	1.5E-05	1.3E-05	2.7E-05	5.9E-05	1.1E-04
50-150	0.0E+00	5.8E-06	6.0E-06	1.3E-05	2.5E-05
>150	0.0E+00	0.0E+00	5.2E-06	1.0E-05	1.8E-05
TOTAL	9.2E-05	1.2E-04	2.4E-04	5.3E-04	1.0E-03

**Flanges (Full pressure leak frequencies per flanged joint year):**

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)
1-3	4.2E-05	6.0E-05	8.6E-05	1.1E-04	1.4E-04
3-10	1.5E-05	2.1E-05	3.0E-05	3.9E-05	4.8E-05
10-50	1.1E-05	7.2E-06	1.0E-05	1.3E-05	1.7E-05
50-150	0.0E+00	6.8E-06	1.7E-06	2.2E-06	2.8E-06
>150	0.0E+00	0.0E+00	5.9E-06	6.1E-06	6.4E-06
TOTAL	6.8E-05	9.5E-05	1.3E-04	1.7E-04	2.1E-04

**Steel Pipes (Full pressure leak frequencies per metre year):**

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)
1-3	1.1E-04	4.3E-05	3.6E-05	3.5E-05	3.4E-05
3-10	3.7E-05	1.5E-05	1.3E-05	1.2E-05	1.2E-05
10-50	1.9E-05	5.1E-06	4.3E-06	4.1E-06	4.1E-06
50-150	0.0E+00	4.3E-06	7.2E-07	6.9E-07	6.8E-07
>150	0.0E+00	0.0E+00	3.4E-06	3.3E-06	3.3E-06
TOTAL	1.6E-04	6.7E-05	5.7E-05	5.5E-05	5.4E-05

**Actuated Valves (Full pressure leak frequencies per valve year):**

HOLE DIA RANGE (mm)	2" DIA (50 mm)	6" DIA (150 mm)	12" DIA (300 mm)	18" DIA (450 mm)	24" DIA (600 mm)
1-3	5.4E-04	5.6E-04	5.8E-04	6.1E-04	6.5E-04
3-10	1.7E-04	1.7E-04	1.8E-04	1.9E-04	2.0E-04
10-50	7.1E-05	5.1E-05	5.4E-05	5.7E-05	6.0E-05
50-150	0.0E+00	2.0E-05	7.7E-06	8.1E-06	8.6E-06
>150	0.0E+00	0.0E+00	1.3E-05	1.3E-05	1.4E-05
TOTAL	7.8E-04	8.0E-04	8.4E-04	8.8E-04	9.3E-04

**Small Bore Fittings (Full pressure leak frequency per instrument year):**

HOLE DIA RANGE (mm)	Full Pressure Leaks
1-3	3.0E-04
3-10	1.3E-04
10-50	7.7E-05
50-150	0.0E+00
>150	0.0E+00
TOTAL	5.0E-04

### 3.2 Leak Frequencies – Process Equipment

Leak frequencies for the QRA were based upon four representative hole sizes as defined in Table 3-2 below using guidance from the QRA Technical Guidance (/1/).

**Table 3-2 – Representative Hole Sizes**

Leak Size	Representative Hole Size	Hole Size Range
Small	10mm	0 – 15mm
Medium	25mm	16 – 49mm
Large	75mm	50 – less than pipeline diameter
Rupture	Rupture or pipeline diameter	

#### Leak Frequency Calculation Software Leak v3.3

The leak frequency will be derived from DNV GL proprietary software Leak v3.3.

Leak calculates leak frequencies for process equipment. A list of the equipment items present is made and ranges of leak sizes to be modeled is made, and Leak will calculate the frequencies of leaks in each size range, using a library database (from UK HSE Offshore Hydrocarbon Release Database) of failure frequencies for different types of process equipment.

#### Leak frequency distributions

The frequency by hole sizes is generated by Leak software using following formula with constants for each equipment.

Based on HCRD, the following frequency functions are applied for equipment:

$$F(d) = C(1 + aDn) dm + Frup$$

F	=	frequency of leaks (per valve year) exceeding size d
C, m	=	constants representing hole size distribution
a, n	=	constants representing equipment size dependency
Frup	=	additional rupture frequency (per valve year)
D	=	valve diameter (mm)
d	=	hole diameter (mm)

**Table 3-3 constants to be applied in the leak frequency functions:**

Scenario	C	a	m	n	Frup
Non-actuated valve, all diameters	8.89E-05	7.00E-07	-8.10E-01	2.60E+00	9.99E-07
Flanges	4.95E-05	6.00E-03	-1.00E+00	9.80E-01	5.00E-06
Process pipe (1m), all diameters.	5.00E-05	3.00E+03	-1.00E+00	-1.85E+00	3.00E-06

applicable for Cryogenic LNG Bowser/Road Truck. Refer to Section 3.4 for frequency of ISO container filling.

#### Parts Count

The parts count of major equipment, piping and fittings was derived by counting of the number of components on the P&IDs for each identified phase within an isolatable inventory.

Parts count sections were primarily defined by isolatable sections.

#### Effect on Analysis:

Used to derive the parts count sections and the leak frequency associated with each parts count section.

#### Source:

1. Compass Energy, Design Brief for LNG Filling System, Doc No. P265, Rev A, 13 June 2018.
2. Compass Energy Pte Ltd, LNG ISO Tank Filling Barge, General Arrangement (110 x 36M Barge), Drawing No. P265-00-015-GD1301, Rev C.
3. Furui CIT Co., Ltd, P&ID for LNG ISO Container Filling Barge, received from LNGE on 18 June 2018.
4. Nantong CIMC Energy Equipment Co., Ltd, 20 Feet Collar Cryogenic Tank, Specification.

### 3 RISK ANALYSIS

#### 3.1 Isolatable Segments and Parts Count

The list of failure cases that will be modeled in the Topsides of the LNG Filling Barge are presented in Table 3-1 below. Isolation of each process section is taken at Emergency Shut Down Valves (ESDVs), connections and coupling/hoses. The isolatable segments marked up in P&IDs are shown in Appendix A. Operating conditions of isolatable segments have been referenced from LNG Filling System Design Document (/1/).

**Table 3-1 List of Isolatable Segments and Operating Conditions**

Failure Case ID	Failure Case Description	Pressure (barg) Note 6	Temperature (deg C)	Inventory (m <sup>3</sup> )
01	Liquid Manifold After ESD (V1) and Liquid Filling Line	0.7	-160	3.4 Note 1
02	Vapour Return Manifold After ESD (V2) and Vapour Return Line	0.7	-160	2.0 Note 2
03A	LNG filling hose at Filling Bay 1	0.7	-160	0.12 Note 3
03B	LNG filling hose at Filling Bay 2	0.7	-160	0.12 Note 3
03C	LNG filling hose at Filling Bay 3	0.7	-160	0.12 Note 3
04A	Vapour return hose at Filling Bay 1	0.7	-130	0.08 Note 4
04B	Vapour return hose at Filling Bay 2	0.7	-130	0.08 Note 4
04C	Vapour return hose at Filling Bay 3	0.7	-130	0.08 Note 4
05	20' LNG Buffer Tank	0.7	-160	18 Note 5
06	ISO Container	0.7	-160	41.4 Note 6
07	Cryogenic LNG Bowser/Road Truck	0.7	-160	47.7 Note 7

Note 1: This is derived from GA (/2/), 80m of DN 200 + 45m of DN 150 + 36m of DN50 piping.

Note 2: This is derived from GA (/2/), 80m of DN 150 + 45m of DN 100 + 76m of DN40 piping.

Note 3: This is derived from 6 pcs of DN 50 in each filling bay, with each hose length is 10m (/1/).

Note 4: This is derived from 6 pcs of DN 40 in each filling bay, with each hose length is 10m (/1/).

Note 5: Payload for 20' Buffer Tank is 8090 kg for LNG (/4/).

Note 6: Iso-Seg 06 is leak from one (1) ISO Container during loading. For worst case scenario, ISO container is considered filled, and inventory is estimated based on 90% full for 46 m<sup>3</sup> size ISO container, as per input from LNGE.

Note 7: Iso-Seg 07 is leak from one (1) Cryogenic LNG Bowser/Road Truck during loading. For worst case scenario, truck is considered filled, and inventory is estimated based on 90% full for 53 m<sup>3</sup> size truck, as per input from LNGE.

It should be noted that loading of LNG can be to ISO containers or Cryogenic LNG Bowser/Road Trucks, thus the QRA will be based on either ISO containers or Cryogenic LNG Bowser/Road Truck filling operations. For this QRA, the analysis will be based on filling of ISO container as the base case, and the loading frequency of ISO containers will be used. The same loading frequency is assumed to be

As informed by LNGE, the SOP weather limits for operation at the Jetty is:

Normal Operation	<30 knots
Suspended Operation	35 knots

In addition, ambient temperature: 30 °C; relative Humidity: 85% will be considered in the QRA modelling.

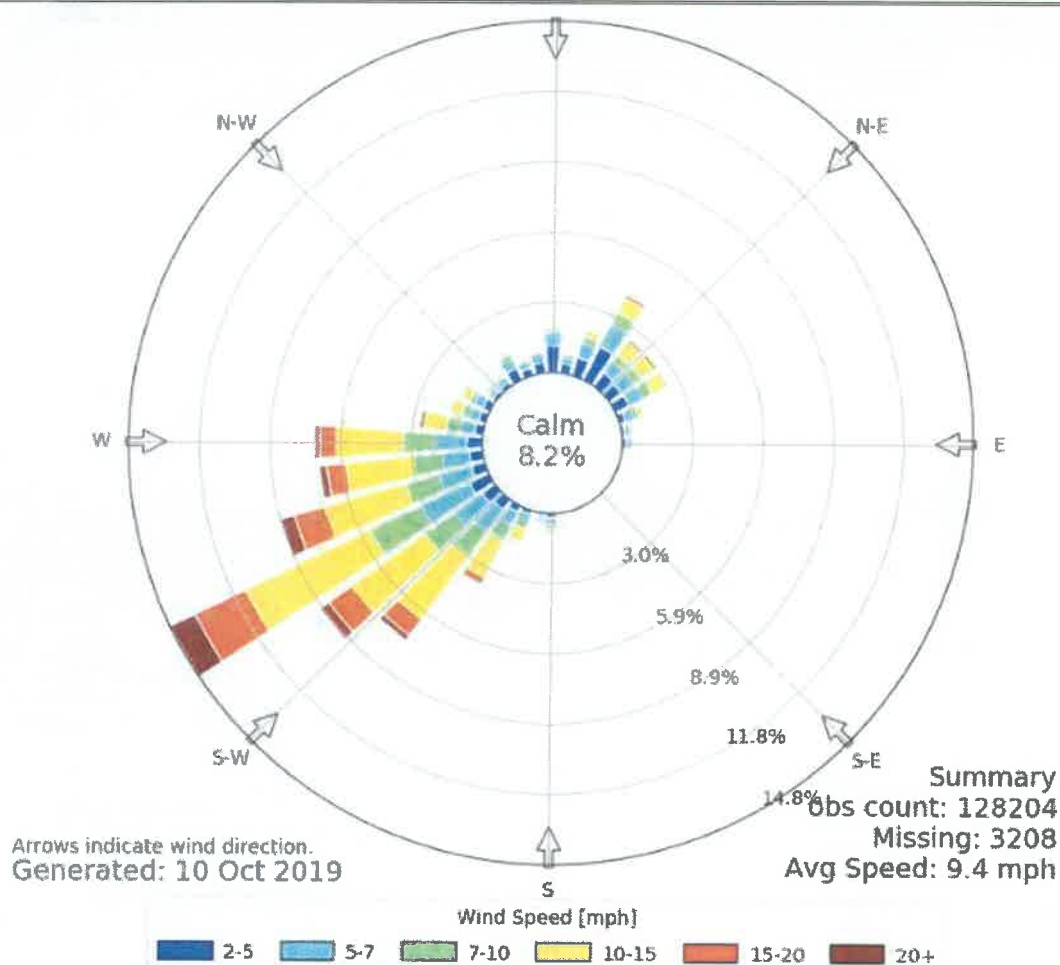
**Effect on Analysis:**

- The wind speed and direction probability distribution determine the direction and length over which an un-ignited gas cloud will disperse. However, this probability distribution has relatively little impact in the event of immediate ignition.
- A higher air temperature and relative humidity tend to reduce atmospheric transmissivity and therefore the level of thermal radiation to which personnel were exposed. However, the impact of this is normally not significant.

**Source:**

1. Weather Data from the Karachi Airport provided by LNGE. Source: Iowa State University.

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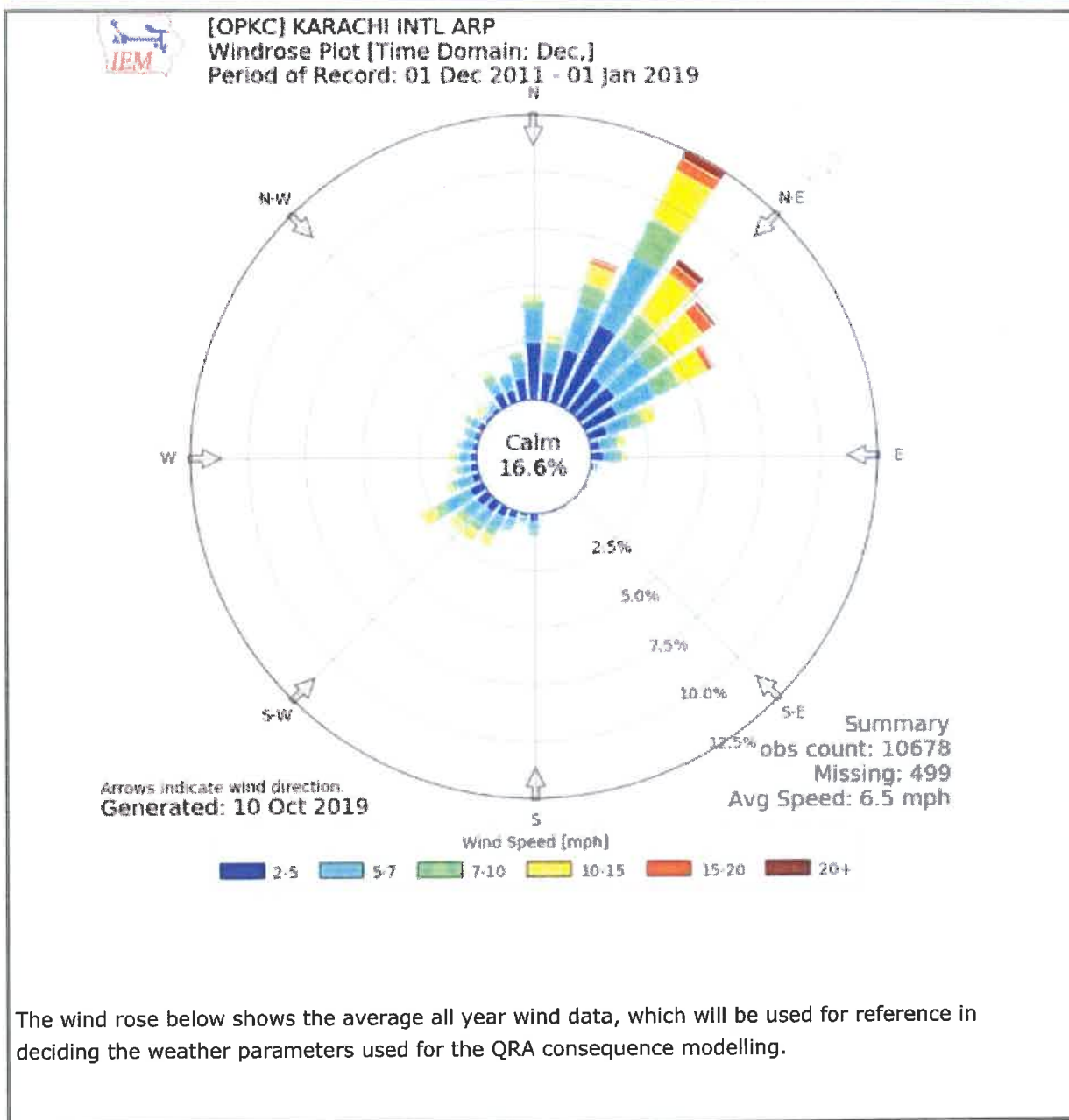
Based on the all-year wind rose, the average wind speed is 9.4mph, which is 4.2m/s. Low wind conditions will result in less gas mixing and dispersion, potentially resulting in a higher concentration of gas built-up and further flammable distance reached (i.e. larger Lower Flammable Limit [LFL] distances). Taking this into consideration, the following weather conditions have been selected when calculating the consequence effect distances for the credible releases:

- 1F: Wind Speed 1m/s and Stability Class F (Very Stable);
- 3C: Wind Speed 3m/s and Stability Class C (Unstable);
- 6D: Wind Speed 6m/s and Stability Class D (Neutral).

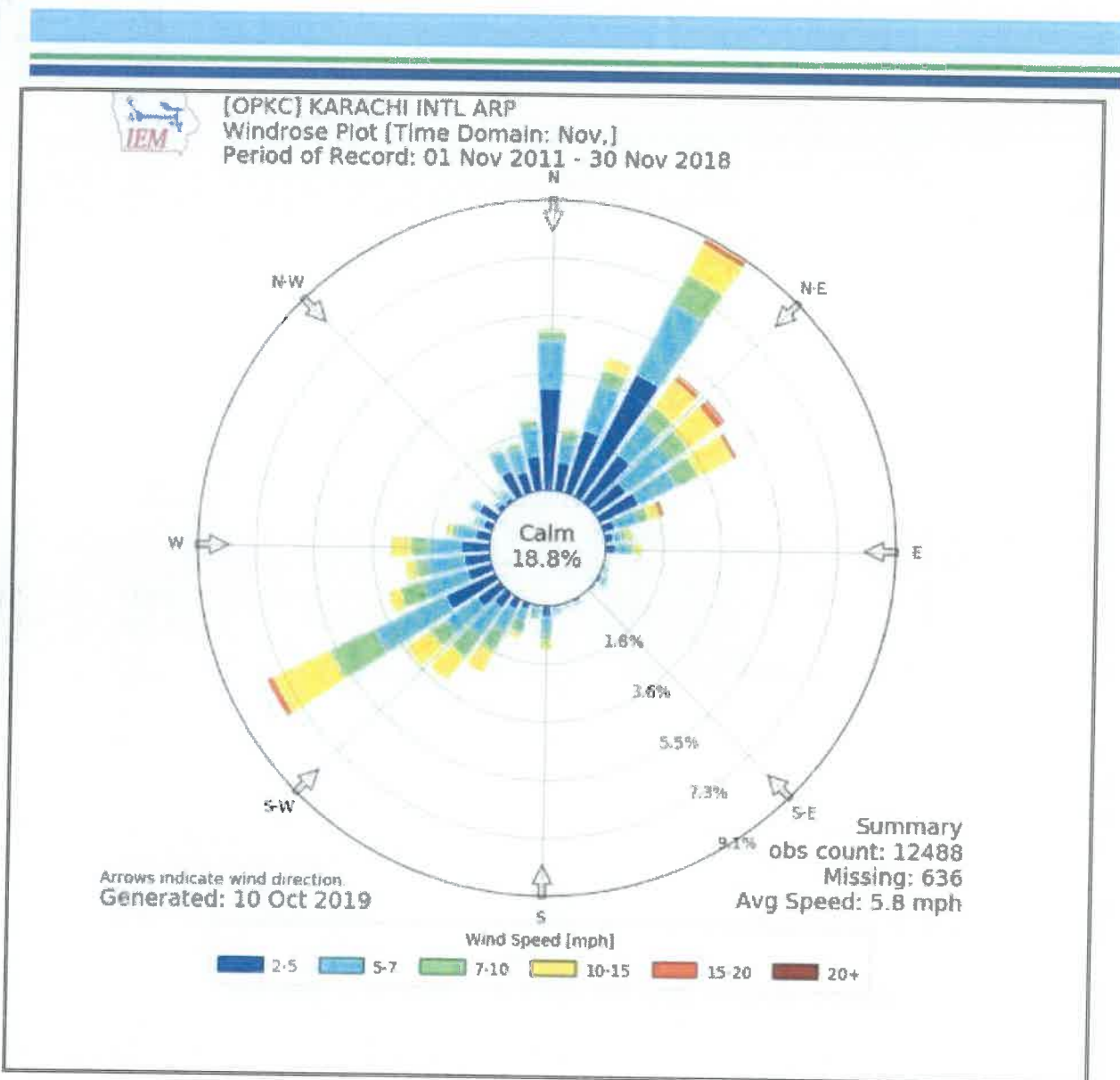
It is noted that, whilst Pasquill stability class D tends to represent the average atmospheric stability condition, stability class F tends to result in the worst-case flammable gas dispersions.

Based on the above all-year wind rose, the normalized wind direction distribution, which will be used in the QRA, is tabulated in the table below:

Weather Categories	% Distribution of average wind direction								
	N	NE	E	SE	S	SW	W	NW	
1F	24.8%	<b>27.3%</b>	3.3%	0.0%	1.7%	16.5%	15.7%	10.7%	100%
3C	7.1%	13.9%	3.2%	0.0%	3.9%	<b>36.1%</b>	28.7%	7.1%	100%
6D	1.3%	8.2%	1.0%	0.0%	2.6%	<b>49.9%</b>	33.7%	3.3%	100%

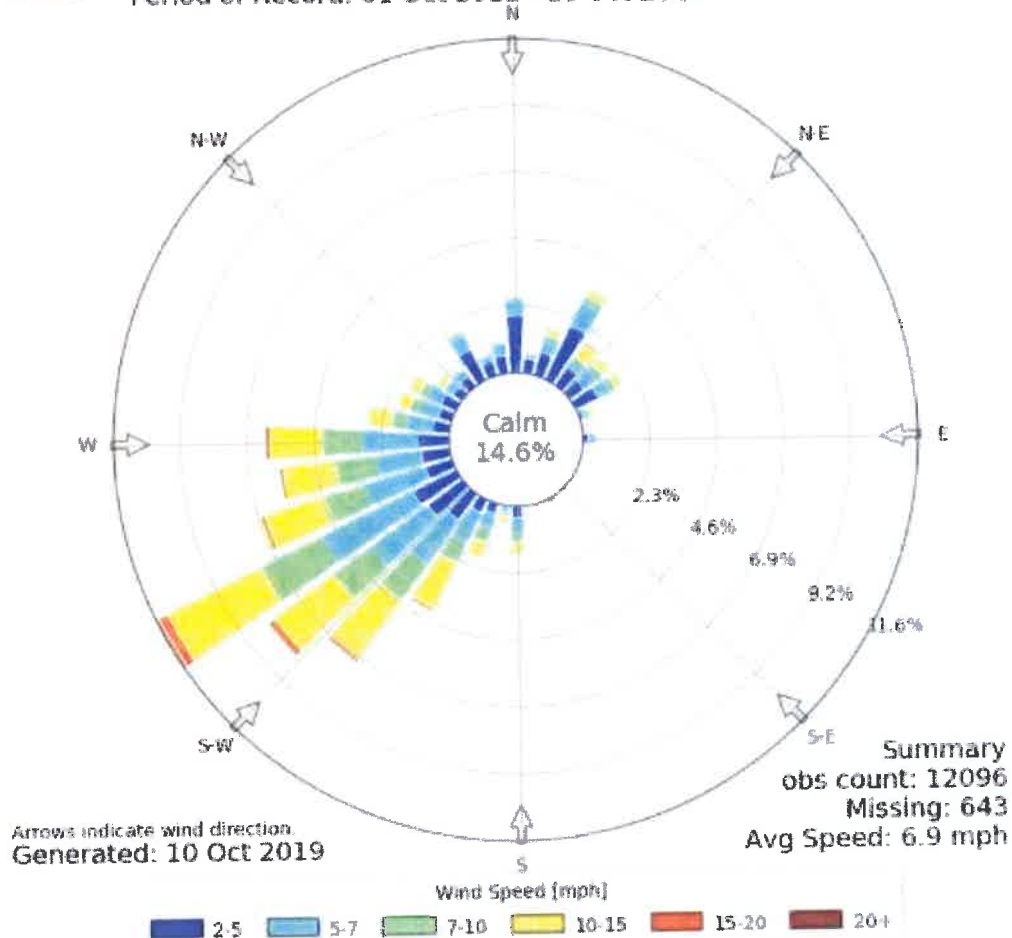


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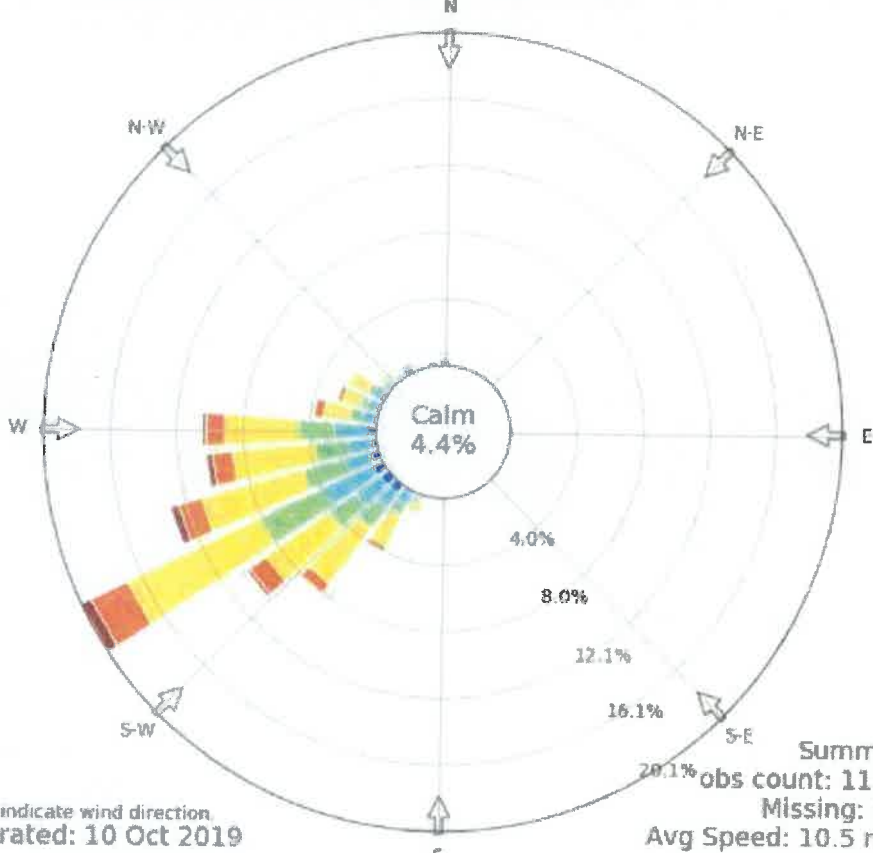
[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: Oct,]  
Period of Record: 01 Oct 2011 - 10 Oct 2019



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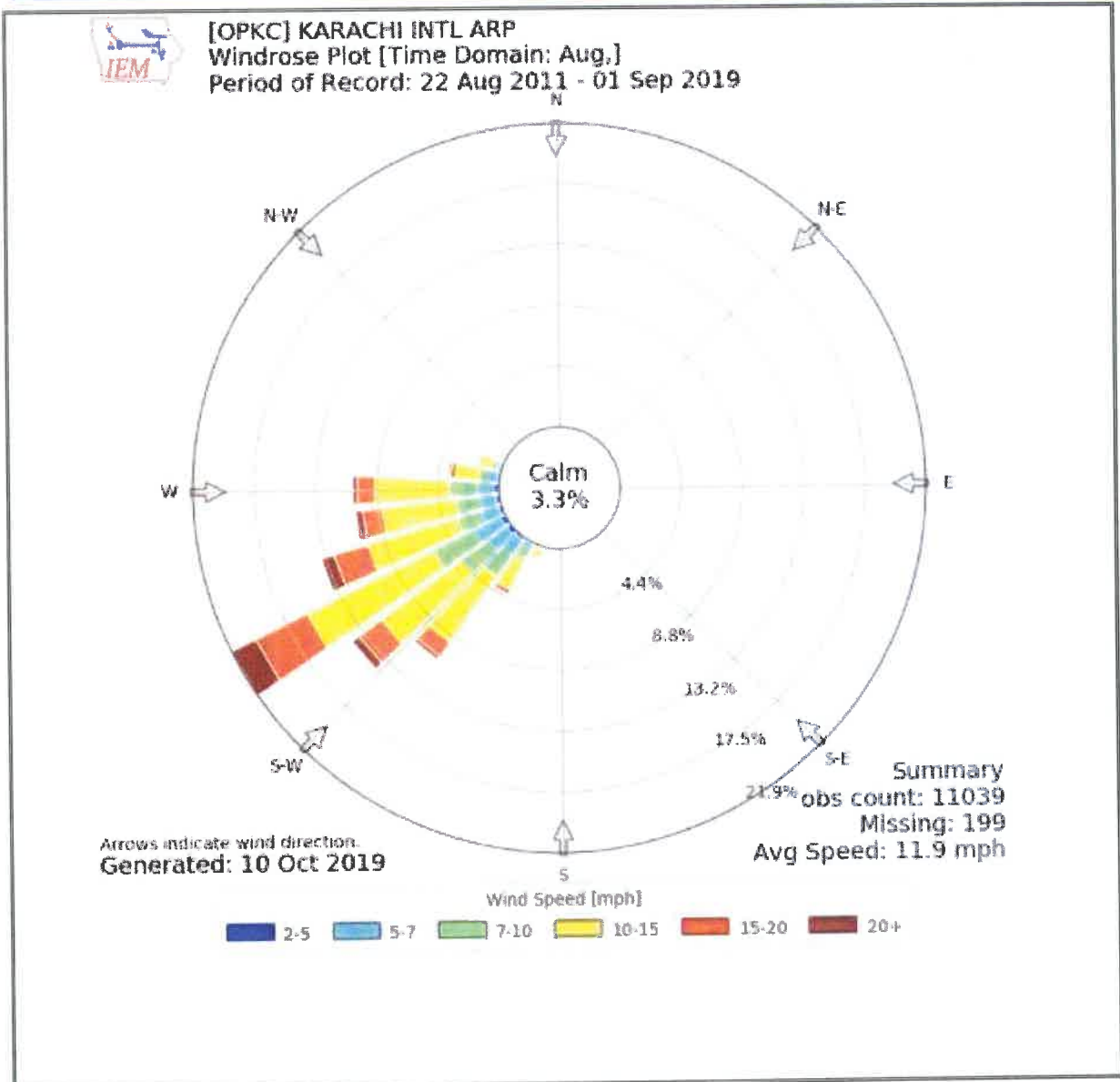
[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: Sep,]  
Period of Record: 01 Sep 2011 - 01 Oct 2019



Arrows indicate wind direction.  
Generated: 10 Oct 2019

Summary  
obs count: 11591  
Missing: 557  
Avg Speed: 10.5 mph

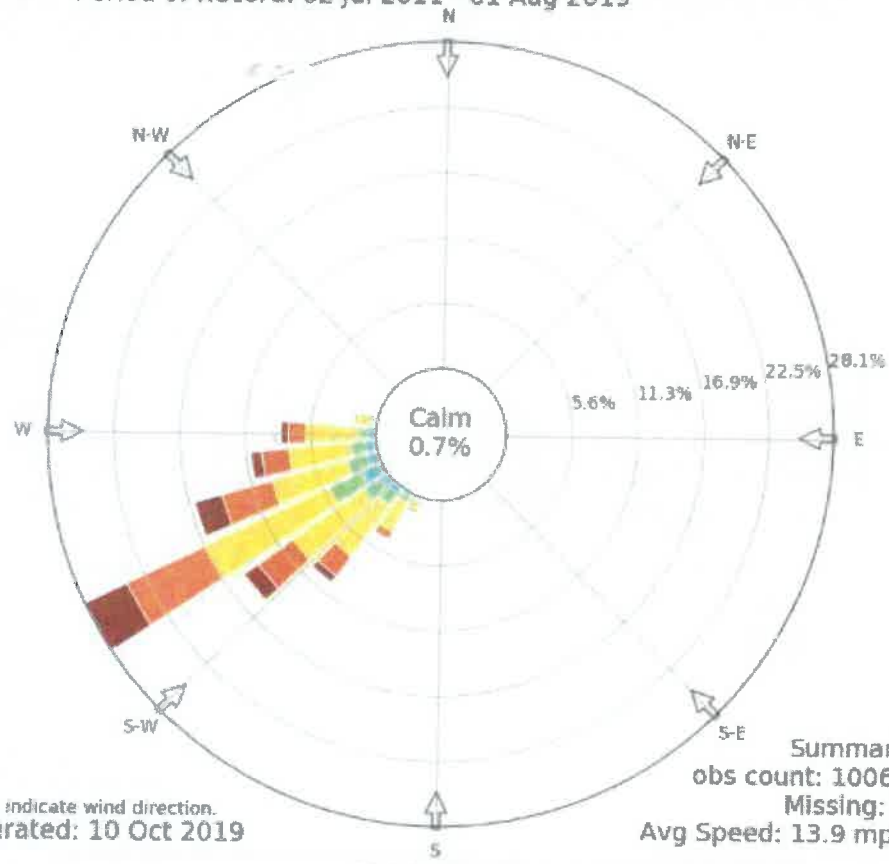
Wind Speed [mph]  
2-5 5-7 7-10 10-15 15-20 20+



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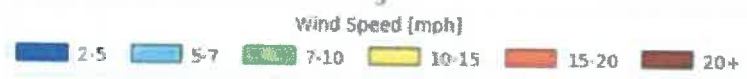


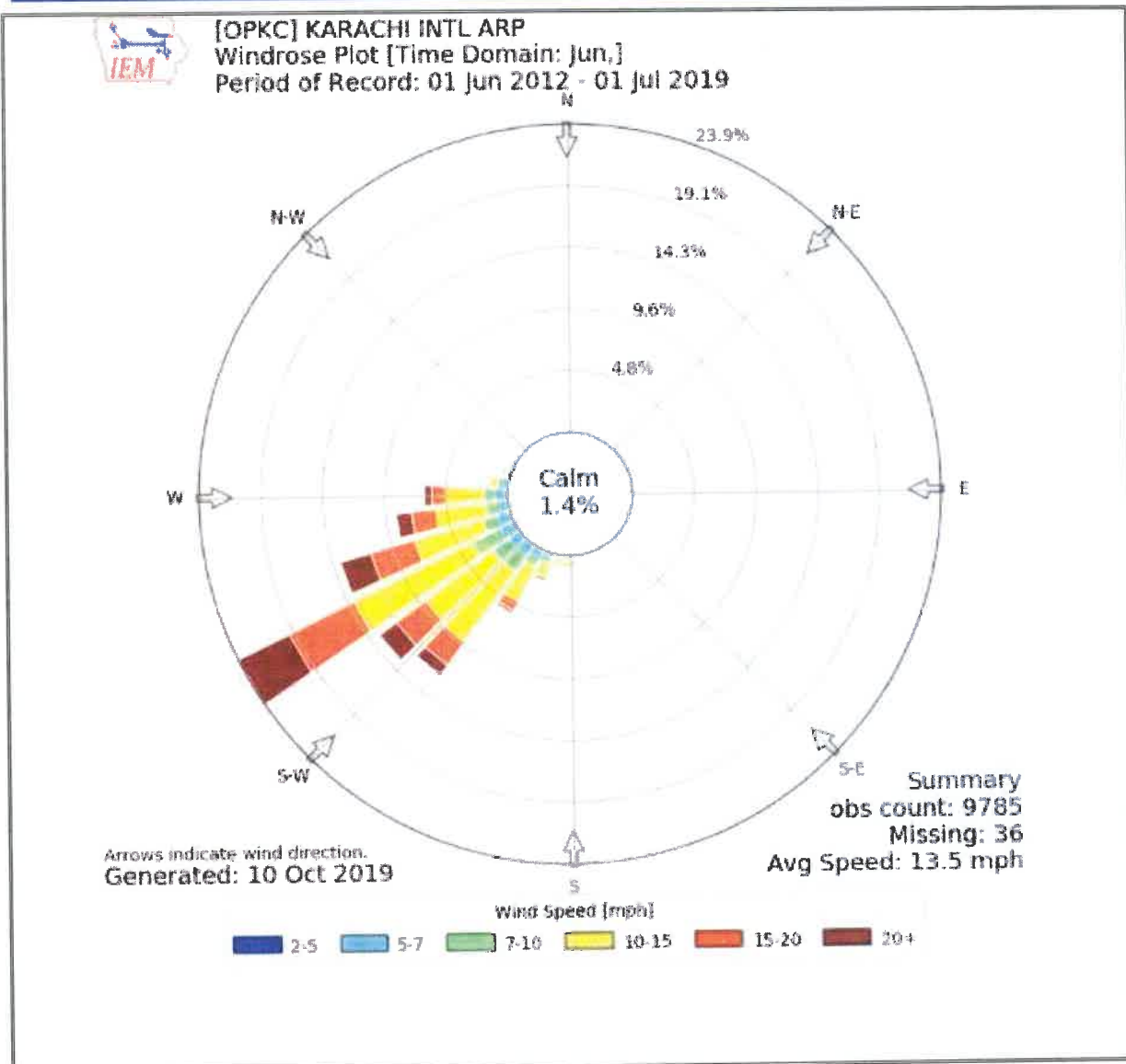
[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: Jul.]  
Period of Record: 02 Jul 2011 - 01 Aug 2019



Arrows indicate wind direction.  
Generated: 10 Oct 2019

Summary  
obs count: 10067  
Missing: 2  
Avg Speed: 13.9 mph

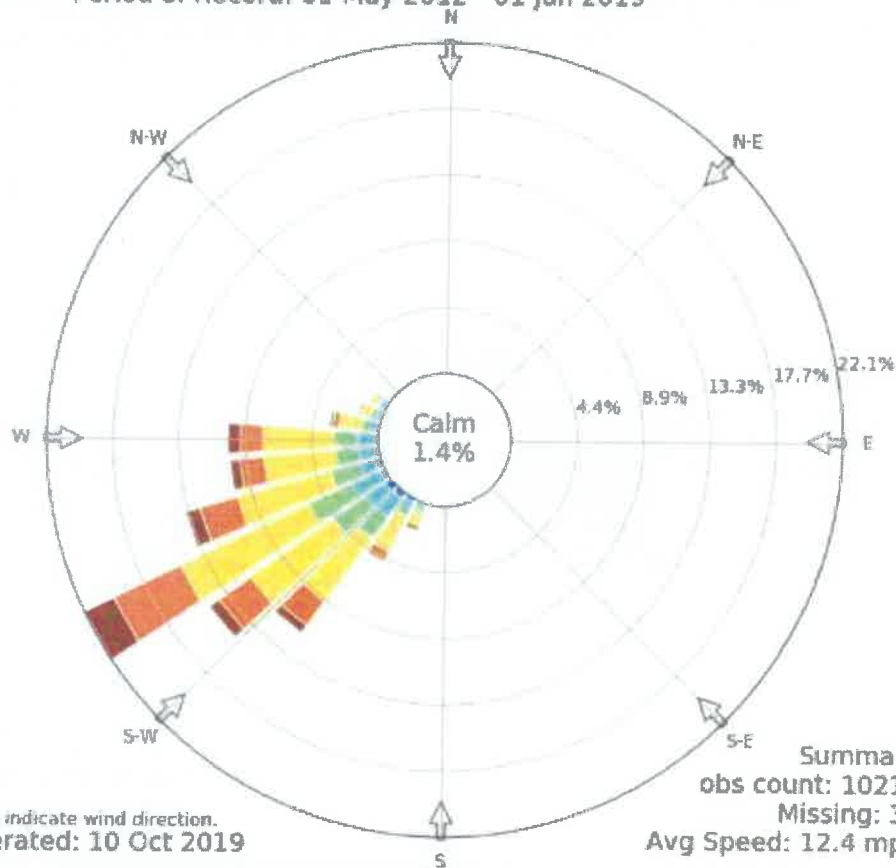




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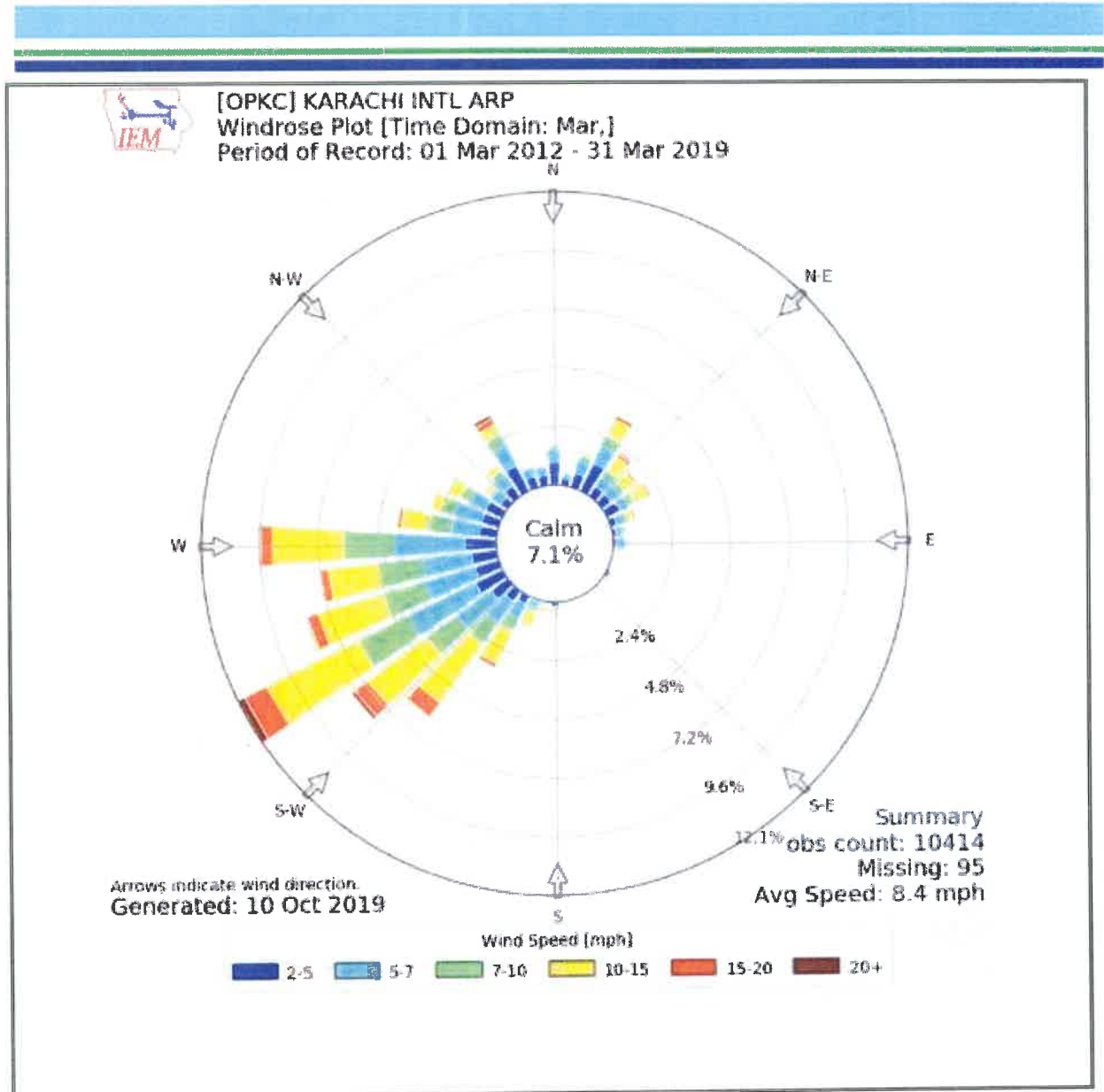


[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: May,]  
Period of Record: 01 May 2012 - 01 Jun 2019



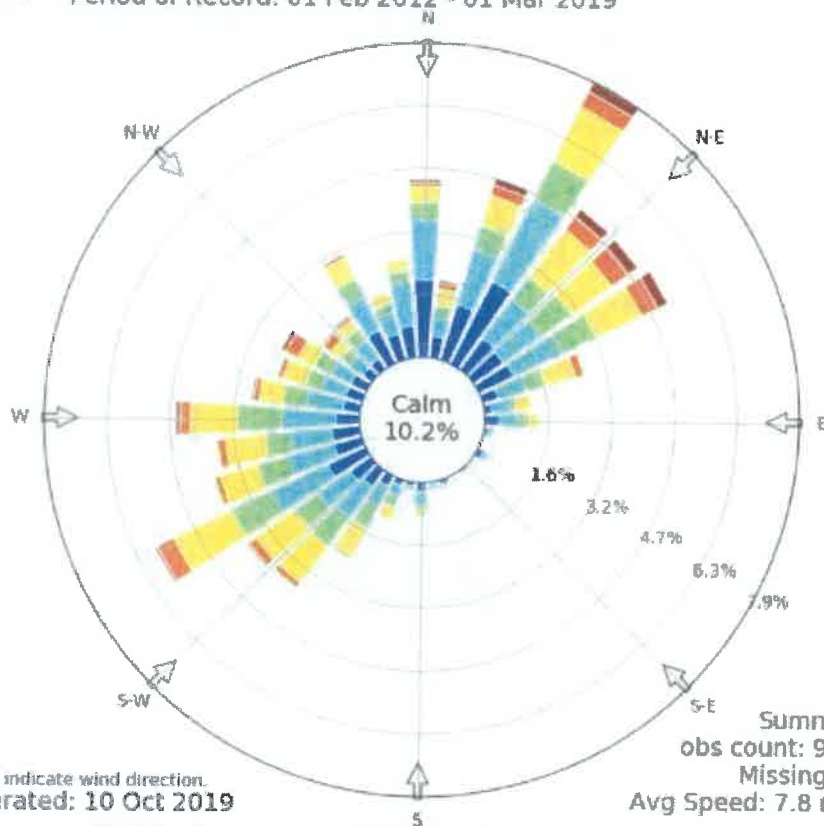
Summary  
obs count: 10211  
Missing: 39  
Avg Speed: 12.4 mph







[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: Feb,]  
Period of Record: 01 Feb 2012 - 01 Mar 2019



Summary  
obs count: 9204  
Missing: 91  
Avg Speed: 7.8 mph

Wind Speed [mph]

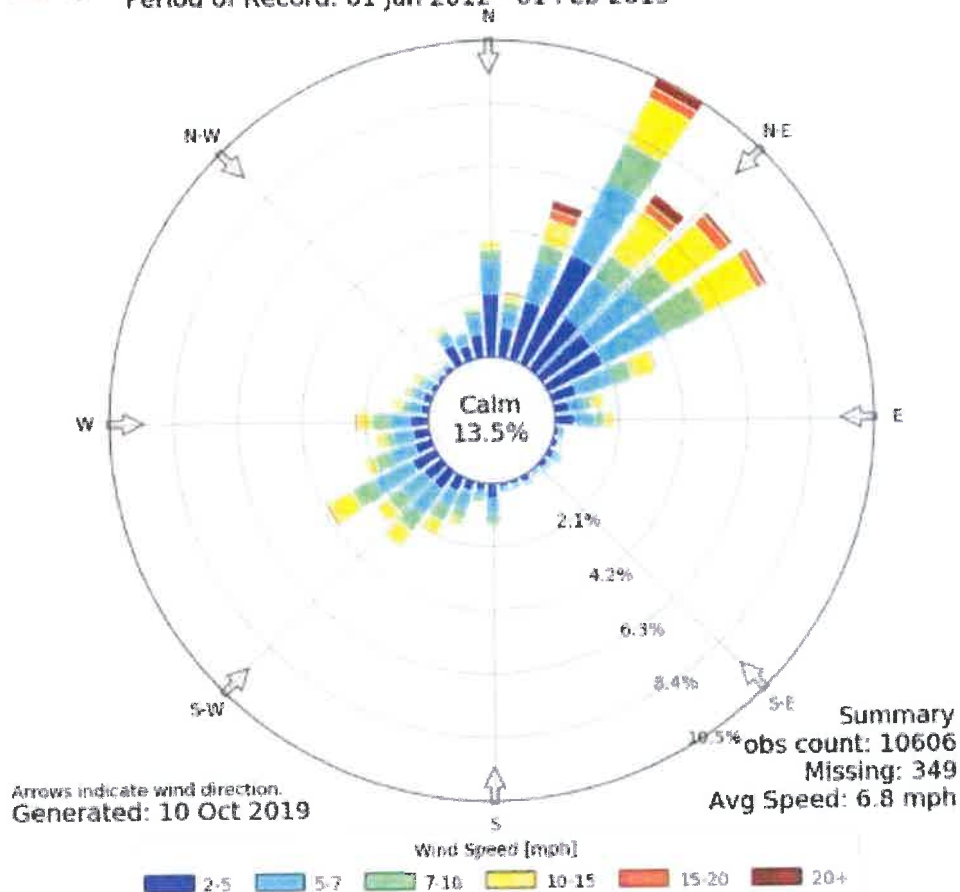
2-5 5-7 7-10 10-15 15-20 20+

## 2.5 Meteorological Conditions

Weather data from Karachi Airport is provided by LNGE and the wind data considering the wind speed and wind direction have been compiled and represented in the wind roses below. The wind roses indicate the wind data for each month over a 7-year period.



[OPKC] KARACHI INTL ARP  
Windrose Plot [Time Domain: Jan,]  
Period of Record: 01 Jan 2012 - 01 Feb 2019



## 2.4 Major Accident Events

A Major Accident/Incident (or Major Accident Event [MAE]) is defined to be an event that is:

- Fire or explosion or the release of a dangerous substance, with a significant potential to cause, death or serious personal injury to person,
- Any other event arising from a work activity that potential lead to multiple fatalities.

Credible hazard events as extracted from the HAZID report with consequence of rating 4, indicating "single fatality or permanent disabilities" are as follows:

- Loss of containment of LNG during STS Operations between LNGC and Barge;
- Loss of containment of LNG from tugboats colliding with the LNG carrier.

Note that none of the hazard events identified in HAZID could lead to multiple fatalities (consequence ranking of 5).

### Effect on Analysis:

Determines the scenarios to be modeled in QRA.

### Source:

2. DNV GL, LNG Easy HAZID/HAZOP – LNG ISO Container Filling & Shipment Operation, HAZID and HAZOP Report, LNG Easy Pte Ltd, Report no. PP205958-119FL113-2, Rev. 0, 28 May 2018.
3. DNV GL, LNG Easy HAZID/HAZOP – LNG Easy HAZID/HAZOP – Mobile filling platform for LNG ISO container/Road truck filling for Pakistan Harbor PP205958-A-119FL113-2-A Report, Rev. 0, 25th February 2020

## 2.3 LNG Offloading from the LNGC

The selected LNGC has a storage capacity of 45,000 m<sup>3</sup>, either Type-C tanks or membrane tanks. It is expected that the same LNGC will be on location for at least 2-3 days at least 4 times a month to discharge LNG into the containers.

It is to be noted that the zero-spill emergency release coupling will be activated, to isolate the LNG carrier and manifold in case of abnormal disconnection while offloading is in progress; thus the spilled mass from the LNG STS hose connection would be negligible.

Effect on Analysis:

To determine the potential release frequencies associated with the LNG offloading operations carried out annually.

Source :

1. Input from LNGE.



**Figure 2-5 – Layout of Karachi Port at Berth 23**

Effect on Analysis:

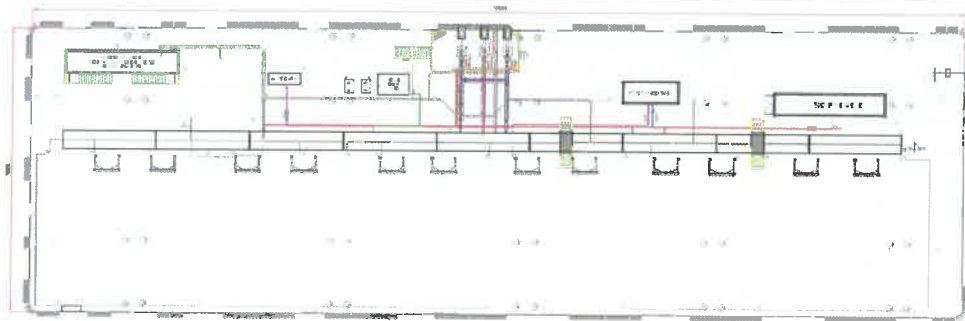
Location of where the failure case for LNG filling operation is placed.

Source:

1. Provided by LNGE, Draft Layout on 15 February 2020.
2. Compass Energy Pte Ltd, LNG ISO Tank Filling Barge, General Arrangement (110 x 36M Barge), Drawing No. P265-00-015-GD1301, Rev C.
3. Provided by LNGE, Berth 19 Karachi Port Project Distances to Permanent Structure, received 30<sup>th</sup> March 2020.



**Figure 2-4 Proposed Location of LNG unloading at Berth 19 [3]**



**Figure 2-2 – Layout of the MFP 1**



**Figure 2-3 – Karachi Port Layout 18/19**

*Note that the area just south of Berth number 18 and 19 is a shallow area without vessels traffic. The bridge to the East of berth 19 is a low bridge for cars and heavy traffic. No tugs or vessels will pass under this bridge.*

## 2.2 Layout of STS Operation

The LNGC will be moored alongside the MFP and the MFP will be moored alongside the Jetty as shown in Figure below. Three (3) alternative locations are proposed as shown below:

- Berth 18 / 19;
- Berth 19; and
- Berth 23.



**Figure 2-1 – Layout of LNGC-LNG MFP layout at berth 18/19 in Karachi Port [1]**

Note that there are 74 meters from the stern of the LNG Carrier to active restaurant outlets at location of Berth 18 and 19. There is another 28 meters from the front of the accommodation to the stern of the ship. Total distance from restaurants to LNG Tank areas is about 100 meters. There is also a railroad crossing between the Restaurants and the LNG carrier.

Berth 23 has no restaurant outlets in the close vicinity.

Figure 2-2 shows the layout of the MFP.

## 2 GENERAL ASSUMPTIONS

### 2.1 Study Boundaries

The boundary of the study is limited to the following:

- LNG vessel
- Filling operation of ISO containers or Cryogenic LNG Bowser/Road Trucks and;
- The departure of the trucks from the jetty (excluding the transportation risk).

This assessment is limited to normal operations, with focus on major accident hazards identified from HAZID.

The following scopes are excluded:

- Maneuvering of the LNG Carrier to and from the berth.
- Transport routing of Cryogenic LNG Bowser/Road Trucks from jetty.

Effect on Analysis:

Scope and coverage of the QRA.

Source:

1. DNV GL, LNG Easy HAZID/HAZOP – LNG Easy HAZID/HAZOP – Mobile filling platform for LNG ISO container/Road truck filling for Pakistan Harbor PP205958-A-119FL113-2-A Report, Rev. 0, 25th February 2020

## 1 INTRODUCTION

This document presents an overview of the information and basis applied, including main modeling assumptions made in order to carry out the Quantitative Risk Analysis (QRA) for LNG ISO containers and Cryogenic LNG Bowser/Road Truck filling. Trucks will arrive with empty LNG containers which will be parked on the Jetty in Karachi Port and will be filled via a Mobile Filling Platform (MFP) from an LNG Carrier.

Three (3) berths are proposed for the LNG ISO containers/ Cryogenic LNG Bowser/Road Truck filling at Karachi Ports:

- Berth 18/19
- Berth 19
- Berth 23

This QRA will presents the risks of the LNG loading activities for the abovementioned locations.

The data and study assumptions compiled within this document will, along with any other documents referenced form the basis for this study. Consequently, alteration of these assumptions may render the results of the analysis invalid and could generate a need for an update of the risk analysis.

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## Appendix A Marked up P&IDs



**LNG EASY QRA STUDY – MOBILE FILLING  
PLATFORM FOR LNG ISO  
CONTAINER/CRYOGENIC LNG BOWSER/ROAD  
TRUCK FILLING FOR KARACHI PORT**

**Assumption Register, Rev 5, 31-03-2020**

55  
7



## APPENDIX A      ASSUMPTIONS REGISTER

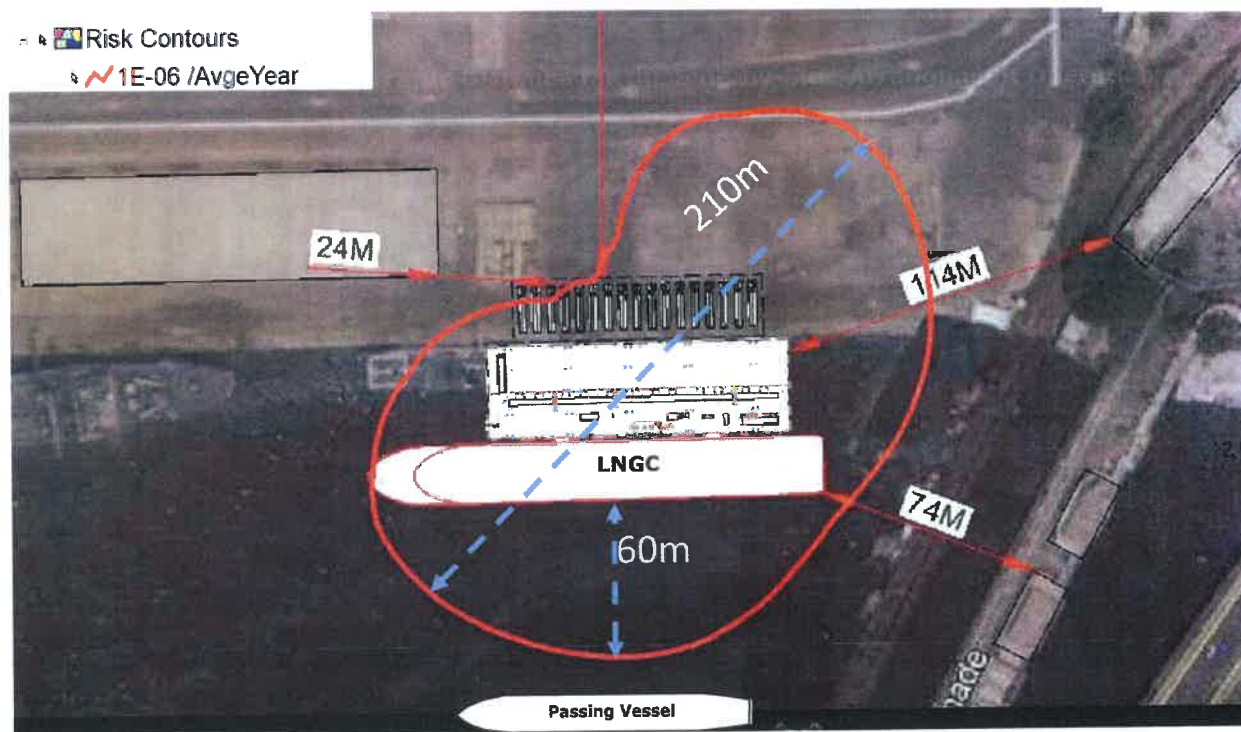
## 9 REFERENCES

- /1/ Compass Energy Pte Ltd, LNG ISO Tank Filling Barge, General Arrangement (110 x 36M Barge), Drawing No. P265-00-015-GD1301, Rev C.
- /2/ DNV GL, LNG Easy HAZID/HAZOP – LNG Easy HAZID/HAZOP – Mobile filling platform for LNG ISO container/Road truck filling for Pakistan Harbor TC689379, Rev. 0, 25<sup>th</sup> Feb 2020.
- /3/ Compass Energy Pte Ltd, LNG Filling System Design Brief, Document No. P265, Rev A, 13 June 2018.
- /4/ UK HSE, Guidance on ALARP Decisions in COMAH,  
[https://www.hse.gov.uk/foi/internalops/hid\\_circs/permissioning/spc\\_perm\\_37/](https://www.hse.gov.uk/foi/internalops/hid_circs/permissioning/spc_perm_37/).
- /5/ DNV GL, Technical Note T17, Risk Criteria, Rev 1.
- /6/ Input by LNGE, dated 28<sup>th</sup> March 2020.
- /7/ HAZID, HAZOP and SIL Classification/LOPA Report - LNG Easy HAZID/HAZOP – Mobile filling platform for LNG ISO container/Road truck filling for Karachi PORT, Rev. 0, 24-05-21.

## 8 CONCLUSION

The following are conclusions derived from this QRA study:

- For public risk, the intolerable risk for public, which is  $1\text{E-}04$  per year, does not extend beyond the MFP, and the broadly acceptable risk level of  $1\text{E-}06$  per year is contained within the jetty area. As such, the risk to public is considered to be within the ALARP region.
- The Individual Risk Per Annum (IRPA) for an individual working on the MFP is estimated to be  $2.15\text{E-}05$  per year. This is calculated based on the risk for an arbitrary person working at a particular location (in this case personnel is assumed to be positioned at the main pipe rack area of the MFP), with a 12 hours work shift per day (split of 70% of time spent outdoor, 30% indoor). The filling operation is assumed to take place 12 days in a month. This risk result shows that the IRPA for workers on the MFP falls within the ALARP region (i.e. between  $1\text{E-}07$  per year to  $1\text{E-}04$  per year).
- The furthest radial distance extended by the  $1\text{E-}06$  per year risk contour from the centre of the MFP is approximately 120m in length. 120m is thus recommended as the minimum distance between centre of the MFP and any on-shore/off-shore facilities, if applicable.
- The Ignition Exclusion Zone (IEZ) has been determined to be approximately 120m from centre of the MFP (potential release at LNG filling hose connection at the filling bay). The marine exclusion zone distance set for LNGC is calculated to be 60m. This is the minimum distance for any passing vessels or marine vessels plying the area (except authorised vessel with appropriate ignition control measures in place) during LNG filling operations.
- Within the defined IEZ / MEZ radius, the following restrictions must be in place:
  - Unauthorised entry must be restricted within the IEZ / MEZ radius. Only dedicated personnel are allowed in the area.
  - On water, this restriction will include small boats, fishing vessels and other marine vessels that are unlicensed for harbour work and are carrying open air ignition sources.
  - No activities can be performed which can introduce ignition sources (e.g. hot work, hot surfaces, etc.).



**Figure 7-11: Passing Traffic Distance for the Side-by-Side Arrangement Operation**



**Figure 7-10: Flash Fire - LFL Contour at 1E-06/yr Frequency**

### 7.5.3 Marine Exclusion Zone

In this study, the IEZ defined from the LFL distance will be used to establish the Marine Exclusion Zone (MEZ), which is the minimum distance that the passing vessels should be prevented from passing the facility.

As discussed in preceding section, the safety distance established by the risk-based approach extends up to 120m, from the centre of the MFP. The marine exclusion zone distance set for LNGC are then calculated to be 60m, as illustrated in Figure 7-11. This is the minimum distance for any passing vessels or marine vessels plying the area (except authorised vessel with appropriate ignition control measures in place) during LNG filling operations.

## 7.5 Safety Zone

The PIANC report, 'Safety Aspects Affecting the Berthing Operations of Tankers to Oil and Gas Terminals (PIANC, 2012), provides categories for safety zones that would allow the safe berthing of LNG tankers and manoeuvring past LNG facilities.

The safety zone is defined as:

- A Safety Zone is in place to prevent a natural gas release from igniting and leading to a serious incident. The primary means of preventing ignition is to exclude ignition sources from the area where gas can be ignited. The safety zone required on water side is referred as the **Ignition Exclusion Zone (IEZ)**.

An ignition exclusion zone is required to be established around the LNG Filling and Receiving Facility to ensure that only essential personnel and activities are allowed in the area that could be exposed to a flammable gas in case of an accidental release of LNG or natural gas during facility operation.

### 7.5.1 LFL Distance

An un-ignited accidental release of natural gas will develop a flammable vapour cloud, which in the presence of an ignition source can lead to a flash fire. The flammable vapour cloud will travel downwind until sufficient heating and mixing with the turbulent atmosphere dilutes the vapour concentration below the limits of flammability. From a safety standpoint, interest is focused on the area covered by the un-ignited flammable vapour cloud before it can no longer be ignited.

### 7.5.2 Ignition Exclusion Zone

Based on Table 7-3, the largest LFL distance reached is 236m, from release from rupture case of ISO-01 LNG filling manifold at weather condition 1F. However, using a risk based approach by considering the frequency of leakage, ignition probability and consequence, the predicted LFL distance at 1E-06 per year (defined as the broadly acceptable IR criteria as given in section 6.6.1) is determined to be 120m from the centre of the MFP. Figure 7-10 displays the flash fire risk contour exceeding 1E-6/year.

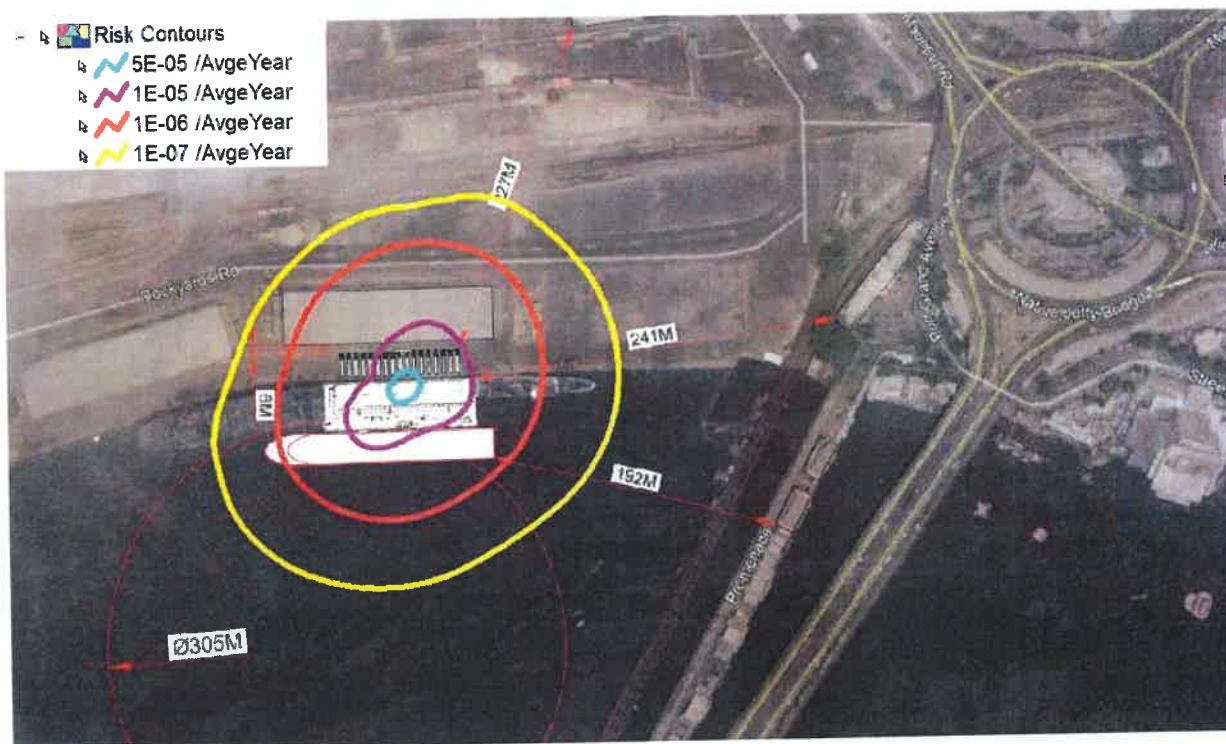
Scenario	Weather	Mass flow rate		LFL	Jet Fire			Pool Fire			Explosion	
		(kg/s)	Distance (m)		Distance downwind to 4 kW/m <sup>2</sup> (m)	Distance downwind to 12.5 kW/m <sup>2</sup> (m)	Distance downwind to 35 kW/m <sup>2</sup> (m)	Distance downwind to 4 kW/m <sup>2</sup> (m)	Distance downwind to 12.5 kW/m <sup>2</sup> (m)	Distance downwind to 35 kW/m <sup>2</sup> (m)	Distance downwind (0.1 bar) (m)	Distance downwind (0.3 bar) (m)
Study\ISO-05 20'LING Buffer Tank1\Rupture	Category 1/F	-	115.741	-	-	-	-	102.2	59.4175	31.1116	127.636	66.9257
Study\ISO-05 20'LING Buffer Tank1\Rupture	Category 3/C	-	177.111	-	-	-	-	109.466	69.6482	42.7401	-	-
Study\ISO-05 20'LING Buffer Tank1\Rupture	Category 6/D	-	230.432	-	-	-	-	112.434	74.8074	51.3843	-	-
Study\ISO-06 40'ISO Containers\10mm	Category 1/F	0.3777	4.40655	-	22.1931	18.2934	n/a	11.8345	8.87074	6.6318	-	-
Study\ISO-06 40'ISO Containers\10mm	Category 3/C	0.3777	7.04186	-	19.286	15.4661	13.7032	11.3679	9.19272	7.41253	-	-
Study\ISO-06 40'ISO Containers\10mm	Category 6/D	0.3777	5.42567	-	17.6059	14.0164	11.8428	10.4299	9.06283	8.36761	-	-
Study\ISO-06 40'ISO Containers\25mm	Category 1/F	2.36062	65.9435	-	48.9549	39.0833	n/a	39.1403	25.3025	15.757	-	-
Study\ISO-06 40'ISO Containers\25mm	Category 3/C	2.36062	36.9263	-	42.7409	33.1154	28.5848	37.4339	26.1847	17.7046	-	-
Study\ISO-06 40'ISO Containers\25mm	Category 6/D	2.36062	28.2034	-	39.1364	30.3393	25.2937	33.6254	24.8302	18.2625	-	-
Study\ISO-06 40'ISO Containers\50mm	Category 1/F	9.44249	130.29	-	83.8918	65.8507	60.1148	73.5391	45.6164	26.912	-	-
Study\ISO-06 40'ISO Containers\50mm	Category 3/C	9.44249	75.527	-	78.4977	60.5067	50.8586	73.3118	49.0947	32.5597	-	-
Study\ISO-06 40'ISO Containers\50mm	Category 6/D	9.44249	64.092	-	71.947	55.2966	44.9265	69.3975	48.6059	35.3521	-	-
Study\ISO-07 Road Truck\Road Truck\Rupture	Category 1/F	-	146.039	-	-	-	-	149.827	86.9362	45.6573	169.465	84.5468
Study\ISO-07 Road Truck\Road Truck\Rupture	Category 3/C	-	225.182	-	-	-	-	158.428	100.236	60.838	258.721	171.948
Study\ISO-07 Road Truck\Road Truck\Rupture	Category 6/D	-	220.325	-	-	-	-	162.01	106.533	72.3748	245.381	156.392

Table 7-3 Consequence Distances

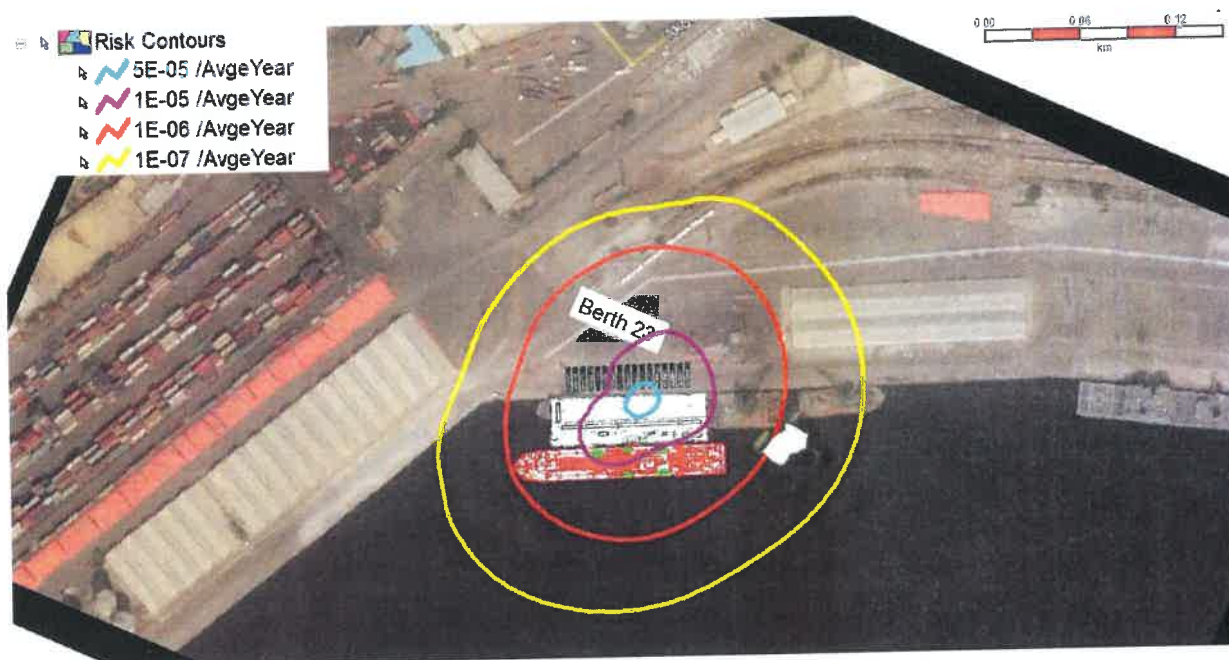
Scenario	Weather	Mass flow rate		LFL	Jet Fire				Pool Fire			Explosion
		{kg/s}	Distance (m)	Distance downwind to 4 kW/m <sup>2</sup> (m)	Distance downwind to 12.5 kW/m <sup>2</sup> (m)	Distance downwind to 35 kW/m <sup>2</sup> (m)	Distance downwind to 4 kW/m <sup>2</sup> (m)	Distance downwind to 12.5 kW/m <sup>2</sup> (m)	Distance downwind to 35 kW/m <sup>2</sup> (m)	Distance downwind (0.1 bar) (m)	Distance downwind (0.3 bar) (m)	
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\10mm	Category 1/F	0.3777	4.40655	22.1931	18.2934	n/a	11.8345	8.87074	6.6318	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\10mm	Category 3/C	0.3777	7.04186	19.286	15.4661	13.7032	11.3679	9.19272	7.41253	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\10mm	Category 6/D	0.3777	5.42567	17.6059	14.0164	11.8428	10.4299	9.06283	8.36761	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\25mm	Category 1/F	2.36062	61.8282	48.9549	39.0833	n/a	25.4751	17.4111	11.6425	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\25mm	Category 3/C	2.36062	36.7529	42.7409	33.1154	28.5848	24.8065	18.223	12.769	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\25mm	Category 6/D	2.36062	28.1382	39.1364	30.3393	25.2937	22.7923	17.6493	13.2518	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 1/F	21.2456	138.497	105.271	82.5115	74.2715	61.9741	39.2105	23.8496	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 3/C	21.2456	104.164	100.469	77.2594	64.101	63.1071	42.9566	29.0399	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 6/D	21.2456	89.6764	99.4175	76.1187	61.2937	61.3061	43.568	32.1538	-	-	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 1/F	151.08	235.889	182.531	142.445	124.832	141.605	86.3239	49.9568	324.294	213.343	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 3/C	151.08	210.508	169.825	130.1	105.119	147.331	96.6898	62.4408	245.415	169.215	-
Stud\ISO-01 LNG Filling Manifold\Liq Filling\Scenario group\75mm	Category 6/D	151.08	213.797	164.263	125.151	100.497	147.949	100.391	70.9873	230.732	161.437	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\10mm	Category 1/F	0.0258247	1.91149	5.14997	4.69534	4.69534	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\10mm	Category 3/C	0.0258247	1.74845	4.41221	3.85907	3.85907	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\10mm	Category 6/D	0.0258247	1.55886	4.02389	3.38222	3.38222	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\25mm	Category 1/F	0.161404	4.59716	11.9043	10.1563	9.34886	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\25mm	Category 3/C	0.161404	4.03853	10.2579	8.48012	7.45824	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\25mm	Category 6/D	0.161404	3.50409	9.38506	7.54816	6.45395	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 1/F	1.45264	15.1412	31.6018	26.5204	23.4968	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 3/C	1.45264	12.527	27.4425	22.3123	19.271	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 6/D	1.45264	10.283	25.2361	19.9427	16.857	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 1/F	5.81055	37.4542	58.6215	48.4836	42.6059	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 3/C	5.81055	35.6718	51.0831	40.9478	34.8685	-	-	-	-	-	-
Stud\ISO-02 Vapour Return Manifold\Vap Return\Scenario group\75mm	Category 6/D	5.81055	33.9687	47.0749	36.7085	30.5415	-	-	-	-	-	-
Stud\ISO-03 LNG Filling Hoses-ISO Container\50mm	Category 1/F	9.44249	97.134	83.8918	65.8507	60.1148	36.207	24.0996	15.684	-	-	-
Stud\ISO-03 LNG Filling Hoses-ISO Container\50mm	Category 3/C	9.44249	72.4829	78.4977	60.5067	50.8586	36.3514	25.9175	17.9667	-	-	-
Stud\ISO-03 LNG Filling Hoses-ISO Container\50mm	Category 6/D	9.44249	62.2521	71.947	55.2966	44.9265	34.7254	25.9024	19.3171	-	-	-
Stud\ISO-04 Vapour Return Hose-ISO Container\40mm	Category 1/F	0.382329	6.81668	12.1434	9.46131	5.74923	-	-	-	-	-	-
Stud\ISO-04 Vapour Return Hose-ISO Container\40mm	Category 3/C	0.382329	5.82326	12.6412	10.6611	8.54791	-	-	-	-	-	-
Stud\ISO-04 Vapour Return Hose-ISO Container\40mm	Category 6/D	0.382329	5.00599	13.3059	11.9809	11.0843	-	-	-	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\10mm	Category 1/F	0.3777	4.40655	22.1931	18.2934	n/a	11.8345	8.87074	6.6318	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\10mm	Category 3/C	0.3777	7.04186	19.286	15.4661	13.7032	11.3679	9.19272	7.41253	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\10mm	Category 6/D	0.3777	5.42567	17.6059	14.0164	11.8428	10.4299	9.06283	8.36761	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\125mm	Category 1/F	2.36062	66.9198	48.9549	39.0833	n/a	38.8628	25.1423	15.6735	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\125mm	Category 3/C	2.36062	37.314	42.7409	33.1154	28.5848	37.1642	26.015	17.6003	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\125mm	Category 6/D	2.36062	28.7447	39.1364	30.3393	25.2937	33.4257	24.6984	18.1863	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\150mm	Category 1/F	9.44249	129.651	83.8918	65.8507	60.1148	58.9889	37.2373	22.5384	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\150mm	Category 3/C	9.44249	75.4707	78.4977	60.5067	50.8586	59.0169	40.1468	27.0321	-	-	-
Stud\ISO-05 20" LNG Buffer Tank1\150mm	Category 6/D	9.44249	64.0547	71.947	55.2966	44.9265	56.1006	39.9379	29.459	-	-	-

## 7.4 Consequence Distances

The consequence distances for Flash Fire (LFL), Jet Fires, Pool Fires and Explosion for all the scenarios modelled are tabulated in Table 7-3.



**Figure 7-8 Risk contour for LNG Filling and Receiving Facility to Cryogenic LNG Bowser/Road Truck at Berth 19**

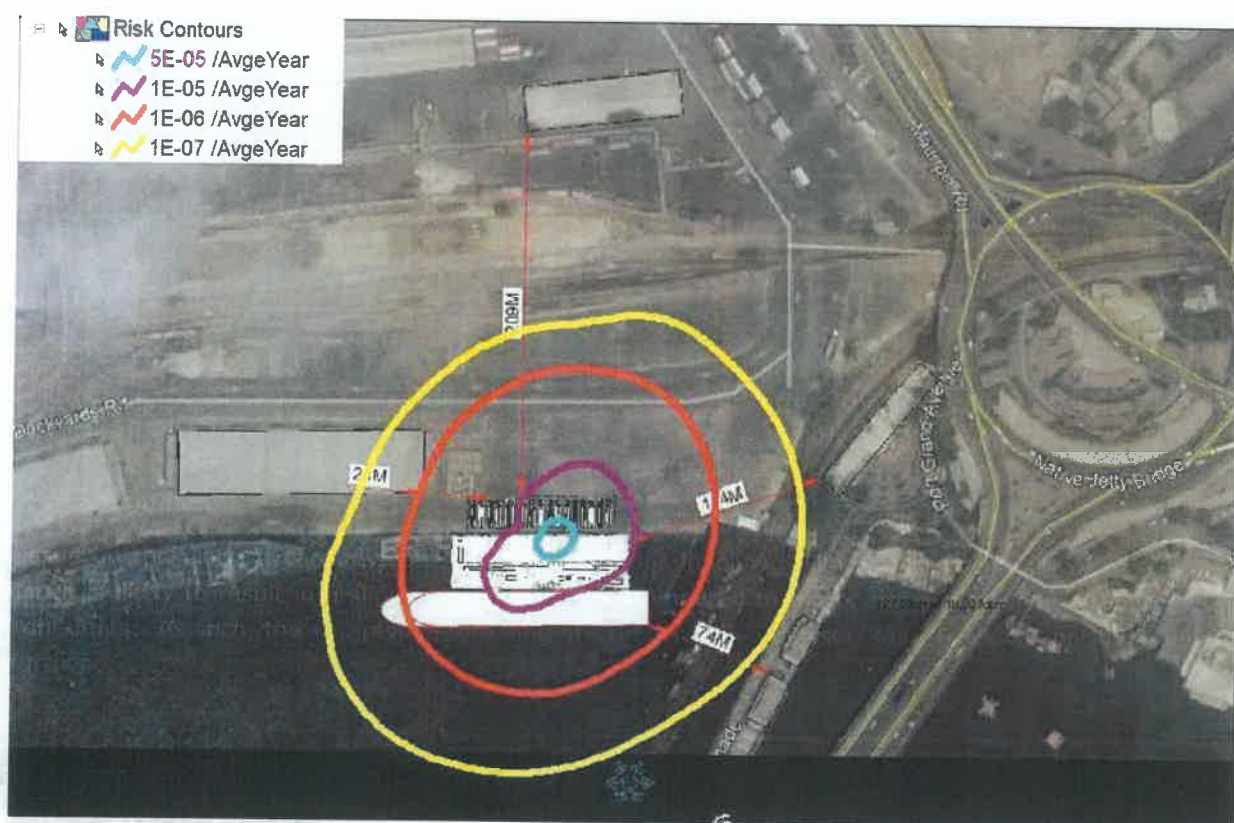


**Figure 7-9 Risk contour for LNG Filling and Receiving Facility to Cryogenic LNG Bowser/Road Truck at Berth 23**

### 7.3 Risk Results – Cryogenic LNG Bowser/Road Truck

Figure 7-7, Figure 7-8 and Figure 7-9 presents the risks contours of the LNG filling operations to Cryogenic LNG Bowser/Road Truck at the respective proposed berths. The risk levels are lower compared to filling to LNG ISO containers (the  $1\text{E-}05/\text{year}$  risk contour is slightly smaller compared to that for the ISO container filling). (Note that risk level higher than  $1\text{E-}04/\text{yr}$  is not obtained, and hence not shown in the risk contours.)

Based on the plots, it can be seen that the operations involving filling of Cryogenic LNG Bowser/Road Truck is likely to result in a slightly lower risk level compared to the operations involving filling of ISO-containers. As such, the risk results for filling of Cryogenic LNG Bowser/Road Truck will not be assessed further.



**Figure 7-7 Risk contour for LNG Filling and Receiving Facility to Cryogenic LNG Bowser/Road Truck at Berth 18/19**

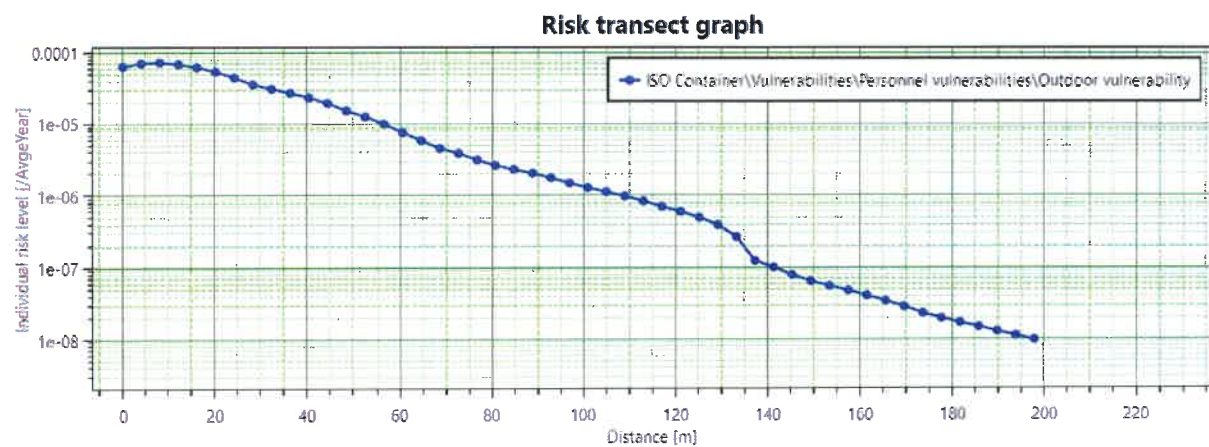
Scenarios	Sum of Risk Increment [/yr]	Sum of Contributions (%)
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	5.03E-09	0.0042%
Continuous release with Rainout delayed Flash Fire with Pool fire	7.54E-09	0.0063%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	1.25E-11	0.0000%
<b>ISO-05 20'LNG Buffer Tank1\50mm\50mm Leak</b>	<b>1.32E-07</b>	<b>0.1104%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	2.47E-08	0.0207%
Continuous release with Rainout delayed Flash Fire with Pool fire	3.70E-08	0.0310%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	7.00E-08	0.0587%
<b>ISO-05 20'LNG Buffer Tank1\Rupture\Catastrophic rupture</b>	<b>1.61E-08</b>	<b>0.0135%</b>
Instantaneous release with Rainout delayed Flash Fire Only	2.21E-09	0.0018%
Instantaneous release with Rainout delayed Flash fire with eXplosion	1.47E-09	0.0012%
Instantaneous release with Rainout delayed Flash fire with eXplosion and Pool fire	3.32E-10	0.0003%
Instantaneous release with Rainout delayed Flash Fire with Pool fire	4.98E-10	0.0004%
Instantaneous release with Rainout Immediate fireBall with additional Pool fire effects	1.16E-08	0.0097%
<b>ISO-07 40'ISO Containers\10mm\10mm Leak</b>	<b>6.79E-06</b>	<b>5.6906%</b>
Continuous release with Rainout Delayed Flash Fire Only	1.28E-08	0.0107%
Continuous release with Rainout delayed Flash fire with eXplosion	8.54E-09	0.0072%
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	1.76E-06	1.4717%
Continuous release with Rainout delayed Flash Fire with Pool fire	2.63E-06	2.2075%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	2.38E-06	1.9935%
<b>ISO-07 40'ISO Containers\25mm\25mm Leak</b>	<b>8.52E-06</b>	<b>7.1406%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	2.67E-06	2.2342%
Continuous release with Rainout delayed Flash Fire with Pool fire	4.00E-06	3.3513%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	1.85E-06	1.5550%
<b>ISO-07 40'ISO Containers\50mm\50mm Leak</b>	<b>5.07E-05</b>	<b>42.5055%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	1.48E-05	12.4389%
Continuous release with Rainout delayed Flash Fire with Pool fire	2.23E-05	18.6584%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	1.36E-05	11.4082%
<b>Grand Total</b>	<b>1.19E-04</b>	<b>100%</b>

## 7.2.5 Top Risk Contributors

Main contributors to IR fatality are presented in Table 7-2. It can be observed that the 50mm leak of the LNG Filling Hose and 50mm leak of ISO containers poses the highest risks at approximately 42.83% and 42.51% respectively.

**Table 7-2 Top Risk Contributor Scenarios for IR**

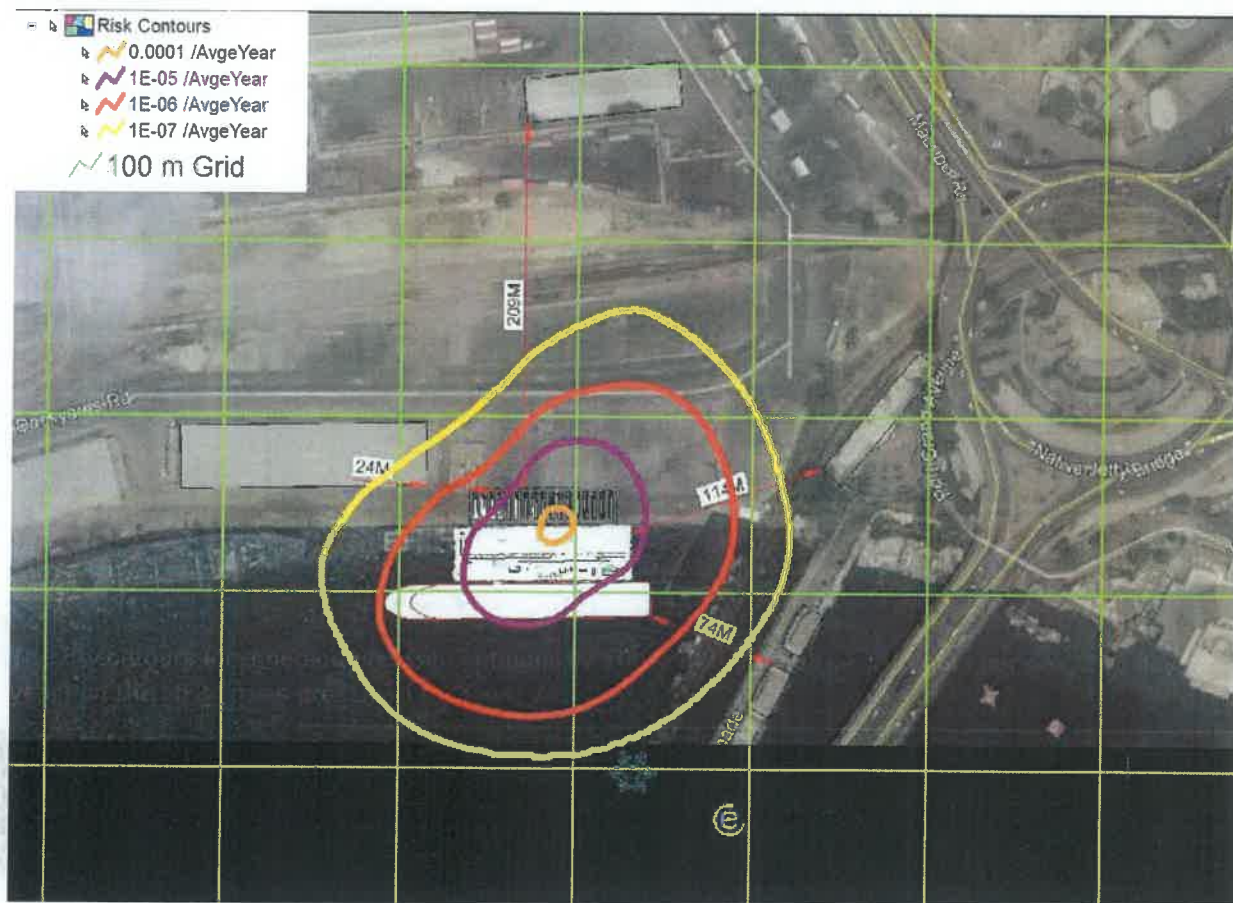
Scenarios	Sum of Risk Increment [/yr]	Sum of Contributions (%)
<b>ISO-01 LNG Filling Manifold\Liq Filling\10mm\10mm Leak</b>	<b>6.05E-09</b>	<b>0.0051%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	2.37E-09	0.0020%
Continuous release with Rainout delayed Flash Fire with Pool fire	3.55E-09	0.0030%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	1.30E-10	0.0001%
<b>ISO-01 LNG Filling Manifold\Liq Filling\25mm\25mm Leak</b>	<b>1.64E-08</b>	<b>0.0137%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	3.51E-09	0.0029%
Continuous release with Rainout delayed Flash Fire with Pool fire	5.27E-09	0.0044%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	7.61E-09	0.0064%
<b>ISO-01 LNG Filling Manifold\Liq Filling\75mm\75mm Leak</b>	<b>1.54E-07</b>	<b>0.1291%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	3.98E-08	0.0333%
Continuous release with Rainout delayed Flash Fire with Pool fire	5.97E-08	0.0500%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	5.45E-08	0.0457%
<b>ISO-01 LNG Filling Manifold\Liq Filling\Rupture\200mm Leak</b>	<b>1.65E-06</b>	<b>1.3820%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	4.50E-07	0.3775%
Continuous release with Rainout delayed Flash Fire with Pool fire	6.75E-07	0.5662%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	5.23E-07	0.4384%
<b>ISO-02 Vapour Return Manifold\Vap Return\75mm\75mm Leak</b>	<b>3.83E-10</b>	<b>0.0003%</b>
Continuous release No rainout Immediate Horizontal Jet fire Only	3.83E-10	0.0003%
<b>ISO-02 Vapour Return Manifold\Vap Return\Rupture\150mm Leak</b>	<b>9.18E-09</b>	<b>0.0077%</b>
Continuous release No rainout delayed Flash Fire Only	8.30E-10	0.0007%
Continuous release No rainout delayed Flash fire with eXplosion	5.53E-10	0.0005%
Continuous release No rainout Immediate Horizontal Jet fire Only	7.79E-09	0.0065%
<b>ISO-03 LNG Filling Hoses-ISO Container\50mm\50mm Leak</b>	<b>5.11E-05</b>	<b>42.8363%</b>
Continuous release with Rainout delayed Flash fire with eXplosion and Pool fire	1.35E-05	11.3552%
Continuous release with Rainout delayed Flash Fire with Pool fire	2.03E-05	17.0328%
Continuous release with Rainout Immediate Horizontal Jet fire with additional Pool fire effects	1.72E-05	14.4483%
<b>ISO-04 Vapour Return Hose-ISO Container\40mm\40mm Leak</b>	<b>1.84E-07</b>	<b>0.1545%</b>
Continuous release No rainout delayed Flash Fire Only	2.87E-09	0.0024%
Continuous release No rainout delayed Flash fire with eXplosion	1.91E-09	0.0016%
Continuous release No rainout Immediate Horizontal Jet fire Only	1.80E-07	0.1505%
<b>ISO-05 20'LNG Buffer Tank1\25mm\25mm Leak</b>	<b>1.28E-08</b>	<b>0.0107%</b>
Continuous release with Rainout Delayed Flash Fire Only	1.05E-10	0.0001%
Continuous release with Rainout delayed Flash fire with eXplosion	7.03E-11	0.0001%



**Figure 7-6 IR (outdoor vulnerability) vs distance, with origin at centre of MFP**

#### 7.2.4 IRPA for Personnel on MFP

The IR contours for a person present continuously 100% of the time (i.e. 24 hours per day, 365 days a year) on the MFP are as presented in Figure 7-5.



**Figure 7-5 IR Fatality risk contour for LNG Filling and Receiving Facility (100m grid spacing)**

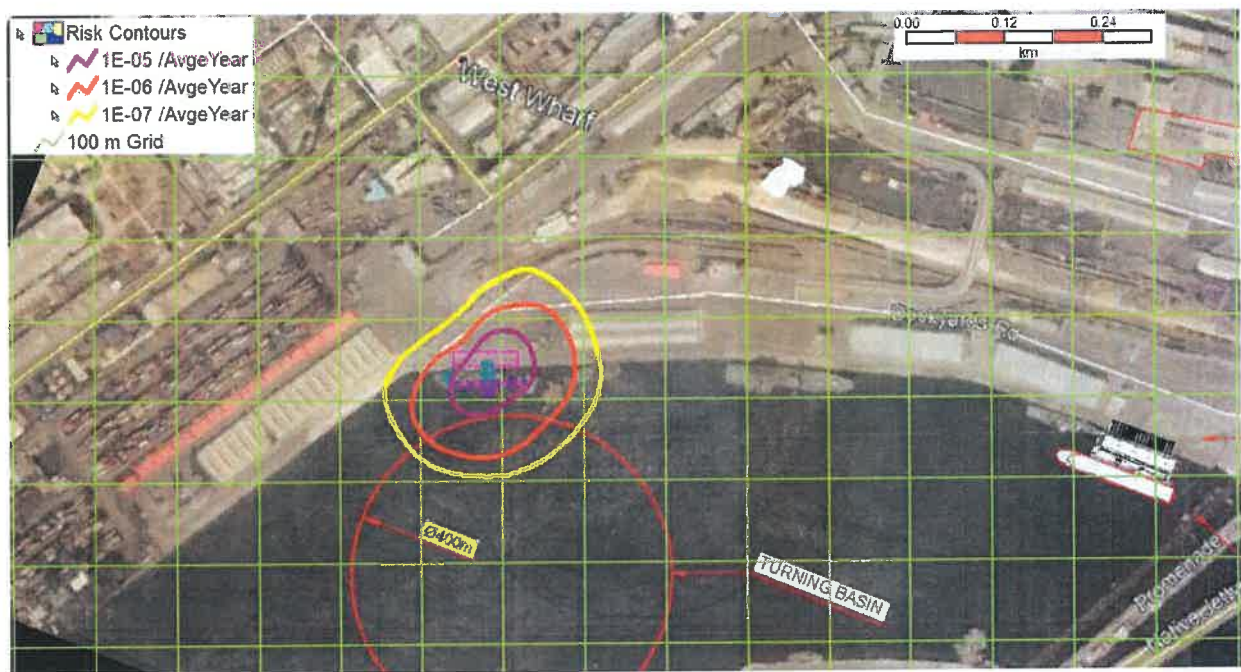
The Individual Risk Per Annum (IRPA) for an individual working on the LNG Filling and Receiving Facility is estimated to be  $2.15\text{E-}05$  per year (regardless of which the berth the MFP will be located). This is calculated based on the risk for an arbitrary person working at a particular location (in this case personnel is assumed to be positioned at the MFP at the main header before splitting to the 3 filling bays), with a 12 hours work shift per day (split of 70% of time spent outdoor, 30% indoor in the indoor). The filling operation is assumed to take place 12 days in a month. The overall risk result shows that the IRPA for a worker on the MFP falls within the ALARP region (i.e. between  $1\text{E-}07/\text{year}$  to  $1\text{E-}04/\text{year}$ ).

Figure 7-6 shows the risk transect across the risk contours, from the centre of the MFP extending outwards.

### 7.2.3 IR Contours for Public for Berth 23

The IR contour arising from LNG filling operations at Berth 23 is presented in Figure 7-3, considering the risk contours extending outside of the LNG receiving and offloading facility. Figure 7-4 shows the zoom in view of the risk contour for better illustration.

Similar to Berth 18 and 19, the intolerable risk for public, which is  $1\text{E-}04/\text{yr}$ , does not extend beyond the MFP, and the risk contour of  $1\text{E-}06/\text{yr}$  is contained within the jetty area. As such, the risk to public is considered to be in the ALARP region.



**Figure 7-3 IR Fatality Risk contour for LNG Filling and Receiving Facility at Berth 23**



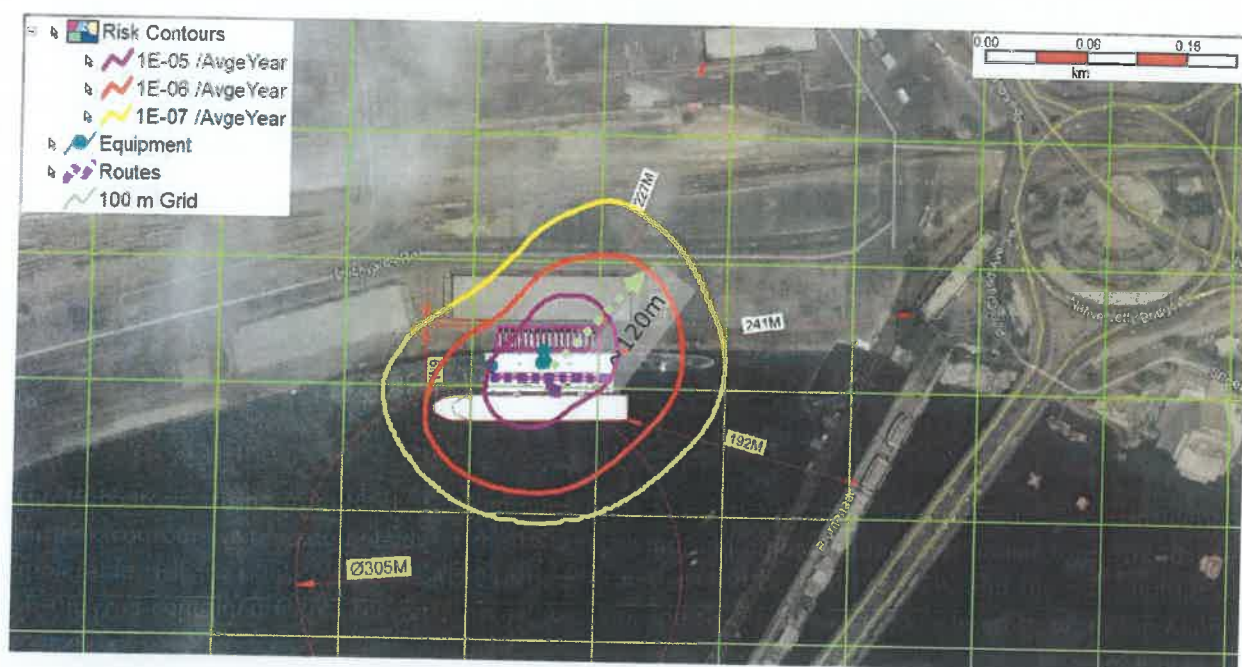
**Figure 7-4 Zoom In on IR Contour for LNG Filling and Receiving Facility at Berth 23**

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The furthest radial distance extended by the 1E-06/year risk contour from the centre of the MFP is approximately 120m in length. 120m is thus recommended as the minimum distance between centre of the MFP and any on-shore/off-shore facilities, if applicable.

## 7.2.2 IR Contours for Public for Berth 19

The IR contour arising from the LNG filling operations at Berth 19 is presented in Figure 7-2, considering the risk contours extending outside of the LNG receiving and offloading facility. Similar to Berth 18, the intolerable risk for public, which is 1E-04/yr, does not extend beyond the MFP, and the risk contour of 1E-06/yr is contained within the jetty area. As such, the risk to public is considered to be in the ALARP region.



**Figure 7-2 IR Fatality Risk contour for LNG Filling and Receiving Facility at Berth 19**

## 7.2 Risk Results – ISO Containers

The following sub-sections, Section 7.2.1 to 7.2.3, presents the individual risk (IR) contours generated in this QRA, which will be used to assess the public risk. The risk contours extending outside of the LNG receiving and offloading facility will be considered for public risk. It should be noted that the IR contours represent risks to personnel assuming they are present at the location continuously or 100% of the time (i.e. 24 hours per day, 365 days a year). This will be a conservative assumption as it is difficult to account for the presence factor for public.

However, for operators or workers working onsite at the MFP or ISO Containers filling area, the presence factor is applied, to account for the actual duration of time spent at the location. Section 7.2.4 presents the Individual Risk Per Annum (IRPA) for the workers working at this LNG receiving and offloading facility.

### 7.2.1 IR Contours for Public for Berth 18/19

The IR contour arising from LNG filling operations at Berth 18/19 is presented in Figure 7-1, considering the risk contours extending outside of the LNG receiving and offloading facility. The intolerable risk for public, which is  $1\text{E-}04/\text{yr}$ , does not extend beyond the MFP, and the risk contour of  $1\text{E-}06/\text{yr}$  is contained within the jetty area. As such, the risk to public is considered to be in the ALARP region.

Figure 7-1 shows that the  $1\text{E-}06/\text{year}$  risk contour is encroaching the railway. However, based on the UK HSE Risk Criteria,  $1\text{E-}06$  is considered to be "broadly acceptable risk level", and hence deemed to be an acceptable risk for the public.



**Figure 7-1 IR Fatality Risk Contour for LNG Filling and Receiving Facility at Berth 18/19 (100m grid spacing)**

Table 7-1 Input Parameters and Leak Frequencies for Identified Failure Cases

Failure Case No.	Failure Scenario Description	Pressure	Temperature (°C)	Total Inventory kg	Hole size mm	Discharge rate kg/s	Immediate Ignition probabilities	Delayed Ignition probabilities	Release Duration minutes	Leak frequency /year
ISO-01	Liquid Manifold After ESD (V1) and Liquid Filling Line	0.7	-160	1632	10mm	0.38	5.28E-04	1.23E-03	71.67	2.43E-02
				1991	25mm	2.37	2.70E-03	6.31E-03	13.99	1.41E-03
				5407	75mm	21.35	1.77E-02	4.12E-02	4.22	3.16E-04
				28893	200mm	151.83	7.43E-02	1.73E-01	3.17	3.31E-04
ISO-02	Vapour Return Manifold After ESD (V2) and Vapour Return Line	0.7	-130	8	10mm	0.03	8.56E-05	2.00E-04	5.18	3.12E-02
				32	25mm	0.16	3.85E-04	8.99E-04	3.35	2.38E-03
				265	75mm	1.45	1.42E-03	3.30E-03	3.04	3.44E-04
				1049	150mm	5.81	6.78E-03	1.58E-02	3.01	2.53E-04
ISO-03	LNG filling hose at Filling Bay to ISO Containers	0.7	-160	1874	Rupture (50mm)	9.49	9.76E-03	2.28E-02	3.29	2.74E-03
ISO-04	Vapour return hose at Filling Bay	0.7	-150 <sup>1</sup>	75	Rupture (40mm)	0.41	5.48E-04	1.28E-03	3.02	2.74E-03
ISO-05	20' LNG Buffer Tank	0.7	-160	8280	10mm	0.38	5.28E-04	1.23E-03	363.57	3.60E-04
				8280	25mm	2.37	2.70E-03	6.31E-03	58.17	3.00E-05
				8280	50mm	9.49	9.76E-03	2.28E-02	14.54	3.00E-05
				8280	Catastrophic	n/a	7.50E-03	1.75E-02	Instantaneous	3.00E-06
ISO-06	40' ISO Container	0.7	-160	18300	10mm	0.38	5.28E-04	1.23E-03	803.54	2.13E-02
				18300	25mm	2.37	2.70E-03	6.31E-03	128.57	1.78E-03
				18300	50mm	9.49	9.76E-03	2.28E-02	32.14	1.78E-03
ISO-07	Cryogenic LNG Bowser/Road Truck	0	-160	21942	Catastrophic	n/a	9.00E-02	2.10E-01	Instantaneous	2.96E-05

<sup>1</sup> Temperature is modified to -150 °C in the consequence modelling as the PHAST model only gives vapour phase at this temperature.

## 7 RESULTS

### 7.1 Leak Frequencies

The operating condition, discharge rate, ignition probability, release inventory, as well as the estimated leak frequency for each leak size for the failure cases are tabulated Table 7-1.

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The risks are divided into three hierarchy levels, as below:

- The upper band is where the risks are usually considered intolerable irrespective of the benefits the activity may bring, and risk-reduction measures are essential whatever their cost.
- The middle band is where risk-reduction measures are desirable but may not be implemented if their cost is high relative to the benefit gained (i.e. the ALARP principle should be demonstrated).
- The lower band is where risks are negligible, or so small that no risk-reduction measures are needed.

## 6.6 Risk Criteria

Individual risk (IR) may be defined as the annualized frequency at which an individual may be expected to sustain a given level of harm from the realisation of all hazards at a given location. The acceptance criteria for offsite population depend on numbers of persons in the impacted zone, their sensitivity (vulnerable populations such as the elderly) and the intensity of the development in this area.

### 6.6.1 Individual Risk Criteria

#### **For Public**

Refer to UK HSE ALARP Principle (Ref. /4/), the following IR criteria for public are used in this study:

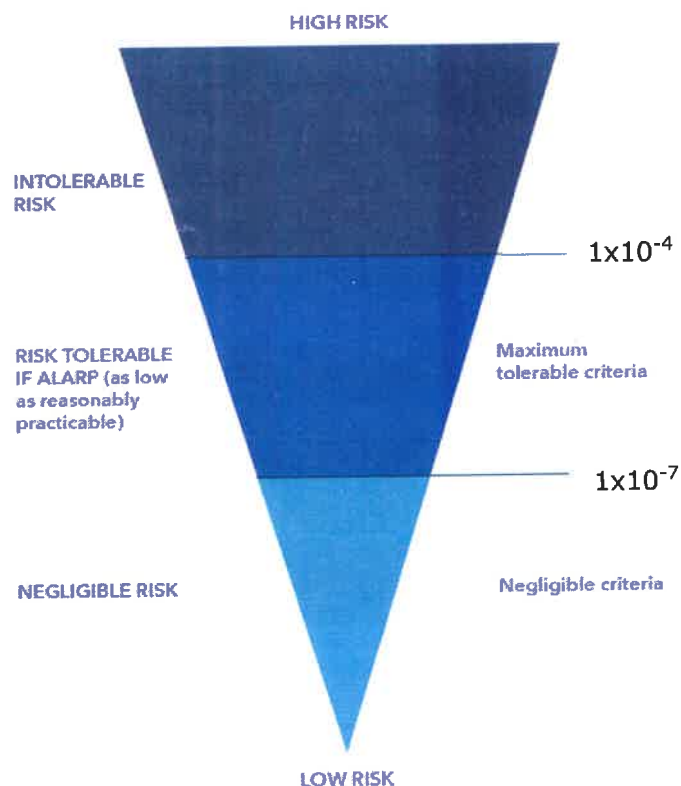
- Maximum tolerable risk for public:  $10^{-4}$  per year – above which risk is considered intolerable;
- Broadly acceptable risk for workers:  $10^{-6}$  per year.

Within the intolerable and broadly acceptable risk levels, is the "As Low As Reasonably Practicable" (ALARP) region.

#### **For Workers**

As per DNV GL technical note, the recommended criteria for individual risks (workers) from new activities are (Ref. /5/):

- Maximum tolerable risk for workers:  $10^{-4}$  per year;
- Negligible risk:  $10^{-7}$  per year.



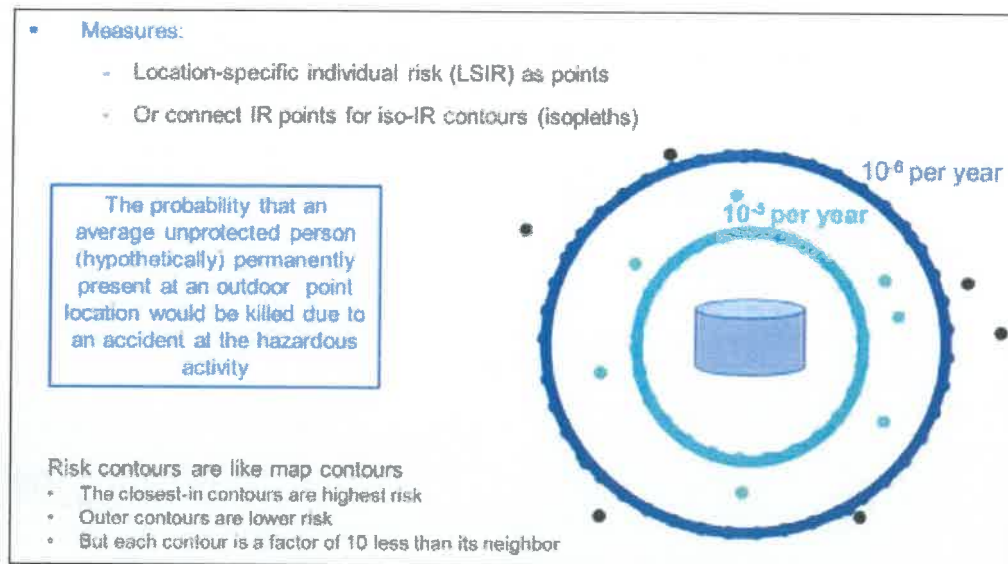
**Figure 6-5 Framework for Three-band Risk Criteria**

Individual Risk (IR) – IR is the risk for an individual who is present at a particular location, continuously all year (i.e., 24 hours a day 7 days a week) without wearing personal protective equipment. Individual risk is the frequency at which an individual may be expected to sustain a given level of harm from the realization of specific hazards. Individual risk is often interpreted as an incident every X number of years. Examples of how to interpret individual risk are as follows:

- $1 \times 10^{-3}$  per year is equivalent to one incident every 1,000 years
- $1 \times 10^{-4}$  per year is equivalent to one incident every 10,000 years
- $1 \times 10^{-6}$  per year or one incident every 1,000,000 years

These numbers do not imply that no event will occur for the specified time period. These risk levels are statistical representations of risk. They predict that an incident might occur within this average timeframe. The incident could happen tomorrow or sometime during the next 1,000 years.

Individual Risk is presented as isopleths similar to elevation contours on a map. The inner contour is the highest risk (often  $10^{-3}$  or  $10^{-4}$  per annum), and normally contours are plotted in declining order of magnitude circles until some very low level of risk is predicted, often  $10^{-6}$  or  $10^{-7}$  per annum. Figure 6-4 an example of an IR contour.



**Figure 6-4 Individual Risk Presentation**

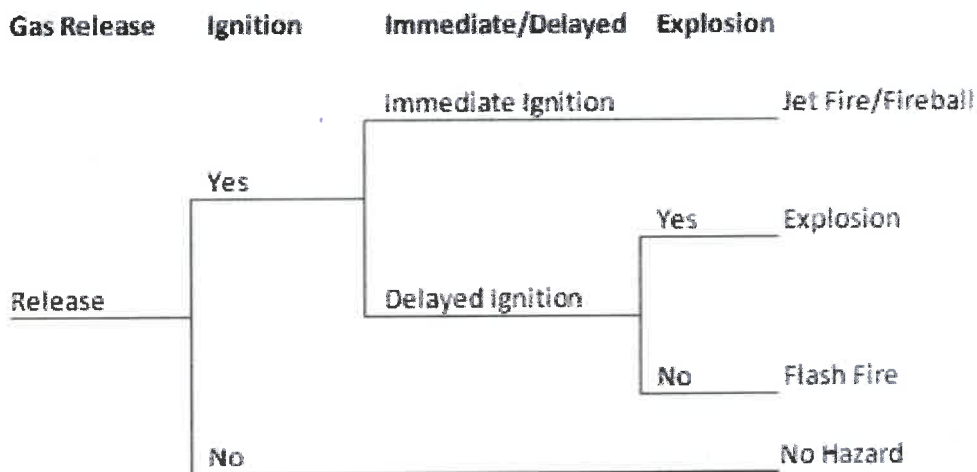
## 6.5 Risk Assessment

Risk assessment is a process by which the results of a risk analysis are used to make judgments, either through relative ranking of risk reduction strategies, or through comparison of the risk assessment with risk targets /criteria. The risk assessment stage (see Figure 6-1) determines whether the risks are tolerable, or if risk mitigation measures are required to reduce the risk to a level which can be considered as low as reasonably practicable.

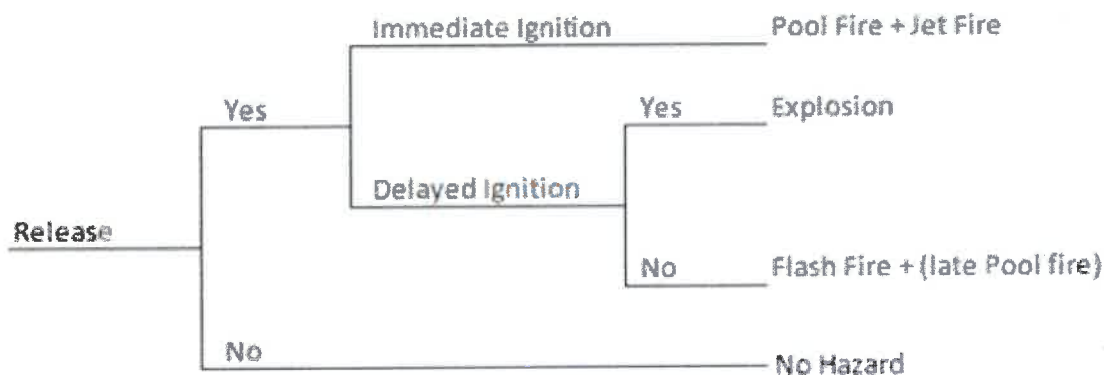
## 6.3 Frequency Assessment

### 6.3.1 Event Tree

The event frequency to be used in the QRA is presented in Figure 6-2 and Figure 6-3.



**Figure 6-2 Event Tree - Release of Flammable Gas**



**Figure 6-3 Event Tree - Release of Flammable Liquid**

## 6.4 Risk Analysis

The Risk Analysis first brings together calculations from the frequency assessment and consequence modelling so that both can be presented together. DNV GL's SAFETI (also called Phast Risk) tool combines the consequences for each failure case in each wind direction, the wind probability data, the frequency of the event, and the vulnerability data to arrive at risk numbers at the different locations. The risk estimate is calculated for each frequency-consequence pair and is summed for each location to provide the total risk for the area.

Risk analysis results are typically presented in several different ways to provide a complete picture. For this study, the risk metric used is the "Individual Risk".

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- For each release case, SAFETI takes the failure case release frequency as initial input, multiplies this by the first weather class / wind speed probability, for the first of eight (8) wind directions.
- SAFETI takes this result and multiplies it by the immediate ignition probability, and delayed ignition probability.
- These two (2) results are multiplied by the first of the event tree consequence branch probabilities, relating to immediate or delayed ignition branch path.
- SAFETI takes the calculated consequence hazard range and verifies which grid points are within the consequence hazard area. For each grid point within range SAFETI then calculates the magnitude of the consequence at each grid point (e.g. explosion overpressure at a particular grid point may be 3 psi).
- The calculated consequence magnitude at each grid point is then compared to the SAFETI programmed impact criteria level, and the likelihood of fatality or damage calculated, based on the impact probability criteria specified in SAFETI, for the type of consequence and the magnitude of the consequence.
- This calculation is repeated for each event tree alternate consequence outcome at each grid point, for that weather class / wind speed and wind direction, and the result added to the previous risk level, at each grid point.
- The above calculations are then repeated for each of the eight (8) wind directions, cumulatively adding to the risk level at each grid point.
- The above calculations are repeated for all weather classes, wind speeds and wind directions, cumulatively adding these risk results at each grid point.
- Once all risk calculations at these grid points have been completed for the first failure case, the next failure case will be calculated, again adding all results cumulatively at each grid point. This is repeated until all failure cases have been calculated, while SAFETI also tracks the risk contribution made by each failure case at each grid point.
- Once completed, SAFETI produces individual risk contour results by linking points of equal risk, based on the pre-specified levels of individual fatality risk (or equipment damage) to be plotted, and using linear interpolation between relevant grid points. The risk contour results are super imposed on the electronic site map, entered in the SAFETI software.

## 6.2 Consequence Modelling

### 6.2.1 Consequence Impact Criteria

The following consequence impact are assessed in the study:

- Radiation distance to 35, 12.5 and 4 kW/m<sup>2</sup>;
- LFL (100%);
- Overpressure of 0.3 and 0.1 bar.

fire, explosion, pool fire), based on the specified consequence impact criteria levels, and specified population data by location, to produce individual and societal risk results, as required.

This SAFETI modelling software requires the following inputs to be able to produce risk results:

- Import an electronic map of the study area, on which individual fatality risk contour results may be produced.
- The electronic map may be programmed in SAFETI to:
  - Superimpose all on-site and off-site populations within the study area by location and specifying the day / night number of people for each location.
  - Superimpose all potential ignition sources within the study area, which may cause delayed ignition of a flammable release.
- Prepare and import weather class, wind speed and wind direction probability data for the study area. Normally separate weather class, wind speed, wind directional probability files are entered into SAFETI, most often broken down into eight (8) wind directions. In this study, it has been assumed that the MFP orientation is 0° to the true north.
- Enter all identified failure cases, which are defined in terms of: Location, Material released, Quantity released, Temperature, Pressure, Leak size, Leak direction, Leak elevation, Leak frequency, Immediate and Delayed ignition probability.
- Each failure case calculation in SAFETI starts with discharge modelling. Based on release duration and release phase (gas, liquid, or 2-phase), SAFETI directs the dispersion and consequence calculations to one of 4 alternate, built-in consequence outcome event trees (continuous vapour release, continuous release with rain-out, instantaneous vapour release, and instantaneous release with rain-out), where each event tree branch probability carries default values.
- SAFETI will then calculate all alternate consequence outcomes (e.g. jet fire, explosion) of the event tree selected, in terms of hazard range and event duration (where applicable), for each weather class / wind speed combination.
- So far the calculations performed in SAFETI only relate to the alternate consequence outcomes and the consequence hazard ranges, for each specified failure case. To produce risk results, SAFETI will perform impact frequency calculations, using the failure case specified leak frequency as starting point. Frequency aspects of the risk calculations relate to the:
  - Risk analyst defined failure case leak frequency.
  - Weather class, wind speed and wind directional probability, for each of the 8 wind directions.
  - SAFETI selected event tree and branch probabilities, for each alternate consequence outcome.
  - Fatal Impact probability for each alternate consequence outcome. This is based on the SAFETI calculated magnitude of each consequence and the impact criteria specified by risk analyst for that type of consequence.
- SAFETI performs its individual risk calculations based on a 400 x 400 grids (160,000 points), with the grid point spacing automatically varied, based on the consequence hazard range results.

## 6 QUANTITATIVE RISK ASSESSMENT METHODOLOGY

A typical QRA methodology utilized by DNV GL is shown in Figure 6-1.

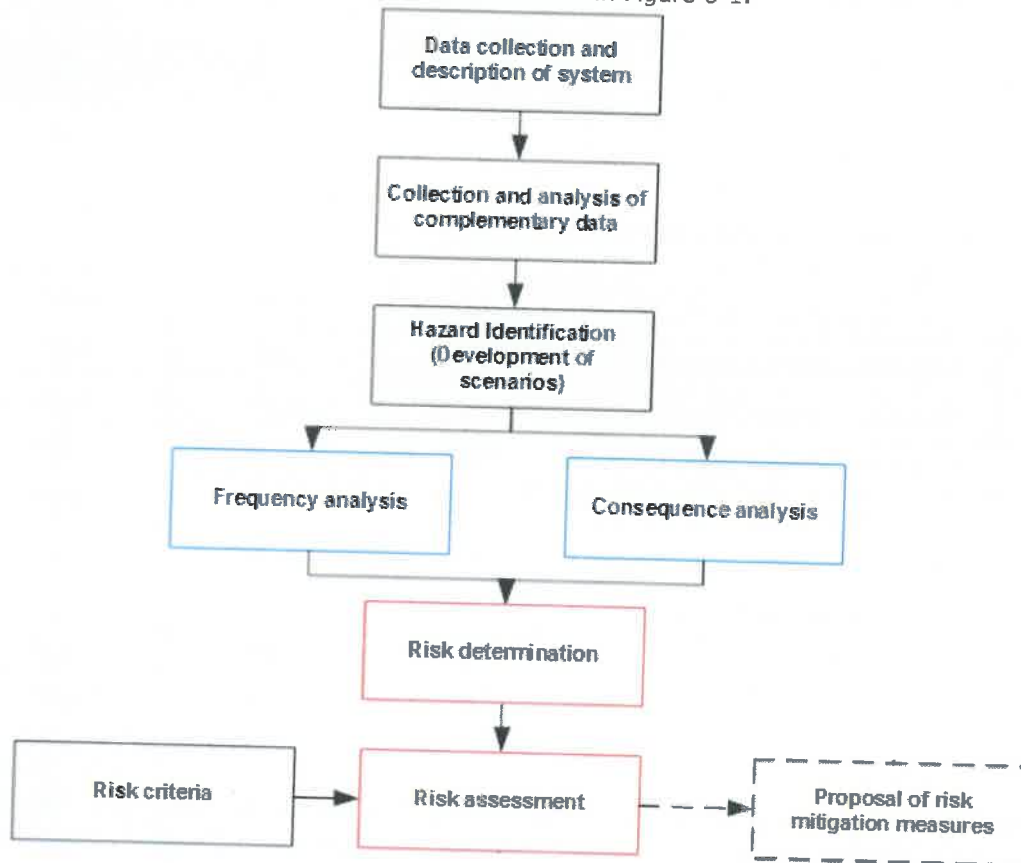


Figure 6-1 Typical QRA methodology

### 6.1 QRA Software Tool

The basis for this QRA study is DNV GL's proprietary risk modelling software, SAFETI software version 8.11 (also called Phast Risk). The SAFETI software has been in existence since the 1970s and has been under continual development and improvement ever since, which is managed by DNV GL's London-based software development division.

An electronic database of approximately 1400 materials is available to the SAFETI software, with the material properties regularly reviewed and if required re-adjusted, based on the latest available data. The SAFETI consequence modelling results (for each material) are regularly reviewed and where required re-calibrated, based on the latest available accident and test data.

The SAFETI software will calculate dispersion and consequence modelling results for all specified weather classes and wind speeds with the failure case specified release frequency data, specified weather class, wind speed, wind directional probability data, specified immediate ignition probability data, software calculated delayed ignition probability data, built-in event tree alternate consequence outcome branch probability data, fatal impact probability data for each alternate consequence outcome (e.g. jet fire, flash

### 5.3 Failure Cases

Based on the marked-up P&ID of isolatable segments, which can be found in Appendix A Assumptions Register, the failure cases to be modelled in this study are presented in Table 5-1.

**Table 5-1 Failure Cases**

Failure Case ID	Failure Case Description	Pressure (barg)	Temperature (°C)	Inventory (m <sup>3</sup> )
01	Liquid Manifold After ESD (V1) and Liquid Filling Line	0.7	-160	3.4
02	Vapour Return Manifold After ESD (V2) and Vapour Return Line	0.7	-160	2.0
03A	LNG filling hose at Filling Bay 1	0.7	-160	0.12
03B	LNG filling hose at Filling Bay 2	0.7	-160	0.12
03C	LNG filling hose at Filling Bay 3	0.7	-160	0.12
04A	Vapour return hose at Filling Bay 1	0.7	-130	0.08
04B	Vapour return hose at Filling Bay 2	0.7	-130	0.08
04C	Vapour return hose at Filling Bay 3	0.7	-130	0.08
05	20' LNG Buffer Tank	0.7	-160	18
06	ISO Container	0.7	-160	41.4
07	Cryogenic LNG Bowser/Road Truck	0.7	-160	47.7

Collision from an errant passing vessel with the LNGC while it is berthed for filling operation may result in potential leak of the cargo tank if the hull is breached. However, the berths in consideration are located at end of the channel, thus the size of vessels in the vicinity of the berths is limited to tugboats or small size vessels only. In addition, speed limit of vessel in traffic is limited to 3-5 knots. As such, these would limit the impact energy in the unlikely event of an errant vessel colliding with the LNGC causing breach or leak of LNGC cargo tank. Therefore, the risk due to an errant vessel collision with the LNGC resulting in a breach of LNG cargo tank causing leak of LNG is considered negligible.

### 5.2.9 Vapour cloud explosion

A vapour cloud explosion (VCE) can occur when a large flammable mass of hydrocarbon vapour is ignited in a confined or partially confined space. The thermodynamics of the combustion of a stoichiometric mixture of hydrocarbon in air will result in an 8 times volume increase of hot combustion products compared to ambient reactants. This is mainly due to the high temperature of the combustion gases and partly due to an increase in the number of moles of gas. In a confined space (e.g. an enclosed box), the final pressure will be a maximum of 8 bar (about 120 psi). In an open space, an outdoors situation, there is no confinement and the experimental evidence is that methane gas will burn relatively slowly (in the order of 10 m/s) with all the expansion resulting in a vertical rise of gas. Ignition trails on dispersed unconfined LNG vapour clouds have confirmed that no significant overpressures are developed (<1 mbar).

Within methane (natural gas) clouds, flame propagation is slow, and the flame may be extinguished prematurely and not be sustained throughout the cloud. Sufficient flame velocity (i.e. >100 m/s) to create significant explosion overpressures will not occur over water if there is no congestion or confinement.

### 5.2.10 Jet fire

Dispersing clouds of hydrocarbons can be ignited anywhere where the concentration is above the LFL and below the UFL. The majority of clouds which are ignited do so at their edge as they disperse and meet a strong ignition source (e.g. open flame, internal combustion engine, sparks). An ignited cloud will "flash back" across all its flammable mass (i.e. that part within the flammable range – between the UFL and LFL).

It will then burn at the UFL boundary until all the hydrocarbon is consumed. This will almost always flash back to the source and lead to a residual jet fire. Factors affecting this include the material flame speed, the concentration (maximum speed at stoichiometric concentrations, lower speeds at LFL and UFL), the temperature, condensed moisture, the degree of turbulence and the presence of congestion or objects that enhance turbulence.

The pressure pulse created by small pockets of LNG that evaporate instantaneously when superheated by mixing in water will travel at the speed of sound and decay like any other pressure pulse. This is unlikely to damage a ship's large structural elements. No specific modelling is undertaken for RPT as it is unlikely to increase the hazard range of a major spill that has already occurred.

### 5.2.6 Flash fire

Dispersing clouds of methane (and any other hydrocarbons present) can be ignited anywhere where the concentration in the air is above the Lower Flammable Limit (LFL) and below the Upper Flammable Limit (UFL) for the given temperature and pressure.

The majority of clouds which are ignited do so at their edge as they disperse and meet a strong ignition source (e.g. open flame, internal combustion engine, sparks). An ignited cloud will "flash back" across all its flammable mass (i.e. that part within the flammable range – between the UFL and LFL). It will then burn at the UFL boundary until the entire hydrocarbon is consumed. This will almost always flash back to the source and ignite the pool.

Flash fire zones move at different speeds through flammable clouds. Factors affecting this include the material flame speed, the concentration (maximum speed at stoichiometric concentrations, lower speeds at LFL and UFL), the temperature, the condensed moisture, the degree of turbulence and the presence of congestion or objects that enhance turbulence.

When the flash fire reaches the evaporating spill of LNG, it will cause this to ignite and burn as a pool fire.

### 5.2.7 Pool fire

If LNG spills near an ignition source, the evaporating gas in a combustible gas-air concentration will burn above the LNG pool. A pool fire may result after a flash fire. An LNG pool fire generates significant thermal radiation. Large LNG fires tend to be smoky (experience indicates little smoke for pool fire diameters exceeding 30 metres) and this smoke absorbs a substantial fraction of the thermal radiation. An additional factor is that the spreading LNG spill pool can become fairly thin. Once combustion is added to evaporation, the pool will shrink significantly in size – to a sustainable pool fire diameter.

### 5.2.8 Fireball/BLEVE

Fireballs are very rapid combustion processes most often associated with Boiling Liquid Expanding Vapour Explosions (BLEVE) and these are only associated with pressurized liquids. When these are released quickly, the gases flash and this creates extreme speeds and turbulence. This in turn allows a flame front to travel rapidly across the whole flammable envelope. As these releases often do not have much air entrained, the fireball burns across the entire external envelope and causes the flammable mass to rise and radiate large amounts of heat in typically 20 to 40 seconds.

Fireballs are also possible with large releases of gases (e.g. large town gas tank failures), but these are much less radiant than a BLEVE and require special high turbulence conditions, unlikely to exist with an LNG spill in the open. The normal mechanism for BLEVE is a pressure vessel containing pressurized liquefied gas (e.g. a recondenser) that is subjected to external fire impingement or is catastrophically failing due to other causes.

### 5.2.2 Non-pressurized liquefied natural gas spill

LNG is stored in bulk storage tanks at its atmospheric boiling point (approximately  $-162^{\circ}\text{C}$ ). Any boil-off gas is collected, and pressure relief valves are set to only allow a very low net positive pressure.

Most spill scenarios for the storage tank occur at atmospheric pressure plus any liquid head of LNG (i.e. the static liquid column above the point of release). The significance of this is that there is no pressure flashing of LNG to methane; the phase change occurs due to very rapid heat transfer and boil-off.

In small spills of LNG discharged from height, most of the LNG will vaporize before reaching the impoundment trenches, soil or water, due to heat transfer with air and concrete. For very large spills, air cannot transfer enough heat to vaporize all the LNG, so the spill forms a pool.

Spilled LNG will simultaneously undergo several physical processes. These include pool formation, spread and boil-off. Pool formation for cryogenic boiling liquids is a dynamic process.

### 5.2.3 Pressurized liquefied natural gas spill/leakage

In an LNG fuel supply chain, pressurised storage and transfer of LNG can occur via a truck storage tank or LNG cargo tank and other smaller intermediate storage units (e.g. LNG buffer tank and ISO Containers), as well as in piping.

In such cases, the spill rate of LNG will depend on the pressure in the intermediate storage tank in addition to the static head, and in cases where LNG has been stored for some time, the immediate flashing will depend on the level of superheating.

Due to the pressure, the reach of liquid sprays and jet scan can be significant, but the formation of liquid pools will be similar with unpressurised non-pressurized LNG spill.

### 5.2.4 Dispersion

Methane gas (plus other associated heavier hydrocarbons if present) that boils off from the pool will form a dense gas due to its cold temperature (initially  $-162^{\circ}\text{C}$ ). The condensation of atmospheric moisture will further contribute to increased gas density above the pool.

As the cloud disperses with the wind, it spreads due to gravitational (density) effects and mixes with air due to atmospheric turbulence (characterized by a stability measure). Processes also affecting this mixing include heat transfer with the air and the re-evaporation of condensed moisture.

Eventually, the cloud will reach a point of neutral density, at which point dense gas processes cease to be important and atmospheric turbulence dominates the mixing.

Depending on circumstances, the cloud may eventually become buoyant as methane is much lighter than air (mole weights of 16 g/mol and 29 g/mol respectively); however, the presence of heavier hydrocarbons and cold will reduce the buoyancy and the cloud may be so diluted before this occurs that the effect may not influence flammable hazards.

### 5.2.5 Rapid phase transformation

Rapid phase transformation (RPT) is a physical phase transformation of LNG to methane vapour mainly due to submersion in water. RPT does not involve any combustion and cannot be characterised as a detonation.

## 5 HAZARD IDENTIFICATION

### 5.1 Major Accident Event

A Major Accident/Incident (or Major Accident Event [MAE]) is defined to be an event that is:

- Fire or explosion or the release of a dangerous substance, with a significant potential to cause death or serious personal injury to person; and
- Any other event arising from a work activity that potential lead to multiple fatalities.

Credible hazard events with consequence of rating 4, indicating "single fatality or permanent disabilities", were extracted from the HAZID report (Ref./2/), as follows:

- Loss of containment of LNG during STS Operations between LNGC and MFP;
- Loss of containment of LNG from tugboats colliding with the LNG carrier.

Note that none of the hazard events identified in HAZID could lead to multiple fatalities (consequence ranking of 5). (Ref./2/)

### 5.2 Hazardous Property of Liquefied Natural Gas

This chapter describes the characteristics of LNG, as well as the typical hazards associated with an LNG release or leak.

#### 5.2.1 Release of liquefied natural gas

At atmospheric pressure, LNG will boil at  $-162^{\circ}\text{C}$ , presenting a cryogenic hazard causing embrittlement of carbon steel structures and potential frost burns to exposed personnel.

Boil off Gas from LNGC is typically warmer than  $-130^{\circ}\text{C}$ , natural gas at around  $-120^{\circ}\text{C}$  is lighter than air (Ref. /6/).

Evaporated natural gas will be cold and heavier than air and will thus be spread by gravity. LNG is neither carcinogenic nor toxic. It is, however, an asphyxiant which dilutes or displaces the oxygen containing atmosphere, leading to death by asphyxiation if exposure is long enough. Since natural gas in its pure form is colourless and odourless, confined spaces are subject to special attention. With large uncontrolled release quantities, personnel in direct surroundings may be suffering from low oxygen concentrations ( $<6-15\text{ V\%}$ ), which should be mitigated by technical and procedural solutions.

When the natural gas is mixed with air, it will gradually become flammable. Natural gas is only flammable within a narrow range of concentrations in the air (typically between 5% and 15% for pure methane). Less air does not contain enough oxygen to sustain a flame, while more air dilutes the gas too much for it to ignite. In the event of a spill, LNG vapours will disperse with the prevailing wind. Cold LNG vapour will appear as a white cloud.

The cryogenic nature of LNG facilities represents a risk of the personnel, structural steel, equipment, instrumentation or control and power cabling being exposed to potentially injurious low temperatures. The cryogenic exposure of personnel causes frost burns; whilst the cryogenic exposure of carbon steel causes embrittlement, possibly resulting in structural failure. Consequently, protection from cryogenic exposure, as well as from fire exposure, is needed.

Since hazardous concentration levels of methane, resulting in asphyxiation, are much higher than the combustible range, this additional hazard is usually not considered in a QRA.



**Figure 4-4 Proposed LNG Filling Operations at Berth 23**

Refer to Section 7 for the risks at these locations due to the LNG filling operations.

### 4.3 Process Description

LNG from the LNGC will be unloaded to the LNG ISO containers or Cryogenic LNG Bowser/Road Truck will be filled via the Mobile Filling Platform (MFP) at the jetty. Operators will need to connect the filling hose and vapour return hose to each ISO Container or Cryogenic LNG Bowser/Road Truck. Vapour return from the ISO containers will be sent to LNG buffer tank where the gas will be heated and sent as fuel gas to the gas generators.

Up to 18 ISO containers or Cryogenic LNG Bowser/Road Truck can be filled simultaneously. Once filling is completed, operators will disconnect the hoses and the ISO containers/trucks will leave the jetty.

The filling rate to each ISO containers is  $40\text{m}^3/\text{hr}$ . It is anticipated that it will take 1hr to fill the ISO containers. For offshore operation, flowrate of up to  $720\text{m}^3/\text{hr}$  ( $40\text{m}^3/\text{hr} \times 18$  ISO tanks) is envisaged.

LNG from LNGC will be pumped from cargo tank to fill the 40' LNG ISO containers. The in-tank main cargo pump design flowrate is  $1400\text{m}^3/\text{hr}$  and since the pumping capacity is much higher than the flowrate into the ISO containers, throttling is necessary from the LNGC. The flowrate can be reduced to  $420\text{m}^3/\text{hr}$  with throttling. Boil off gas (BOG) will be generated and returned to the LNGC via the vapour return line and needs to be handled on the LNGC. Spray pump on the LNGC will be used during start-up / initial filling to cool down the whole system before starting the LNG transfer via the main cargo pump.



**Figure 4-2 Proposed LNG Filling Operations at Berth 18/19**



**Figure 4-3 Proposed LNG Filling Operations at Berth 19**