7.4.6 LNG tanker spill

The likely worst case scenario is spill of the entire quantity of LNG from one of the compartments of the LNG carrier. Spill through a large hole (diameter 5m) is considered. This WCS is modelled for stability classes 2F, 3D and 5D using method provided in the ABS consulting Report. Modelling assumes that the material will spill into the intertidal shallow water area. Table 7.8 provides summary of hazard distances to various consequences. Figs. 7.16 to 7.18 show the risk contours on the chart of Pipavav.

- Estimated maximum distance to LFL concentration of 44000 ppm under 2F weather condition is 3109m from the point of release;
- It is observed that dispersion occurs within the port area
- Fig. 7.18 shows the risk contour for radiation intensities due to fire ball; this can occur if there is an ignition source in the vicinity of the vapour cloud. Radiation intensity of 37.5 kW/m² will occur at 154m around the location of release.

Table 7.8 Hazard distance for hole in tank compartment (5m diameter)

<table>
<thead>
<tr>
<th>Hazard Conditions</th>
<th>Distance (m) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2F*</td>
</tr>
<tr>
<td>Distance to LFL (from the point of release)</td>
<td>3109</td>
</tr>
<tr>
<td>Radiation Effects</td>
<td></td>
</tr>
<tr>
<td>4 KW/m²</td>
<td>561</td>
</tr>
<tr>
<td>12.5 KW/m²</td>
<td>325</td>
</tr>
<tr>
<td>37.5 KW/m²</td>
<td>154</td>
</tr>
<tr>
<td>Late Explosion – Distance to overpressure endpoint for</td>
<td></td>
</tr>
<tr>
<td>0.0268 bar (0.3 psi)</td>
<td>10437</td>
</tr>
<tr>
<td>0.1379 bar (2 psi)</td>
<td>7801</td>
</tr>
<tr>
<td>0.2068 bar (3 psi)</td>
<td>7593</td>
</tr>
</tbody>
</table>

Figure 7-16: Distance to LFL LNG tanker spill (Large diameter hole)
Figure 7-17: Distance to radiation levels for pool fire (Tanker spillage – Large diameter hole)

Figure 7-18: Distance to explosion overpressure (Tanker spillage – Large diameter hole)
7.5 Results of Most Credible Loss Scenario (MCLS)

7.5.1 Unloading arm failure – 1 minute response time

LNG is pumped in the unloading arm @ 3700 m³/hour i.e., 62 m³/min. The MCLS would be spill of 62 m³ for a response time of one minute. The present day emergency response systems cater to this requirement. Modelling is carried out for stability classes 2F, 3D and 5D. The spilled material is likely to reach the deep waters at the jetty. Table 7.9 provides summary of hazard distances to various consequences. Plots of risk contours on the NHO chart for the LNG terminal location are provided in Figs. 7.19 to 7.21.

- Estimated maximum distance to LFL concentration of 44000 ppm under 2F weather condition is 236m from the point of release;
- It is observed that dispersion occurs within the jetty area
- Radiation intensities due to fire ball can occur if there is an ignition source when the vapour cloud is formed. Radiation intensity of 37.5 kW/m² will occur at 124m around the location of release.

Table 7-9 Hazard distance for unloading arm failure (1 min response time)

<table>
<thead>
<tr>
<th>Hazard Conditions</th>
<th>Distance (m) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2F*</td>
</tr>
<tr>
<td>Distance to LFL (from the point of release)</td>
<td>236</td>
</tr>
<tr>
<td>Radiation Effects</td>
<td></td>
</tr>
<tr>
<td>4 kW/m²</td>
<td>456</td>
</tr>
<tr>
<td>12.5 kW/m²</td>
<td>264</td>
</tr>
<tr>
<td>37.5 kW/m²</td>
<td>124</td>
</tr>
<tr>
<td>Explosion – Distance to overpressure endpoint for</td>
<td></td>
</tr>
<tr>
<td>0.0268 bar (0.3 psi)</td>
<td>902</td>
</tr>
<tr>
<td>0.1379 bar (2 psi)</td>
<td>426</td>
</tr>
<tr>
<td>0.2068 bar (3 psi)</td>
<td>389</td>
</tr>
</tbody>
</table>
Figure 7-19: Distance to LFL for unloading arm failure (1 min response)

Figure 7-20: Distance to radiation intensities for pool fire (1 min response for unloading arm failure)
7.5.2 Spill from LNG tanker compartment

The likely credible scenario is spill of the entire quantity of LNG from one of the compartments of the LNG carrier. Spill through a hole of 1m diameter is considered. This scenario is modelled for stability classes 2F, 3D and 5D using method provided in the ABS consulting Report. Modelling assumes that the material will spill into the intertidal shallow water area. Table 7.10 provides summary of hazard distances to various consequences. Risk contours for various effects are plotted in Figs.7.22 to 7.24.

- Estimated maximum distance to LFL concentration of 44000 ppm under 2F weather condition is 327m from the point of release; Time taken to reach LFL is 600 seconds.
- It is observed that dispersion occurs within the jetty area
- Risk contour for radiation intensities due to fire ball is likely to occur if there is an ignition source when the vapour cloud is formed. Radiation intensity of 37.5 kW/m² is likely to occur at 88m from location of release.

Table 7-10 Hazard distance for pipeline rupture (1 minute response time)

<table>
<thead>
<tr>
<th>Hazard Conditions</th>
<th>Distance (m) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2F</td>
</tr>
<tr>
<td>Distance to LFL (from the point of release)</td>
<td>327</td>
</tr>
<tr>
<td>Radiation Effects</td>
<td>4 kW/m²</td>
</tr>
<tr>
<td></td>
<td>12.5 kW/m²</td>
</tr>
<tr>
<td></td>
<td>37.5 kW/m²</td>
</tr>
<tr>
<td>Explosion – Distance to overpressure endpoint for</td>
<td>0.0268 bar (0.3 psi)</td>
</tr>
<tr>
<td></td>
<td>0.1379 bar (2 psi)</td>
</tr>
<tr>
<td></td>
<td>0.2068 bar (3 psi)</td>
</tr>
</tbody>
</table>
Figure 7-22: Distance to LFL for pipeline rupture (1 min response)

Figure 7-23: Distance to radiation intensities for pool fire (1 min response for pipeline rupture)
7.5.3 Leakage in pipeline transferring LNG from FSRU to gasification plant

The most probable scenario in a pipeline transferring LNG from FSRU to gasification plant would be leakage during pipeline transfer with a response time of 1 minute. LNG is pumped @ 8220 Tons / day in the pipeline from FSRU to the gasification plant. For a pipeline leakage with a response time of 1 minute, the spillage would be 5.7 Tons. The scenario is modelled for stability classes 2F, 3D and 5D. Modelling assumes that the material will spill into the intertidal shallow water area under the approach trestle. Table 7.11 provides summary of hazard distances to various consequences. Figs. 7.25 and 7.27 show the risk contours on the chart of Pipavav.

- Estimated maximum distance to LFL concentration of 44000 ppm under 2F weather condition is 643m from the point of release;

- It is observed that dispersion occurs within the jetty area

- Fig. 7.27 shows the risk contour for radiation intensities due to fire ball; This can occur if there is an ignition source in the vicinity of the vapour cloud. Radiation intensity of 37.5 kW/m² will occur at 34m around the location of release.
Table 7-11  Hazard distance for pipeline – LNG carrier to FSRU (10 minute response time)

<table>
<thead>
<tr>
<th>Hazard Conditions</th>
<th>Distance (m) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2F*</td>
</tr>
<tr>
<td>Distance to LFL (from the point of release)</td>
<td>643</td>
</tr>
<tr>
<td>Radiation Effects</td>
<td></td>
</tr>
<tr>
<td>4 KW/m²</td>
<td>135</td>
</tr>
<tr>
<td>12.5 KW/m²</td>
<td>79</td>
</tr>
<tr>
<td>37.5 KW/m²</td>
<td>34</td>
</tr>
<tr>
<td>Late Explosion – Distance to overpressure endpoint for</td>
<td></td>
</tr>
<tr>
<td>0.0268 bar (0.3 psi)</td>
<td>1039</td>
</tr>
<tr>
<td>0.1379 bar (2 psi)</td>
<td>795</td>
</tr>
<tr>
<td>0.2068 bar (3 psi)</td>
<td>790</td>
</tr>
</tbody>
</table>

Figure 7-25: Distance to LFL for FRSU pipeline leakage (1 minute response)
Figure 7-26: Distance to radiation levels for pool fire (FRSU pipeline leakage with 1 minute response)

Figure 7-27: Distance to overpressure intensity for explosion (FRSU pipeline leakage with 1 minute response)
7.5.4 Leakage in hose transferring BoG from FSRU

The most likely scenario is leak in pipeline transferring 345 cum/day for 0.25% of 138000 m³ with 10 minute response. Modelling is carried out for stability classes 2F, 3D and 5D. Modelling assumes that the material will spill into the intertidal shallow water area. Table 7.12 provides summary of hazard distances to various consequences. Figs. 7.28 and 7.30 show the risk contours on the chart of Pipavav.

- Estimated maximum distance to LFL concentration of 44000 ppm under 2F weather condition is 563m from the point of release;
- It is observed that dispersion occurs within the jetty area
- Fig. 7.12 shows the risk contour for radiation intensities due to fire ball; this can occur if there is an ignition source in the vicinity of the vapour cloud. Radiation intensity of 37.5 kW/m² will occur at 14m around the location of release.

**Table 7-12  Hazard distance for pipeline rupture (10 min response time)**

<table>
<thead>
<tr>
<th>Hazard Conditions</th>
<th>Distance (m) for</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>2F*</td>
</tr>
<tr>
<td>Distance to LFL (from the point of release)</td>
<td>563</td>
</tr>
<tr>
<td>Radiation Effects</td>
<td>4 KWh/m²</td>
</tr>
<tr>
<td></td>
<td>12.5 KWh/m²</td>
</tr>
<tr>
<td></td>
<td>37.5 KWh/m²</td>
</tr>
<tr>
<td>Late Explosion – Distance to overpressure endpoint for</td>
<td>0.0268 bar (0.3 psi)</td>
</tr>
<tr>
<td></td>
<td>0.1379 bar (2 psi)</td>
</tr>
<tr>
<td></td>
<td>0.2068 bar (3 psi)</td>
</tr>
</tbody>
</table>

**Figure 7-28: Distance to LFL for BoG pipeline failure (one min response)**
Figure 7-29: Distance to radiation levels for pool fire (BoG pipeline failure – one minute response)

Figure 7-30: Distance to overpressure due to explosion (BoG pipeline failure – one minute response)
7.6 Result of modelling using ALOHA

7.6.1 Worst Case Scenario

This scenario assumes a puddle formation along the pipeline route due to release of 620 m$^3$ of LNG with a response time of 10 minutes assuming a puddle diameter of 100m. Following is the summary of the analysis using ALOHA. The material properties are taken for Methane from the chemical library.

Fig.7.31 provides the overhead footprint for this scenario. The maximum threat zone for this scenario is 184m from the source point.

**Figure 7-31: Representation of maximum threat distance for the MCLS**
### CHEMICAL INFORMATION:
- Chemical Name: METHANE
- Molecular Weight: 16.04 kg/kmol
- TLV-TWA: -unavail-
- IDLH: -unavail-
- Footprint Level of Concern: 33 mg/liter
- Boiling Point: -161.49° C
- Vapor Pressure at Ambient Temperature: greater than 1 atm
- Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

### ATMOSPHERIC INFORMATION: (MANUAL INPUT OF DATA)
- Wind: 3 meters/sec from WSW at 10 meters
- Inversion Height: 12 meters
- Stability Class: F
- Air Temperature: 22° C
- Relative Humidity: 50%
- Ground Roughness: open country
- Cloud Cover: 5 tenths

### SOURCE STRENGTH INFORMATION:
- Puddle Diameter: 180 meters
- Puddle Volume: 833 cubic meters
- Soil Type: Concrete
- Ground Temperature: 22° C
- Initial Puddle Temperature: boiling point
- Release Duration: 16 minutes
- Max Computed Release Rate: 132,000 kilograms/min
- Max Average Sustained Release Rate: 38,900 kilograms/min (averaged over a minute or more)
- Total Amount Released: 851,950 kilograms

### FOOTPRINT INFORMATION:
- Model Run: Heavy Gas
- User-specified LOC: 33 mg/liter
- Max Threat Zone for LOC: 104 meters

### TIME DEPENDENT INFORMATION:
- Concentration Estimates at the point:
  - Downwind: 124 meters
  - Off Centerline: 62.2 meters
- Max Concentration:
  - Outdoor: 71.5 mg/liter
  - Indoor: 2.73 mg/liter
- Note: Indoor graph is shown with a dotted line.

Fig.7.32 shows the Concentration Vs Time graph predicted during the first hour after the release begins at a point chosen in the footprint (blue point – 124 m downwind and 62m off centreline) away from the source of spill. The solid red line represents the outdoor, ground level concentrations. The wide, horizontal green line represents the Level of Concern (LOC), in this case the LFL of Methane i.e., 33 mg/L is assumed as the LOC. From the figure, it is evident that dispersion is quick and most of the concentrations are below LFL.
7.7 Discussion of results

The main failure scenarios are:

- Unloading arm failure during discharge from tanker with a response time of 10 minutes
- Tanker collision/grounding
- Puddle formation from pipeline leakage with a response time of 10 minutes along the pipeline route.

**Unloading arm failure**

The spillage during LNG transfer from tanker to pipeline at the jetty from rupture of one of the unloading arms would be

- 833 m³ assuming a response of one hour during transfer at 10000 m³/hr for both lines. Wind speeds of 3 m/sec are very common in the Gulf of Kambhat region and is therefore the most probable scenario. The thickness of film will reach 1.0mm within 100 seconds of the leak with a maximum diameter of 450m, which shall be confined to the jetty and trestle location. The complete spill will evaporate in 120 seconds. The location of LFL is at a distance of 1766m in the downwind direction, which is the maximum threat zone. This is located within the intertidal areas.

- 62 m³ assuming a response of 10 minutes during transfer at 10000 m³/hr for the three lines. The thickness of film will reach 1.0mm within 50 seconds of the leak and shall be confined to the jetty location – 187m diameter maximum

This amount of spill can be handled by the response planning by the project proponent.
Puddle formation along pipeline

For this case, 620 m$^3$ has been considered to spill due to pipeline leakage along the pipeline route. The response time is taken as 10 minutes.

- Modelling results of ALOHA indicate that the threat distance is limited to the pipeline corridor (<200m distance).
- All the pipelines have Emergency Shut off Valve (ESV) and Pressure Safety Devices (PSD), which are checked before every transfer operation, and therefore the response time is a few seconds only. The probability of pipeline leakage is remote.

Tanker collision & grounding

Due to collision or grounding, the entire quantity of LNG is unlikely to spill, as they are stored in several compartments. And all the compartments are unlikely to fail at the same instant and therefore LNG may be released in packets resulting in cryogenic effects.

According to an ABS consulting report$^3$, a study by Lloyds (2001) includes brief descriptions of 10 LNG spills involving LNG carriers that occurred between 1965 and 1989. Seven of these spills led to brittle fracture of the deck of tank covers, but none of them caused serious structural damage. Given where the damage occurred (i.e., to the deck or tank cover), it is likely that all these releases occurred from piping systems used during LNG transfers. Also, vessels built since 1976 have to comply with current ship design rules and are designed with steel rated for low temperature in areas where LNG leak might be expected to contact deck or internal structures.$^1$

Regarding ice formation, the literature (Quest, 2001, 2003) indicates that ice can form when cryogenic material is spilled on water in laboratory-scale experiments. In larger-scale experiments (such as ponds), ice formation is minimal. For large LNG spills from carriers, it is recommended to assume no ice formation.

- The probability of collision is 1.0x10-6 /transit (for 2 tankers to collide) and therefore the probability of the event of 600 transit /year in the Gulf of Kambhat channel would be once in 1670 years.
- The probability of grounding is 0.30x10-6 /transit and therefore the probability of the event of 160 transits / year would be once in 20800 years.

This amount of spill would be considered a national disaster and needs to be handled at the national level with TIER3 Response.

However, the most likely scenario would be unloading arm rupture for which emergency response and contingency planning is required.

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$^3$Study undertaken by ABG Consulting for the Federal Energy Regulatory Commission under contract number FERC04C019 (May 2004)
Environmental and Disaster Management Plans

8.1 Environmental Management Plan

An approved EMP shall be treated as a commitment on the part of the Swan Energy to control environmental impacts. While Swan Energy is responsible for the overall environmental mitigation, it may delegate the tasks of implementation to contractors, and thus be capable of costing for the EMP.

- Number of vehicles / day shall be restricted to 50 numbers
- Material shall be brought only from approved sources
- Heavy vehicles shall be covered with tarpaulin sheets to minimise fugitive dust from moorum during transportation
- There shall be regular emission checks on vehicles
- There shall be bunding around the proposed construction site to prevent leaching of material from the site into the surrounding areas.

Management Plans need to put in place during construction for the labour camp. Examples of controls to be included in the construction contract are provided below:

- Location of temporary dwellings for construction labour away from the waterfront
- Sanitary facilities for labourers
- Septic tanks / soak pits for toilet wastes
- Disposal options for domestic sewage
- Water supply to labourers from approved sources
- Dustbins for solid waste collection and disposal in approved sites
- Constant emission checks on equipment/machinery
- Stockpiles shall be located 100m away from the waterfront
- Removal of construction wastes and disposal in approved sites

During operations, the following aspects will need to be monitored to minimize environmental impacts

- Marine Water Quality: Turbidity/ water quality deterioration needs to be controlled during dredging by ensuring proposal disposal
- Seabed sediment quality
- Shoreline changes: Shoreline changes will need to be monitored by periodic beach profile measurements
- Seabed changes
• Marine Flora and Fauna
• Generation of noise and emissions from dredgers and plant equipment needs to be minimized by regular maintenance and emission checks
• Discharge of Oil and oil sludge, cargo residues, operational waste from ship (domestic refuse, engine room waste), waste water, bilge water will need to be collected and treated

8.2 Safety systems and prevention

This section outlines measures and facilities necessary to prevent and mitigate potential releases during transfer operations in the marine areas.

Safety procedures

The first step to minimise risk would be to ensure efficient and safe operations at the various stages of transfer operations. This can be achieved by adhering to strict inspection and routine maintenance schedule of the various components of the transfer system.

Checklist for Jetty monitoring and transfer operations

The scope of inspection schedule and frequency of individual components shall be determined by the Port Operator. The schedule shall be based on the best available information concerning the sea conditions at site. It is essential that the schedules are followed and work logs maintained. The schedule can be modified as needed on the basis of the actual operating experience. While the following list gives the general guideline, specific details needs to conform to the manufacturer manuals. The following schedules enable reduction of incidence of component failure.

The pre-berthing inspection comprises inspection of mooring connections, hatches, lights, telemetry systems and signs of damage.

Terminal operations during transfers shall comprise inspection of gas detection and safety shutdown systems.

LNG unloading systems and docks will be equipped with LNG Vapour detection, fire detection and associated safety shutdown systems that shut down pumping operations and close valves to isolate the transfer lines.

The shutdown operations can be actuated by the ship’s crew or LNG terminal personnel.

These systems also respond automatically to any detection of LNG in the atmosphere by shutting down pumping operations and closing valves to isolate the LNG transfer lines.

Inspection of emergency release couplings of the unloading arms: LNG terminals have emergency release couplings that are fitted between the ship’s cargo manifold and the receiving station. These couplings are designed to release if vessel movement exceeds predetermined limits. If the couplings release, the resulting LNG loss to the atmosphere is designed to be very small (approximately 0.003 m³).
Inspection of LNG carrier deck for protection with materials suitable for withstanding LNG exposure, as LNG is a cryogenic liquid that can cause severe embrittlement of steel structures.

**Operational requirements**

- Cargo transfer operations shall be suspended at the jetty when significant wave heights exceed 2 metres and/or wind velocities exceed 20m/s (39 knots)
- During cyclones, the supply tankers shall disengage from the jetty and move to the anchorage
- Daily reports will be received from weather forecasting services and any variance from predictions will be communicated back to the service providers to improve future forecast for this site.
- The terminal crew shall have minimum training equivalent to those specified for LNG carrier crews in the IMO-STCW Convention. (International Convention on Standards of Training, Certification and Watch keeping for Seafarers, 1978).
- Development of safety and environment policies, along with assignment of responsibilities, development of procedures, periodic audits and reviews for responding to LNG releases and situations like fire as per ISM Code (International Management Code for the Safe Operation of Ships and for Pollution Prevention adopted by the IMO Resolution A.741 (18) – 1994)

The marine security plans shall address:

- Security administration and organization of the facility
- Personnel training
- Drills and exercises
- Records and documentation
- Response to change in security level
- Procedures for interfacing with vessels
- Declaration of Security (DoS)
- Communications
- Security systems and equipment maintenance
- Security measures for access control, restricted areas, handling cargo, delivery of vessel stores and bunkers and monitoring
- Security incident procedures
- Audits and security plan amendments
8.2.1 Release response system

While the LNG industry traditionally focuses on release prevention, it is essential that release response systems exist to help mitigation in the event of releases. The primary aim is to protect human health and safety, minimize environmental impacts and to restore the environments, as nearly as practicable, to pre-release conditions. The response system at the marine terminal includes gas detection, safety shutdown and fire protection systems. The other elements of response system comprise:

- Safety and security zones
- Ship and facility emergency response plan
- Coordination with GMB and local emergency responders
- Evacuation plans and procedures

8.3 Emergency Response Planning (ERP)

8.3.1 Handling major releases

On noting a release transfer operations shall be suspended immediately

The onsite personnel at the marine facility shall indicate the position and cause of release to onshore control room. The onsite personnel shall also indicate the probable size of the release

The site main controller shall assist the designated release response team / Coast Guard reach the site of release and mobilize release combating equipment to the site depending on the size of the release

The responsibility of the site main controller is also to inform all statutory authorities, i.e., Gujarat Maritime Board, GPCB, Coast Guard, Superintendent of Police, and Local Customs etc.

The operational command structure can be similar to Fig. 8.1. The spills shall be contained as per the National Oil Spill Disaster Contingency plan with SEL providing the necessary equipment and manpower assistance.

Figure 8-1: Typical Command structure for emergency response
8.3.2 Handling unignited release

The un-ignited vapours could accumulate or move to a vulnerable area where any ignition source would produce an explosion with even more dramatic consequences. In this case, the emergency responders may involve law enforcement or other public resources to help notify personnel in the downwind direction to take action and move away from the hazard.

8.3.3 Handling Fire and Explosion Emergencies

The general strategy that can be used to deal with a fire emergency comprises three steps, namely:

- Information gathering and accident assessment
- Decision making
- Implementation of the response actions

The types of actions to be implemented will depend on the first two steps, and can be summarized in three possible courses of action, i.e.

- Attacking the fire
- Controlling the fire without attempting to put it out, or
- Complete withdrawal

Step 1 - Information gathering and accident assessment

- Determine whether casualties have occurred, and whether rescue operations would be required
- Identify the materials involved in the accident. It is possible that more than one material is involved in the accident. It is possible that more than one material is stored in the same location.
- Use the MSDS for the material involved.
- Appropriate extinguishing agents for the material
- Determine weather conditions such as wind direction and speed, temperature, humidity, and precipitation.
- Determine available resource in terms of manpower, equipment and supplies. Also determine what additional resources could be mobilized and how soon

Step 2 - Decision Making

After all this information has been collected, a decision should be made as to the type of action to take. Rescue of casualties should, of course, be the first task. However, even this task will depend on the overall accident assessment, on the resources available, and on the alternatives implementable. In general, three possibilities should be considered,

- Attack the fire
• Control the fire without attempting to put it out
• Withdrawal of emergency response personnel

The choice of one of these actions will depend on the accident assessment and the materials involved. Putting out the fire could sometimes introduce even greater hazards due to dispersion of the un-ignited cloud and therefore, the other alternative can sometimes be to let the fire burn, thus limiting the exposure of personnel.

The duties of the fire and rescue team leader include:

• Overall in-charge of the fire fighting operations.
• Inform the Main Controller if external fire tender/fire fighting equipment/materisl/Mutual Aid is required.
• Liaise with the utilities and arrange for external water supply/diesel for hydrant pump/D.G. Sets, etc.
• Maintaining adequate supplies for fire fighting equipment and facilities.

8.3.4 Roles and Responsibilities

Contingency plans backed up by adequate and well-maintained equipment, detailed procedures, necessary supplies of products for treatment, and personnel trained to deal with spills are essential to ensure an effective response. The following section defines the roles and responsibilities of the various agencies involved in combating oil pollution in the event of spillage in the event of a disaster.

Port Operator

Provision of safety and security zones for LNG carriers to reduce the likelihood of collisions or the need for an LNG vessel to try to avoid other port traffic.

• Identify releases: Location, size, source and intimate site main controller at SEL
• Inform statutory bodies, Coast Guard about releases
• Establish crisis management group and define roles and responsibilities
• Coordination on quick and safe handling of tankers
• Provide for training of personnel involved in operations
• Organization of periodic exercise and mock drills under the guidance of the regional Coast Guard to keep equipment and personnel in constant readiness.
• Identification of suitable means for treatment and disposal of debris, emulsions etc.

Regional Coast Guard Commander

• Coordination of activities of Regional Communication Center
• Receive reports of oil pollution and mobilize Coast Guard resources to support On Scene Commander (OSC) action at spill area
• Provision of administrative and infrastructure to the Regional Communication Center (RCC) to conduct routine and operational tasks
• Maintain a list and assess available resources including local, regional, national and international groups, and the scale of spillage at which they should be contacted
• Conduct periodical exercises of combating oil pollution at sea
• Maintain and update inventory on anti-pollution equipment and material
• Provide assistance to local groups in implementation of Local Action Plan

8.4 Disaster Management Planning (DMP)

SEL will establish a Disaster Management Plan (DMP) in place that is professionally addressed & duly weighed. SEL will engage an experienced Port Operator to provide various services that include Hazard Prevention, and, Health, Safety & Environment services on the waterfront. SEL will take care of HSE & Hazard prevention activities on the waterfront with the assistance of Port Operator. The DMP prepared by SEL is fully effective for preventing and managing any incidents or accidents in and around the LNG import terminal and the waterfront and for ensuring their safety.

8.4.1 Disaster Prevention and Management

The port operator has to establish and maintain suitable systems, and employ / contract skilled and trained Personnel, necessary and efficient communication equipment and all other equipment and facilities for prompt application at any time of the DMP procedures. SEL shall organise periodic exercises and simulations with Port Operator, the LNG Tanker's/vessel's owner in accordance with simulated accident scenario.

8.4.2 Fire Fighting, Health, Safety and environment

The Port Operator shall deploy qualified HSE manager for overseeing and ensuring overall implementation of policy as regards Health, Safety and Environment Plan for the port. The Operating personnel have to be extensively trained in fire fighting at LNG terminals in operation elsewhere. The Port operator shall also deploy trained manpower for managing the waterfront activities. The waste management plan shall be compliant with MARPOL standards.

8.4.3 Pollution control

The Port Operator will be entrusted with the responsibility of safe navigational operations and cargo transfer procedures as per guidelines of international bodies for vessels and shore facilities. Additionally port operator shall completely control and verify compliance with the checklist before unloading operations at the LNG terminal. and hall ensure safe bunkering operation and compliance with rules specified by International Maritime Organisation and SIGTTO guidelines.

8.4.4 Supply and deployment of fleet

The Port Operator shall deploy, operate and maintain at least four (4) harbour Tugboats, one (1) pilot boat; and two (2) jetty mooring boats.
One Tugboat shall be fitted with anti pollution equipment. This Tugboat shall also be fitted with two four hundred meters of oil trapping boom designed for sea; six (6) mooring buoys for the oil trapping boom; two pumps designed to pump very heavy and viscous oil two ESKA heads or equivalent and other anti-pollution equipment.

Two of the four tugboats shall be classified as Fi-Fi, with following minimum characteristics:

- Freshwater : 50.0 cubic meters (approx.)
- Fuel oil : 200 cubic meters (approx.)
- ME Lube oil : 8.0 cubic meters
- Foam : 19.0 cubic meters
- Detergent : 10.0 cubic meters

The tugboats shall be equipped with 8 fire extinguishers, 2 fire pumps, 8 life buoys, 12 life jackets, gas detection meter etc.

Offsite Emergency Response Plans involving nearby industries and settlements will include training and awareness, alarms, procedures for evacuation, fire fighting, emergency communication systems, first aid, etc. Procedure and plans will be developed and established for large emergency with district and state authorities, coast guard, etc.
Summary and Impacts

Swan Energy Limited proposes to construct an LNG Import Terminal at Pipavav, District Amreli, Gujarat for a throughput capacity of 3 MTPA of natural gas in the initial phase with a potential to be increased to 10 MTPA. SEL has tied up with Gujarat State Petroleum Corporation Limited (GSPC) for LNG imports for the proposed 700 MW Gujarat Pipavav Power Corporation (GPPC) gas based power plant at Pipavav. The propose site is located near village Kovaya, and in close proximity to GPPC. The LNG gas will be supplied to GPPC and will also be connected to the GSPC pipeline for other users in Gujarat.

The site is within 5km of the existing Gujarat Pipavav Port (GPPL) and will be amalgamated within the existing operations of Gujarat Pipavav port Limited (GPPL) with the expansion of the GPPL port limits with the required GMB approvals.

A single LNG carrier will moor either directly at the berth or alongside a Floating Storage and Re-gasification Unit (FSRU) permanently moored to the jetty. The FSRU will be a converted LNG carrier. The carrier will use onboard pumps to transfer the LNG from its cargo tanks through the 3 LNG liquid unloading arms and the LNG transfer pipeline to FSU storage tanks. LNG will be transferred from LNG tanks in the FSRU to the LNG export header through LNG cargo pumps and transferred from the LNG export header to a re-gasification plant located on the jetty through cryogenic hose.

Multiple options for LNG import terminal were evaluated keeping in mind various factors such as safety, cost, existing operations at Pipavav Port, shoreline erosion, sedimentation and environmental factors. Detailed field surveys and modelling studies were conducted to establish the port layout that would result in required wave tranquility of safe navigation and operations, negligible change to sedimentation patterns at the existing GPPL channel and jetties, minimal capital and maintenance dredging, low land acquisition, minimal to no shoreline change/erosion, safe navigation of vessels including the existing vessel movement at Pipavav and minimal environmental impact.

This report summarises the rapid environmental impact assessment of the proposed facility. The primary focus of the EIA study is based on the approved MoEF terms of reference provided to M/s Swan Energy on 20th September 2010 vide Letter No. F.No.11-36/2010A.III.

Baseline studies to establish the present environmental status were conducted for terrestrial and marine environments in November 2010 to January 2011 and February 2011 respectively. In all cases, the parameters were found to be within ambient quality limits, with the exception of particulate matter in air. This is due to the dry, windy and arid conditions at site, with little foliage and thus, the ambient air quality has a naturally dusty environment. No critical habitats, forests and endangered species are known to exist at the site from literature and were not found at the project site during baseline studies. Mangroves exist beyond the project site, yet the flow regime at the mangrove locations are not in the least likely to be affected by the proposed terminal.

The following major issues were studied in greater detail based on the terms of reference provided by MoEF and the scoping conducted for the study:
1) Impact on proposed activities on fisheries
2) Risk Assessment and emergency evacuation and Disaster Management Plan
3) Details of hydrodynamic studies including pre and post monsoon conditions
4) Impacts on water quality from dredging and breakwater construction
5) Shoreline changes
6) Dredging and disposal
7) Impacts on benthic ecology at disposal site and intertidal flora/fauna
8) Cold water discharge from the re-gasification unit

The study indicates that Jafrabad located 10 km is one of the major fishing harbours of Gujarat. At the Jafrabad fishing harbour, the total fish catch is in the order of 30,000 – 50,000 tonnes per year, accounting for 6-10% of the state’s marine productivity. There are about 300 mechanized vessels from Jafrabad as well as 120 boats from Shial Bet that operate away from the coast and away from the proposed site.

Pipavav is located at the entrance of the Gulf of Kachch, which has relatively lower fisheries potential when compared to the Arabian Sea beyond the Gulf. The fish catch mostly comes from deeper waters using mechanized trawlers. Artisanal fishermen are few at this location, possibly due to the intertidal and benthic surveys indicating low productivity and/or that the location is a high energy environment with cliffs exposed to waves. Thus, Veraval and Porbandar along the Saurashtra coast facing the Arabian Sea have much higher fish landings.

The Risk Assessment study which included a consequence analysis indicated that the Lower Flammability Limit is located within the premises of the proposed terminal for the most probable scenarios. In addition, the overall safety record of the LNG industry needs to be recognized as there has not been a major marine accident worldwide during LNG shipping and transfer, while 7 minor accidents have been reported by Lloyds. Discussions with other LNG import operators in India also indicate that suppliers and LNG operators enforce strict safety standards and personnel have to undergo rigorous training before the plant is commissioned and operations can commence.

Mathematical modelling studies have been conducted with TUFLOW-FV, a state of the art flexible mesh 2-D model for tidal hydrodynamics and sedimentation and with SWAN and BOUSS2D for waves. In addition, waves and currents were determined for various cyclone events and incorporated in the modelling results. The breakwater layout was determined using the layout to ensure that there is no change in flow circulation and sedimentation beyond the immediate vicinity of the proposed terminal. In addition, the shoreline consists largely of cliffs and rocky beaches where negligible sand movement or beach formation is seen. Thus, littoral drift is not a significant factor in sediment transport at this site, while tidal circulation with sediments from the Gulf of Kachch are the dominant factors in sediment transport. The site is also not included as a highly eroding site as the ICMAM report.

The impacts of dredge spoil disposal were evaluated and found it will be negligible, temporary and reversible. Capital dredged material will be used to create a backup area and stabilize the cliff, such that unusual/rare events of slippage do not occur and to provided access roads and pipeline corridor for safe and direct access to the power plant with minimal land acquisition. Maintenance dredging of 1-1.5 Mm³ per year is estimated and
it is recommended that this be disposed at the identified GPPL site, especially since the site is already approved, the activity will occur for only one month in a year and where the strong Gulf of Kachchh currents have disperse the sediments in a similar manner to the ambient sediments of the Gulf of Kachchh, thereby resulting in negligible and temporary impacts.

The present intertidal and benthic ecology survey indicates that the site is low in productivity due to the high energy environment caused by the direct waves from Arabian Sea and due to the strong tidal currents. The proposed breakwater provides a calm and tranquil area and thus may provide a better environment for improving the diversity and population of intertidal flora/fauna as well as mangroves.

The coldwater discharges at 5 -10 deg C from the re-gasification unit can be discharged with the warm water discharge from the power plant, thereby neutralizing any change in temperature. While this is considered to the best case for minimizing impacts on the environment, the worst case scenario of a direct discharge into the sea is also evaluated. A surface discharge of the coldwater over a cascade/steps on the breakwater allows the temperature to increase due to contact with air as well as creates sufficient diffusion to minimize the sinking the more dense coldwater discharge. In addition to ensure that residual chlorine is limited to 1 mg/L at the discharge point, pulse chlorination is also recommended to minimize any impacts to marine biology.

Based on the above assessment and suggested mitigatory measures, the Environmental Management Plan and Disaster Management Plan has been suggested. These include practices to minimize waste generation, emissions and effluents, safety measures and training of local people in the actions to be taken during a disaster, even though the LNG industry has an excellent safety track record.

**In conclusion, the report concludes that the environmental impact will be negligible as environmentally critical issues were considered in the layout planning phase. The project brings additional industrial development to a location with limited agriculture and employment opportunities, while providing infrastructure to supply clean fuel to industries in the region.**