REPORT

ON

RISK ANALYSIS

FOR

RA STUDY FOR DEVELOPMENT OF CRYOGENIC LPG IMPORT, STORAGE AND DISTRIBUTION FACILITY ALONG WITH ALLIED INFRASTRUCTURE AT HALDIA

OF

M/s AEGIS LOGISTICS LIMITED

Prepared By

PROJECTS & DEVELOPMENT INDIA LIMITED
(A Govt. of India Undertaking)
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			Gopa Bandopadhyaya	DK Chatterjee	
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EXECUTIVE SUMMARY

BACKGROUND

Aegis Group is one of India's leading Logistics group providing total logistics solutions for Oil, Gas and Chemicals. The company is ISO-9001 2008 certified.

The demand of LPG for domestic purposes is increasing day by day. To cope up with increasing demand of LPG, Oil Companies are setting up new bottling plants as well as augmenting their existing capacity. Even after this, there is large gap between demand and supply. Government of India is also encouraging private companies to utilize their resource for meeting the demand of LPG in the country.

Aegis group owns/ operates India's largest integrated bulk Liquid cum LPG Terminal in the port of Mumbai and also the largest private bulk Liquid Terminal at Kochi port, apart from a pressurized LPG Storage Terminal at Pipavav Port and a LPG Bottling/ Blending Unit at Kheda & Dharwad in Gujarat and Udupi in Karnataka.

Haldia is a strategically located port and well connected with National Highways, Rail Network and is a gateway to Eastern and North-Eastern Indian Market. The area of port has low population density and does not have Natural Forests and ecologically sensitive areas. These qualities of Haldia Dock Complex in the new proposed development will complement the existing Business of Aegis Group on the Eastern coast of India.

In view of the above, Aegis India Limited proposes to develop Cryogenic Propane/Butane/LPG Terminal with allied facilities for pipeline receipt from Haldia Oil Jetty (HOJ)- I, II & III storage, Handling and dispatch of products. The proposed storage terminal also includes loading facilities, Allied Machineries, Loading Gantries for dispatch through road at the plot allotted by the Haldia Dock Complex.

The pipeline (Approx 12.0 km long) for transport of material completely falls in the KoPT, Haldia. The pipeline does not pass through national parks/sanctuaries/coral reefs/ecologically sensitive areas including LNG terminal and as per MoEF notification dated 06.01.2011, No Development Zone (NDZ) shall not be applicable in such area falling within any notified port limits.

Aegis Logistics has appointed M/s Projects & Development India Limited (PDIL), a Government of India Undertaking, for preparation of EIA/ EMP/ Risk Analysis Reports for proposed project in order to seek environmental clearance from MoEF vide Work Order No. PSCC-AEGIS-L-BJM27D-3802 dated Oct 2014. PDIL is a QCI-NABET accredited EIA consultancy organisation (Sl. No.: 121, List as per notification dated 11.06.2015 issued by QCI).

PROJECT PROPOSAL

The project proposal is limited to receipt of Cryogenic LPG through pipeline and develop storage terminal with allied facilities for storage, Handling and dispatch of product. It also includes loading facilities, Allied Machinery, Loading Gantries for onward dispatch by road in the existing land allotted by the Haldia Dock Complex. The estimated cost of the proposed project is Rs 150 Crores and is expected to be completed within 24 months after grant of EC.

PROJECT LOCATION

The proposed cryogenic LPG terminal of M/s Aegis Logistic is located at Jagatchak village, under Haldia Dock complex of Purba Mednipore district in the State of West Bengal. The LPG terminal is spread over in an area of 4.0 acres of land provided by the Haldia Development Authority. Geographically, it is located at longitude $88^0$8'16.78" East and latitude $22^0$3'30.65" North at an altitude of about 7.0 m above mean sea level (MSL). The plant is at a distance of about 1.3 km from Durgachak town railway station and 1.0 km from Durgachak town. The nearest highway, NH-41 is located about 5.0 km from the proposed LPG terminal.

BENEFITS OF PROPOSED PROJECT

- The proposed project is a complementary requirement of the Haldia Dock complex for the economy, better serviceability to end customer and to improve the primary / secondary logistic cost. The development of this project will help the industrial growth especially in Eastern and North-Eastern part of India in eco-friendly way.
- The project creates an infrastructure to import the Eco-friendly Fuel LPG, which in turn makes the fuel available for use in Domestic/Commercial/Automotive and Industrial sectors, replacing the highly polluting Solid and Liquid Fuels.
- The project will also create an environment for development in the region and create ample employment opportunities directly or thru ancillary requirement for construction, operations and maintenance.
- Currently, the Haldia port handles similar cargoes hence; development of this project will complement the optimum utilization of the Port Infrastructure and contribute to the national and state exchequer.
- The easy availability of LPG in the region will save the manpower used in cooking purposes and it will improve the health of women engaged in cooking. Indirectly, this benefit will strengthen the socio-economic condition in the region.

SPECIAL FEATURES OF THE PROJECT

JETTY FACILITIES

(1) Cryogenic LPG will be unloaded from Ship at HOJ-I/II/III by a new unloading arm which will have the following safety devices like QCDC (Quick Coupling and Decoupling) / ERC (Emergency Release Coupling) and ESD (Emergency Shut Down).
(2) Jetty is having a full-fledged fire fighting facilities like fire hydrants & monitors, Tower Monitors, facilities for making water curtain and also portable fire fighting apparatus like DCP extinguishers, foam extinguishers, etc.
(3) Hose boxes and water sprinkler system.

PIPELINE FROM JETTY TO LPG TERMINAL

(1) Line will be designed and erected as per international practices.
(2) Pipeline (Approx 12.0 km long) will be over ground except 300 m near lock gate where it will be laid below the River bed.
(3) Over ground pipeline will be protected for external corrosion by providing a corrosion resistant paint and proper insulation.
(4) Pipeline below the River bed will be protected by corrosion resistant paint and by cathodic protection.
(5) PLC based leak detection system will be provided for the pipeline.

LPG TERMINAL

(1) Refrigerated LPG will be stored in two (Each of 12500 MT) numbers of double wall double integrity storage tanks provided with all safety features and instrumentation like two numbers of submerged intake pumps in each tank, high and low level alarm, high-high level cut off, remote operated valves and ESD.
(2) LPG tanks will be provided with pressure control valve, two numbers of pressure safety valves connected with a cold flare of 30 m high.
(3) Refrigeration in tanks will be maintained by two numbers of Boil Off and two numbers of Flash Off Compressors.
(4) Two (each of 50 MT) numbers of mounded bullets will be provided to contain liquid LPG coming from Boil Off & Flash Off Compressors.
(5) Sprinkler system will be provided on the top of storage tanks, pump & compressor house, loading bays, mounded bullets, etc.
(6) There will be no boiler for heating LPG prior to loading LPG Tankers. LPG will be heated by circulating water.

(7) Loading in tank trucks will be done through loading arms.
(8) Cathodic protection will be provided for mounded bullet.

PROJECT DESCRIPTION

Proposed Receipt Facilities

Cryogenic LPG would be transported through approx. 12 Km long shore pipeline from HOJ-I /II /III to storage terminal.

Proposed Storage Facilities

The proposed Cryogenic LPG storage terminal shall be provided with 02 nos. of double walled double integrity above ground (A/G) tanks (Gross Capacity – 25100 MT). The details are given below in Table – E.1.

Table – E.1

Sl. No.	Facility	Quantity	Capacity
1	Refrigerated atmospheric storage tank	02 Nos.	12, 500 MT each
2	Boil-off compressor	02 Nos.	2.5 MT each
3	Flash-off compressor (Discharge Pressure: 16 bar)	02 Nos.	Capacity: 5.5 MT each
4	LPG transfer pumps on refrigerated tanks (Discharge Pressure:18 Kg/cm^2)	02 Nos. on each Tank	60MT/Hr(Submersible)
5	Mounded Bullet	02 Nos.	50 MT each
6	LPG heating system	Air & Water (Heating Medium)	
7	Flare Stack (Cold Flare)	01 No.	30 m height
8	Road Tanker Loading		-
	a) No. of Gantries	01 No.	
	b) Number of bays	08 Nos.	

Along with the facilities for LPG Vapouriser, LPG Heater, Packaged Cooling Tower and other facilities like Mercaptan dosing, DG Set etc. shall be made available within the LPG terminal.
LPG would be dispatched through Road Tankers.

PROCESS DESCRIPTION

Product Receipt

Cryogenic LPG will be unloaded from ship at Haldia Oil Jetty HOJ- I/II/III) and transported through 02 nos. of dedicated pipelines of 12" dia to Cryogenic LPG storage tanks of 12500 MT capacity each. The pipeline will pass through the existing pipeline corridor adjacent to offshore road which is laid by the side of river Hooghly.

Storage Facilities

To maintain the temperature of -27^{O}C in the refrigerated storage tanks, two numbers of Boil off compressors have been provided which takes suction from top of the tank including two numbers of Flash off compressors to be used during filling of the storage tank. Vapour, after compression, will be cooled in heat exchanger when vapour is condensed and collected in Collection Drum and liquid LPG is transferred to Mounded Bullets (Cap.: 50 MT each).

LPG from the storage tank (Temp. -27^{O}C) is pumped to LPG Heater (I) & LPG Heater (II) where LPG (-27^{O}C) is heated by air & then by cooling water to 20^{O}C for loading in Road Tankers. For operation of heating system, temperature and pressure control system is so adjusted to achieve the final temperature of 20^{O}C downstream of LPG Heaters. One odorizing unit comprising of Mercaptan Dosing Tank and pump has been provided for mixing with LPG before dispatch to existing Road Tanker.

Dispatch

LPG Loading operation from cryogenic storage tanks to road tankers loading gantry via LPG Heaters will be done by two vertical submerged LPG Loading pumps (Cap. 60m^3/Hr each) installed in storage tank.
Loading rate will be controlled though flow indicator controllers to be installed on the discharge line of each pump.

RISK ANALYSIS

Risk analysis has been conducted separately for the storage terminal and the transfer pipelines by using the latest software named Phast Risk of M/s DNV, Technica, UK.

Pipeline

A total 17 nos. of cases were considered for the consequence analysis of the pipeline and arrived at following conclusions based on the analysis results:

Conclusion

Individual Risk Profile (Risk Transects) has been drawn and given as Figure No. 2 which shows that Risk Transect Profile for individual risk of fatality 1.0 x 10-8 per year goes only upto 30.5 m towards maximum probable wind velocity. Individual Risk Profile (Risk Transects) near Patikhali Creek beside BPCL & near IOCL's refinery has been drawn and presented as Figure No. 3 & 4 which shows that Risk Transect Profile for individual risk of fatality 1.0 x 10-8 per year goes only upto 15.4m & 17.2m respectively towards maximum probable wind velocity. Hence the pipeline route is safe from environmental risk point of view. Moreover, there is no population around the proposed pipeline routes.

Based on the above conclusion following recommendations were made to minimise the risk due to pipeline failure:

Recommendation

i) Unloading arms should be procured and erected in Oil Jetties. The unloading arms will have the facility of QCDC (Quick Coupling & De-coupling)/ ERC (Emergency Release Coupling) and ESD (Emergency shut-down valve).
ii) Pipeline route has been fixed in consultation with Haldia Dock Complex Authorities. Shortest possible route has been chosen as there is least crossing & min. population in the route.
iii) Applicable and relevant standards, petroleum rules and all other national & international standards/ codes and practices shall be considered during design/ procurement and installation of the pipelines.
iv) Only trained operators shall be deployed for operation of the pipeline system. Such facility is already working at Haldia.
v) Flow meters should be installed at storage plant side as well as on the ship side. If any mismatch is there which indicates the leakage, the ship pump should be immediately stopped. In addition, leak detection system should be installed in the pipeline. Provision should be there to stop pump if any leak is detected.
vi) The pipelines should be provided with proper insulation.
vii) Design and construction of the pipe supports should be rigid to avoid failure of the pipe supports due to earthquake or other natural calamities.
viii) 100% radiography to be done for all welded joints.
ix) Mutual aid agreements should be done with the HDC nearby industries, fire service stations, hospitals and other agencies.
x) Pipeline route should be patrolled round the clock during LPG transfer operation.
xi) Offsite emergency mock drills should be done once in six months in consultation with District Collectorate and other industries including Haldia Dock Complex.
xii) Suitable PLC based leak detection system for pipelines have to be provided.

Storage Terminal

A total 11 nos. of points were considered for assuming different size of hole formation & failure for the consequence analysis of the storage terminal and arrived at following conclusions based on the analysis results:

Conclusion

Individual Risk Contour has been drawn and given as Figure No. 6 & FN curve in Figure No. - 7 for cryogenic LPG storage facilities.

Major recommendations are as follows:

- LPG storage and handling facilities at Haldia is situated at a place where there is no human habitation nearby. Iso-risk contour, Figure No. 6 has been drawn for LPG storage & handling Plant which goes 11 m outside the battery limit in south-eastern direction. In all case, it has been found that acceptable risk contour ($1x10^{-6}$ per year) goes outside the plot of land earmarked for the LPG storage and handling facilities, however it is an industrial area with no population within 0.5 Km. F-N Curve (i.e. Societal Risk) Figure No. 7, is also in the acceptable range Hence, it is safe to install the facilities at the place earmarked for the LPG storage and handling facilities in LPG Bottling Plant.

Recommendation

- Officers and staffs of the LPG Handling Plant should be trained in such plant before they are put in the job.
- Procurement of materials, construction & erection of the plant should be done as per international codes & practices.
- 100% radiography should be done for all weld joints in tanks and pipelines.
- Health check and maintenance of tanks & machineries should be done at regular intervals.
- Instruments and trip interlocks should be checked and calibrated at regular intervals to prevent any wrong signalling and consequent failures.
- Good liaison should be maintained with HDC nearby organizations, District Administration and hospitals & mutual aid agreement should be done with nearby industries so that help may be obtained in case of any major hazard.
- Mock Drills for fire & emergency should be conducted at regular intervals.
- Flow indicator transmitter & pressure indicator transmitter with indication in control room should be provided in the receipt pipeline at the Durgachak LPG Handling Plant side. Whenever a flow mismatch is observed between dispatch and receipt of LPG or a sudden fall of pressure is indicated in LPG transfer line, immediate action should be taken to shut the LPG pump at ship to avoid further delivery of LPG.
- Good communication facility should be established between Jetty personnel and the receipt point at Haldia LPG Bottling Plant control room personnel to take appropriate action during unloading and transfer of LPG. Also good communication facilities should be provided for communication with the personnel in the plant.
- Safety valves should be checked regularly.
- In addition to the fire hydrant & monitors, fire extinguishers should be placed at vulnerable places
- Proper lighting system should be done in the plant so that plant personnel can approach in any part of the plant during night.
- One ESD (Emergency Shut Down) Switch should be provided in plant control room to stop all operations in case of failure of any equipment & pipeline.
- Adequate number of Hydro carbon (HC) detectors to be provided at vulnerable points of operation, especially in TLF shed in the terminal.

Considering various safety features and risk reduction measures adopted for proposed facility, it may be concluded that the proposal for storage and handling of LPG at Haldia is considered safe from environmental risk point of view.

1.0 INTRODUCTION

Aegis Group is one of India's leading Logistics group providing total logistics solutions for Oil, Gas and Chemicals. The company is ISO-9001 2008 certified.

The demand of LPG for domestic purposes is increasing day by day. To cope up with increasing demand of LPG, Oil Companies are setting up new bottling plants as well as augmenting their existing capacity. Even after this, there is large gap between demand and supply. Government of India is also encouraging private companies to utilize their resource for meeting the demand of LPG in the country. Aegis group owns/ operates India's largest integrated bulk Liquid cum LPG Terminal in the port of Mumbai and also the largest private bulk Liquid Terminal at Kochi port, apart from a pressurized LPG Storage Terminal at Pipavav Port and a LPG Bottling/ Blending Unit at Kheda & Dharwad in Gujarat and Udupi in Karnataka.

Haldia is a strategically located port and well connected with National Highways, Rail Network and is a gateway to Eastern and North-Eastern Indian Market. The area of port has low population density and does not have Natural Forests and ecologically sensitive areas. These qualities of Haldia Dock Complex in the new proposed development will complement the existing Business of Aegis Group on the Eastern coast of India.

In view of the above, Aegis India Limited proposes to develop Cryogenic Propane/Butane/LPG Terminal with allied facilities for pipeline receipt from Haldia Oil Jetty (HOJ)- I, II & III storage, Handling and dispatch of products. The proposed storage terminal also includes loading facilities, Allied Machineries, Loading Gantries for dispatch through road at the plot allotted by the Haldia Dock Complex.

The pipeline for transport of material completely falls in the KoPT, Haldia. The pipeline does not pass through national parks/sanctuaries/coral reefs/ecologically sensitive areas including LNG terminal and as per MoEF notification dated 06.01.2011, No Development Zone (NDZ) shall not be applicable in such area falling within any notified port limits.

Aegis Logistics has appointed M/s Projects & Development India Limited (PDIL), a Government of India Undertaking, for preparation of EIA/ EMP/ Risk Analysis Reports for proposed project in order to seek environmental clearance from MoEF vide Work Order No. PSCC-AEGIS-L-BJM27D-3802 dated Oct 2014. PDIL is a QCI-NABET accredited EIA consultancy organisation (Sl. No.: 121, List as per notification dated 07.04.2015 issued by QCI).

1.1 PROJECT PROPOSAL

The project proposal is limited to receipt of Cryogenic Propane/Butane/LPG through pipeline and develop storage terminal with allied facilities for storage, handling and dispatch of products. It also includes loading facilities, allied machinery, loading gantries for onward dispatch by road in the existing land allotted by the Haldia Dock Complex. The estimated cost of the proposed project is Rs 300 Crores.

1.2 PROJECT LOCATION AND JUSTIFICATION

1.2.1 Project Location

The proposed cryogenic LPG terminal of M/s Aegis Logistic is located at Jagat Chak village, under Haldia Dock complex of Purba Mednipore district in the State of West Bengal. The LPG terminal is spread over in an area of 4 acres of land provided by the Haldia Development Authority. Geographically, it is located at longitude $88^0$8’16.78" East and latitude $22^0$3’30.65” North at an altitude of about 7 m above mean sea level (MSL). The plant is at a distance of about 1.3 km from Durga chak town railway station and 01 km from Durga chak town. The nearest highway, NH-41 is located about 5.0 km from the proposed LPG terminal.

1.2.2 Justification of Project Site

Aegis Logistic Limited, in their expansion plan, has identified Haldia port as one of the most suitable site for the following reasons:

- The port area is a low population zone and does not have Natural forest and ecological sensitive area.
- Haldia is strategically located all season port with excellent draft.

- Haldia port has excellent liquid/ gas jetties and has plans to expand the same.
- This port is one of the nearest ports for accessing the Eastern & North-eastern markets and can supply the LPG to the deficient market and contribute to the national cause of promoting LPG as an eco- friendly fuel.
- The installation of the proposed cryogenic facilities will give operational leverage to Aegis and will complement the already operational LPG Terminals on West Coast.
- The company already owns 4.0 acres of land in Haldia Dock Complex to be used for construction of tank farms for petroleum product.

1.3 BENEFITS OF PROPOSED PROJECT

The proposed project is a complementary requirement of the Haldia Dock complex for the economy, better serviceability to end customer and to improve the primary / secondary logistic cost. The development of this project will help the industrial growth especially in Eastern and North-Eastern part of India in eco-friendly way.

The project creates an infrastructure to import the Eco-friendly Fuel LPG, which in turn makes the fuel available for use in Domestic/Commercial/Automotive and Industrial sectors, replacing the highly polluting Solid and Liquid Fuels.

The project will also create an environment for development in the region and create ample employment opportunities directly or thru ancillary requirement for construction, operations and maintenance. Currently, the Haldia port handles similar cargoes hence, development of this project will complement the optimum utilization of the Port Infrastructure and contribute to the national and state exchequer.

1.4 METEOROLOGICAL CONDITIONS

Weather at Haldia is moderate. Temperature during summer is 31^{o} to 34^{o}C during day and 30^{o} to 31^{o}C during night. In winter the temperature fall and lies between 23^{o} to 27^{o}C during day & between 18^{o} to 22^{o} during night. Wind speed lies between 1-19 Km/hr. Wind direction is mostly from south & southwest. Average rainfall during the year is 1478.4 mm.

1.5 SCOPE OF THE STUDY

Cryogenic LPG will be handled in the proposed project which is highly inflammable & explosive when exposed to normal temperature & pressure. It can remain in liquid form only under pressure or at very low temperature and release of it is hazardous (can cause fire & explosion). So it is necessary to evaluate risk from the proposed facilities. Accordingly ***M/s Aegis Logistics*** have retained ***M/s Projects & Development India Ltd***., for carrying out Risk Analysis study of the proposed facilities. Broad scope of work of PDIL includes the following:

(i) Identify different hazard scenarios which are likely to cause damage to the installation & other properties, and damage or injury to operating staffs as well as to the surrounding communities.

(ii) Evaluate the damage potential of probable hazardous events in relation to their location to assess the magnitude of impacts and the impact zones.

(iii) Assessment of total individual risk & societal risk for the activities in the proposed facilities.

TOR Points:

(iv) Details of the various applicable regulations including safety regulations along with the proposed compliances. Also details of safety aspects associated with handling of LPG vis-à-vis other cargo in other facilities within the port have been considered.

(v) Disaster Management Plan including emergency evaluation during natural and manmade disaster like floods, cyclone, tsunami and earth quakes etc.

(vi) Details of Oil Spill Contingent Management Plan have been given in DMP.

1.6 SPECIAL FEATURES OF THE PROJECT

JETTY FACILITIES

(1) Cryogenic LPG will be unloaded from Ship at HOJ-I/II/III by a new unloading arm which will have the following safety devices like QCDC (Quick Coupling and Decoupling) with Ship Pump manifold, ERC (Emergency Release Coupling) and ESD (Emergency Shut Down).

(2) Jetty is having a full fledged fire fighting facilities like fire hydrants & monitors, Tower Monitors, facilities for making water curtain and also portable fire fighting apparatus like DCP extinguishers, foam extinguishers, etc.

(3) Hose boxes and water sprinkler system.

PIPELINE FROM JETTY TO LPG TERMINAL

(1) Line will be designed and erected as per international practices.

(2) Pipeline will be over ground except 300 m near lock gate where it will be laid below the River bed.

(3) Over ground pipeline will be protected for external corrosion by providing a corrosion resistant paint and proper insulation.

(4) Pipeline below the River bed will be protected by corrosion resistant paint and by cathodic protection.

(5) PLC based leak detection system will be provided for the pipeline.

LPG TERMINAL

(1) Refrigerated LPG will be stored in two numbers of double wall double integrity storage tanks provided with all safety features and instrumentation like two numbers of submerged intake pumps in each tank, high and low level alarm, high-high level cut off, remove operated valves and ESD.

(2) LPG tanks will be provided with pressure control valve, two numbers of pressure safety valves connected with a cold flare of 30 m high.

(3) Refrigeration in tanks will be maintained by two numbers of Boil Off and two numbers of Flash Off Compressors.

(4) Two numbers of mounded bullets will be provided to contain liquid LPG coming from Boil Off & Flash Off Compressors.

(5) Sprinkler system will be provided on the top of storage tanks, pump & compressor house, loading bays, mounded bullets, etc.

(6) There will be no boiler for heating LPG prior to loading LPG Tankers. LPG will be hated by propane / LPG vapour/ water.

(7) Loading in tank trucks will be done through loading arms.

(8) Cathodic protection will be provided for mounded bullet.

Table - 1.1

BASIS OF STUDY

i) Material to be imported: LPG in cryogenic condition.

ii) Size of the tankers to be unloaded: 50,000 MT.

iii) LPG tanker parcel size: 20,000 MT.

iv) Monthly import capacity: 50,000 MT

v) Methods of Unloading: Through Unloading Arm

vi) Type of Tanker (whether refrigerated): Fully refrigerated

vii) Tanker Unloading Rate/ Pumping Capacity: 600 MT/Hr.

viii) LPG Cross Country Pipeline

a) Number: 2 (one is pre-cooling line)

b) Size: 12"

ix) Length of the pipeline

a) Option I: 12.0 Km

b) Option II: 13.0 Km

c) Option III: 14.0 Km

Option I has been considered as it is shortest in the length and there is no population around the pipeline.

viii) Position of pipeline: Overground

ix) Applicable Regulations: Petroleum Rules, MSIHC Rules, OISD-105, Factory Act & Rules, BIS Standards.

2.0 PROJECT & PROCESS DESCRIPTION

2.1 PROJECT DESCRIPTION

M/s Aegis Logistics Ltd. proposes to install the facilities for receipt of Cryogenic Propane/Butane/LPG through pipeline to storage terminal with allied facilities for storage, handling and dispatch of products. It also includes loading facilities, Allied Machinery, Loading Gantries for onward dispatch by road in the existing land allotted by the Haldia Dock Complex. Aegis Logistics proposes to lay a pipeline from Haldia Oil Jetty-I/II/III of Haldia Dock Complex to its cryogenic LPG storage terminal proposed in the HDC. Option-I has been considered as the most suitable route for the pipeline as it travels the shortest path with least crossings and negligible population. The project envisages construction of approximately 12 km long pipeline with the whole length passing through dedicated pipeline corridor in option-I within the HDC. The pipeline shall be laid by adapting latest art and option for unloading of liquid cargo to the storage facilities. At present, liquid ammonia and LPG is being transported through pipeline since last 15 years without witnessing any adverse scenario. The transport of cryogenic LPG is less hazardous and practically inert in comparison with ammonia & other chemicals including the pressurized LPG.

LPG Terminal will have the following facilities:

Table- 2.1
Facilities envisaged at LPG Terminal

Sl. No.	Facility	Quantity	Capacity
1	Refrigerated atmospheric storage tank	2 Nos.	12, 500 MT each
2	Boil-off compressor	2 Nos.	2.5 MT each
3	Flash-off compressor (Discharge Pressure: 16 bar)	2 Nos.	Capacity: 6.5 MT each
4	LPG transfer pumps on refrigerated tanks (Discharge Pressure:18 Kg/cm^2)	2 nos. on each tank	60MT/Hr (Submersible)
5	Mounded Bullet	Nos.	50 MT each
6	LPG heating system	Air & Water (Heating Medium)	
7	Vent Stack	1 No.	30 m height
8	Road Tanker Loading		-
	a) No. of Gantries	01	
	b) Number of bays	08	

Along with the facilities for LPG Heater, Packaged Cooling Tower and other facilities like Mercaptan dosing, DG Set etc. shall be made available within the LPG terminal.

2.2 DESCRIPTION OF THE PIPELINE ROUTE

OPTION-I: The Cryogenic LPG pipeline starting from the cryogenic storage terminal of M/s Aegis Logistics takes right turn from its main gate and run along the boundary wall of BPCL. After running about 238.01 m, the pipeline again turns right to run along the existing pipeline corridor by the side of BPCL boundary wall for upto a distance of 510.27 m. The pipeline turns right upto 30.20 m length to cross the pipeline corridor and then crosses a creek (Patikhali creek) by a pipe cross-over bridge (1) upto p/l length of 67.48 m on the right side of the pipeline corridor. The pipeline takes straightway along the boundary wall of Tata Power for a length of 1258.94 m and crosses a pipe cross-over bridge (2) located behind the boundary wall of Tata Power (near water intake). The pipeline follows the route along the boundary wall of HFC and crosses over bridge (03) at 758.73 m then follows the straight path by side of the boundary wall of IOCL for a length of1707.28m. On the left side of the road, running along this route, is located the Fly ash jetty & Berge Jetty. The pipeline running along the IOCL boundary reaches the entry gate to HDC premises of KoPT at 603.76 m. Here, the pipeline enters the premises of HDC through an over bridge (04). After running for a length of 234.50m, the pipeline comes to the left side of the road with the help of over bridge (05) at 39.71m. Then, the pipeline crosses an over bridge (06), follows the pipeline corridor along the shore and enters the HOJ-I at 168.44 m. From HOJ-I, the pipeline head towards the HOJ-II on the pipeline corridor along the shoreline and crosses an over bridge (07 & 08) of Mitsubishi to connect to HOJ-II at 649.55 m.

On coming out of the HOJ-II, pipeline crosses an over bridge (09) to cross the road at149.33 m to come on the right side and takes left turn by crossing over bridge (09) at 100.36 m to follow the path of existing pipeline corridor passing behind the Marine office. At a length of 952.68 m, the pipeline crosses over bridge (10) to cross the road near Port Diving Unit. Passing behind the canteen & workshops, the pipeline crosses an over bridge (11) to cross a kachcha road and follow upto Lock gate. Here, the pipeline has to run submerged underwater,

approx. 5m beneath the river bed to cross the water body for a length of approx. 300 m. After crossing the lock gate area, the pipeline runs by the right side of the road in front of DCIL's (Dredging Company) office. At a length of 103.3 m, the pipeline crosses the road by over bridge (12) then crosses again a road going to Haldia Bhawan by over bridge (13) at a length of1963.31m. After running a length of 454.57m, the pipeline reaches near the Jawahar Tower Traffic Circle by crossing over bridge (14) and enters the HOJ-III from the culvert opposite to HOJ-III. The pipeline travels a length of approx. 12.0 Km

OPTION-II: The pipeline following the route option- III takes left turn from the main gate of proposed LPG terminal. The pipeline encounters following industries, road crossings, nallah crossings, railway crossings in addition to the thickly populated area across the route.

United Phosphorus, Culvert no.-01 to cross the road connecting CFCL, Sanjana Chemicals & HPCL, Over bridge no.- 01 to cross the channel connected to Hoogly river at Patikhali, over bridge no.-02 to cross the rail line connecting Tata & BPCL, Over bridge no.- 03 near the IOCL main gate towards the rail lines 7 adjacent to Maruthi service centre, Over bridge no.-04 to cross the rail lines connecting Haldia port and IOCL, bridge/culvert no.02 to cross the nallah behind Ralson chemicals, over bridge no. 05 to cross the Kachcha road towards IOCL main gate and prior to Ralson chemicals, Over bridge no. 06 to cross the road connecting Vidyasagar bridge, Over bridge no. 07 to cross the road connecting Haldia Port Administration and CISF building at Chiranjibpur, Over bridge no.08 to cross the road connecting Chiranjibpur Police Station and HDC Finger Jetty Gate, Over bridge no.09 to cross the road connecting the container yard opposite to Bandar station, Over bridge no. 10 to cross the HDC road entrance at Ranichak, BSNL tower, Over bridge11 to cross the nallah near HP petrol pump, Over bridge no. 12 to cross the VIP road, culvert no.-03 (existing) near Helipad Maidan, Over bridge no. 15 to cross the road near Jawahar Tower Traffic Circle, Jawahar Tower- Port office, Culvert no.-04 (existing) near HOJ-III entrance.

Approximate length of the pipeline in this option is 13 km.

OPTION-III: The Cryogenic LPG pipeline starting from the cryogenic storage terminal of M/s Aegis Logistics takes right turn from its main gate and run along the boundary wall of BPCL. After running about 238.01 m, the pipeline again turns right to run along the existing pipeline corridor by the side of BPCL

boundary wall for upto a distance of 510.27 m. The pipeline turns right upto 30.20 m length to cross the pipeline corridor and then crosses a creek (Patikhali creek) by a pipe cross-over bridge (1) upto p/l length of 67.48 m on the right side of the pipeline corridor. The pipeline takes straightway along the boundary wall of Tata Power for a length of 1258.94 m and crosses a pipe cross-over bridge (2) located behind the boundary wall of Tata Power (near water intake). The pipeline follows the route along the boundary wall of HFC and crosses over bridge (03) at 758.73 m then follows the straight path by side of the boundary wall of IOCL for a length of 1707.28m. On the left side of the road, running along this route, is located the Fly ash jetty & Berge Jetty. The pipeline running along the IOCL boundary reaches the entry gate to HDC premises of KoPT at 603.76 m. Here, the pipeline enters the premises of HDC through an over bridge (04). After running for a length of 234.50m, the pipeline comes to the left side of the road with the help of over bridge (05) at 39.71m. Then, the pipeline crosses an over bridge (06), follows the pipeline corridor along the shore and enters the HOJ-I at 168.44 m. From HOJ-I, the pipeline head towards the HOJ-II on the pipeline corridor along the shoreline and crosses an over bridge (07 & 08) of Mitsubishi to connect to HOJ-II at 649.55 m.

On coming out of HOJ-II, the pipeline crosses an over bridge to cross the road to come on the right side and takes straight path parallel to 03 nos. of pipelines of BPCL connected to HDC berth no. 03. The pipeline passes through an Over bridge/culvert (01) to cross a railway line twice in front of HDC berth no. 02. The pipeline passes from an Over bridge in front of HDC berth no. 03 to cross the road and comes to right side of it. After running parallel to the road p/l connects the HDC berth no. 2, 3, 4 & 4A, the pipeline crosses the road at HDC berth 4B by over bridges (11 & 12). In front of HDC gate 4 (Tata Phosphorus gate), the pipeline crosses a road by over bridge. Then, pipeline follows the boundary wall of coal yard, crosses the finger jetty gate at over bridge (14. The pipeline crosses a railway line connecting HDC GC berth by over bridge (15) and crosses main gate of HDC by over bridge (16). Then, the pipeline crosses the railway line connecting Tata material stock yard by over bridge (17) and crosses the HDC boundary wall to go outside. The pipeline runs parallel to the Lock gate-Jawahar Tower road and crosses a road going to Haldia Bhawan by overbridge (18). The

pipeline crosses another road by over bridge (19) near Jawahar Tower Circle and after, the pipeline reaches near the Jawahar Tower Traffic and enters the HOJ-III from the culvert (2). The pipeline travels a length of approx. 14.5 Km

Table- 2.3
Comparison between Option- I, II & III of pipeline route

	OPTION-I	**OPTION-II**	**OPTION-III**
Nearby Industries	BPCL, UPL, IMC Terminal, Tata Steel, HFCL, IOCL, KoPT	BPCL, UPL, IMC Terminal, Tata Steel, HFCL, IOCL, KoPT, Ralson Chemicals, haldia Petro-carbon, Ruchi Infrastructure Pvt. Ltd., Exide	BPCL, UPL, IMC Terminal, Tata Steel, HFCL, IOCL, KoPT.
No. Of Road crossings	10 nos.	12 nos.	16 nos.
No. Of Nallah Crossings	01 no.	05 nos.	01 no.
No. of railway Crossings	Nil	02 nos.	03 nos.
No. of River Crossings	01 no. (Dock Basin)	Nil	Nil
Ship Pump Pressure for Cryogenic LPG	8-10 Kg-cm^2	8-10 Kg-cm^2	8-10 Kg-cm^2
Length of Cryogenic LPG Pipeline	Approx. 12.0 KM	Approx 13 KM	Approx. 14.5 KM
FACILITIES AT HALDIA JETTY			
	HOJ-I	**HOJ-II**	**HOJ-III**
No. of Unloading Arms	05 nos.	06 nos.	02 nos.
Products being unloaded thru unloading arms	POL, Paraxylene, Liquid Ammonia, Chemicals, LPG, Naphtha, Benzene, FO, ATF Butadiene, Bitumen, & LSHS	Crude & POL products (SKO, HSD, Naphtha, FO & ATF), LPG	Crude & POL products (MS, HSD, SKO & FO)
Unloading Pressure	6-8 Kg-cm^2	6	8 Kg
Fire Fighting facilities: a. Fire Hydrants b. Monitors c. Tower Monitors	a. 12 nos. (Double Headed) b. 02 nos. (Portable) c. Nil	a) 08 nos. (Double Headed) b) 02 nos. (Ground) c) 02 nos.	a) 08 nos. (Double Headed) b) 02 nos. (Ground) c) 02 nos.
Portable Fire Fighting Apparatus a. DCP extinguishers b. Foam	a) 04 nos (10 Kg) b) 04 nos (9 L)	a)05 nos (10 Kg) b)06 nos (9 L)	a) 06 nos (10 Kg) & 04 nos. (25 Kg)

Extinguishers c. Hose Boxes d. Water Sprinkler System	c) 03 nos. d) NA	c) 04 nos. d) Available	b) Nil c) 04 nos. d) NA
Fire Water Pumps	02 nos. of 7 Kg-cm^2 each	03 nos. of 12 Kg-cm^2 each	03 nos. of 15 Kg-cm^2 each

Note: Each unloading arms at jetties is having provision of QCDC (Quick Coupling & De-Coupling), ERC (Emergency Release Coupling) & ESD (Emergency Shutdown) facilities. Any unloading arm to be procured will have the above facilities.

2.3 PROCESS DESCRIPTION:

Cryogenic LPG will be unloaded from ship at Haldia Oil Jetty HOJ- I/II/III) and transported through 02 nos. of dedicated approximately 12km pipelines of 12" dia. to two nos. of Cryogenic LPG storage tanks of 12,500 MT capacity each. The pipeline will pass by the side of existing pipeline corridor passing adjacent to offshore road which is laid by the side of river Hooghly. There is no habitation on the pipeline route. To maintain the temperature of -27^{O}C in the refrigerated storage tanks, two numbers of Boil off compressors have been provided which takes suction from top of the tank including two numbers of Flash off compressors to be used during filling of the storage tank. Vapour after compression, will be cooled in heat exchanger when vapour is condensed and collected in Collection Drum and liquid LPG is transferred to two nos. of Mounded Bullets (Cap.: 50 MT each).

LPG from the storage tank (temp. -27^{O}C) is pumped to LPG Heater (I) & LPG Heater (II) where LPG (-27^{O}C) is heated by air & then by cooling water to 20^{O}C for loading in Road Tankers. For operation of heating system, temperature and pressure control system is so adjusted to achieve the final temperature of 20^{O}C downstream of LPG Heaters.

One odorizing unit comprising of Mercaptan Dosing Tank and pump has been provided for mixing with LPG before dispatch to existing Road Tanker.

Tanker Loading

LPG Loading operation from cryogenic storage tanks to road tankers loading gantry via LPG Heaters will be done by two vertical submerged LPG Loading pumps (Cap. 60m^3/Hr each) installed in storage tank.

Loading rate will be controlled though flow indicator controllers to be installed on the discharge line of each pump.

2.4 DESIGN BASIS

1	Pipeline Thruput	1000000 MT per Annum
2	Design Codes	ASME B31.4 and OISD-214 guidelines will be followed as applicable. However, in case of contradictory stipulations, the more stringent conditions will prevail.
3	Pipeline operating life	35 Years
4	Pipeline Length	Option-I: 12.0 Km
		Option-II: 13.0 Km
		Option-III: 14.5 Km
5	Basis for hydraulic Calculation	Hydraulic calculations will be based on supply of cryogenic LPG from ships pumps.
6	Pipeline Diameter	12"
7	Pipeline roughness	45 microns
8	MOC for Pipeline	Carbon Steel suitable for low temp. service
9	Pipeline Corrosion Allowance	Minimum 0.5 mm
10	Pigging Facilities	Pigging facilities suitable for pipeline emptying and cleaning.
11	Design Pressure P/L	25 kg/cm2g
12	Design temperature P/L	Sub-sea/ Buried : 55^0C Above ground : 55^0C
13	Pipeline laying	Above ground except lock gate crossing on river for approx. 300 m length.
14	Pipeline corrosion protection system	Pipeline shall be protected from external corrosion by suitable external coating/ insulation, and suitable coating /impressed current cathodic protection for underwater P/L.
15	Source of LPG	LPG Cargos coming from foreign countries
16	Design conditions of LPG storage i) Cryogenic Tanks ii)Mounded vessels	i) Pressure : 2000 mmWC+static head Temperature : 55^0C/(-) 45^0C ii) Pressure : 22kg/cm2g Temperature : 55^0C/(-) 45^0C
17	Power	SEB supply
18	Emergency Power	DG sets
19	Instrumentation	Adequate instrumentation and control system will be provided for safe & efficient operation. PLC based control system shall be provided at dispatch and receipt stations.
20	Metering System	Flow meters shall be provided at jetty ends and terminal for leak detection purpose.

3.0 RISK ANALYSIS

3.1 GENERAL

When Refrigerated LPG is released from containment to the atmosphere, a fraction of LPG vapourises immediately and the rest may form a pool depending upon released quantity, temperature of the substrate and surface temperature. If the released liquid quantity is more, LPG from the pool vapourises rapidly entrapping some liquid as droplets as well as considerable amount of air, forming a gas cloud. The gas cloud is relatively heavier than air and forms a thin layer on the surface. The cloud flows into trenches & depressions and in this way travels a considerable distance.

The proposed onshore cryogenic LPG pipeline poses fire & explosion hazard due to accidental release of LPG from the pipeline due to leakage or rupture. However, all precautions will be taken for its integrity from procurement stage upto installation as well as during commissioning and operation. The pipeline will be welded throughout and will be given a corrosion proof coating and thereafter suitable insulation will be provided on the surface of the pipeline. Even if all precautions are taken, possibility of leakage exists resulting in the release of hydrocarbon (LPG) and consequent fire and explosion.

As the cloud formed in the area of spill moves downwind under influence of wind, it gets diluted. A small spark within the flammability limit can cause flash fire, explosion and if the liquid pool still exists and remains in touch of cloud under fire it can ignite the whole mass of liquid. However in case of non existence of any source of fire there will be no occurrence of hazardous event and the cloud may get diluted to such a level that the mixture is no longer explosive. But it can cause asphyxiation due to displacement of oxygen. Different types of combustion reactions associated in case of release of LPG from the containment are listed herein.

3.1.1 Pool Fire

The liquid pool, if ignited, causes a "Pool Fire". In the pool fire, LPG burns with long smoky flame throughout the pool diameter radiating intense heat, which creates severe damage to the adjoining buildings, structures, other vessels and

equipments causing secondary fires. The flame may tilt under influence of wind and may get propagated / blown several pool diameters down wind.

3.1.2 Jet Fire

Escaping jet of LPG from pressure vessels/piping, if ignited, causes a jet flame. The jet flame direction and tilt depend on prevailing wind direction and velocity.

3.1.3 Unconfined Vapour Cloud Explosion (UVCE)

Clouds of LPG vapour mixed with air (within flammability limit) may cause propagating flames when ignited. In certain cases flame may take place within seconds. The thermal radiation intensity is severe depending on the total mass of LPG in the cloud and may cause secondary fires. When the flame travels very fast it explodes causing high overpressures or blast effects causing heavy damage at considerable distance from the release point. Such explosions are called unconfined vapour cloud explosion and is most common cause of such industrial accidents.

3.2 PRELIMINARY HAZARD ANALYSIS

3.2.1 The handling of LPG, which is highly inflammable and explosive, is hazardous. The hazards involved in such operations are:

- Fire and explosion hazard due to damage of the pipeline.
- Equipment failure/malfunction like flange gasket failure, holes in pipeline etc. resulting in leakage of LPG to atmosphere.
- Lack of adequate fire protection facilities available at different places of LPG handling.
- Experience level of personnel involved and their capacity to cope with emergency situation.

Apart from the above, accidents due to maloperation, negligence and sabotage are also not ruled out.

3.3 BASICS OF CONSEQUENCE ANALYSIS

3.3.1 Introduction

Consequence analysis is that part of Risk Analysis, which considers the individual failure cases and the damage caused by these failure cases. It is done in order to form an opinion on potentially serious hazardous outcome of accidents and their possible consequence on man and material in and around the source. To get the best effect out of it, it is carried out on probable major accident scenarios. The purpose and benefits that are likely to be derived by carrying out consequence analysis are as follows:

- For computation of risk
- To aid better pipeline route
- To improve the layout
- For evaluating damage and protective measures necessary for saving other properties.
- To ascertain damage potential to public and evolve protective measures
- For formulating an effective Disaster Management Plan
- For formulating safe design criteria and protection system
- To meet statutory requirement
- Training tool

The results of consequence analysis generates sufficient information about known and unknown hazard effects from any accident scenario and also to get information on how to deal with possible catastrophic events. It also gives plant personnel and the public living around an understanding of the risk they are living in.

3.3.2 Damage Criteria

3.3.2.1 Modes of Failure

There are various potential sources of large/small leakages, which may release hydrocarbon to the surrounding atmosphere. This leakage may be in the form of a small hole, gasket failure in a flanged joint, a guillotine failure of a pipeline or any other source of leakage.

In the pipeline, it may be due to failure of welded joint or corrosion, wrong opening of the valves / blinds, pipeline bursting due to excess pressure and other

causes. Some typical modes of failure and their possible causes are discussed in the Table No.3.1.

Table - 3.1
GENERAL MECHANISM OF LOSS OF CONTAINMENT

Sl. No.	Loss of Containment	Probable Cause	Remarks
1]	Weld failure	- Incorrect use of welding material and weld procedure. - Lack of inspection during welding. - Incorrect use of design code.	Welding to be done by certified welder with proper quality of welding rod under strict inspection with stage wise checking and acceptance after final radiography. Proper code to be followed for welding.
2]	Pipe over stress causing fracture	- Error in stress analysis, improper pipe material. - Inappropriate design code and incorrect supports lack of inspection during erection.	Pipe stress may also cause weld failure unless there exist a combination of causes. Stress analysis of piping and proper support selection to be done during design. During erection, strict inspection to be ensured.
3]	Over pressurization of pipe causing rupture	- Incorrect setting of SRV & pop off valve pressures. - Incorrect SRV/Pop off valve size.	Careful attention is needed for selection of SRV/Pop off valve size. Setting of SRVs and pop off valves to be checked before installation as well as at regular intervals.
4]	Failure of pipe due to corrosion or erosion.	H_2S and water corrosion.	Proper care should be taken against internal as well as external corrosion & monitoring of condition of pipeline to be done regularly.
5]	Leaking valve to atmosphere	Gland failure, packing failure, spindle/plug cock flow out.	Leakage to be rectified at shortest possible time.
6]	External causes	Earthquake, sabotage, etc.	Adequate design consideration to withstand the earthquake and regular patrolling to be done.
7]	Overpressure	- Inadequate relief. - Fire impingement.	Failure to be rectified immediately and other suitable action to be taken.
8]	Pipeline failure due to low temperature brittle fracture	- Error in calculation of minimum temperature. - Wrong material selection. - System not designed for low temperature etc.	The design package to be checked/ selected cautiously.

3.3.2.2 Damage Criteria

The damage effects are different for different types of failure scenarios. The physical effects of ignition of hydrocarbon vapours, e.g. blast wave, thermal radiation due to release of LPG from the containment are discussed below:

(i) Hydrocarbon vapours released accidentally will normally spread out in the direction of the wind. If it comes into contact with an ignition source before being dispersed below the lower flammability limit (LFL), a flash fire is likely to occur and the flame may travel back to the source of leak. Any person caught in the flash fire is likely to suffer from severe burn injury. Therefore, in consequence analysis, the distance to LFL value is usually taken to indicate the area, which may be affected by flash fires. Any other combustible material within the flash fire is likely to catch fire and may cause secondary fires. In the area close to the source of leakage of hydrocarbon there is a possibility of Oxygen depletion since the LPG vapour is heavier than air. A minimum of 19.5% Oxygen in air is considered essential for human lives.

(ii) Thermal radiation due to pool fire, jet flame may cause various degrees of burn on human bodies. Also its effects on inanimate objects like equipment, piping, building and other objects need to be evaluated. The damage effects with respect to thermal radiation intensity are elaborated in Table-3.2.

In case of transient fires total thermal dose level (total incident energy) is used to estimate threshold damage level.

Table - 3.2
DAMAGE DUE TO INCIDENT RADIATION INTENSITIES

Sl. No.	Incident Radiation (KW/M2)	Type of Damage Intensity	
		Damage to Equipment	Damage to People
1.	37.5	Damage to process equipment	100% lethality in 1 min.1% lethality in 10 sec.
2.	25.0	Minimum energy required to ignite wood at indefinitely long exposure without a flame.	50% lethality in 1 min. and significant injury in 10 sec.
3.	12.5	Min. energy to ignite with a flame; melts plastic tubing.	1% lethality in 1 min.
4.	8.0	Max. thermal radiation intensity allowed on thermally unprotected adjoining equipment.	-
5.	4.5	-	Causes pain if duration is longer than 20 sec., however blistering is unlikely (First Degree Burns).
6.	1.6	-	Causes no discomfort on long exposures.

Source: Techniques for Assessing Industrial Hazards by World Bank.

Table - 3.3
RADIATION EXPOSURE AND LETHALITY

Radiation Intensity (KW/M^2)	Exposure Time (Seconds)	Lethality (%)	Degree of Burns
1.6	-	0	No discomfort even after long exposure
4.5	20	0	1^{st}
4.5	50	0	1^{st}
8.0	20	0	1^{st}
8.0	50	<1	3^{rd}
8.0	60	<1	3^{rd}
12.0	20	<1	2^{nd}
12.0	50	8	3^{rd}
12.5	-	1	-
25.0	-	50	-
37.5	-	100	-

Source: Techniques for Assessing Industrial Hazards by World Bank.

Table - 3.4
DAMAGE DUE TO PEAK OVERPRESSURE

Human Injury		Structural Damage	
Peak Overpressure (bar)	**Type of Damage**	**Peak Overpressure (bar)**	**Type of Damage**
5.00 - 8.00	100% lethality	0.3	Heavy (90% damage)
3.50 - 5.00	50% lethality	0.1	Repairable (10% damage)
2.00 - 3.50	Threshold lethality	0.03	Damage of Glass
1.33 - 2.00	Severe lung damage	0.01	Crack of windows
1.00 - 1.33	50% eardrum rupture	-	-

Source: Marshall, VC (1977) "How lethal are explosives and toxic escapes"

Table - 3.5
PHYSIOLOGICAL EFFECTS OF THRESHOLD THERMAL DOSE

Dose (Kj/m^2)	Threshold Effect
375	3^{rd} Degree Burns
250	2^{nd} Degree Burns
125	1^{st} Degree Burns
65	Threshold of pain, no reddening or blistering of skin caused
1^{st} Degree Burns	Involve only epidermis, blister may occur. Example sunburns
2^{nd} Degree Burns	Involve whole of epidermis over the area of the burn plus some portions of dermis
3^{rd} Degree Burns	Involve whole of epidermis and dermis. Sub-cutaneous tissues may also be damaged

Table - 3.6
HEAT RADIATION AND ESCAPE TIME

Radiation Intensity ($Btu/hr/ft^2$)	Time to paid threshold (seconds)
440	60
550 (1.6 KW/m^2)	40
740	30
920	16
2200	6
3300 (9.5 KW/m^2)	5
3700	4
6300	2

Permissible thermal radiation flux levels are also indicated in the *IP Code*.

For continuous presence of persons, the following thermal radiation intensity levels are usually adopted:

- 1.6 KW/m^2 for population outside.
- 4.5 KW/m^2 for plant operations.

3.4 QUANTITATIVE RISK ANALYSIS

3.4.1 Properties of LPG

LPG is a mixture of commercial propane and commercial butane, which may also contain small quantity of unsaturated hydrocarbons. LPG marketed in India is governed by ***IS 4576*** and test methods by ***IS-1448***.

LPG being highly inflammable may cause fire and explosion. It, therefore, calls for special attention during its handling.

3.4.2 Physical properties

Liquid Density	:	583.22 kg/m^3
Saturated Vapour Density	:	2.42 kg/m^3
Vapour Density (1 atm)	:	2.59 kg/m^3
Saturated Liquid Enthalpy	:	511706 J/kg
Liquid Enthalpy	:	511323 J/kg
Saturated Vapour Enthalpy	:	88756.6 J/kg
Liquid Heat Capacity	:	2321.80 J/kg K
Heat of Vaporization	:	422949 J/kg
Ratio of Sp. Heat	:	1.122
Surface Tension	:	1.627 x 10^{-2} N/m
Flammability	:	1.8 % to 9.5 % by volume of gas in air
Toxicity	:	Slightly toxic (IDLH value = 19000 ppm)

3.4.3 The saturation vapour pressure, flammability range, toxicity data of Propane-Butane mixed compounds are listed below:

Table - 3.7

Propane %	Butane %	S.V. Press at 55°C Kg/Cm^2	Flammability range %	Toxicity IDLH (ppm)	Odour Threshold (ppm)
100	-	21.12	2.1 - 9.5	20,000	5,000
20	80	7.31	1.8 - 9.5	N/A	N/A
30	70	8.25	1.8 - 9.5	N/A	N/A
-	100	5.84	1.9 - 8.4	N/A	N/A

3.5 FAILURE CASE LISTING FOR THE CRYOGENIC PIPELINE AND AT CRYOGENIC STORAGE TERMINAL

The mode of approach adopted for consequence analysis is first to select the probable failure scenarios and then to conduct the analysis of selected failure cases. The failure cases selected are listed in Table- 3.8.

Table – 3.8

SELECTED FAILURE CASES

Sl. No.	Failure Case	Credible/ Non-Credible	Consequence
Receipt Pipeline (Refrigerated LPG)			
1.	Full-Bore failure of Ship unloading Arm (10" dia.)	Non- Credible	Pool fire and explosion
2.	Holes formation in Ship unloading arm a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
3.	Holes in Pipeline near Lock Gate Area in KoPT a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
4.	Holes in Pipeline near boundary of IOCL refinery a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
5.	Holes in Pipeline near HFCL a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
6.	Holes in Pipeline beside BPCL (near Patikhali creek) a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
LPG Terminal			
7.	5 mm, 10 mm and 15 mm dia. hole in inlet Line (12" dia.) to refrigerated storage tank-Refrigerated LPG	Partially Credible	Jet Fire, Unconfined vapour cloud Explosion
8.	Safety Valve pop-off of Refrigerated storage tank	Credible	Dispersion
9.	5mm, 10 mm & 15 mm dia. hole in discharge line of In-tank Pump-Refrigerated LPG	Partially Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
10.	Gasket Failure in discharge line of In-tank Pump- Refrigerated LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
11.	Mounded Bullet Outlet Line (6" dia.) Full-Bore Failure-Pressurized LPG	Non- Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
12.	5mm, 10 mm and 15 mm dia. holes in truck loading pump	Credible	Jet Fire, Dispersion,

	Discharge Line- Pressurized LPG		Unconfined vapour cloud Explosion
13.	Truck loading pump Discharge Line Gasket Failure- Pressurized LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
14.	Truck loading pump Mechanical Seal Failure- Pressurized LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
15.	Boil-off Compressor discharge line Full-Bore failure.- Pressurized LPG	Non Credible	Dispersion, Unconfined vapour cloud Explosion
16.	Flash-off Compressor discharge line Full-Bore failure - Pressurized LPG	Non Credible	Jet Fire, Unconfined vapour cloud Explosion
17.	Loading arm for Road Tanker loading failure	Partly Credible	Jet Fire, Unconfined vapour cloud Explosion

The purpose of listing failure cases, as given in the above table is to evaluate the consequence of the failures individually or in combination. The above failure cases depicts that most probable scenarios have been considered.

3.6 CONSEQUENCE ANALYSIS

Consequence analysis of various major accident scenarios will yield hazard distances for specific damage levels. With the help of damage criteria, it is possible to judge the type of damage to man and material due to realization of any of the accident scenarios. The result of consequence analysis of selected failure cases is discussed in the following chapter based on type of hazard like thermal radiation, flash fire and explosion hazard etc.

Consequence analysis has been done through world renowned software *"Phast-Risk" of M/s DNV Technica, UK* Consequences of different failure scenarios are detailed below:

3.7 SELECTED FAILURE CASES FOR THE CRYOGENIC PIPELINE

Due care shall be taken in selection of material of pipeline/equipments and all safety & other statutory requirement shall be adopted as per the standard

practices to avoid any kind of failures in the system. However, in order to prepare a suitable Disaster Management Plan, quantitative risk analysis has been carried out to evaluate the various damage potential w.r.t individual failure cases.

3.7.1 Full-Bore failure of Ship unloading Arm (10" dia.)

Unloading arm at jetty is connected to ship pump flange for transfer of refrigerated LPG to terminal at a rate of 500 MT/ Hr. through 12" dia. dedicated pipeline. Failure frequency of unloading arm is $3x10^{-8}$ per hour of operation, which can be considered as incredible in nature. In case of failure of unloading arm, LPG will fall on jetty and may form a pool. In case of source of ignition, it may catch fire and pool fire may take place within half minutes the pump on the ship will be stopped.

Table – 3.9

HAZARD DISTANCES TO THERMAL RADIATION DUE TO POOL FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Distances from radius of the pool (m) at wind speed & stability classes of				
		2F	2B	3D	5D	7D
Release Rate: 138 Kg/Sec						
1]	37.5	60	59	63	68	70
2]	12.5	97	96	99	99	100
3]	4.5	139	137	138	136	132

It is evident from the above table that the hazard distances for 1% lethality i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 100 m & for unloading arm failure.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.10.

Table – 3.10

HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Max. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
1]	2	F	472	484	547
2]	2	B	429	448	520
3]	3	D	407	423	521
4]	5	D	349	377	496
5]	7	D	326	372	498

It is evident from the above table that maximum damage due to overpressure of 0.3 Bar may go upto a maximum distance of 472m. Equipment & structures may be collapsed for objects upto these distances. However, this is a incredible scenario in nature. To contain/ avoid such situations Haldia Dock Complex is maintaining appropriate safety guidelines.

3.7.2 Holes formation in ship unloading arm

a) 5 mm dia.
b) 10 mm dia.
c) 15 mm dia.

For unloading of LPG at the jetty from ship, unloading arm will be used. In case of formation of holes in the unloading arm, there will be leakage. The out coming material may come out in the form of jet. In case of any ignition source, there is likelihood of formation of jet fire. Hazard distances due to thermal radiation in case of 5 mm, 10 mm & 15 mm dia. holes have been considered and presented below.

Table – 3.11

HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Hazard Distances				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR: 0.37 Kg/Sec)						
1]	37.5	13	13	12	11	10
2]	12.5	15	15	14	13	13
3]	4.5	19	19	18	17	16
10 mm dia. hole (RR: 1.49 Kg/Sec)						
1]	37.5	24	24	22	20	19
2]	12.5	29	29	27	25	24
3]	4.5	35	35	33	31	31
15 mm dia. hole (RR: 3.36 Kg/Sec)						
1]	37.5	34	34	32	29	28
2]	12.5	41	41	38	37	34
3]	4.5	51	51	48	45	44

It is evident from the above table that the hazard distances for 1% lethality i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 15m, 29m & 41m for 5mm, 10mm & 15mm dia. holes respectively.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud

explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.12.

Table – 3.12

HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Max. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
1]	2	F	23	27	36
2]	2	B	13	16	24
3]	3	D	13	16	24
4]	5	D	13	15	22
5]	7	D	-	-	-
10 mm dia. Hole					
1]	2	F	71	82	111
2]	2	B	57	65	84
3]	3	D	57	64	83
4]	5	D	46	52	69
5]	7	D	35	40	54
15 mm dia. Hole					
1]	2	F	109	129	181
2]	2	B	92	104	136
3]	3	D	93	105	139
4]	5	D	70	81	108
5]	7	D	59	69	94

It is also evident from the above table that maximum damage due to overpressure level of 0.3 Bar due to release of LPG may be caused upto a distance of 23/71m&109m due to creation of 5mm/10mm & 15mm dia. holes respectively. Equipment & structures may be collapsed for objects upto these distances. In jetty many pipelines & unloading arm exist, they may get damaged due to hole in unloading arm. However, possibility of hole formation in unloading arm is remote.

3.7.3 Holes in Pipeline near Lock Gate Area in KoPT

a) 5 mm dia.
b) 10 mm dia.
c) 15 mm dia

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The pipeline from jetty will cross the area near Lock Gate in KoPT. In case of any leakage in the pipeline LPG will come out as jet and in presence of any ignition source there is the possibility of jet fire. Hazard distances due to thermal

radiation in case of 5 mm, 10 mm & 15 mm dia. holes have been considered and presented in table below.

Table – 3.13
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Hazard Distances				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR: 0.32 Kg/Sec)						
1]	37.5	12	12	11	10	10
2]	12.5	15	15	14	12	12
3]	4.5	18	18	17	16	15
10 mm dia. hole (RR: 1.29 Kg/Sec)						
1]	37.5	23	23	21	19	18
2]	12.5	27	27	25	23	23
3]	4.5	33	33	32	30	29
15 mm dia. hole (RR: 2.91 Kg/Sec)						
1]	37.5	32	32	30	30	27
2]	12.5	39	39	37	34	32
3]	4.5	48	48	46	43	42

It is evident from the above table that the hazard distances for 1% lethality i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 15m/27m & 39m for 5mm/10mm & 15mm dia. holes respectively. However, the area around pipeline is vacant.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.14.

Table – 3.14

HAZARD DISTANCES TO OVERPRESSURE
DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Maxm. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
1]	2	F	23	*26*	*35*
2]	2	B	13	16	23
3]	3	D	13	15	23
4]	5	D	-	-	-
5]	7	D	-	-	-
10 mm dia. Hole					
1]	2	F	60	*69*	*93*
2]	2	B	57	65	84
3]	3	D	47	53	71

4]	5	D	35	41	56
5]	7	D	35	40	53
15 mm dia. Hole					
1]	2	F	98	*117*	*166*
2]	2	B	81	92	122
3]	3	D	82	93	125
4]	5	D	59	69	94
5]	7	D	58	67	89

It is also evident from the above table that maximum damage due to overpressure level of 0.3 Bar due to release of LPG may be caused upto a distance of 23m/60m & 98m due to creation of 5mm/10mm & 15mm dia. holes respectively. Equipment, structures, buildings, walls may be collapsed for objects upto these distances. However the space is vacant and no damage is envisaged.

3.7.4 Holes in Pipeline near boundary of IOCL refinery

a) 5 mm dia.
b) 10 mm dia.
c) 15 mm dia

. After crossing the KoPT area, the pipeline will pass beside the IOCL's refinery boundary. In case of any leakage in the pipeline LPG will come out as jet and in presence of any ignition source there is the possibility of jet fire. Hazard distances due to thermal radiation in case of 5 mm, 10 mm & 15 mm dia. holes have been considered and presented in table below.

Table – 3.15

HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Hazard Distances				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR: 0.29 Kg/Sec)						
1]	37.5	23	23	21	19	18
2]	12.5	27	27	25	23	23
3]	4.5	33	33	32	30	29
10 mm dia. hole (RR: 1.18 Kg/Sec)						
1]	37.5	22	22	20	18	18
2]	12.5	26	26	25	23	22
3]	4.5	32	32	31	29	28
15 mm dia. hole (RR: 2.65 Kg/Sec)						
1]	37.5	31	31	29	26	25
2]	12.5	38	38	35	33	31
3]	4.5	47	47	44	42	40

It is evident from the above table that the hazard distances for 1% lethality i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 27m/26m & 38m for 5mm/10mm & 15mm dia. holes respectively and does not reach the nearby installations. IOCL's boundary wall is at more distance than 45m.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.16.

Table – 3.16

HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Max. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
1]	2	F	59	*69*	*93*
2]	2	B	57	65	84
3]	3	D	47	53	71
4]	5	D	35	41	56
5]	7	D	35	40	53
10 mm dia. Hole					
1]	2	F	59	*68*	*92*
2]	2	B	47	53	71
3]	3	D	46	53	70
4]	5	D	35	40	54
5]	7	D	24	29	41
15 mm dia. Hole					
1]	2	F	86	*101*	*143*
2]	2	B	81	91	120
3]	3	D	82	93	125
4]	5	D	59	68	92
5]	7	D	59	67	90

It is also evident from the above table that heavy damage due to overpressure level of 0.3 Bar because of release of LPG may be caused upto a distance of 59m/59m & 86m due to creation of 5mm/10mm & 15mm dia. holes respectively. Equipment in IOCL refinery, structures, buildings, walls may be collapsed for objects upto these distances. Equipments and pipelines are at a greater distance than 86 m from the LPG pipeline.

3.7.5 Holes in Pipeline near HFCL

a) 5 mm dia.
b) 10 mm dia.
c) 15 mm dia.

The pipeline after crossing the IOCL's refinery boundary will run near the installation of HFCL which is presently out of work. In case of any leakage in the pipeline LPG will come out as jet and in presence of any ignition source there is the possibility of jet fire. Hazard distances due to thermal radiation in case of 5 mm, 10 mm & 15 mm dia. holes have been considered and presented in table below.

Table – 3.17

HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Hazard Distances				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR: 0.26 Kg/Sec)						
1]	37.5	11	11	10	9	9
2]	12.5	14	14	13	12	11
3]	4.5	17	17	16	15	14
10 mm dia. hole (RR: 1.06 Kg/Sec)						
1]	37.5	21	21	19	18	17
2]	12.5	25	25	24	22	21
3]	4.5	31	31	30	28	27
15 mm dia. hole (RR: 2.37 Kg/Sec)						
1]	37.5	30	30	28	25	24
2]	12.5	36	36	34	31	30
3]	4.5	45	45	43	40	38

It is evident from the above table that the hazard distances for damage of process equipment, structures etc. i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 14m/25m & 36m for 5mm/10mm & 15mm dia. holes respectively.

However, HFCL is in discarded condition and no equipment is there in 36 m from the source of fire.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.18.

Table – 3.18
HAZARD DISTANCES TO OVERPRESSURE
DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Maxm. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
1]	2	F	13	*15*	*22*
2]	2	B	13	15	22
3]	3	D	12	16	23
4]	5	D	-	-	-
5]	7	D	-	-	-
10 mm dia. Hole					
1]	2	F	60	*71*	*99*
2]	2	B	46	52	69
3]	3	D	47	53	71
4]	5	D	35	40	52
5]	7	D	24	28	39
15 mm dia. Hole					
1]	2	F	87	104	151
2]	2	B	82	94	126
3]	3	D	70	79	106
4]	5	D	59	68	92
5]	7	D	47	54	74

It is also evident from the above table that heavy damage due to overpressure level of 0.3 Bar because of release of LPG may be caused damage upto a distance of 13m/60m & 87m due to creation of 5mm/10mm & 15mm dia. holes respectively. Equipment, structures, buildings, walls may be collapsed for objects upto these distances but as we discussed earlier that the installation of HFCL is out of work. Hence there will be no such damages.

3.7.6 Holes in Pipeline beside BPCL (near Patikhali creek)

a) 5 mm dia.
b) 10 mm dia.
c) 15 mm dia.

The pipeline before entering the terminal will cross near to Patikhali Creek beside BPCL' boundary. In case of any leakage in the pipeline LPG will come out as jet and in presence of any ignition source there is the possibility of jet fire. Hazard distances due to thermal radiation in case of 5 mm, 10 mm & 15 mm dia. holes have been considered and presented in table below.

Table – 3.19

HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Radiation Intensity KW/M^2	Hazard Distances				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR: 0.23 Kg/Sec)						
1]	37.5	11	11	10	9	8
2]	12.5	13	13	12	11	10
3]	4.5	16	16	15	14	13
10 mm dia. hole (RR: 0.91 Kg/Sec)						
1]	37.5	20	20	18	17	16
2]	12.5	24	24	22	21	22
3]	4.5	30	30	28	26	25
15 mm dia. hole (RR: 2.06 Kg/Sec)						
1]	37.5	29	29	26	24	23
2]	12.5	34	34	32	30	28
3]	4.5	42	42	40	38	36

It is evident from the above table that the hazard distances for 1% lethality i.e. for a thermal radiation level of 12.5 KW/m^2 may extend upto a distance of 13m/24m & 34m for 5mm/10mm & 15mm dia. holes respectively.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place. The explosion overpressure distances has been calculated and presented in the table no. 3.20.

Table – 3.20
HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed (m/sec)	Stability Class	Max. Distance (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. hole					
1]	2	F	13	*15*	*22*
2]	2	B	12	15	21
3]	3	D	-	-	-
4]	5	D	-	-	-
5]	7	D	-	-	-
10 mm dia. hole					
1]	2	F	48	*56*	*78*
2]	2	B	47	53	71
3]	3	D	36	41	56
4]	5	D	35	40	54
5]	7	D	24	28	38
15 mm dia. hole					
1]	2	F	74	*87*	*124*

2]	2	B	71	82	111
3]	3	D	71	81	110
4]	5	D	47	55	76
5]	7	D	47	54	74

It is also evident from the above table that maximum damage due to overpressure level of 0.3 Bar due to release of LPG may be caused upto a distance of 13m/48m & 74m due to creation of 5mm/10mm & 15mm dia. holes respectively. Equipment, structures, buildings, walls may be collapsed for objects upto these distances.

3.8 RISK AND FAILURE FREQUENCY

3.8.1 The term risk involves the quantitative evaluation of likelihood of any undesirable event as well as likelihood of harm or damage being caused to life, property and environment. This harm or damage may only occur due to sudden/accidental release of any hazardous material from the containment. This sudden/accidental release of hazardous material can occur due to failure of component systems. It is difficult to ascertain the failure probability of any system because, it will depend on the generic data on the failure probability of various components of the system or detailed “Fault Tree” and “Event Tree” analysis are required to be done. Even if failure occurs, the probability of fire/explosion and the extent of damage will depend on many factors like:

(a) Quantity of material released.

(b) Source of ignition.

(c) Wind direction, stability class of the atmosphere etc.

(d) Presence of population, properties etc. nearby.

Failure frequency of different components like pipe, valves, instruments, pressure vessels and other equipment manufactured in India are not available nor has any statutory authority tried to collect the information and form an acceptable data bank to be used under Indian condition.

3.8.2 Risk Transects

Individual Risk Profile (Risk Transects) has been drawn and given as Figure No. 2 which shows that Risk Transect Profile for individual risk of fatality 1 x 10^{-8} per year goes only upto 30.5 m towards maximum probable wind velocity and Individual Risk Profile (Risk Transects) near Patikhali Creek beside BPCL & near

IOCL refinery has been drawn and presented as Figure No. 3 & Figure No. 4 which shows that Risk Transect Profile for individual risk of fatality 1 x 10^{-8} per year goes only upto 15.4 m & 17.2 m respectively towards maximum probable wind velocity Hence the pipeline route is safe from environmental risk point of view.

3.9 SAFETY AND SECURITY SYSTEM

Considering the hazard associated with transport of LPG, state of the art safety and security system has been conceived to eliminate the hazard. Salient features of the safety & security system will be guided mainly by OISD - 214. However, salient features of safety & security system for transportation of LPG can be analysed in following way:

- The pipeline shall be of carbon steel suitable for low temp. service.
- Design temperature of the pipeline shall be (-) 50^0C to (+) 55^0C.
- The entire pipeline is overground except the section immersed in the river.
- The pipeline will be protected against external corrosion by application of a corrosion resistant coating and suitable insulation impressed current cathodic protection for immersed section. Battery backup system will also be provided to ensure uninterrupted power supply. Cathodic protection system will be inspected periodically.
- Pipeline will be provided with sophisticated tele-supervisory leak detection system like SCADA which will detect leakage point and will help the control operator to close the ESD/ ROV on either side of the leaking point and take subsequent actions to prevent hazard and repair. ROV can also be closed from control room if there is rupture of the pipeline passing through river bed.
- Suitable flammable gas detection system shall be provided at all critical locations (Despatch/ Receipt stations)
- Suitable fire detection system will be installed in the miscellaneous rooms like electrical room, control room, battery room of different stations along the LPG pipeline network.
- A periodic pipeline patrolling program will be maintained for the ROU to observe surface condition, leakage, construction activities and encroachments. Patrolling shall be done once in a week.

- Periodic inspection shall be carried out for river crossings for sufficiency of cover, accumulation of debris or for any other conditions affecting the safety and security of the crossings.
- Sophisticated telecommunication system (optical fibre based) will be provided for communication between the operating personnel who will be deployed for operation of the pipeline including the personnel deployed in jetty.

Instrumentation

The LPG pipeline will be provided with Coriolis type mass flow meter along with flow computer for despatch station at jetty and in the receiving end and also where metering is envisaged.

3.10 RISK REDUCING MEASURES FOR THE PIPELINE SYSTEM

The following measures are suggested for reducing the risk involved in pipeline system

a] VISUAL INSPECTION OF PIPELINE ROUTE

Visual inspection of the pipeline along its entire route shall be done periodically. Some of the important aspects to be checked during the inspection are:

- Any breaches and soil erosion along the route of the pipeline especially earth wash outs.
- Unauthorized occupation and use of right of way, growth of vegetation etc.
- If there is any digging or ploughing in the vicinity of the pipeline which may result damage to the pipeline supports due to mechanical interference.
- Any leakages, etc.

Inspection to be done during pre-commissioning, commissioning, during transfer of LPG as well as periodic checking.

b] INSTRUMENTS

- All the recorders should be periodically calibrated.

- The pressure, temperature and alarm switches and safety interlocks should be tested for their intended application as per the preventive maintenance schedule.
- The emergency shutdown system should be tested as per the preventive maintenance.
- Pressure safety valve (if any) should be tested as per the preventive maintenance schedule.

3.11 PRINCIPAL CONCLUSIONS AND RECOMMENDATIONS (FOR IMPORT PIPELINE)

Conclusion

Individual Risk Profile (Risk Transects) has been drawn and given as Figure No. 2 which shows that Risk Transect Profile for individual risk of fatality 1 x 10^{-8} per year goes only upto 30.5 m towards maximum probable wind velocity and Individual Risk Profile (Risk Transects) near Patikhali Creek beside BPCL & near IOCL refinery has been drawn and presented as Figure No. 3 & Figure No. 4 which shows that Risk Transect Profile for individual risk of fatality 1 x 10^{-8} per year goes only upto 15.4 m & 17.2 m respectively towards maximum probable wind velocity Hence the pipeline route is safe from environmental risk point of view.

Recommendation

i) An unloading arm should be procured and erected in Oil Jetty. The unloading arm will have the facility of QCDC (Quick Coupling & De-coupling), ERC (Emergency Release Coupling) and ESD (Emergency shut-down valve).

ii) Pipeline route has been fixed in consultation with Haldia Dock Complex Authorities. Shortest possible route has been chosen as there is no habitation in the route.

iii) Prevailing OISD standard, petroleum rules and all other national & international standards/ codes and practices shall be considered during design/ procurement and installation of the pipelines.

iv) Only trained operators shall be deployed for operation of the pipeline system. Hence all the operators/ officers should be trained in similar facility. Such facility already exists at Haldia. M/s IPPL are importing refrigerated propane & butane through Haldia Oil Jetty.

v) Flow meters should be installed at storage plant side as well as on the ship side. If any mismatch is there which indicates the leakage, the ship pump should be immediately stopped. In addition, leak detection system should be installed in the pipeline. Provision should be there to stop pump if any leak is detected.

vi) The pipelines should be coated and then provided with proper insulation in the upper layer.

vii) Design and construction of the pipe supports should be rigid to avoid failure of the pipe supports due to earthquake or other natural calamities.

viii) 100% radiography to be done for all welded joints.

ix) Mutual aid agreements should be done with the nearby industries, fire service stations, hospitals and other agencies.

x) Leak detection system should be provided for the pipeline

xi) Pipe line route should be patrolled once in a week

xii) Offsite emergency mock drills should be done once in six months in consultation with District Collectorate and other industries including Haldia Dock Complex.

xiii) PLC/ SCADA based leak detection system for pipelines have to be provided.

Risk Analysis of the cryogenic storage & handling is given in the following pages.

3.12 SELECTED FAILURE CASES AT CRYOGENIC STORAGE TERMINAL

The following failure scenarios were evaluated to assess the effect on people and property.

The failure cases that are selected for study are indicated in Table - 3.8.

The approach that has been adopted for analysis of failure case is as follows:

a) Conduct consequence analysis for the failure cases. This will give a feel of extent of damage effect or hazard distances for such cases. Such information and data will be useful for emergency planning.

b) Carry out consequence analysis for a few small but frequent leaks. This will give enough data for planning safety exercise. This will also act as a training tool.

Effect of Release

In the event of release of hydrocarbons of atmosphere the following effects are usually observed:

a) Spreading of hydrocarbon vapours with wind till it finds a source of ignition or safety disperse.

b) Spillage of liquid hydrocarbons will result in a pool of liquid, which will evaporate taking heat from the surface, forming a flammable atmosphere about it. Ignition of this pool will result in pool fire causing different levels of incident thermal radiations.

c) Explosion of vapour cloud, which will cause blast waves of different intensities.

3.12.1 5 mm, 10 mm and 15 mm dia. hole in inlet Line (12" dia.) to refrigerated storage tank- Refrigerated LPG

Refrigerated LPG will transfer to the refrigerated storage tanks with the help of a 12" dia. pipeline. If some leakage happens in the inlet line of refrigerated storage tanks, LPG will come out to the open atmosphere and may catch fire if comes in contact with any ignition source.

Thermal Radiation distances are given in Table – 3.21.

Table – 3.21
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Load KW/m^2	Hazard Distance (m)				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR - 0.23 Kg/Sec)						
01.	37.5	11	11	10	9	8
02.	12.5	13	13	12	11	10
03.	4.5	16	16	15	14	13
10 mm dia. hole (RR - 0.91 Kg/Sec)						
01.	37.5	20	19	18	17	16
02.	12.5	24	23	22	21	20
03.	4.5	30	29	28	26	25
15 mm dia. hole (RR - 2.06 Kg/Sec)						
01.	37.5	29	28	26	24	23
02.	12.5	34	33	32	30	28
03.	4.5	42	41	40	38	36

From the above table, it is evident that the distance to thermal radiation of 4.5 KW/m^2 extends to a distance of 16 m, 30 m, & 42 m due to 5 mm, 10 mm and 15

mm hole respectively from the line. It is also evident that distance to 1st degree burn i.e. 4.5 KW/m^2 remains mainly inside the battery limit.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place.

The hazard distances to over pressures of 0.3 bar, 0.1 bar & 0.03 bar are presented here below table no.3.22

Table – 3.22
HAZARD DISTANCES TO OVERPRESSURE DUE TO UVCE

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
01.	2	F	13	15	22
02.	2	B	12	15	21
03.	3	D	-	-	-
04.	5	D	-	-	-
05.	7	D	-	-	-
10 mm dia. Hole					
01.	2	F	36	42	59
02.	2	B	35	40	52
03.	3	D	34	39	51
04.	5	D	24	28	39
05.	7	D	14	17	27
15 mm dia. Hole					
01.	2	F	60	70	98
02.	2	B	59	68	91
03.	3	D	58	67	90
04.	5	D	47	54	74
05.	7	D	36	43	59

From the above table it is evident that the maximum distance to heavy damage i.e. for over pressure of 0.3 bar extends upto 13 m, 36 m, & 60 m for 5 mm, 10 mm and 15 mm dia. hole in the line. Since the pipeline goes outside the factory boundary and no other objects/ population are coming in the way it will have no impact. However a pump in ship has to be closed immediately, area to be cordoned and fire to be extinguished.

3.12.2 Safety Valve pop-off of Refrigerated storage tank

During power failure, the boil-off and flash off compressor will be stopped. In this case, pressure inside refrigerated LPG storage tank will increase and hence the safety valve provided over the top of tank will pop-off till the pressure reduces. Safety valve discharge will vent to atmosphere through flare stack.

The vapor will disperse safely to LFL value of LPG if it does not come in contact with any ignition source between its flammability limits. The hazard distance to LFL value of LPG has been calculated for wind speed of 2B, 3D, 5D & 7D (Day condition) and 2F (Night condition).

Table - 3.23
MAXIMUM HAZARD DISTANCE TO LFL DUE TO SAFETY VALVE RELEASE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (m)
Release Rate: 10.05			
01.	2	F	9
02.	2	B	7
03.	3	D	10
04.	5	D	10
05.	7	D	11

Table - 3.23 shows that the hazard distance with respect to LFL concentration of LPG remains within 11 meter from the release point of safety valve and shall be confined to the factory premises only.

3.12.3 5mm, 10 mm & 15 mm dia. hole in discharge line of In-tank Pump-Refrigerated LPG

4 Nos. of LPG in-tank Pumps have to be provided for transfer of LPG from Refrigerated storage tanks through LPG heater to road tankers. The pump discharge lines for the storage tanks both (4" dia.) will combine and make line header.

The design pressure and temp. of the pumps are 20 bar and -45^{o}C respectively.

In case of hole in the pipeline line LPG will flow out and spill on the surface. The outflow of LPG in large and need to be stopped at shortest possible time. However, the hole failure frequency of 5mm, 10 mm & 15 mm in 100 mm dia. pipeline is 2.8 x 10^{-6}/m/year & 1.7x10^{-6}/m/year which indicates that chances of such failure are very remote and failure case may be considered as incredible in

nature. The consequences of 1 min. spill of LPG due to 5mm, 10mm and 15 mm hole may be the following.

(i) Spilled liquid will come out as jet and jet fire may occur in case of ignition, source may touch.

(ii) The spilled liquid shall form a liquid pool and may catch fire in presence of an ignition source and may result pool fire.

(ii) The spill liquid may not catch fire. In that event it shall evaporate forming vapour cloud which may disperse safely beyond its lower flammability limit (LFL) in the direction of the wind, if there is no ignition source between its upper and lower flammability limits.

(iii) The dispersing vapour cloud may come in contact with an ignition source between its flammability limits. In that event flash fire shall occur and unconfined vapour cloud explosion shall result. Anything coming within the fire zone shall be severely affected.

The hazard distances for the above mentioned cases are given in tabular form here below:

(i) Jet fire.

Table - 3.24
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
5 mm dia. (RR - 0.59 Kg/Sec)						
01.	37.5	15	15	14	12	12
02.	12.5	18	18	17	15	15
03.	4.5	22	22	21	20	19
10 mm dia. (RR - 2.36 Kg/Sec)						
01.	37.5	28	28	26	24	22
02.	12.5	33	33	31	29	28
03.	4.5	41	41	39	37	36
15 mm dia. (RR - 5.31 Kg/Sec)						
01.	37.5	40	40	37	34	32
02.	12.5	48	48	45	42	40
03.	4.5	59	59	56	53	52

It is evident from the above table that the hazard distance to 1st degree burn level of 4.5 KW/m^2 (1st degree burn) may extend up to a maximum distance of 22 m, 41 m & 59 m for 5 mm, 10 mm & 15 mm dia. hole respectively in the line.

(ii) In the event of the spill liquid does not catch fire, simultaneous evaporation and spreading without any physical obstruction of the spill shall occur.

The evaporating cloud may disperse safely to LFL value of LPG if it does not come in contact with any ignition source between its flammability limits. The hazard distance to LFL value of LPG has been calculated for wind speed of 2B, 3D, 5D & 7D (Day condition) and 2F (Night condition).

Table - 3.25
MAXIMUM HAZARD DISTANCE TO LFL DUE TO HOLES IN THE LINE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (m)
5 mm dia.			
01.	2	F	12
02.	2	B	10
03.	3	D	10
04.	5	D	8
05.	7	D	7
10 mm dia.			
01.	2	F	41
02.	2	B	32
03.	3	D	31
04.	5	D	26
05.	7	D	22
15 mm dia.			
01.	2	F	81
02.	2	B	61
03.	3	D	60
04.	5	D	51
05.	7	D	45

(iii) If the evaporating vapour cloud comes in contact with an ignition source between its flammability ranges, the unconfined vapour cloud explosion shall result. The hazard distances for over pressures of 0.3 bar, 0.1 bar and 0.03 bar are given here below:

Table - 3.26
HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed m/sec (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia.					
01.	2	F	34	38	49
02.	2	B	23	27	36
03.	3	D	23	27	35
04.	5	D	13	16	24
05.	7	D	13	15	22
10 mm dia.					
01.	2	F	46	52	70
02.	2	B	89	97	120
03.	3	D	78	87	109
04.	5	D	68	77	99
05.	7	D	57	65	84
15 mm dia.					
01.	2	F	111	128	180
02.	2	B	124	138	175
03.	3	D	114	128	165
04.	5	D	93	105	139
05.	7	D	82	93	124

It is evident from the above table that the maximum distances to 0.1 bar overpressure may extend upto a maximum distance of 38m, 97 m & 138 m for 5mm, 10mm & 15 mm dia. hole respectively. This scenario is incredible in nature; hence utmost care should be taken to prevent such failure by checking the pipeline by NDT periodically.

3.12.4 Gasket Failure in discharge line of In-tank Pump- Refrigerated LPG

Gasket failure is one of the foreseeable scenarios, which is considered here. Gasket failure of flange joint in main pump discharge line may be full gasket or partial. The design pressure & temp. of the pumps are 20 bar & -45^{o}C respectively.

Experience shows that gasket failures are mostly partial and segment between two bolt holes mainly fails. This is true for spiral wound metallic gasket normally used in such services. Use of CAF gasket may be discouraged as full segment rupture may be possible. The spilled LPG may be released in the form of jet and many result in:

a) Jet fire if the released hydrocarbon forms a jet and finds a ignition source within its flammability limits.

b) Evaporation, vapour cloud formation and safe dispersion beyond its LFL.

c) UVCE, if the vapour cloud finds a source of ignition between its flammability limits.

Hazard distances for partial failure of gaskets have been calculated and are presented in the Table-3.27 & 3.28.

Table - 3.27
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR – 4.72 Kg/Sec						
01.	37.5	38	38	35	32	31
02.	12.5	45	45	43	40	38
03.	4.5	56	56	53	53	51

From the above tables no. 3.26 it is seen that 1st degree burn i.e. Radiation level of 4.5 KW/m^2 for partial failure of gasket may extend upto 56m. The jet may impinge any pipeline or equipment, which may fall within its distances in the direction of the flame. The domino effect of such impingement may be very severe and may cause failure of other equipment/pipeline.

The evaporating cloud may disperse safely to LFL value of LPG if it does not come in contact with any ignition source between its flammability limits. The hazard distance to LFL value of LPG has been calculated for wind speed of 2B, 3D, 5D & 7D (Day condition) and 2F (Night condition).

Table - 3.28
MAXIMUM HAZARD DISTANCE TO LFL FOR GASKET FAILURE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (metre)
01.	2	F	69
02.	2	B	56
03.	3	D	56
04.	5	D	47
05.	7	D	41

Table - 3.27 shows that the hazard distance with respect to LFL concentration of LPG remains within 69 meter from the source of leakage and shall be confined to the factory premises only.

Hazard distances to overpressure due to Pump discharge line gasket failure are presented in Table 3.29.

Table - 3.29
HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	127	145	192
02.	2	B	113	126	161
03.	3	D	103	116	150
04.	5	D	82	93	125
05.	7	D	81	91	120

From above table, it is evident that for release of LPG due to gasket failure over pressure distances of 0.1 bar may extend up to a maximum distance of 145 m which may go out of factory premises.

3.12.5 Mounded Bullet Outlet Line (6" dia.) Full-Bore Failure- Pressurized LPG

Full-Bore failure of 150 mm dia. discharge line of mounded bullet is an incredible phenomena and its failure frequency is $2.5x10^{-7}$m/year. However, the failure scenario has been considered for 1 min. of release. In case of Full-Bore failure of discharge header the

i) Thermal radiation in case of Jet fire.
ii) LFL of LPG in case of safe dispersion
iii) Overpressure in case of UVCE

The results are tabulated in the following tables.

Table – 3.30
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE FOR FULL-BORE FAILURE OF PUMP DISCHARGE LINE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR – 218.60 Kg/Sec						
01.	37.5	190	189	176	162	154
02.	12.5	228	227	215	201	193
03.	4.5	283	282	271	259	251

Form the above table it is seen that hazard distance to 1st degree burn extend upto 283 m only and may go out of factory premises. However the failure is very low.

Table – 3.31
HAZARD DISTANCE TO LFL CONCENTRATION FOR FULL-BORE FAILURE OF MOUNDED BULLET OUTLET LINE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (m)
01.	2	F	351
02.	2	B	367
03.	3	D	373
04.	5	D	374
05.	7	D	349

Form the above table hazard distances to LFL of LPG shall extend to only 374 m form the source for the weather conditions i.e. for wind speed/stability class of 5D goes outside the factory premises.

In case of release of LPG, the vapor may disperse in the atmosphere. If vapour cloud gets source of ignition within its flammability limit, unconfined vapour cloud explosion may take place.

The hazard distances to over pressures of 0.3 bar, 0.1 bar & 0.03 bar are presented here below table no.

Table – 3.32
HAZARD DISTANCES TO OVERPRESSURE DISTANCES DUE TO UVCE FOR FULL- BORE FAILURE

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	460	503	722
02.	2	B	477	521	723
03.	3	D	499	569	764
04.	5	D	597	655	832
05.	7	D	582	654	850

The above tables shows that the hazard distances under the neutral weather condition of 2F for 0.1 bar overpressure (repairable damage) shall extend up to a distance of 503 meters which is outside the battery limit.

3.12.6 5mm, 10 mm and 15 mm dia. holes in truck loading pump Discharge Line- Pressurized LPG

LPG truck loading Pumps will be provided for transfer of LPG from mounded bullets to road tankers of line size 4". The design pressure & temp. of the pumps are 40 bar (g) & -45/+55^{o}C pressure. In case of hole in the pipeline line LPG will flow out and spill on the surface. The outflow of LPG in large and need to be stopped at shortest possible time. The consequences of 3 mints spill of LPG due to 5mm, 10mm and 15 mm hole may be the following.

(i) The spilled liquid shall form a jet and may catch fire in presence of an ignition source and may result jet fire.

(ii) The spill liquid may not catch fire. In that event it shall evaporate forming vapour cloud which may disperse safely beyond its lower flammability limit (LFL) in the direction of the wind, if there is no ignition source between its upper and lower flammability limits.

(iii) The dispersing vapour cloud may come in contact with an ignition source between its flammability limits. In that event flash fire shall occur and unconfined vapour cloud explosion shall result. Anything coming within the fire zone shall be severely affected.

The hazard distances for the above mentioned cases are given in tabular form here below:

(i) Jet fire.

Table – 3.33
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE FOR HOLE OF PUMP DISCHARGE LINE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
5 mm dia. hole (RR – 0.35 Kg/Sec)						
01.	37.5	11	11	10	9	8
02.	12.5	13	13	12	11	11

03.	4.5	15	15	15	14	14
10 mm dia. hole (RR – 1.41 Kg/Sec)						
01.	37.5	21	20	19	17	16
02.	12.5	25	24	22	21	20
03.	4.5	29	28	27	26	25
15 mm dia. hole (RR – 3.18 Kg/Sec)						
01.	37.5	29	29	27	25	24
02.	12.5	34	34	32	30	29
03.	4.5	42	42	40	38	37

Form the above table it is seen that hazard distance to 1st degree burn extends upto 29m & 42m in case of 10mm and 15mm dia. hole respectively only and remain within factory premises.

Table – 3.34
HAZARD DISTANCE TO LFL DUE TO HOLE IN PUMP DISCHARGE LINE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (m)
5 mm dia. Hole			
01.	2	F	7
02.	2	B	6
03.	3	D	6
04.	5	D	6
05.	7	D	5
10 mm dia. Hole			
01.	2	F	16
02.	2	B	14
03.	3	D	13
04.	5	D	12
05.	7	D	10
15 mm dia. Hole			
01.	2	F	28
02.	2	B	26
03.	3	D	25
04.	5	D	23
05.	7	D	21

Form the above table hazard distances to LFL of LPG shall extend to only 16 m and 28 m max. for 10 mm & 15 mm dia. hole form the source respectively.

Table – 3.35
HAZARD DISTANCES TO OVERPRESSURE DISTANCES DUE TO UVCE FOR HOLE

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
5 mm dia. Hole					
01.	2	F	12	15	21
02.	2	B	12	14	20
03.	3	D	12	13	20
04.	5	D	-	-	-
05.	7	D	-	-	-
10 mm dia. Hole					
01.	2	F	45	50	63
02.	2	B	35	39	51
03.	3	D	34	38	50
04.	5	D	24	28	38
05.	7	D	23	27	37
15 mm dia. Hole					
01.	2	F	78	86	109
02.	2	B	67	74	94
03.	3	D	66	73	93
04.	5	D	57	63	81
05.	7	D	56	62	78

It is evident from the above table that the maximum distances to 0.1 bar overpressure may extend upto a maximum distance of 50 m & 86 m which remains within the battery limit.

Automatic gas detector/heat detector and automatic water sprinkler system may be considered to mitigate the hazard.

3.12.7 Truck loading Pump Discharge Line Gasket Failure- Pressurized LPG

Two nos. of mounded bullets of capacity 60 MT each has been provided of design pressure 20 Kg/cm^{2}g and design temp. -45/+55^{o}C for holding LPG coming from LPG heater and Compressor. Mounded bullet pump or truck loading pump discharge line (4" dia.) gasket failure has been considered as gasket failure is one of the foreseeable scenarios. Gasket failure of flange joint may be full gasket or partial. Experience shows that gasket failures are mostly partial and segment between two bolt holes mainly fails. This is true for spiral wound metallic gasket normally used in such services. Use of CAF gasket may be discouraged as full segment rupture may be possible.

Truck loading pump shall have the following specification:

Discharge Flow rate	125 m^3/hr
Diff. head rate	80 MLC
Design Pressure	40 bar (g)
Design Temperature	-45/+55^oC

The spilled LPG may be released in the form of jet and many result in:

a) Jet fire if the released hydrocarbon forms a jet and finds an ignition source within its flammability limits.
b) Evaporation, vapour cloud formation and safe dispersion beyond its LFL.
c) UVCE, if the vapour cloud finds a source of ignition between its flammability limits.

Hazard distances for partial failure of gaskets have been calculated and are presented in the Table- 3.36 & 3.37.

Table - 3.36
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE FOR GASKET FAILURE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR – 3.16 Kg/Sec						
01.	37.5	29	29	27	24	23
02.	12.5	34	34	32	30	29
03.	4.5	42	42	40	38	37

From the above tables no. 3.35, it is seen that 1st degree burn i.e. Radiation level of 4.5 KW/m^2 for partial failure of gasket may extend upto 42 m. The jet may impinge any pipeline or equipment, which may fall within its distances in the direction of the flame. The domino effect of such impingement may be very severe and may cause failure of other equipment/pipeline.

The evaporating cloud may disperse safely to LFL value of LPG if it does not come in contact with any ignition source between its flammability limits. The hazard distance to LFL value of LPG has been calculated for wind speed of 2B, 3D, 5D & 7D (Day condition) and 2F (Night condition).

Table - 3.37
HAZARD DISTANCE TO LFL CONCENTRATION OF LPG FOR GASKET FAILURE

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (m)
01.	2	F	28
02.	2	B	25
03.	3	D	25
04.	5	D	23
05.	7	D	20

Table - 3.36 shows that the hazard distance with respect to LFL concentration of LPG remains within 28 meter from the source of leakage and shall be confined to the factory premises only.

Hazard distances to overpressure due to Pump discharge line gasket failure are presented in Table 3.38.

Table - 3.38
HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	78	86	108
02.	2	B	67	74	94
03.	3	D	66	73	93
04.	5	D	57	63	81
05.	7	D	56	62	78

It is evident from the above table that the maximum distances to 0.1 bar overpressure may extend upto a maximum distance of 86 m.

Present available data of flange gasket failure rate is about $0.5x10^{-6}$ per running hour which is considered as high rate of frequency. The consequence due to gasket failure may be considered as foreseeable or credible. Automatic gas detector/heat detector and automatic water sprinkler system may be considered to mitigate the hazard.

3.12.8 Truck loading Pump Mechanical Seal Failure- Pressurized LPG

LPG truck loading Pumps have to be provided for transfer of LPG from mounded bullets to road tankers. In case of pump mechanical seal failure of pump, LPG

will flow out as jet and spill on the surface. The outflow of LPG in large and need to be stopped at shortest possible time. The consequences of 3 mints spill of LPG due to mechanical seal may be the following.

(i) The spilled liquid shall come out as jet and may catch fire in presence of an ignition source and may result jet fire.

(ii) The spill liquid may not catch fire. In that event it shall evaporate forming vapour cloud which may disperse safely beyond its lower flammability limit (LFL) in the direction of the wind, if there is no ignition source between its upper and lower flammability limits.

(iii) The dispersing vapour cloud may come in contact with an ignition source between its flammability limits. In that event flash fire shall occur and unconfined vapour cloud explosion shall result. Anything coming within the fire zone shall be severely affected.

The hazard distances for the above mentioned cases are given in tabular form here below:

(i) Jet fire.

Table – 3.39
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE FOR MECHANICAL SEAL FAILURE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR – 2.26 Kg/Sec						
01.	37.5	25	25	23	21	20
02.	12.5	30	30	28	26	25
03.	4.5	36	36	35	33	32

Form the above table it is seen that hazard distance to 1st degree burn extend upto 36m only and remain within factory premises.

Table – 3.40
HAZARD DISTANCE TO LFL DUE TO MECHANICAL SEAL FAILURE OF PUMP

Sl. No.	Wind Speed (m/sec)	Stability Class	Distances (metre)
01.	2	F	22
02.	2	B	20
03.	3	D	20
04.	5	D	17
05.	7	D	15

Form the above table hazard distances to LFL of LPG shall extend to only 22 m form the source for weather conditions of 2F which remains within the factory premises.

Table – 3.41
HAZARD DISTANCES TO OVERPRESSURE DISTANCES DUE TO UVCE FOR MECHANICAL SEAL FAILURE OF PUMP

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	67	73	91
02.	2	B	56	62	77
03.	3	D	46	52	67
04.	5	D	45	50	64
05.	7	D	35	40	52

From the above table it is evident that the maximum distance to heavy damage i.e. for over pressure of 0.3 bar extends upto 67 m for mechanical seal of Pump. This remains mainly within factory premises. However, to prevent such situation GMS & Water sprinkler should be provided in pump house.

3.12.9 Boil-off Compressor discharge line Full-Bore failure.- Pressurized LPG

The details of the compressors are as follows:

No. of Compressors Boil off: 2

Capacity: 2066 Kg/ hr.

Discharge Pressure: 20 Kg/ cm^2g (max.)

Design Temperature: 90^oC

Following scenarios have been envisaged for consequence analysis:

i) The out coming gas may be in the form of jet and in presence of any source of ignition may catch fire resulting in jet fire.

ii) LPG may disperse safely beyond its LFL.

iii) Vapor cloud may come in contact with an ignition source between its flammability limits resulting in flash fire and unconfined vapor cloud explosion.

The results of the above three consequence envisaged are presented here below in Tables 3.42 and 3.43.

Table – 3.42
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR - 0.5 Kg/Sec						
01.	37.5	13	13	12	11	11
02.	12.5	16	16	15	14	13
03.	4.5	20	20	19	18	17

It is evident from the above table that the hazard distance to 1st degree burn level of 4.5 KW/m^2 may extends to a distance of 20 m. This distance remains within the factory premises.

In the event of the spill liquid does not catch fire, simultaneous evaporation and spreading on the ground without any physical obstruction of the spill shall occur.

The evaporating cloud may disperse safely to LFL value of LPG if it does not come in contact with any ignition source between its flammability limits. The hazard distance to LFL value of LPG has been calculated for wind speed of 2B, 3D, 5D & 7D (Day condition) and 2F (Night condition).

Table – 3.43
MAXIMUM HAZARD DISTANCE TO LFL OF LPG FOR FAILURE OF MOUNDED BULLET OUTLET LINE

Sl. No.	Wind Speed(m/sec)	Stability Class	Distances (m)
01.	2	F	9
02.	2	B	8
03.	3	D	8
04.	5	D	7
05.	7	D	6

It is evident from the above table that the LFL distances go upto a maximum distance of 9 m.

If the evaporating vapour cloud comes in contact with an ignition source between its flammability ranges, the unconfined vapour cloud explosion shall result. The hazard distances for over pressures of 0.3 bar, 0.1 bar and 0.03 bar are given below:

Table – 3.44
HAZARD DISTANCES TO OVERPRESSURE DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	23	26	34
02.	2	B	13	15	23
03.	3	D	13	15	22
04.	5	D	12	15	22
05.	7	D	12	15	21

It is also evident from the above table that the maximum distances to 0.3 bar overpressure (heavy damage) extends upto 23 m which remain inside the battery limit.

3.12.10 Flash-off Compressor discharge line Full-Bore failure - Pressurized LPG

The details of the compressors are as follows:

No. of Compressors Flash off: 2

Capacity: 5049 Kg/ hr.

Discharge Pressure: 20 Kg/ cm^2g (max.)

Discharge Temperature: 90^oC

Following scenarios have been envisaged for consequence analysis.

i) The out coming liquid may be in the form of jet and in presence of any source of ignition may catch fire resulting in jet fire.

ii) LPG may disperse safely beyond its LFL.

iii) Vapor cloud may come in contact with an ignition source between its flammability limits resulting in flash fire and unconfined vapor cloud explosion.

The results of the above three consequence envisaged are presented here below in Tables 3.45 and 3.46.

Table – 3.45
HAZARD DISTANCES TO THERMAL RADIATION DUE TO JET FIRE

Sl. No.	Thermal Load KW/m^2	Distance (m)				
		2F	2B	3D	5D	7D
RR – 1.4 Kg/Sec						
01.	37.5	20	20	19	17	16
02.	12.5	24	24	23	21	20
03.	4.5	30	30	28	27	26

From the above table, it is evident that the distance to thermal radiation of 4.5 KW/m^2 extends to a distance of 30 m. It is also evident that distance to 1st degree burn i.e. 4.5 KW/m^2 remains inside the battery limit.

This scenario envisages that the dispersing vapour cloud comes in contact with an ignition source resulting in UVCE. The hazard distances to over pressures of 0.3 bar, 0.1 bar, 0.03 bar are presented here below for wind speed 2B, 3D, 5D & 7D (day condition) and 2F (night condition).

Table – 3.46
HAZARD DISTANCES TO OVERPRESSURE DUE TO UVCE

Sl. No.	Wind Speed m/sec. (Day/Night)	Stability Class (Day/Night)	Max. Distances (m) to overpressure of		
			0.3 Bar	0.1 Bar	0.03 Bar
01.	2	F	45	50	63
02.	2	B	34	39	51
03.	3	D	34	39	50
04.	5	D	34	38	48
05.	7	D	24	27	37

From the above table it is evident that the maximum distance to heavy damage i.e. for over pressure of 0.3 bar extends upto 45 m.

3.11.11 Loading arm for Road Tanker failure

Loading arm (H 601/2/3/4) will be used for loading of LPG in road tankers. Failure probability of loading arm is in the order of $3x10^{-8}$ per hour of operation and. Although the probability is very low, the failure scenario is taken for calculation of consequences due to failure of these loading arm and unloading hose for different products. The consequences have been calculated for 3 minutes release has been considered as it is assumed that action will be taken by the operators for stopping the pumps and closing the isolation valves immediately within this period. Hazard distances for fire due to snapping of loading arm are presented in Table – 3.47 & 3.48.

Table - 3.47
HAZARD DISTANCES DUE TO JET FIRE FOR LOADING ARM FAILURE

Incident Thermal Radiation KW/M^2	Hazard distances (m) for			
	2F	2B	3D	5D
Release Rate – 19.00 Kg/Sec.				
37.5	65	64	60	55
32	66	65	61	56
12.5	77	76	72	68

8	84	83	79	75
4.5	95	94	91	87

It is evident from the above table that in case of snapping of 3 inch dia. loading arm action has to be taken to stop leakage immediately as well as for prevention of fire.

Another possibility is vapour cloud explosion due to LPG loading arm failure, if the evaporated vapour cloud moving in down wind direction, comes in the contact of an ignition source within its flammability limits. For such scenario the result of consequence analysis are presented in the following table.

Table - 3.48
HAZARD DISTANCES DUE TO UNCONFINED VAPOUR CLOUD EXPLOSION

Sl. No.	Wind Speed m/sec./Stability Class	Max. Distances (m) to overpressure of		
		0.3 bar	0.1 bar	0.03 bar
01.	2F	244	267	331
02.	2B	220	241	295
03.	3D	211	231	286
04.	5D	180	200	254
05.	7D	159	179	232

The above table evident that overpressure distances may go up to 244 m for heavy damage i.e. 0.3 bar in case of loading arm failure. So, extreme care should be taken to avoid any such type of spillage and if so happened, then it should be covered immediately with DCP compound to avoid any further catastrophe.

3.12.12 RISK ASSESSMENT

For the assessment of 'Individual Risk' due to the LPG storage & handling facilities at Haldia following has been taken into consideration:

a) The individual risk has been calculated as cumulative effect of all the scenario mentioned for selected failure case as listed in tables for 2F, 2B, 3D, 5D & 7D (Day & Night conditions), where 2F, 2B, 3D, 5D & 7D are wind speed of 2 m/sec. & stable stability class, wind speed of 3 m/sec. & neutral stability class, wind speed of 5 m/sec. & neutral stability class and wind speed of 7 m/sec. & neutral stability class atmospheric conditions respectively.

b) Probability of wind directions has been taken from IMD data.

c) No mitigation factors such as shelters, escape etc. are considered which will result in conservative risk estimation.

d) During risk assessment population data and source of ignition has been considered.

3.12.13 PRINCIPAL CONCLUSION & RECOMMENDATIONS (FOR MAIN PLANT)

Major recommendations are as follows:

Individual Risk Contour has been drawn and given as Figure No. 4 & FN curve in Figure No. - 5 for cryogenic LPG storage facilities.

Major recommendations are as follows:

- LPG storage and handling facilities at Haldia is situated at a place where there is no human habitation nearby. Iso-risk contour, Figure No. 6 has been drawn for LPG storage & handling Plant which goes 21 m outside the battery limit in north-western and 16 m in south-eastern direction. It has been found that acceptable risk contour ($1x10^{-6}$ per year) goes outside the plot of land earmarked for the LPG storage and handling facilities, however it is an industrial area with no population within 0.5 Km. F-N Curve (i.e. Societal Risk) Figure No. 7, is also in the acceptable range Hence, it is safe to install the facilities at the place earmarked for the LPG storage and handling facilities in LPG Bottling Plant.
- Since such type of the plant in only a few in India, officers and staffs of the LPG Handling Plant should be trained in such plant before their put in the job.
- Procurement of materials, construction & erection of the plant should be done mainly as per international codes & practices.
- 100% radiography should be done for all weld joints in tanks and pipelines.
- Health check and maintenance of tanks & machineries should done at regular intervals.
- Instruments and trip interlocks should be checked and calibrated at regular intervals to prevent any wrong signaling and consequent failures.
- Good liaison should be maintained with nearby organizations, District Administration and hospitals & mutual aid agreement should be done with nearby industries so that help may be obtained in case of any major hazard.
- Mock Drills for fire & emergency should be conducted at regular intervals.
- Flow indicator transmitter & pressure indicator transmitter with indication in

control room should be provided in the receipt pipeline at the Durgachak LPG Handling Plant side. Whenever a flow mismatch is observed between dispatch and receipt of LPG or a sudden fall of pressure is indicated in LPG transfer line, immediate action should be taken to shut the LPG pump at ship and close ESD to avoid further delivery of LPG.

- Good communication facility should be established between Jetty personnel and the receipt point at Haldia LPG Bottling Plant control room personnel to take appropriate action during unloading and transfer of LPG. Also good communication facilities should be provided for communication with the personnel in the plant.
- Safety valves should be checked regularly.
- In addition to the fire hydrant & monitors, fire extinguishers should be placed at vulnerable places
- Proper lighting system should be done in the plant so that plant personnel can approach in any part of the plant during night.
- One ESD (Emergency Shut Down) Switch should be provided in plant control room to stop all operations in case of failure of any equipment & pipeline.
- ROV should be provided on the LPG entry line in the installation.
- Suitable isolation arrangement on both sides of water crossing to be provided in case of leak inside the water between HOJ-II & HOJ-III.

Considering individual risk contour within factory premises and various safety features and risk reduction measures adopted for proposed facility, it may be concluded that the proposal for storage and handling of LPG at Haldia is considered safe from environmental risk point of view.

4.0 DISASTER MANAGEMENT PLAN

4.1 SCOPE

The scope of DMP are:

(i) the identification of emergencies;
(ii) the mitigation measures that attempt to reduce and eliminate the risk or disaster;
(iii) the preparedness that to develop plans for actions when disaster or emergencies occur;
(iv) the responses that mobilize the necessary emergency services including responders (primary, secondary and tertiary) like fire service, police service, medical service including ambulance, government as well as non-governmental agencies;
(v) the post disaster recovery with aim to restore the affected area to its original conditions;

4.2 INTENT

The intent of DMP are:

It is intended to apply these regulations –

(a) to develop an DMP that should be concise and informative so that members of the emergency control organization should be able to quickly refer to the action plan to determine important functions that are being carried out;
(b) to manage an emergency and not to use ERDMP just as reference material for training and shall be made applicable -

(i) to prevent casualties - both on-site and off-site;
(ii) to reduce damage to property, machinery, public and environment;
(iii) to develop a state of readiness for a prompt and orderly response to an emergency and to establish a high order of preparedness (equipment, personnel) commensurate with the risk;
(iv) to provide an incident management organogram with clear missions and lines of authority (incident command system, field supervision, unified command);
(v) to ensure an orderly and timely decision-making and response process (notification, standard operating procedures);
(vi) to maintain good public relations;

4.3 CLASSIFICATION OF EMERGENCIES

Emergencies can be categorized into three broad levels on the basis of seriousness and response requirements, namely: –

(a) **Level 1**: This is an emergency or an incident which

(i) can be effectively and safely managed, and contained within the site, location or installation by the available resources;
(ii) has no impact outside the site, location or installation.

(b) **Level 2:** This is an emergency or an incident which –

(i) cannot be effectively and safely managed or contained at the location or installation by available resource and additional support is alerted or required;
(ii) is having or has the potential to have an effect beyond the site, location or installation and where external support of mutual aid partner may be involved;
(iii) is likely to be danger to life, the environment or to industrial assets or reputation.

(c) **Level 3**: This is an emergency or an incident with off-site impact which could be catastrophic and is likely to affect the population, property and environment inside and outside the installation, and management and control is done by district administration. Although the Level-III emergency falls under the purview of District Authority but till they step in, it should be responsibility of the unit to manage the emergency.

NOTE: Level-I and Level-II shall normally be grouped as onsite emergency and Level-III as off-site emergency.

Definitions

"boiling liquid expanding vapour explosion (BLEVE)" means the violent rupture of a pressure vessel containing saturated liquid or vapour at a temperature well above its atmospheric boiling point and the resulting flash evaporation of a large fraction of the superheated liquid which produces a large vapour cloud which burns in the form of a large rising fireball due to ignition;

(d) "chief incident controller" means the person who assumes absolute control of the unit and determines action necessary to control the emergency;

(e) "codes of practice" means the codes of practice for emergency response and disaster management plan notified by the Board;

(f) "disaster" means an occurrence of such magnitude as to create a situation in which the normal patterns of life within an industrial complex are suddenly disrupted and in certain cases affecting the neighborhood seriously with the result that the people are plunged into helplessness and suffering and may need food, shelter, clothing, medical attention protection and other life sustaining requirements;

(g) "disaster management plan" means a well coordinated, comprehensive response plan to contain loss of life, property, environment and provide speedy and effective recovery by making the most effective use of available resources in case of a disaster;

(h) "emergency" means a situation or scenario which has the potential to cause serious danger to persons, environment or damage to property and which tends to cause disruption inside or outside the premises and may require the help of outside resources;

(i) "emergency response vehicle (ERV)" means a vehicle for handling emergencies having necessary equipment meant for rescue and relief operations and ERV can be put to use within installation, outside of installation including road incident;

(j) "hazard" means an event related to the property of substance or chemicals with a potential for human injury, damage to property, damage to the environment, or some combination thereof;

(k) "incident" means an unplanned or unintended or intended event having potential to cause damage to life, property and environment;

(l) "incident record register" means a register containing complete information pertaining to all incidents covering near miss, and all other incidents leading to Level-I, Level-II and Level-III emergencies;

(m) "installation" means facilities, namely, gaseous product pipeline, liquid Product pipeline, hydrocarbons processing installation, oil and natural gas terminals and commercial storage and transportation, hydrocarbons gas bottling Installations including CNG, city gas distribution facilities and retail outlets;

(n) "leak" means release or discharge of a dangerous chemicals or substances or material into the environment;

(o) "Level-I emergency" means an emergency as defined under sub-regulation 6

(p) "Level-II emergency" means an emergency as defined under sub-regulation 6

(q) "Level-III emergency" means an emergency as defined under sub-regulation 6

(r) "mutual aid association" means an industrial mutual aid association in which participating industries as a community shall assist each other in case of emergency. Mutual aid associations supplement a site"s emergency control plan. Services of member industries shall be requested only when the emergency threatens to exceed the capability of otherwise available resources;

(s) "occupier" of an installation means the person who has ultimate control over the affairs of the installation;

(t) "off site emergency plan" means a response plan to control and mitigate the effects of catastrophic incidents in above ground installation (AGI) or underground installations (UGI) or road transportation. This plan shall be prepared by the district administration based on the data provided by the installation(s), to make the most effective use of combined resources, i.e. internal as well as external to minimise loss of life, property, environment and to restore facilities at the earliest;

(u) "on site emergency" means an emergency that takes place in an installation and the effects are confined to the Installation premises involving only the people working inside the plants and to deal with such eventualities is the responsibility of the occupier and is mandatory. It may also require help of outside resources;

(v) "on site emergency plan" means a response plan to contain and minimize the effects due to emergencies within the installations which have a potential to cause damage to people and facilities within the installation premises;

(w) "risk" means the chance of a specific undesired event occurring within a specified period or in specified circumstances and it may be either a frequency or a probability of a specific undesired event taking place;

(x) "risk analysis" means the identification of undesired events that lead to the materialization of a hazard, the analysis of the mechanisms by which these undesired events could occur and, usually, the estimation of the extent, magnitude, and likelihood of any harmful effects;

(y) "risk assessment" means the quantitative evaluation of the likelihood of undesired events and the likelihood of harm or damage being caused by them, together with the value judgments made concerning the significance of the results;

(z) "risk management" means the programme that embraces all administrative and operational programmes that are designed to reduce the risk of emergencies involving acutely hazardous materials. Such programmes include, but are not limited to, ensuring the design safety of new and existing equipment, standard operating procedures, preventive maintenance, operator training, incident investigation procedures, risk assessment for unit operations, emergency planning, and internal and external procedures to ensure that these programmes are being executed as planned;

(aa) "site incident controller" means the person who goe**s to the scene of the emergency** and supervises the actions necessary to overcome the emergency at the site of the incident;

(ab) "spill" means an unintended release or discharge of hydrocarbon or any other dangerous liquid into the environment;

(ac) "transport emergency (TREM) card" means a card containing details about the nature of hazards, protective devices, telephone numbers and actions related to spillage, fire, first aid and other details of national and international (UN) numbers or signage which is common in India and abroad;

(ad) "unconfined vapour cloud explosion (UVCE)" means the formation of vapour cloud due to release of significant quantity of liquefied hydrocarbons

into the atmosphere and its explosion due to ignition which may cause high over pressure and low pressure that cause very heavy damage.

4.4 PRE-EMERGENCY PLANNING

Hazard identification

(1) The first step towards ERDMP shall be to identify potential on-site and off-site hazards such as gas leaks, spills, fire, explosion, transportation incident, pipeline ruptures, equipment failure, natural calamities, etc. and the types of damage caused by them. The hazard identification shall include –

(a) information on toxicological, physical, and chemical properties of the substances being handled in the format of Material Safety Data Sheet (MSDS);
(b) the identification of potential impact on downwind air quality or downstream water quality from an incidental release and possible danger to human, Flora and Fauna and animal health;
(c) hazards to the installation shall also include Natural perils such as floods, earthquakes, cyclones or landslides etc. ;

Risk analysis and risk assessment

The second step of the ERDMP process is to determine the risk of an incident associated with each hazard. The basic procedure in a risk analysis shall be as follows:

(a) identify potential failures or incident s (including frequency) ;
(b) calculate the quantity of material that may be released in each failure, estimate the probability of such occurrences;
(c) evaluate the consequences of such occurrences based on scenarios such as most probable and worst case events;
(d) the combination of consequences and probability will allow the hazards to be ranked in a logical fashion to indicate the zones of important risk. Criteria should then be established by which the quantified level of risk may be considered acceptable to all parties concerned;
(e) after assessing the risk, the "maximum tolerable criterion" must be defined and above which the risk shall be regarded as intolerable. Whatever be the benefit level must be reduced below this level;
(f) a risk of 10 per million per year, or 10-5/Year, effectively means that any person standing at a point of this level of risk would have a 1 in 100 000 chance of being fatally injured per year.

4.5 CAUSES OF DISASTERS

The common causes for the above events are tabulated below for reference and the DMP should be prepared by the installation to deal with the following emergencies.

Manmade

Heavy Leakage
Fire
Explosion
Failure of Critical Control system
Design deficiency
Unsafe acts
In-adequate maintenance

Natural

Flood
Earth Quake
Cyclone
Outbreak of Disease
Excessive Rains
Tsunami

Extraneous

Riots/Civil Disorder/ Mob Attack
Terrorism
Sabotage
Bomb Threat
War / Hit by missiles
Abduction
Food Poisoning/ Water Poisoning

4.6 CONSEQUENCES

(1) The consequences of an Incident may be confined within the premises or may spill off-site triggering cascading effects.

(2) The consequences of an Incident are fire explosion, deflagration, blast waves, fast spreading flames, BLEVE, UVCE resulting in direct effects like damage to buildings/property, burns, fatalities. However, an Incident in the neighbourhood may sometimes cascade into an on-site emergency. It should be prevented or managed to avoid major emergency.

4.7 EMERGENCY MITIGATION MEASURES

After determining the risk level, the following actions shall be required for mitigation of emergency.

Resource mobilisation - Resource mobilisation shall include manpower requirement, fire fighting materials, appliances or equipment, safety equipment, communication facilities, transport, list of emergency drugs and appliances, etc

Incident preventing measures and procedures - The incident prevention measures and procedures at installation or other locations shall include the following:-

(i) health safety and environment (HSE) policy;
(ii) proper layout and inter facility distances (the layout should not have any criss-cross movement of men and materials);
(iii) safety committees with fair participation of Union leaders and workers;
(iv) safety audits and inspections shall be carried out with the help of prescribed checklists.
(v) work permit system (including confined space and entry permit);
(vi) early warning alarm system in the installation (gas monitoring system, heat detection, high level alarms, low pressure/high pressure alarms etc.) especially in the vicinity of storage tanks, pump house , loading gantry.
(vii) in-built safety interlocks system in design such as safety relief valves (SRVs), thermal safety valves (TSVs), non-returning valves (NRVs), remote operated valves (ROVs) and other various emergency trip systems in Installations;
(viii) fire protection (preferably automatic) and HSE Management system;
(ix) drill for visitors including assembly procedure and escape route, do‟s and don‟ts written instructions before entry, etc;
(x) setting up of safety MIS system and sending Exception reports to the head of organisations or CEO;
(xi) all standby equipments should be tried and operated periodically and recorded. Similarly back up power for safety equipment and instrument should be checked periodically and observations be recorded;
(xii) check points for incident prevention measures

Emergency preparedness Measures - After detailing the prevention measures, preparedness measures to handle the emergency shall be explained in DMP document.

Emergency Drills and Mock Exercises

(a) To evaluate the thoroughness and effectiveness of an ERDMP, it is necessary to conduct periodic table top exercises full-scale or announced, and unannounced drills. Each site should hold drills on the night shifts, change shifts as well as during the day as mandated under regulation

(b) Drills should present a variety of Emergency scenarios and designed to challenge each segment of the organization. Limited scale drills are useful and should be used by Chief of each Support Service to train his own team. Plans should be made to have periodic mass casualty exercises. These exercises should attempt to simulate as closely as possible a fire, explosion, or toxic agent release and comparison of the prescribed time lines and the actual received.

(c) The warning system, first aid, evacuation procedures and the definitive treatment procedures should all be tested periodically.

(d) Some of the drills should also include the participation of outside groups and agencies such as police, fire companies, ambulance service, civil defence organizations and mutual aid groups.

(e) Testing and mock drills for onsite emergency plan shall be carried once in three months and for offsite emergency plan twelve months.

(f) For other installations, the mock drill shall be carried out once a year. However, for locations having more than one industry member, the annual mock drill can be carried out by one industry member in turn, thus ensuring one mock drill in every year at the location.

(g) These mock drills will enable the unit/location to assess the capability of the individual and performance as a group. The frequent discussions and drills will help in eliminating the confusion and shortcomings, if any.

(h) Each Mock Drill should be recorded with observations and deficiencies to be rectified within 24 hours.

(i) Check Points for mutual aid and mock drills are given.

Training

(1) A DMP shall be easier to use if training material and general philosophy on emergency prevention and control are kept separate from the working plan.
(2) Training shall be imparted to all the personnel likely to be involved directly or indirectly to the emergencies including employees, contract workers, transport crew and security personnel.
(3) Contract personnel and contract labourer shall be allowed to start work only after clearance of attending and passing safety training.
(4) Refresher training shall be conducted at regular intervals.
(5) The basic requirements of Central Motor Vehicles Rules, 1989 pertaining to dangerous or hazardous goods transport must be complied by the transporters. For this the loading station must conduct training of tank truck crew as per the requirement under Central Motor Vehicles Rules, 1989.

Mutual Aid

Since combating major emergencies might be beyond the capability of individual unit, it is essential to have mutual aid arrangements with neighbouring industries. Consideration shall be given to the following while preparing mutual aid arrangements:-

(a) Written mutual aid arrangements are to be worked out to facilitate additional help in the event of Level-II emergencies by way of rendering manpower, medical aid or fire fighting equipments, etc.

(b) The mutual aid arrangement shall be such that the incident controller of the affected installation shall be supported by neighbouring industries on call basis for the support services materials and equipments already agreed. Further, all such services deputed by member industry shall work under the command of the site incident controller of the affected installation.

(c) Mutual aid associations shall conduct regular meetings, develop written plans and test the effectiveness of their plans by holding drills. Drills are essential to establish a pattern for operation, detect weaknesses in communications, transportation and training. Periodic drills also develop experience in handling problems and build confidence in the organization.

(d) To make the emergency plan a success, the following exchange of information amongst the member organizations of mutual aid association is considered essential: -

(i) The types of hazards in each installation and fire fighting measures.
(ii) List of all the installations or entities falling along the routes of transport vehicles carrying petroleum or petroleum products.
(iii) The type of equipment, that would be deployed and procedure for making the replenishment.
(iv) Written procedures which spell out the communication system for help and response. This is also required to get acquainted with operation of different fire-fighting equipment available at mutual aid members and compatibility for connecting at users place.
(v) Familiarization of topography and drills for access and exit details carried out by mutual aid members.

NOTE: Incidents involving road transport vehicles carrying bulk LPG shall be attended by the nearest installation on request of civic authorities even in absence of mutual aid agreement with the consignor.

Response Procedures and Measures - Containing the consequences of an emergency requires well planned and documented procedures to ensure prompt response and coordination among various task groups. The following response procedures as prevalent in the location shall be carried out:

(a) the risk should also be made "as low as reasonably practicable" (ALARP) and least impacting the neighbourhood. While conducting the risk analysis, a quantitative determination of risk involves three major steps:-

4.8 DECLARATION OF ON-SITE AND OFF–SITE EMERGENCY

(1) Any emergency starts as a small incident which may become a major incident with passage of time. At the initial stages, the Emergency organisation chart shall be put into action. If the incident goes beyond control the on-site emergency plan will be actuated by Chief Incident Controller at the appropriate stage as considered necessary.
(2) During idle shift/holidays, the security personnel will combat the incident as per the fire organisation chart and at the same time inform various emergency controllers for guidance and control the situation.
(3) When emergency becomes catastrophic and evacuation beyond the plant premises is considered necessary by the chief Incident Controller, the situation will be handed over to District Authority for implementing the offsite emergency plan.

(4) The management of emergency henceforth has to be controlled by the district crisis management group from control room under the supervision of the District Collector.

(5) For off-site Emergency Plan, Chief Inspector of Factories is the enforcement authority, who will also enforce directions and procedures in respect of preparation of Off-Site Emergency Plan in consultation with the District Collector.

(6) In addition to preparation of on-site emergency plan, furnishing relevant information to the district authorities (Collector) for the preparation of offsite emergency plan is a statutory responsibility of the occupier of every industry handling hazardous substance.

4.9 RESOURCES FOR CONTROLLING EMERGENCY

(1) To meet all possible emergencies, installation has to provide a number of systems and resources based on the risk level as identified above in addition to requirements under Factory Act and other Statutory Regulations applicable to the installation.

(2) The available emergency control systems and facilities within the installation shall be as under:

(a) Fire & Gas Detection System
(b) Fire Protection System (Active & Passive)
(c) Fire Fighting Systems
(d) Rescue facilities & Personal Protective Equipments (PPEs)
(e) First Aid and Medical facilities
(f) Communication facilities
(g) Escape Route and Evacuation Zones
(h) Emergency Shutdown System

(3) Details of the resources shall be suitably incorporated into the plan. Number and type shall be as per the relevant code, standards and best practices in the industry. This section shall also identify sources of local assistance including telephone numbers and names of contacts for:

(a) fire departments
(b) police
(c) municipal and provincial agencies
(d) hospitals
(e) doctors
(f) other company facilities
(g) mutual aid organize
(h) co-operatives
(i) helicopter and air transport services
(j) surface transport services
(k) safety and monitoring equipment suppliers
(l) spill response and/or cleanup services

(4) The LPG import terminal shall also determine type of resources such as equipment, personnel, technology, expertise, etc. provided by the respective governments under different conditions.

4.9.1 Medical Facilities

There are good medical facilities provided at Haldia. The names and phone numbers of hospitals and nursing homes are as below:

Sl. No.	Name of hospital / nursing home	No. of beds	Phone N
01.	Dr. BC Roy Hospital Banbishnupur, Balughata	300	03224-269048
02.	Haldia Sub-Divisional Hospital Basudevpur, Haldia	200	03224-274108, 278112
03.	Midland Nursing Home Manjushree, HPL Link Road Haldia	30	03224-275200
04.	Sab Nursing Home and Diagnostic Centre HPL Link Road, Haldia	25	03224-274318
05.	Hospital of IOCL Haldia Township		
06.	Hospital of Haldia Dock Complex Haldia Township		

Dr. BC Roy Hospital and Haldia Sub-Divisional Hospital have full-fledged facilities for treatment and more numbers of indoor beds. Apart from above, a full-fledged hospital with all facilities exists at Tamluk which is about 30 km away from Durgachak, Haldia. In addition, will be a first aid post inside the terminal manned by a Doctor and a male nurse equipped with all emergency medical facilities.

4.9.2 Evacuation

(1) A Planning and training on evacuation techniques are important in preventing injuries. Evacuation of local communities or people near the site may be prudent depending on the situation and down-wind dispersion information etc. Although this action will normally be initiated and handled by district authorities, the affected installation shall help to implement such evacuation.

(2) This planning should consider:

a. Basis for recommending on-site or off-site action
b. Authorize person for area or site evacuation.

4.9.3 Termination of emergency

(1) Termination activities should concentrate on giving accurate information to people who need it most, and should begin as soon as the emergency phase of the operation is completed.

(2) The termination of emergency shall be declared through siren as per the Siren Code defined by industry in case of Level- I & II. For Level-III termination of emergency shall be declared by District Authority.

4.9.4 Recovery Procedures

After the emergency, the following activities need to be carried out in detail.

a) Information to Statutory Authorities.
b) Incident Investigation.
c) Damage Assessment.
d) Salvage of products, de-contamination, clean-up and Restoration.
e) A detailed report shall be prepared based on the entire experience of the incident, including restorations, limitations and Lessons learnt.

4.10 INTEGRATION OF THE ERDMP WITH THE NATIONAL DISASTER MANAGEMENT PLAN (NDMP) 29.1 NATIONAL DISASTER MANAGEMENT PLAN (NDMP)

(1) On 23 December 2005, the Government of India took a definite step towards NDMP by enacting the NDMP ACT, 2005. The NDMP Act, 2005 is a Paradigm Shift from a response and relief-centric approach to a proactive and comprehensive mindset towards NDMP covering all aspects from prevention, mitigation, preparedness to rehabilitation, reconstruction and recovery.

(2) Similar to National Authority at the Centre, the State Government is to establish a State Disaster Management Authority for the State. The State Authority is to be headed by the Chief Minister of the State as the Chairperson. Every State Government, in turn, is to establish a District Disaster Management Authority for every district in the State with the District Collector as the Chairperson.

(3) The Central Government is empowered to take further measures as it deems fit for the purpose of disaster management like deployment of naval, military and air forces, other armed forces of the Union or any other civilian personnel as may be required for the purposes of this NDMP Act. Government of India is empowered to establish institutions for research, training, and developmental programmes in the field of disaster management as per this Act.

(4) The national vision is to build a safer and disaster resilient India by developing a holistic, proactive, multi-disaster and technology driven strategy for NDMP. This will be achieved through a culture of prevention, mitigation and preparedness to reduce the impact of disasters on people. The entire process will centre stage the community and will be provided momentum and sustenance through the collective efforts of all government agencies supported by Non-Governmental Organisations (NGOs).

(5) National Disaster management Structure showing the interactive linkage among various agencies for synergised management of disaster is given below.

4.10.1 District Administration

On receipt of information, District Administration may take the following actions as per Schedule-V derived from the National Disaster Management Guidelines

Chemical Disasters (Industrial), April, 2007. However, On receipt of information, following actions should be taken care:

(a) to keep watch on the overall situation.
(b) rush ambulance to the incident site if casualties are reported.
(c) direct cranes or any other such equipment to carry out rescue operations.
(d) issue warning messages to people through public address system, if any evacuation is required.
(e) arrange emergency vehicles for evacuation purposes.
(f) give direction to hospitals having burns injury ward for readiness to receive patient in case of incident involving fire.
(g) provide basic amenities, e.g., water, electricity, food and shelter to the affected people as required.

In addition to the above, the Schedule-V shall be followed.

4.10.2 Security Threat Plan

(1) With increase in terrorist activities towards the end of 20th century and installations having, significant role in national economy, sabotage and bomb threats to such installation should also be considered in the disaster management plan. Such as high level of alertness measures, strengthening security measures by security gadgets mechanical and electronic security gadgets. In any of such situation, city police/ administration should be informed immediately and their help should be sought.

(2) Emergency Action in case of Bomb Threat:

(a) The persons inside the Plant should be evacuated as soon as possible.
(b) All the vehicles in the plant premises should be evacuated to safer places.
(c) Plant personnel should contact district authorities immediately.
(d) Any new or doubtful thing should not be touched.
(e) All pipeline and tank valves should be closed and all the operations inside the Plant should be stopped.
(f) In case of fire, fire-fighting equipments shall be operated and city fire brigade should be called immediately during emergency.

4.10.3 List of Relevant Statutes on Management of Hazardous Substances

(a) The Environment (Protection) Act, 1986 (amended 1991) and following Rules there under:

- The Environment (Protection) Rules, 1986 (amended 2004).
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (amended, 1994 and 2004).
- The Hazardous Wastes (Management and Handling) Rules, 1989 (amended 2000 and 2003).
- The Environment Prior Clearance Notification, 2006.
- The Chemical Accidents (Emergency Planning, Preparedness and Response) Rules, 1996.
- Bio-medical Wastes (Management and Handling) Rules. 1989.

(b) The Factories Act, 1948 (amended 1987).

- State Factory Rules.

(c) The Inflammable Substances Act, 1952.

(d) The Motor Vehicles Act, 1988 (amended 2001).

- The Central Motor Vehicles Rules, 1989 (amended 2005).
- The Public Liability Insurance Rules, 1991 (amended 1992).
- The Public Liability Insurance Rules, 1991 (amended 1993).

(e) The Petroleum Act, 1934.

- The Petroleum Rules, 2002.

(f) The Insecticide Rules, 1968 (amended 2000).

- The Insecticide Rules, 1971 (amended 1999).

(g) The National Environment Tribunal Act, 1995.

(h) The Explosives Act, 1884 (amended till 1983).

- The Gas Cylinder Rules, 2004,
- The Static and Mobile Pressure Vessels (Unfired) Rules, 1981 (amended 2002).
- The Explosives Rules, 1983 (amended 2002).

4.11 THE IMPORTANT ROLES AND RESPONSIBILITIES OF VARIOUS STAKEHOLDERS

a) Oil and Gas Installations and Areas

The above mentioned Installation should provide necessary information to Mutual Aid Association, District Authority, Police and Fire Services.

i) List of Hazardous Chemical and Systems which have potential to cause danger to Human, Environment and Property.
ii) On-Site Emergency Plan and Periodic Mock Drill.

The above entities should support authorities in mitigation, rescue and rehabilitation, with resources identified and agreed with the authorities in advance. Such areas shall be included in Off-Site Emergency Plans.

b) **The district authority** is responsible for the Off-Site emergency plan and it shall be equipped with up-to-date Major Accident Hazard units, website, control room etc., with provisions for monitoring the level of preparedness at all times. Regular meetings of various stakeholders of Chemical Disaster Management will be conducted by district administration/District Disaster Management Authority to review the preparedness of Chemical Disaster Management.

c) **The police** will be an important component of all disaster management plans as they will be associated with investigation of incident s/disasters. Police take overall charge of the Off-Site situation until the arrival of the district collector or its representative at the scene.

d) The **fire services** are one of the first responders and shall be adequately trained and equipped to handle chemical emergencies. Fire services are to acquire a thorough knowledge of likely hazards at the incident site and the emergency control measures required to contain it.

e) In a chemical emergency, the **revenue department** shall coordinate with other agencies for evacuation, establishment of shelters and provision of food, etc.

f) When required for evacuation purposes in a chemical emergency, the **department of transport** should made transport promptly available.

g) The role of **civil society and private sector** in the Off-Site plan shall be defined.

h) **The health department** needs to assure that all victims get immediate medical attention on the site as well as at the hospitals/health-care facility where they are shifted. In addition, the department needs to network all the health-care facilities available in the vicinity for effective management and also take effective measures to prevent the occurrence of any epidemic.

i) **Pollution control boards** need to ascertain the developing severity of the emergency in accordance with responsive measures by constant monitoring of the environment. If and when an area is fit for entry will depend upon the results of the monitoring. A decontamination operation would be required to be carried out with the help of other agencies and industries.

j) **The NDRF and SDRF** are the specialised forces to manage these disasters in a longer run according to the severity and nature of the disaster. Their specialised training is an effective measure that needs to be built up and maintained with time for achieving a higher standard of preparedness. They need to coordinate with other local agencies such as the Central Industrial Security Force that may be responsible for security at the industrial site.

4A.1 DMP FOR THE CRYOGENIC LPG RECEIPT & DESPATCH PIPELINE

Disaster is an undesirable occurrence of events of such magnitude and nature that adversely affect production, cause loss of human lives and property as well as damage to the environment. Industrial installations are vulnerable to various kinds of natural and manmade disasters. Examples of natural disasters are flood, cyclone, earthquake, lightning etc. and manmade disasters are like major fire, explosion, sudden heavy leakage of toxic/poisonous gases, civil war, nuclear attacks, terrorist activities etc. It is impossible to forecast the time and nature of disaster, which might strike an undertaking. However, an effective disaster management plan helps to minimize the losses in terms of human lives, plant assets and environmental damage and resumes working condition as soon as possible.

Risk Analysis forms an integral part of disaster management plan and any realistic disaster management plan can only be made after proper risk analysis study of the activities and the facilities provided in the installation. Correct assessment and evaluation of the potential hazards, advance meticulous

planning for prevention and control, training of personnel, mock drills and liaison with outside services available can minimize losses to the plant assets, rapidly contain the damage effects and effectively rehabilitate the damage areas.

The LPG transported by the pipeline is highly inflammable. Any occurrence of leak /burst and consequent fire/explosion will not only inflict heavy loss and damage to the properties but can also disrupt the normal pattern of the life and environment of people living around as well as operation in the Refinery. Possibilities of injuries or deaths also cannot be ruled out. Although elimination of all these hazards is not possible, having an advanced preparedness to handle different types of emergencies and having a disaster control plan can minimize the loss. However, population around the pipeline is minimum or nil situated on the bank of the river Hooghly in one side and on the other side factories are situated. Since the pipeline originates from Haldia oil Jetty No. 3 and terminates in the plant at Patikhali area detailed off- site emergency plan shall be prepared by District Collectorate in consultation with M/s Aegis and the neighbouring industries, local municipality, Hospital and other Statutory Bodies.

However, an outline of the Emergency and OFF-SITE plan has been discussed here.

4A.2 ROUTING OF THE PIPE LINE AND SURROUNDING AREA

The routing of the pipeline has been selected through the shortest possible path. The on-shore pipeline will originate from Haldia Oil Jetty No. 3 and end in Refrigerated storage tanks in the plant which is located in Patikhali, Durgachak area. On the route it will pass by the side of IOC, Haldia Refinery, HFCL, Tata Power, BPCL area. The pipeline will pass by the side of river Hooghly on one side and factories on the other side. The pipeline will also connect the HOJ 2 & HOJ 1 jetties.

4A.3 OBJECTIVES OF THE DISASTER MANAGEMENT PLAN

The main objectives of the Disaster Management Plan would be to –

i] Ensure that loss of life and injuries to persons are minimized.
ii] Ensure that property losses are minimum.
iii] Ensure that relief and rehabilitation measures are put into action in the shortest possible time.

4A.4 PRIORITY OF HANDLING EMERGENCIES

The general order of priority for invoking measures during the course of emergency will be as follows:

i] Safeguard Life.
ii] Stop product leakage & contain the spillage from spreading.
iii] Safeguard Property.
iv] Extinguish any fire, which develops.
v] Bring to normal operating condition as early as possible.

4A.5 PROBABLE DISASTER

A disaster in a pipeline could occur due to any of the following reasons:

FIRE / EXPLOSION

- ☞ At cross country location.

LEAKAGE OF LPG AND DAMAGE

- ☞ To mainline.
- ☞ To other pipelines

OPERATIONAL

- ☞ Fire at Mainline – Leakage, Pilferage, Sabotage, Burst of pipeline etc.
- ☞ LPG Spillage – Leakage due to line breakage or open valves.
- ☞ Leakage from mainline due to corrosion.

NATURAL CALAMITIES

- ☞ Heavy rains resulting in washout or breaches.
- ☞ Earthquakes.
- ☞ Cyclonic Winds.
- ☞ Landslides.
- ☞ Tsunami

MAN MADE

- ☞ Sabotage.
- ☞ Pilferage.
- ☞ War.
- ☞ Riots.
- ☞ Civil Commotion.
- ☞ Terrorist activity.

4A.5.1 Declaration of the Disaster

The disaster is declared by the Chief Coordinator.

DISASTER SIGNALS

- ☞ SIREN will be provided for warning & signaling they will be used.
- ☞ Two minutes wailing sound siren is sounded for any major fire. Thereafter, as per the direction of Chief Coordinator.

TERMINATION OF EMERGENCY

- ☞ Once the all clear Signal is given by the Chief Coordinator.

WHO SHOULD REPORT THE FIRE DISASTER AND HOW

- ☞ Any person who sees a fire or unsafe conditions anywhere in the route should report it to Aegis Logistics or IOCL Authorities or Haldia Dock Complex authorities, Police Station, Fire Brigade etc.
- ☞ Person reporting the fire/emergency should state the location at a prominent place to guide fire fighting crew arriving on the scene.

- ☞ Aegis Logistics/ IOCL Authorities/ HDC authorities/ Police/ Fire Brigade will inform the concerned authorities of the District Administration and other bodies.

4A.6 EMERGENCY COMMAND CENTER

Transit camp near IOCL may be identified as Emergency Command Center during emergency in order to have command over the emergency & control the emergency in an effective manner. This will be headed by District Collectorate or Chief Crisis Coordinator at Aegis Logistics.

4A.7 FACILITIES/DOCUMENTS IN EMERGENCY COMMAND CENTER

Following facilities and documents will be available in the Emergency Command Center:

- ☞ P&T/Mobile telephone/Internal Telephonic like VHF sets.
- ☞ Hazardous area drawing of pipeline route and surroundings.
- ☞ Piping & Instrumentation Diagram.
- ☞ Route map of mainline under respective jurisdiction.
- ☞ Disaster Management Plan.
- ☞ Map of the adjoining area.

4A.8 CLASSIFICATION OF DISASTERS

The factors causing the disasters are different. However, the control measures required to combat some incidents are similar. These are classified into various groups as given in the following table:

SL. NO.	TYPE
1.	LEAK
2.	FIRE
3.	LEAK & FIRE
4.	BURST
5.	BURST & FIRE
6.	EXPLOSION

4B.8.1 Leak in the pipeline

CAUSES

- ☞ Corrosion.
- ☞ Mechanical Failure.
- ☞ Operational Failure.
- ☞ Damage to the pipeline due to malicious intensions of third party like sabotage.
- ☞ Natural Calamities like earthquake, flood, cyclones, etc.

CONSEQUENCES

- ☞ LPG spillage
- ☞ Fire hazard
- ☞ Explosion

CONTROL MEASURES

- ☞ Cordon the area.
- ☞ Prevent ignition.
- ☞ Stop LPG spillage and contain LPG spillage.
- ☞ Clean the area.

CHECK LIST FOR MOBILIZATION REQUIRED

MANPOWER

- ☞ Coordinators
- ☞ Police/Home Guard
- ☞ Fire Fighting Crew
- ☞ Labour

EQUIPMENT

- ☞ Fire Fighting Equipment.
  - Extinguishers.
  - Fire Tenders from Mutual Aid & Fire Brigade.
- ☞ Cars, Jeep.
- ☞ Communication equipment.

4A.8.2 Burst of the pipeline in onshore line

CAUSES

- ☞ Corrosion.
- ☞ Mechanical failure.
- ☞ Third Party Activity.
  - Damage to the pipeline with malicious intentions of the third party (Attempt for pilferage, riots etc.)
- ☞ Damage due to the Natural Calamities.
  - Earthquake.
  - Cyclone.
  - Tsunami

CONSEQUENCES

- ☞ LPG spillage
- ☞ Fire Hazard / Explosion

CONTROL MEASURES

- ☞ Prevent Ignition
- ☞ Stop LPG spillage
- ☞ Contain LPG spillage
- ☞ Clean the Area

CHECK LIST FOR MOBILIZATION REQUIRED

MANPOWER

- ☞ Emergency Coordinators.
- ☞ Supervisory/Non-Supervisory Personnel from Aegis Logistics and Other factories and Mutual aid members
- ☞ Fire Fighting Crew from Aegis Logistics and Other factories and Mutual aid members

☞ Police/Home Guard/District/PWD

EQUIPMENT

☞ Fire Fighting Equipment
- Fire Tender
- Extinguishers
- Water Sources

☞ Tank Lorries for Transportation of Labour and Equipment.
☞ Cars, Jeeps
☞ Mainline Emergency Equipment.
☞ Portable radio sets, antenna, bamboo etc. or Cellular Phone
☞ Portable Generators, Cables, Bulbs, Bamboo etc.

4A.9 ORGANIZATIONAL STRUCTURE, RESPONSIBILITIES AND ACTION PLAN

4A.9.1 Emergency Procedures

The control measures will depend upon the type and the degree of the disaster. The causes, the likely consequences, control measures and the check list for the mobilization required for man power and equipment for different types of emergencies classified in earlier section. However, the typical measures required will be:

☞ To stop pumping.
☞ To prevent ignition.
☞ To stop leakage.
☞ To extinguish fire if leaked LPG catches fire and cooling of the neighbouring equipment/pipeline.
☞ To cordon off the area and to prevent public from going near the site.
☞ To inform statutory authorities and mutual aid partners.

4A.9.2 Organization Structure and Responsibilities

4A.9.2.1 Organization

District Collectorate or Chief Manager of Aegis Logistics will be the Chief Coordinator. He will be assisted by junior officers from the various departments to effectively combat the situation. The organization during the disaster control period for the emergencies in the station and at the cross country locations are given in earlier section.

District Collectorate & Chief Manager of Aegis Logistics should name the coordinators and should make charges whenever there are movements. The alternate coordinators to take care of the situations when the coordinators are on leave/tour are also to be named. The remaining junior officers should be assigned to different coordinators. Both the lists should be displayed in the control room of Aegis Logistics.

The organogram for disaster management require to be prepared based on typical set up of M/s.Aegis Logistics, Haldia Dock Complex and IOCL. For mobilizing the resources, Safety Department of IOCL will take action in consultation with M/s.Aegis Logistics. GMs/DGMs and other officers of mutual aid will be the crisis coordinators at the time of emergencies.

4A.9.3 Emergency Equipment

The equipment required for handling the emergencies is identified. These are kept separately and not used for normal maintenance work. It is also ensured that the equipment like portable generator, communication system, safety accessories etc. are in working condition by checking them at predetermined intervals. The tentative list of the normal equipment required shall be as per statutory requirement and shall be regularly updated.

LIST OF PERSONAL PROTECTIVE EQUIPMENT FOR THE USE DURING EMERGENCY

The following personal protective equipment are available during an emergency in AEGIS. Such personal protective equipments are to be available during off-site emergency.

a) Safety Shoes
b) Fire proximity suit
c) Low temp suit
d) Low temp gloves
e) Self Contained Breathing Apparatus
f) Water Gel Blanket
g) Safety Helmet
h) Asbestos and Cotton Hand Gloves
i) Rubber hand gloves for the use in electrical jobs
j) Resuscitator
k) Explosimeter

The quantities available should be sufficient to meet the needs of emergency handling personnel.

4A.9.4 Mutual Aid

4A.9.4.1 Arrangements should be made with outside agencies for the mutual assistance during the emergencies in different fields as recommended and detailed below for pipeline emergencies:

i) IOCL Refinery/ Local Municipal fire brigade	:	Fire Fighting
ii) Hospitals of IOCL, Haldia Dock Complex	:	Ambulance
iii) Major Industries	:	Repairs
iv) Police/Home Guards	:	Traffic Control/Security
v) Coast Guard/HDC	:	Fire Fighting

4A.9.4.2 Help required from various outside agencies is given in the later part of this Chapter. M/s.Aegis Logistics should interact/apprise the concerned agencies about disaster control plan and the help required from them at the time of emergencies.

4A.9.4.3 Chief Coordinator maintains constant liaison with the authorities of these establishment. For firefighting operations they are required to visit the site for familiarization of location, system and layout. Formats and check list of the information to be given to the outside agencies at the time of crisis is mentioned as hereunder:

FORMAT AND CHECK LIST

☞ **TO POLICE**

- Location of the incident .
- Type and Nature of Accident.
- Dos & Donts
- No. of fatal cases /Injured.
- Situation.
- Security arrangements required for cordoning the area.
- Help of the people, wireless for communication.

☞ **TO HOSPITAL**

- Location.
- Type and Nature of Accident.
- No. of Injured with details
- Type of treatment required for burns/injuries etc.
- Assistance required, ambulance, service or doctors etc.

☞ **TO DISTRICT MAGISTRATE & OTHER STATE AUTHORITIES**

- Location.
- Type and Nature of Accident.
- Situation.
- No. of fatal cases /Injured.
- Precaution to be taken.
- Assistance required.
- Any other relevant information.

4A.9.5 Welfare

☞ Food , beverages, water , periodic resting arrangements will be ensured for the emergency team working round the clock at the pipeline site.

☞ The welfare and whereabouts of the officers will be informed to the family members.

4A.9.6 Training

☞ Emergency drills are to be organized. All the employees are to be trained in fire fighting annually. Every new employee should be trained before taking charge.

☞ All the employees should be familiarized with the disaster control plan and about their individual roles & responsibilities for different scenarios and action to be taken.

☞ The Chief Manager of Aegis Logistics / District Collectorate will discuss at least once in a quarter with the officers of mutual aid about the plan. The officers should discuss this with the employees working with them once in a month.

☞ The Chief Manager of Aegis Logistics will also interact with counterparts of mutual aid partners and District Collectorate about tasks to be done by them at times of emergency.

4A.9.7 Security

- ☞ Only employees of mutual aid companies and other connected persons like fire fighting, security, ambulance crew will be allowed around the site of incident..
- ☞ At the site of the incident , the area will be cordoned off.
- ☞ Unauthorized persons will not be allowed to enter the area.
- ☞ Smoking will not be allowed in the area.

4A.9.8 Public Relations

- ☞ Only the Chief Manager of Aegis Logistics / District Collectorate and their authorized representative will brief the Press.
- ☞ The authorized representative will consult the Organization Head before briefing the Press.
- ☞ Recommended (DO'S & Don'ts) are given as hereunder & the concerned person will exercise right judgment & discretion in communication:

PUBLIC RELATIONS

DO'S

- ☞ Release only authorized verified written information.
- ☞ Escort the press to the nearest safe place on the emergency site.
- ☞ Keep accurate records and logs of all the enquiries and news coverage.
- ☞ Only Aegis Authorised Press Coordinator/ District Collectorate or authorized representative will be the spokesman.

DON'Ts

- ☞ Speculate on resumption of normal operations.
- ☞ Speculate on causes of the emergency.
- ☞ Speculate on the outside effects of emergency.
- ☞ Interfere with the legitimate duties of media representatives like Air/TV/ Press.

4A.9.9 Information to Public

It will be useful to educate the people working or living nearby about the hazards and Do's and Don't about the LPG Safety Precautions to be taken by individuals. Information to be given to the public is mentioned as hereunder. For this purpose meetings will be organized in small groups of 10 to 15 persons in the nearby area. Responsible persons from Aegis Logistics will visit the populated areas and organize the meetings with the help of Municipality Personnel. However, people living near the pipeline are almost nil.

INFORMATION TO PUBLIC

- ☞ No construction activity should be carried out near the pipeline.
- ☞ If any LPG is found near ROW, it should be informed to the nearest police station/ Aegis Logistics/ IOCL authorities/ HDC/ Fire Station.
- ☞ If any LPG is found, public should stay away at a minimum distance of 30 meters from the pool of LPG.

LPG is highly inflammable and it is very dangerous to handle it.

4A.9.10 Organizational Structure During Disaster

The disaster will be handled by Chief Coordinator who is generally District Collector / Chief Manager of Aegis Logistics. As the pipeline is outside the factory premises he will be assisted by various Coordinators.

4A.9.10.1 The responsibility of the various coordinators are stated hereunder

4A.9.10.2 Chief Coordinator

- ☞ Emergency control centre shall be established in consultation with the District Administration and concerned neighbouring industries.
- ☞ To inform top management and highest management level about the incident, magnitude of the disaster, combating operations and number of casualties, if any etc.
- ☞ To contact crisis cell of the administrative set up of Govt and inform about the incident, magnitude of the disaster, combating operations, number of causalities if any and any assistance required from outside agencies at the state & national level.
- ☞ To approve release of information to Press, TV and Government agencies.
- ☞ To supply manpower from Aegis Logistics and other mutual aid partners as required by Crisis Coordinators.
- ☞ To arrange mobilization of material and equipment from Aegis Logistics and outside agencies as required by Crisis Coordinators.
- ☞ To arrange periodic mock drill for emergency.
- ☞ To assess the scale of emergency and decide if a major emergency situation exists or is likely. On this decision he will declare a state of emergency.
- ☞ To supply manpower, equipment and machinery from unit and other mutual aid companies as per the requirement of the Crisis Coordinators.
- ☞ To ensure and confirm about the contact of statutory bodies/Governmental agencies viz.

  - District Collectorte
  - Chief Inspector of factories.
  - Chief Controller of Explosives, Nagpur.
  - State and Central Pollution Control Board.
  - State Chief Secretary, Home Secretary, Director General of Home Guard, Civil Defence and Coast Guard authorities.

- ☞ Maintain a speculative continuous review of possible development and assess these to determine most probable course of events.
- ☞ Prepare the message of incident for the release of information to the Press & Television.

4A.9.10.3 Crisis Coordinator (Fire Fighting)

On getting the information, he will instruct fire services of IOCL and Municipality to be present at the Disaster Management Control Room / Emergency Control Centre along with Fire Tender. His jobs will be –

- ☞ To instruct personnel at ship to stop pumping and close valves in ship.
- ☞ To instruct to spray foam compound to prevent fire or to extinguish fire.
- ☞ To arrange more Fire Tenders from state Fire Services, if necessary.
- ☞ To involve Coast Guards, if necessary for fire fighting.

4A.9.10.4 Crisis Coordinator (Material)

He will be responsible for –

- ☞ Supply of material to disperse released LPG.
- ☞ Inform to Fire wing for readiness or if any help is needed.
- ☞ Seek help for -
  - **Fire Fighting –** IOCL, Municipal Fire Service/Home Guard/Civil Defence.
  - **Medical Aid –** District Medical Officer.
  - **Rescue –** Civil Defence/Home Guards/Police.

4A.9.10.5 Administration Coordinator

- ☞ He will be overall responsible for any administrative affair.
- ☞ He will be responsible to liaise with civil administrative affair.
- ☞ He will liaise with concerned town police station.
- ☞ He will be responsible to provide all medical facilities with the help of medical coordinator.
- ☞ He will ensure all welfare facilities to the company employees and to the affected people at site through Welfare/Media Coordinator.
- ☞ He will be responsible to convey all necessary information regarding security, medical and welfare activities to the Chief Coordinators.
- ☞ He will be responsible to set a Public Address System in coordination with communication incharge and will make the public conscious about the incident through Welfare/Media Incharge.
- ☞ He will contact all statutory bodies and Government agencies to feed necessary information about incident.
- ☞ He will inform custom / excise authorities.
- ☞ To ensure mobilization of all available vehicles and transport for emergency use, including renting of vehicles as needed.

4A.9.10.6 Security Coordinator

- ☞ He will be responsible to make all security arrangement.
- ☞ He will be always in contact with Administration Coordinator and will pass all information to him.
- ☞ He will be responsible for necessary arrangement to cordon off the danger zone.
- ☞ He will be responsible to escort jeeps to bring higher authorities, external fire tender etc.
- ☞ He will ensure arrangement of security personnel, if required.
- ☞ He will be responsible to arrange extra security personnel, if required.
- ☞ He will be responsible to liaise with local police stations.
- ☞ To have gates and roads clear of traffic for easy movement of fire tenders, ambulance's staff on emergency duty.
- ☞ To ensure liaison with Chief Coordinator.

4A.9.10.7 Medical Coordinator

- ☞ He will be responsible to set First Aid Centre at site.
- ☞ He will mobilize first aid team and start giving first aid measures to the injured persons.
- ☞ He will arrange ambulance and nurse at site round the clock.
- ☞ He will ensure procurement of required drugs/appliances through Material Coordinator. Hospital staff (if any) will report to Medical Coordinator.
- ☞ To ensure maintenance of casualties register, type of injury, number, hospitalization etc. and will coordinate with police for completing the formalities, if anyone is found dead.
- ☞ He will be responsible to send the required persons to the hospitals / nursing home.
- ☞ He will inform Chief Coordinator if there are any constraints/difficulties.

4A.9.10.8 Welfare / Media Coordinator

- ☞ He will provide all welfare facilities to company personnel and the affected people.
- ☞ He will coordinate with Public Bodies like Police, Civil Authorities, Civil Defence, and Hospital etc.
- ☞ He will liaise with Admn. Coordinator for transportation arrangement to send the victims to Hospital.
- ☞ He will arrange for announcement for families of staff who are injured and to avoid panic in the nearby locality.
- ☞ He will ensure release of approved press statements.
- ☞ He will ensure arrangement for photographs/video filming of the incident and liaison with various press media, handle media interviews.
- ☞ To assist and provide food, clothing to all affected persons and for fire brigade and mutual aid personnel.
- ☞ To ensure arrangement of providing mineral water, soft drink, snacks etc. to fire fighting crew/medical teams/personnel on emergency duties. The food would be required depending on the situation, however, arrangement shall be made to have enough provisions to provide additional 50 meals during 24 hours period.

4A.9.10.9 Maintenance Coordinator

- ☞ He will promptly mobilize a technical/engineering team of all disciplines of maintenance as per the requirements.
- ☞ To promptly arrange for renting/hiring equipment and men to meet emergency requirements.
- ☞ To keep liaison with Admn. Coordinator for transport service.
- ☞ After reaching the site he will make arrangement to contain the disaster.
- ☞ To mobilize all necessary materials at site.
- ☞ He will coordinate with the authorities of Refinery, Marketing, Irrigation and PWD for necessary requirements of equipment, materials and manpower.
- ☞ To provide all engineering help needed by Fire and Safety crew/Civil Defence and other Civil/Govt. agencies in consultation with Chief Coordinator.
- ☞ To ensure arrangement of urgent fabrication jobs from outside agencies if the need arises.

- ☞ He will test and commission the affected pipeline after the repairing work is over and will be responsible to issue work completion certificate to Chief Coordinator.

4A.9.10.10 Electrical Coordinator

- ☞ To arrange all electrical facilities at site.
- ☞ To ensure electrical safety at work place.
- ☞ To arrange electrical generator and other major electrical equipment as an emergency standby.
- ☞ To keep informed Chief Coordinator.

4A.9.10.11 Communication Coordinator

- ☞ To arrange entire communication system and to keep the system alive.
- ☞ To install the portable radio set with antenna and establish communication with portable mobile radio set.
- ☞ To arrange PA System, install it and make public aware of the danger involved.
- ☞ To ensure local P&T telephone line is in order.
- ☞ To maintain a liaison with other coordinator for their communication needs.
- ☞ To keep informed Chief Coordinator.

4A.9.10.12 Mechanical Coordinator

- ☞ To carry out all emergency activities, actions work at site.
- ☞ To stop and contain LPG spillage.
- ☞ To perform pipeline repair job, if required and decided.
- ☞ To test and commission the repaired pipeline.
- ☞ To be in close contact with maintenance coordinator and will inform constantly the progress of the work.
- ☞ To keep informed Chief Coordinator.

4A.9.10.13 Material Coordinator

- ☞ In-charge of urgent emergency & maintenance materials procurement, receipt and issue.
- ☞ To provide any equipment required by maintenance and fire and safety coordinator.
- ☞ To give feed back to Chief Coordinator regarding material procurement.
- ☞ To coordinate with marketing division of Aegis Logistics for diesel procurement.
- ☞ To ensure positioning of staff at storage/warehouse points.
- ☞ To maintain liaison with other coordinators.

4A.9.10.14 Search Party Coordinator

- ☞ He will promptly proceed to find out the actual location of incident.
- ☞ To ensure that pipeline section is isolated, as per emergency plan of the scenario.
- ☞ After locating the site, ensure the closing of the upstream/downstream valves to contain the leaks.

- ☞ Assess the situation i.e. quality of leakage / spillage, how far it has spread, likely consequences, resources required and give feed back to the Chief Coordinator and request for the following assistance:
  - F&S personnel
  - Maintenance group with all resources
  - Labourers
- ☞ Ask for local fire brigade, inform police and take assistance in evacuating the areas, if necessary.
- ☞ Identify nearby water sources for fire fighting.
- ☞ Ensure security at site by posting Chowkidar, Patrolman, local police or Home Guards.
- ☞ He will work as the off-site coordinator and be a part of the Maintenance Coordinator.

4A.9.10.15 Fire & Safety Coordinator

- ☞ As soon as the Fire & Safety Coordinator receives the call, he will immediately mobilize his trained fire fighting personnel with all necessary firefighting equipment and extinguishing agents, Fog nozzles etc.
- ☞ He will immediately contact fire brigade station at Haldia Dock Complex & IOCL refinery and mobilize the necessary help.
- ☞ He will ensure immediate information to all mutual aid agencies for turnouts.
- ☞ After involvement of all the fire services, it will be duty of F&S Coordinator to direct and assist them with necessary information and other requirement to achieve the target.
- ☞ He will be fully responsible to mobilize all the activities related with fire and safety equipment, materials and personnel's.
- ☞ He will liaison with other coordinators and feed all information to Chief Coordinator.
- ☞ To liaison with Chief Coordinator for replacing of fire fighting materials and shall arrange to despatch it to the site or scene of fire.

4A.9.10.16 Finance Coordinator

- ☞ To ensure arrangement of finance for the coordinators for emergency purchase.
- ☞ To ensure care of insurance formalities.
- ☞ To provide other financial help, if required.
- ☞ Assist Welfare/Medical Coordinator in actual disbursements of funds.
- ☞ Keep a record of all expenses.
- ☞ Ensure that such expenses are included in the insurance claim.

4A.9.10.17 Action Plans (Emergency in Mainline)

a) EMERGENCIES ON MAINLINE-ACTION PLAN

Indication of an emergency on the mainline can come from different sources. These can be -

- ☞ Notification from people living in the vicinity.
- ☞ Notification from local authorities e.g. Police.

- ☞ Notification from station instruments like leak detection system, flow meters and in pressure drop in the pipeline. When any such notifications is received that there is a possible emergency on the main pipeline, the following persons shall take responsibility for the actions detailed.

b) SEARCH PARTY LEADER

- ☞ Proceed to the location along with other specified manpower and will lead the search team towards the suspected site along the Right of Way.
- ☞ After locating the site, try & ensure cutting of source of leakage of LPG
- ☞ Assess the situation and give feedback to Chief Coordinator for further assistance/mobilization.
- ☞ Request local fire brigade, inform nearest Police Station and seek assistance in evacuating the area, if necessary.
- ☞ Identify nearby water resource for firefighting which is river Hoogly.
- ☞ Ensure security at site.

c) MAINTENANCE COORDINATOR

- ☞ Decide whether and how to attend, arrest & repair the leakage
- ☞ Arrange for the mobilization of the emergency response team to repair damage.
- ☞ Ensure that any materials used are reordered to replenish the stock of emergency material.
- ☞ Maintain the stock of emergency materials in accordance with company policy.

d) OTHER COORDINATORS

Responsibility of Crisis Coordinators and Chief Coordinator will remain same as mentioned above.

4A.10 RESPONSIBILITIES DURING ODD HOURS

4A.10.1 The roles of shift personnel during odd hours

4A.10.1.1 On getting the information/seeing the emergency in the pipeline route, shift engineer should inform ship personnel to take emergency shut down and inform the concerned officials in the Plant.

4A.10.1.2 With the actuation of ESD he should ensure that transfer operation is under shutdown and relevant valves are closed to minimize / stop leakage.

4A.10.1.3 Subsequent to operation of ESD, shift engineer should sound the fire siren.

4A.10.1.4 Shift Engineer should also communicate the emergency message to Chief Coordinator and also inform the fire brigade of HDC as well as local fire brigade & IOCL refinery as it is closest with all resources.

4A.10.1.5 Chief Coordinator should immediately rush to the spot for establishment of emergency control centre and act as per the existing DMP.

4A.10.1.6 Shift Engineer should assess the scene and start fire-fighting operation/try to control the situation with the help of shift helper.

4A.10.1.7 Upon arrival of Chief Coordinator and other coordinators to the spot, Shift Engineer should assist the crew for fighting fire/trying to control the situation.

4A.11 ASSISTANCE REQUIRED FROM OUTSIDE AGENCIES

4A.11.1 Liaison

Assistance may be required during the course of an emergency from any or all of the coordinator and they will be responsible for establishing liaison with these to effect assistance in as rapid manner as possible.

4A.11.2 District Collector and police for emergency on the pipeline

- ☞ To inform M/s Aegis Logistics about leak/burst on the mainline when the public brings it to the notice of IOCL, HDC, Police & Fire Brigade.
- ☞ In case of LPG Spillage, to ensure security at site to cordon off the areas and post guards for preventing the outside personnel going near the site of the spillage.
- ☞ In case of fire, mobilization of fire Tenders and Crew from local Fire Stations/other agencies are required.
- ☞ For deployment of Home Guards, if necessary.
- ☞ Traffic Control and Diversion (However, traffic does not exist in the route).
- ☞ Wireless communications facilities.
- ☞ Evacuation of civilian population, if necessary.
- ☞ Maintenance of communication with the public.

4A.11.3 Assistance required from neighbouring industry

- ☞ Repair equipment like portable Generator, Compressor and Welding Machine.
- ☞ Technicians for carrying out the Welding/Repairs.
- ☞ Fire Tender and Crew.
- ☞ Fire extinguishers & other associated accessories for emergency handling.
- ☞ Pneumatic Pumps and Hoses.
- ☞ Lories and trucks for movement of labour, equipment.
- ☞ Facilities for radiography.

4A.12 OFFSITE EMERGENCY PLAN

Offsite emergency plan deals with measures to prevent and control emergencies that would affect public and environment outside the premises. The main purposes of offsite plan are:

- ☞ To provide the local/District Authorities, Police, Fire Brigade, Doctors, surrounding industries and the public the basic information of risk and environmental impact assessment and to apprise them of the consequence and the protection/prevention measures and control plans to seek their help to communicate with the public in case of a major emergency.

- ☞ To assist the District Authorities for preparing contingency plan for the District or particular area and to organize rehearsals from time to time and initiate corrective actions based on past experience.
- ☞ Organization structure for offsite emergency plan is given before and therefore organograms are not repeated.
- ☞ Chief Controller shall organize various exercises to cultivate site preparedness and estimate offsite requirements in case of disaster.
- ☞ Central Control Room shall display address and phone nos. of all industries in the area and that of Govt. Authorities like District Collector, DSP, Fire Brigade and Hospitals, etc. Central Control Room shall be in touch with all these agencies and help District Authorities to plan their contingency plans.
- ☞ The lists of Government Agencies featuring in offsite action plan are mentioned elsewhere.

4A.13 HAZARDS OF THE PIPELINE

4A.13.1 General Nature of Hazard

In the transport of LPG through the pipeline the hazard can happen only in case of accidental release of hydrocarbons from pipeline due to faulty operation or due to accidental failure of pipeline, sabotage, terrorist activity or the like. In such cases the liquid will spill in the surrounding area and will cause mainly fire in the form of pool fire if it gets ignited. Explosion may occur if the vapour gets an ignition source within flammability limit. The fire/explosion in any form can cause damage to the property and people if failure occurs. The pipeline installation/operation requires:

i) Regular physical check up of the route.
ii) Well organized trained manpower for operation of the system safely and as per procedure.
iii) A quick responsive containment and control system requiring well planned safety and fire fighting system.
iv) Well trained personnel to handle safety and firefighting equipment to extinguish fire.
v) A well formulated Disaster Management Plan which covers well coordinated planning involving mutual aid between different organisations, district administration, hospitals and more over training/awareness of the people living around the pipeline route.

4A.13.2 Hazardous Areas along the Route

Refrigerated LPG will be under low pressure and as such release in case of probable failures would be minimum, and after stoppage of pump it would be almost negligible. Entire portion of the pipeline carrying the LPG is hazardous due to flammable nature of LPG. Other pipelines are also installed in the same route in option No 1 & have their own protection & mitigation system.

4A.13.3 Hazard Assessment

The hazard potential of LPG pipeline due to different scenarios has been discussed in chapter on Risk Analysis. The maximum credible hazard scenarios are LPG spillage due to small bore pipeline failure, pilferage, sabotage etc.

However, disaster potential observed from calculation of risk analysis has been done for different sizes of holes failure which are credible.

4A.14 DISASTER PREVENTIVE AND PREEMPTIVE MEASURE

4A.14.1 After identification and assessment of disaster potential the next step in Disaster Management Plan is to formulate and practice the preventive and preemptive measures. Proper preventive and preemptive measures can reduce the disaster potential to a minimum.

Preventive and preemptive measures are taken from design stage itself. Preventive measures, which are to be taken during design stage, are:

a) Use of proper material of construction for equipment and piping as per relevant code/specification.

b) Layout of the pipeline through less populated areas as far as possible.
c) Use of SRVs of proper size and capacity.
d) Safe design for supports for the over ground pipeline.
e) Leak detection & isolation system

Similarly precautions should be taken regarding procurement of materials, installation of the pipe line and supervision of work so that the pipeline installed can be regarded safe. Precautions during installation can be categorized as follows:

a) Procurement of pipes, flanges, gaskets, valves, NRVs etc. as per proper code/specification.
b) Inspection of the materials by some reputed & approved 3rd party inspection agency.
c) Selection of experienced & competent contractors specialized in such jobs with skilled persons for the trades.
d) Supervision of work by experienced engineers.

Next step in the preemptive measure is to formulate a detailed Disaster Management Plan where actions to be taken before, during and post disaster activities are to be clearly mentioned.

Although preparation of OFF- SITE Disaster Management Plan is the responsibility of District Administration, M/s. Aegis Logistics have to inform possible damage effects and disaster potential to the District Authorities. A district Hazard Management Committee/District Crisis Management Group as well as a local Crisis Group should be formed to take care of OFF-SITE emergency. Local police stations, industries, hospitals, etc. are to be associated in Off-Site Disaster Management.

4A.14.2 In case of Disaster management the most important activities to be taken up are:

i) <u>Physical Inspection</u>

Physical inspection of the pipeline route as well as monitoring of condition shall be done at regular intervals by Aegis Logistics personnel.

ii) Public Awareness

Creation of awareness amongst the employees/public living near the route about the disaster and the role they have to play in case of any disaster occurring is very important. Residents living near the route will be educated to recognize and report any emergency to the appropriate company personnel of Aegis, IOCL refinery which is close by with all emergency facilities at disposal, HDC as well as to personnel in District Administration like police, fire brigade, etc.

iii) Mock Drill

Mock drill is very important to know the strength and weakness of the response team. Efficient fixed as well as portable fire fighting arrangements are already existing inside IOCL and maintained by them. Fire services people of IOCL and state fire services are alert 24 hours to put out any type of fire.

Mock drill shall be conducted for different hazard scenarios along the route with the help of district administration, Aegis, as well as other industries/ establishment having mutual aid arrangement.

iv) Liaison with outside agencies

Liaison with industries in the area having arrangements of fire fighting e.g. other industries, Fire Brigade, Hospitals, District Administration i.e. Police, District Collectorate etc. for helping in mock drill as well as for a co-ordinated effort in combating disaster and provide relief and rehabilitation measures in case of disaster occurring.

v) Mutual Aid

A mutual aid scheme between Aegis Logistics and nearby industries and hospitals should be done for combating emergency based on risk analysis scenarios , mitigation measures & preventive measures.

vi) Communication

Proper and timely communication to the response team helps to minimise the effect of any disaster by taking suitable and timely action. Proper and latest communication facility has been envisaged for this facility.

vii) Formation of a Disaster Management Cell

Disaster Management Cell needs to be formed in case of OFF-SITE emergency condition. Planning and formation of cell is necessary for OFF-SITE emergencies on the route involving Aegis, IOCL, HDC, District Administration, Police, State Fire Services and heads of hospitals nearby and other statutory bodies like Chief Inspectorate of Factories, Pollution Control Board, other industries, etc.

4A.15 SITE SPECIFIC EMERGENCY PLAN INFORMATION

1] Key personnel of organization and responsibilities assigned to them in the event of an emergency

The key personnel for handling an emergency is derived from this structure and they are given specific roles and functions and detailed in the earlier sections.

2] Responsibilities Assigned to Key Persons

It has been discussed earlier.

3] Outside organizations that may be involved in assisting during Off-Site Emergency

It has been detailed elsewhere.

4] Details of liaison arrangement between the organizations

A formal MUTUAL AID scheme needs to be drawn between Aegis Logistics and other industries for assistance during emergency.

4A.15.1 Information on preliminary hazard analysis

1] Types of Accident

Laying of LPG onshore pipeline for the facility has potential for FIRE AND EXPLOSION in the event of leakage of LPG from pipeline. Failure cases may be considered as follows:

Sl. No.	Failure Case	Failure Mode	Consequence
1.	Full-Bore failure of Ship unloading Arm (10" dia.)	Non- Credible	Pool fire and explosion
2.	Holes formation in Ship unloading arm a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
3.	Holes in Pipeline near Lock Gate Area in KoPT a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
4.	Holes in Pipeline near boundary of IOCL refinery a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion
5.	Holes in Pipeline near HFCL a) 5 mm dia. b) 10 mm dia. c) 15 mm dia.	Partially Credible	Jet fire and explosion

2] System elements or events that can lead to major accident

Major cause of failure of pipeline may be due to development of stress, overpressure, failure of pipe wall due to corrosion/erosion, sabotage or natural phenomena like earthquake, etc.
Human error can also cause a major accident.

3] Hazards

Hazard from product release has been characterized in the form of –

- Pool Fire, Jet fire
- UVCE (Unconfined Vapour Cloud Explosion)

VAPOUR CLOUD EXPLOSIONS are potential hazards, which can cause widespread damage very quickly. After consequence analysis is done with the help of world renowned SOFTWARE i.e. *PHAST RISK of M/S DNV TECHNICA (U.K)* it has been found that damage distances even in case of credible scenario does not go beyond 49 m for thermal radiation level of 12.5 KW/M^2 (1% lethality) and 175 m for an overpressure of 0.3 Bar (heavy damage).

4A.15.2 Personal Protective Equipment

The following personal protective apparatus are available during an emergency in Aegis Logistics. Such personal protective equipments are to be available during off-site emergency.

- Fire proximity suit.
- Low temperature suit for refrigerated LPG
- Low temp gloves for refrigerated LPG
- Self contained Breathing Apparatus
- Water gel blanket.
- Safety helmet.
- Asbestos hand gloves (Suitable for low temperature LPG)
- Rubber hand gloves for use in electrical jobs.
- Resuscitator.
- Explosimeter

The quantities available should be sufficient to meet the needs of emergency handling personnel.

4A.15.3 Rehearsal and Testing

'Mock Drills' will be arranged periodically to test the laid down system and facilities. The emergency handlers will also "act out" their individual roles in accordance with the emergency procedures laid down to demonstrate that the entire emergency response system can perform efficiently and accurately. Mock drills will be conducted periodically.

4A.16 OFF-SITE EMERGENCY PLAN

4A.16.1 As per Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989, notified and enforced by Union Ministry of Environment & Forests on 27th

November 1989 under Sections 6, 8 and 25 of THE ENVIRONMENT (PROTECTION) ACT, 1986 concurrently provide the requirement of an OFF-SITE EMERGENCY PLAN. As per the rule, it shall be the duty of the concerned authorities as identified in column 2 of Schedule 5 to prepare and keep upto date (an adequate Off-Site Emergency Plan containing particulars specified in Schedule 12 and detailing) how emergencies relating to a possible major accident on that site will be dealt with and in preparing that plan the concerned authority shall consult the occupier, and such other persons as it may be deemed necessary.

An integral part of the Disaster Management Plan is the Off-Site Emergency Plan since the pipeline is outside the plant premises. The plan is mainly dependent upon a very close co-ordination and assistance from the Local Administration like District Collectorate, Police, Fire Brigade, Medical Services, local Panchayat, local industries.

4A.16.2 Off-Site Action

Any person seeing the product leakage should inform any of the following persons / establishment over phone:

i] Aegis Logistics
ii] IOCL
iii] Haldia Dock Complex
iv] Police
v] Fire Brigade

On getting information about leakage of product through any source including leak detection system, Aegis should instruct immediately ship personnel to stop pumping. M/s Aegis Logistics will verify the extent of leakage and consequent hazard and at the same time try to activate Off-Site Emergency Plan through District Hazard Management Group/Local Crisis Group.

The Site Main Controller of M/s Aegis Logistics will inform about the incident like leakage, Fire, Explosions to –

1] District Collectorate
2] Police
3] Fire Brigade
4] Medical Services Centres
5] Technical Agencies
6] Rehabilitation Agencies
7] Other industries in the area

4A.16.3 Responsibilities of the Services

1] <u>District Collectorate</u>

- He will activate the District Hazard Management Group and Local Crisis Management Group to act according to Off-Site Emergency Plan.

2] <u>Police</u>

- To control traffic & mob by cordoning off the area.

- Arrange for evacuation of people on advice from the Site Controller/District Collector/any Authorised person in District Crisis Group or Local Crisis Group.
- Broadcast/communicate through public address systems to the community (where available) on advice from the District Collector/SDO.
- Inform relatives about details of injured and casualties.

3] Fire Brigade

- Fighting fire & preventing its spread.
- Rescue & salvage operation.

4] Medical/Ambulance

- First Aid to the injured persons.
- Shifting critically injured patients to the hospitals.
- Providing medical treatment.

5] Technical/Statutory Bodies

(Constitutes Factory Inspectorate, Pollution Control Board, Technical Experts from Industries)

- Provide all technical information to the emergency services, as required.
- Investigate the cause of the disaster.

6] Rehabilitation

- Arrange for evacuation of persons to nominated rescue centre in coordination of district and local authorities and arrange for their food, medical and hygienic requirements.
- Co-ordinating with the Insurance Companies for prompt disbursement of compensation to the affected persons.
- Maintain communication channels like telephone, fax etc. in perfect working condition.

Analysis of risk from different scenario shows that people living nearby are not likely to be affected due to leakage from pipeline due to corrosion/ erosion. In fact population beside the pipeline route is almost nil.

However, formulation of Off-Site Emergency Plan designating the team members, training of team members and creating awareness amongst local people are of utmost importance.

4A.17 LPG Spill contingency plan

4A.17.1 Scenario Description

LPG import facilities of M/s Aegis Logistics will be located at Durgachak area of Haldia where LPG will be brought through pipeline. From oil jetty No.3 two 12" dia. pipeline will be installed along the bank of river Hoogly. LPG will come through Ship tankers and will be transported through pipeline from oil jetty no.3 to Storage tanks located in Durgachak area beside Bharat Petroleum POL Depot. In case of major leak in the line during transfer operation LPG will come out as jet

and fall on the ground forming a pool. On pool evaporation vapour cloud may be formed which may ignite resulting vapour cloud explosion or flash fire. Pool of LPG may be ignited if it gets contact with any ignition source. However once pumping from ship is stopped, extent of leakage will reduce and flow will be less due to low temp / less vapour pressure of LPG. In case refrigeration system is on, the pressure build up in the pipeline will be minimized.

4A.17.2 Action plan in case of leak resulting into pool fire

(i) In case of any leakage detected by leak detection system during transfer or hearing the information about leak and pool fire, designated personnel of M/s Aegis Logistics will rush to the spot along with required PPEs and leak arresting accessories. They will inform fire and safety personnel also to rush to the spot.
(ii) Aegis personnel will arrange for identification and isolation of leak using required PPEs and simultaneously will inform the personnel in LPG tanker to stop the transfer pump and close the isolation valve (ESD) of the transport line from jetty /terminal as the case may be.
(iii) In case of small fire, the fire can be extinguished with the help of DCP Extinguishers.
(iv) Area to be cordoned off for unauthorized entry.
(v) LPG fires may be effectively put off by using DCP from DCP tender.
(vi) In the event of any threat to the neighboring industries, alert them on the incident.
(vii) Mutual Aid to be activated and district authorities shall be contacted for activating Off-Site Emergency Plan, if required.

4A.17.3 Action plan in case of leak and formation of vapour cloud without fire

(i) M/s Aegis Logistics designated personnel will rush to the spot along with PPEs on being informed about leak. They will inform fire and safety personnel of IOCL and State fire services to be on the spot with fire tenders.
(ii) Aegis personnel will arrange for identification and isolation of the pipeline by using required PPEs and simultaneously will inform the personnel in LPG oil tanker to stop the transfer pump and close the isolation valve of the transport line (ESD).
(iii) Eliminate all sources of ignition in the vicinity in the direction of LPG flow as well as the direction vapour flow as per prevailing wind direction.
(iv) Gas monitoring to be done periodically for identifying the area involved.
(v) Water in spray form to be operated for dispersion and diluting the vapour by operating water monitors, fog nozzles etc.
(vii) Oil dispersant may be used for final clean up.
(viii) Mutual Aid to be activated and district authorities shall be contacted for activating Off-Site Emergency Plan.
(ix) No one will enter vapour cloud
(x) Gas concentration will be continuously monitored.

4A.18 Action Plan in case of leakage in unloading arm. In case of leakage from unloading arm the pump in the ship should be stopped immediately. ESD should also be closed. Water jet/water curtain should be applied on the leaking point to

disperse LPG along with water till LPG flow stops. The operator directing the spray nozzle should use proper PPEs like Low temp. suit and Low temp. service hand gloves etc. All sources of ignition should be eliminated. Gas concentration to be continuously measured.

4A.19 IMPORTANT TELEPHONE NUMBERS

01.	MUTUAL AID MEMBERS (Expected)	Haldia STD CODE-03224	
	Indian Oil Corporation Limited, Marketing Division - Haldia Installation	252-668/253-306	
	Hindustan Petroleum Corporation Limited - Haldia Terminal	253-805/252-277	
	Bharat Petroleum Corporation Limited - Haldia Installation	252216/252983/251103	
	Indian Oil Corporation Limited, (Marketing Division) Haldia Terminal - B	278-115/205-633/634/	
02	POLICE STATION		
	Durgachak Police station - C.P.T. Market	251111/ 252378	
	Haldia Police Station - Chiranjibpur	252335	
	Township Police Station - Ancorage Camp	263487	
	Bhowanipur Police Station	253187	
	Sutahata Police Station	286202	
03	FIRE STATION		
	West Bengal Fire Station - Chiranjibpur	252500	
	IOC Fire Station	252322/252521	
	CPT Fire Station - LPG Jetty	252433	
	CPT Fire Station - Dock	252480/252404	
04	DISTRICT AUTHORITY		
	District Magistrate - Purba Medinipur : Tamluk	03228-263-098	
	Superintendent of Police - Purba Medinipur : Tamluk	03228-269-766	
	CEO- Haldia Development Authority	255-926	
	Additional District Magistrate - Haldia	275-568	
	S.D.P.O - Haldia	274878	274147
	SDO - Haldia	278-110 /274015	263131
	Haldia Municipality - City Center	254186/254307	
	Factory Inspector - Durgachak	274105	
	West Bengal Pollution Control Board - Haldia Regional Office	03224-274-190	

4B.0 DMP FOR CRYOGENIC LPG STORAGE AND HANDLING FACILITIES

4B.1 INTRODUCTION

The objective of any plant should be safe and trouble free operation and smooth production. This is ensured by taking precautions right from design stage i.e. design of plant, equipment/pipeline as per standard codes, ensuring selection of proper material of construction, well designed codes/rules and instruments for safe operation of the plant. Safety should be ensured afterwards by operating the plant by trained manpower. In spite of all precautions accidents may happen due to human error or system malfunction. Any accident involving release of hazardous material may cause loss of human lives & property and damage to environment. Industrial installations are vulnerable to various natural as well as

manmade disasters. Examples of natural disasters are flood, cyclone, earthquake, lightening, tsunami etc. and manmade disasters are like major fire, explosion, sudden heavy leakage of toxic and poisonous gases and liquids, civil war, nuclear attacks, terrorist activities etc. The damage caused by any disaster is determined by the potential for loss surrounding the event. It is impossible to predict the time and nature of disaster, which might strike on undertaking. However, an effective disaster management plan i.e. pre-planned procedure involving proper utilisation of in-house as well as outside resources helps to minimise the loss to a minimum and resume the working condition as soon as possible.

4B.2 STATUTORY REQUIREMENT

Disaster Management Plan is a statutory requirement for Aegis Haldia Terminal. The applicable regulations are:

a) Factories Act, 1948 and as amended
b) Manufacture, Storage and Import of hazardous Chemicals Rules, 1989, notified under Environment Protection Act 1986 and amended in 1994.
c) Rules on Emergency Planning Preparedness and Response for Chemical Accidents, 1996.
d) Stipulations of OISD-168
e) Public Liability Insurance Act, 1991.

The Disaster Management Plan has been prepared based primarily on Schedule-11 of the rule, Manufacture, storage and Import of hazardous Chemicals Rules, 1989 and amended in 1994.

4B.3 OBJECTIVE OF DISASTER MANAGEMENT PLAN

Disaster Management Plan is basically a containment, Control & mitigation Plan. The plan includes activities before disaster, during disaster and post disaster:

The objective of disaster management plan is to formulate and provide organizational set up and arrange proper facilities capable of taking part and effective action in any emergency situation in order to:

a) Brief the incident under control making full use of inside and outside resources
b) Protect the personnel inside the terminal as well as public outside.
c) Safeguard the terminal as well as outside property and environment.
d) Carry out rescue operation and treatment of casualties.
e) Preserve relevant records and evidences for subsequent enquiry
f) Ensure rapid return to normal operating conditions.

The above objectives can be achieved by –

i) Proper identification of possible hazards and evaluation of their hazard potential and identification of maximum credible hazard scenario.
ii) Arrange/augment facilities for fire fighting, safety, medical (both equipment and manpower)

iii) Evolving proper action plan with proper organizational set-up and communication facilities as well as warning procedure.

4B.4 DEFINITIONS

Disaster

Disaster is a general term, which implies a hazardous situation created by an accidental release or spill of hazardous materials, which poses threat to the safety of workers, residents in the neighbourhood, the environment or property.

Emergency

Emergency condition and Disaster Condition are synonymous

ON-SITE Emergency/Disaster

In an On-Site Emergency the effect of any hazard (fire/explosion/release of toxic gases) are confined within the factory premises. An accident taking place inside the terminal and its effects are confined within the boundary wall.

OFF-SITE Emergency/Disaster

In case of any hazard inside Aegis, Haldia Terminal the effects that are also felt outside the boundary wall.

4B.5 DESCRIPTION OF INDUSTRIAL ACTIVITY

Name and Address of the person furnishing the information

Incharge LPG Terminal
Aegis Logistics Ltd;
Haldia, Durgachak
Dist: Purba Medinipur, West Bengal

a) Site Location

The pipeline terminal is located in the outskirts of Durgachak in the district of Purba Medinipur in West Bengal. Site falls within an industrial area.

b) Population around Site

There is no any major habitation within a radius of 0.5 KM of the factory.

c) Activities & Facilities

A brief description the activities in Haldia Terminal are:

i) Receipt of the Refrigerated LPG from ship, through pipeline to terminal.
ii) Storage of LPG in two nos. of refrigerated storage tanks.
iii) Compression of LPG Vapour from refrigerated storage tanks is done in two nos. of compressors & storage of liquid LPG in Mounded Bullet.

d) Tank Lorry Filling

Tank Lorries are filled in filling bay by pumping products from storage tank to filling bay. 8 Nos. of bays are provided. The discharge pipeline branches

are connected to tank Lorries by loading arm through a flow control valve and flow meter. The tank Lorries are properly earthed before receiving the LPG products.

4B.6 SAFETY RELATED UTILITIES

i) Water

Water Storage Facilities: In two nos. of water tanks.
Source of Water: Deep wells provided inside the terminal.
Fire hydrants/monitors shall be provided in all the vulnerable areas of the plant.

Sprinkler system for water spray cooling shall be provided for tank lorry filling bays as well as compressor shed. Sprinkler system is also provided on the refrigerated storage tanks, mounded storage and LPG pump house for mounded bullets.

ii) Power

The terminal's power requirement is supplied by WBSEB at 33 KV and Emergency power: DG Sets.

iii) GMS, manual call points are provided at vulnerable locations in the plant like top of storage tanks, pump & compressor bay, mounded storage, loading bays etc.

4B.7 DISASTER PLANNING

Modern approach to disaster management plan involves

a) Risk analysis Study
b) Action Plan

Risk analysis study involves

a) Risk Identification
b) Risk Evaluation

Risk identification involves

i) Identification of hazardous events in the installation, which can cause loss of capital equipment, loss of production, threaten health and safety of employees, threaten public health and damage to the environment.

ii) Identification of risk, important processes & areas to determine effective risk reduction measures.

Risk evaluation involves calculation of damage potential of the identified hazards with damage distances (which is termed as consequence analysis) as well as estimation of frequencies of the events.

Hazardous areas with different hazard scenarios and their damage potential with respect to fire & explosion have already been mentioned in earlier section. However, failure rate of different hazard scenarios has been discussed broadly based on data available for similar incidents outside India.

Probability of any hazardous incident and the consequent damage also depends on –

a) Wind speed
b) Wind direction
c) Atmospheric stability
d) Source of ignition and also
e) Presence of plant assets & population exposed in the direction of wind.

Action plan depends largely on results of risk analysis data and may include one or more of the following:

a) Plan for preventive as well as predictive maintenance.
b) Augment facilities for safety, fire fighting, medical (both equipment and manpower) as per requirements of risk analysis.
c) Evolve emergency handling procedure both on-site and off-site.
d) Practice mock drill for ascertaining preparedness for tackling hazards/ emergencies at any time-day or night.

4B.8 IDENTIFICATION OF HAZARDS

4B.8.1 General Nature of Hazard

In Haldia Terminal LPG to be handled are highly inflammable and explosive. Any small fire in the installation, if not extinguished at early stage can cause large scale damage and may have a cascading effect. Hence the terminal requires.

a) A quick responsive containment and control system requiring well planned safety and fire fighting system.
b) Well organized trained manpower to handle the process equipment & systems safely.
c) Well trained personnel to handle safety and firefighting equipment to extinguish fire inside the installation promptly as well as tackle any type of emergency.
d) Well planned Disaster Management Plan.

4B.8.2 Hazards Areas of the Plant

The plant activities handling LPG products can be subdivided into the following:

Activities	Place
a) Receipt of LPG	i) Through Pipeline.
b) LPG storage	ii) Refrigerated storage Tanks
c) LPG pumping	iii) Top of storage Tanks
d) Dispatch of LPG	iv) Road Tanker Loading Bay

4B.8.3 Hazard Scenarios and effects

This has been discussed in detail in the Chapter on Risk Analysis. However, a brief outline is given in the following table:

Sl. No	Failure Scenarios Description	Likely Consequence	Credible/ Non credible
1.	5 mm, 10 mm and 15 mm dia. hole in inlet Line (12" dia.) to refrigerated storage tank- Refrigerated LPG	Partially Credible	Jet Fire, Unconfined vapour cloud Explosion
2.	Safety Valve pop-off of Refrigerated storage tank	Credible	Dispersion
3.	5mm, 10 mm & 15 mm dia. hole in discharge line of In-tank Pump- Refrigerated LPG	Partially Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
4.	Gasket Failure in discharge line of In-tank Pump- Refrigerated LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
5.	Mounded Bullet Outlet Line (6" dia.) Full-Bore Failure- Pressurized LPG	Non- Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
6.	5mm, 10 mm and 15 mm dia. holes in truck loading pump Discharge Line- Pressurized LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
7.	Truck loading pump Discharge Line Gasket Failure- Pressurized LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
8.	Truck loading pump Mechanical Seal Failure- Pressurized LPG	Credible	Jet Fire, Dispersion, Unconfined vapour cloud Explosion
9.	Boil-off Compressor discharge line Full-Bore failure.- Pressurized LPG	Non Credible	Dispersion, Unconfined vapour cloud Explosion
10.	Flash-off Compressor discharge line Full-Bore failure - Pressurized LPG	Non Credible	Jet Fire, Unconfined vapour cloud Explosion
11.	Loading arm for Road Tanker loading failure	Partly Credible	Jet Fire, Unconfined vapour cloud Explosion

All the scenarios are having damage potential to a different degree. However, maximum damage can happen due to storage tank pipeline failure.

In all the above cases fire/explosion can occur due to ignition of the vapour of LPG coming out from the containment. The sources of ignitions may be (I) Hot work in the vicinity (ii) Smoking (iii) Lightning (iv) Generation of static electricity (v) Radiant heat from outside. (v) Deliberate ignition or sabotage.

4B.9 SAFETY RELATED COMPONENTS PROVIDED IN THE TERMINAL

4B.9.1 Haldia Terminal is being provided with safety related measures right in the design stage, which will minimise any accident e.g.

i) Layout of the plant with safety distances.
ii) Use of proper material of construction for equipment and piping
iii) Storage tanks provided inside a dyke wall.

iv) The tanks shall be provided with water spray sprinklers for cooling tanks in case of fire in the vicinity. Water sprinklers are also provided in pump & compressor house, loading bays, mounded storages etc.
v) All electrical items have been carefully selected and are either flame proof/ intrinsic safety type in licensed area.
vi) Proper earthing of all storage tanks, pipelines, structures and trucks for filling /despatch of LPG product.
vii) Loading Arm shall be provided whose failure rate is much lower than loading hoses by a factor of at least ten.
viii) Provision of LPG vapour trap for separation of LPG to avoid any LPG water going out of the terminal or spoiling ground water.
ix) Arrangement of fire hydrants monitors and hose boxes have been kept in all the hazardous areas and fire water storage tanks.
x) Use of level indicators and level control measures with alarm system to ensure storage tanks are filled upto the desired level only.
xi) Use of flow control devices and meters for tank truck filling to ensure that in the tank truck is filled to the desired level.
xii) Provision of portable fire extinguishers at vulnerable places to extinguish fire.
xiii) The plant is properly guarded by a boundary wall of sufficient height as per norms.
xiv) Licensed area shall be properly guarded for any unauthorized entry of personnel.
xv) All areas in the terminal are properly illuminated through lighting. Requisite numbers of High Mast Towers have been proposed around the terminal for better illumination.
xvi) Emergency Diesel Generator Sets are provided to ensure operation and illumination during power failure.
xvii) Emergency shutdown switches are provided to stop all operations at control room and other vulnerable places.
xviii) Leak detection system shall be provided for the pipeline from jetty to terminal.
xix) Gas monitoring system and manual call points are provided at vulnerable locations in the plant.

4B.9.2 Other Safety Measures

Some of the preventive & pre-emptive measures which are to be taken during operational phase are as follows:

a) Safety measures

Following safety tips should always be borne in mind while working in the plant to avoid emergency & hazardous situation.

i) Follow specified procedures and instructions for start-up, shut down and any maintenance work.
ii) Follow permit to work system.
iii) Identify correctly the part of the plant in which work is to be done.
iv) Isolate the part, machine properly on which work is to be done.
v) Release pressure from the part of the plant on which work is to be done.

vi) Remove flammable liquid/gases thoroughly, on which work is to be done.
vii) Use non-sparking tools.

b) Plant & Pipe Line Inspection

Apart from planned inspection, checks and tests should be carried out to reduce failure probability of containments.

i) Storage Tanks and pipeline should be checked regularly during both their construction and operational phase.
ii) Critical trips, interlocks & other instruments should be checked regularly to avoid fail danger situation.
iii) Fire fighting system should be checked regularly to ensure proper functioning during emergency situation.
iv) Proper lightning protection system should be provided and checked regularly to avoid lightning effect.
v) Cross-Country pipeline for receipt of LPG from jetty to terminal should be patrolled at least once in a weak.

c) Performance or Condition Monitoring

A systematic monitoring of performance or condition should be carried out especially for large machines and equipment, which may be responsible for serious accidents/disaster in case the defined limits are crossed.

i) Vibration, speed & torque measurements for pumps, DG sets etc.
ii) Thickness and other flaw measurements in metals of storage vessels, Inlet & Outlet lines from storage vessels etc.

Many types of non-destructive testing/condition monitoring techniques are available. X-ray radiography, acoustic emission testing, magnetic particle testing, eddy current inspection techniques etc. are used for detection of flaws and progression of cracks in metals. Testing equipments are also there for checking vibration, speed, torque etc.

The above condition monitoring techniques should be applied regularly by internal/external agencies. Immediate corrective measures should be taken if any flaws are detected.

d) Preventive Maintenance

A schedule for preventive maintenance for moving machineries should be prepared based on experience in other similar plants as well as instruction of the suppliers. The schedule should be followed strictly during operation as well as planned shutdown period.

e) Entry of Personnel

Entry of unauthorized personnel is strictly prohibited inside the premises. The persons entering the plant should not carry matches, lighters, mobile phones etc.

f) Gas Monitoring System

LPG gas monitoring system will be provided at all vulnerable locations like storage tank top, pump & compressor house, loading bays, mounded storage outlet etc.

g) Emergency Shut-down Switch (ESD)

ESD shall be provided at control room and one at site to stop all operation in case of emergencies like major leak, fracture of pipeline etc.

h) Hot work

Hot work should not be permitted except in-designated areas with utmost precaution and proper work permit.

i) Explosimeter

Explosimeter will be provided to monitor the presence of explosive gas like LPG.

4B.9.3 Details of Fire Fighting Facilities

Modern fire fighting facilities shall be provided in the Terminal in line with norms of OISD.

i] Fire Water System

Two numbers fire water tanks of capacity 1950 KL each

ii] Fire Water pumps

No of Pumps	-	03 Nos.
Capacity of Pumps	-	410m^3/hr
Discharge pressure	-	8 Kg/cm^2
No. of Jocky Pumps	-	01
Capacity of Pump		137 m^3/hr
Discharge pressure	-	8 Kg/cm^2

iii] Fire Hydrant System

The entire area is provided with a looped fire hydrant pipeline connected to fire engines on auto system and always kept under pressure to meet emergencies. Two numbers of fire water storage tanks (adequate capacity) are provided, which are kept full and take care of fire fighting requirement. The water required for the terminal shall be obtained from Haldia Development Authorities (HAD). The fire hydrant line is equipped with required numbers of single/double headed hydrant valves, monitors and hoses.

iv] Sprinkler System

Water sprinkler system with spray nozzles are proposed for storage tanks, pumps & compressor house and similar system are proposed for tank lorry filling bays for cooling the tankers if required. The facility will be provided for mounded storage also.

v] Portable Fire Fighting Equipment

Portable firefighting equipment shall be provided in all vulnerable places in the plant.

vi] First Aid

In Haldia Terminal First Aid kits equipped with First Aid medicines will be provided as per factory act.

4B.9.4 Emergency Control Centre & Shelter Room

The emergency control centre shall be situated in the office building. The office room of Terminal Incharge shall be designated as Emergency Control Centre. P&T telephones, Alarms, Emergency Control Manual and Safety and Personal Protective Appliances are to be arranged in sufficient numbers and kept in the room.

Emergency Shelter

The room has been proposed outside the licensed area for giving shelter to employees/ other personnel who are not involved in emergency control actions.

4B.9.5 Alarm and Communication System

A] Alarm System

i] Electrical Sirens and Hand Sirens are provided in office building/Emergency Control Room and other vulnerable areas for warning the public as well as employees inside.
ii] The sound of electrical siren shall be audible upto 3 KMs.
iii] For fire condition electrical siren will be wailing for minimum 2 minutes and for all clear signals it will be a straight run siren for 2 minutes.
iv] For disaster condition the wailing sound shall be repeated with a minimum 10 seconds gap.

B] Communication System

For communication with officers/employees page phone services, manual call points and intercom services are provided with sufficient nos. of P&T telephones at different places including Sr. Manager's room for communication with other agencies. Public address system shall also be provided for communication with employees.

4B.9.6 Mutual Aid

It is not possible to combat large scale fire/disaster single handed effectively by any organization. Assistance of resources of fire fighting and other services are of utmost importance during the hour of crisis. Following type of mutual aids are envisaged:

i] Assistance by fire fighting teams & equipment.
ii] Medical and first aid assistance.
iii] Assistance of vehicles for any emergency requirement.

iv] Help in liaisoning with police, District Collectorate, Fire Brigade & Hospitals. Mutual aid agreement has been done with nearby industries.

4B.10 DISASTER CONTROL PLAN

The plan include three major plans –

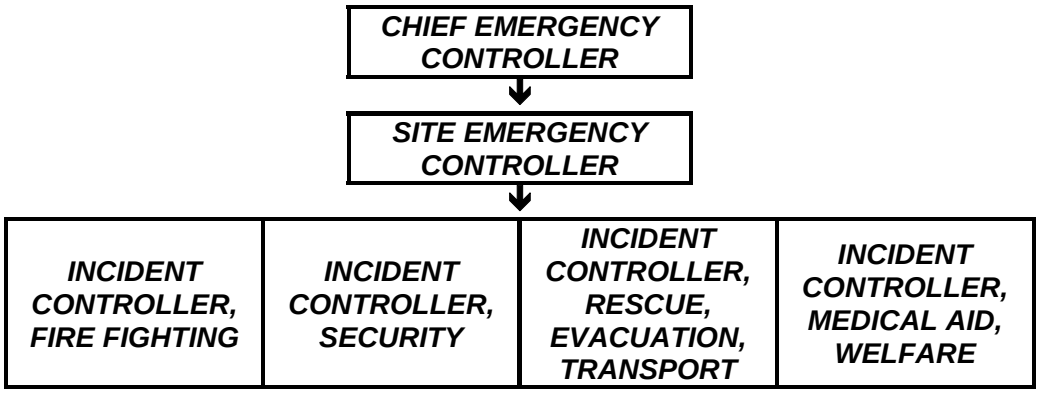
i] Equipment Plan
ii] Organization Plan
iii] Action Plan

4B.10.1 Equipment Planning

Equipment plan i.e. arrangement of fire fighting, safety, transport etc. has been discussed earlier.

4B.10.2 Organization Plan

The disaster management organization and action plan is made in such a way that it is capable of quick response at any time to meet emergency situation. The plan gives a detailed chain of command, area of responsibility of each personnel involved, information flow pattern and coordination activity required to meet the emergency. A typical Disaster Management Organization Chart is given below:



Chief Emergency Controller

Chief Emergency Controller is the person to head the group during emergency situation. Generally chief of the installation e.g. Terminal Incharge shall be the Chief Emergency Controller. In his absence next man in the hierarchy or any designated officer shall take charge.

Chief Emergency Controller is the ultimate authority in directing emergency operations. He will be assisted by other incident controllers i.e. Site Incident Controller and

i]	Site Emergency controller	-	Overall help
ii]	Incident Controller	-	Fire fighting
iii]	Incident Controller	-	Security
iv]	Incident Controller	-	Medical Aid & Welfare
v]	Incident Controller	-	Rescue, Evacuation, Transport & Welfare

Main task of Chief Emergency Controller is to ensure that facilities are made available without any confusion. He also activates District Crisis Group/Local Crisis Group for necessary action during Pre Emergency and during emergency period.

He shall be responsible for –

a] Essential communication & liaison with outside agencies.
b] Fire fighting & rescue operations.
c] Emergency plant shutdown and declare emergency.
d] Demolition and repairs.
e] Accident investigation.
f] Ensuring safety of important records.
g] Public relations for giving authoritative information to news media and others.
h] Removal of casualties, giving information to their relatives & compensation
i] Arranging medical aid for treatment of the injured.
j] Bring back normalcy as early as possible.

Site Emergency Controller

He maintains close liaison between Chief Emergency Controller and other functional Incident Controllers and controls emergency at site. He coordinates with different team members to ensure that various activities are carried out promptly without any chaos. He acts as per guidance of Chief Emergency Controller and takes charge in absence of Chief Emergency Controller. The main functions of Site Emergency Controller are –

i] Maintains close liaison with Chief Emergency Controller.
ii] Controls operation depending on situation. Shut down loading and unloading operations and isolate storage area pipelines.
iii] Give alarm siren to warn all employees and public.
iv] Evacuate non essential persons to the designated place if required.
v] Operate water sprinklers for cooling if fire has occurred or nearby places.
vi] Start fire fighting till arrival of designated fire fighting crew from inside and outside if necessary.
vii] Initiate rescue operations and first aid to the injured person till the arrival of doctor and ambulance.
viii] Notify adjacent factory authority and local administration.
ix] Enforce entry of persons with authorised duties from outside with due care.

Functions of other incident controllers are detailed below:

Incident Controller - Fire Fighting

He will keep close liaison with Site Emergency Controller and Chief Emergency Controller. His main functions are –

i] Arrange and keep necessary appliances and supplies to combat emergency.
ii] Guide the fire fighting people under his command and render technical assistance to combat fire/emergency.
iii] Establish barricade in the danger zone, if necessary.
iv] Keep liaison with fire fighting team coming from outside.

Incident Controller - Security

His functions during emergency operation will be –

i] Check entry of unauthorised personnel inside the installation.
ii] Control mob and spectators.
iii] Keep careful watch to prevent any further damage by sabotage.
iv] Help fire fighting controller to cordon affected area/danger zone.

Incident Controller - Rescue, Evacuation & Transport

His functions are –

i] Plan and organise rescue and evacuation services and train team members both inside and outside if necessary.
ii] Arrange vehicles, ambulance etc. for transfer of injured personnel to nearby hospitals, rural health centres and nursing homes as per instruction of medical assistance coordinator/designated doctor.

Incident Controller - Medical Aid & Welfare

His functions are –

i] Designate doctors from outside who can be available during emergency and keep liaison with them.
ii] Prepare plant dispensary under readiness for emergency.
iii] Call the designated doctor during emergency.
iv] Provide first aid to the injured and arrange to transfer them to nearby hospitals, other designated doctors depending on the gravity of the injury.
v] Arrange food and shelter to the evacuated employees.
vi] Inform relatives of the victims.

In Haldia Terminal he will control all activities with the help of officers, workers, clerical staff, casual workers and security staff. All of them shall be trained in fire fighting and use of safety appliances.

In case of any leakage of LPG product or fire any body witnessing the same should take immediate necessary action to stop leakage and extinguish fire with the help of fire extinguishers as well as inform Terminal Incharge through page phone or through messenger or shouting.

In case of any fire or explosion Terminal Incharge takes charge of the situation and controls it with a well organized plan.

If any accident e.g. fire occurs during night, shift/security personnel shall attend it and in case of emergency Terminal Incharge and others shall be informed / called from their residence.

4B.10.3 Action Plan

This gives guidelines to PREVENT, CONTROL AND TERMINATE AN EMERGENCY and consists of three parts.

a) Pre-emergency action
b) Action during emergency
c) Post emergency actions

Pre-Emergency Actions

These are essentially PRE-EMPTIVE AND PREVENTIVE measures and are extremely important. They include mock drills, checking of fire fighting facilities, keeping personal protective equipments in good condition in proper places, medical equipments, scheduled checking of safely devices, safety audits, preventive maintenance, good house keeping, training of employees, education to the public and liaison with State Fire Services, Police and district administration etc.

Public Awareness

In case of major accidents like large fire, explosion, effect of which may spread outside the plant boundary, people of the adjoining area may be panicky due to ignorance and may aggravate the problems. To avoid panic, the terminal management will make easily understandable pamphlets in local language about the properties of LPG and actions to be taken by them during an Off-site Emergency. Training and education will also be imparted to the local public by audio-visual system with the help of local authorities. This will be done through Local Crisis Group consisting of District Administration.

Mock Drills

This is periodic simulation of emergency condition, sometimes in consultation with District Crisis Group/Local Crisis Group. The sequence of operation undertaken by Disaster Management Team members and systems provided like alarm & communication system, information flow pattern etc. are carefully put into operation by competent officials and the deficiencies/problems are recorded. Based on this observation appropriate actions are taken to improve the efficiency of the plan.

Training of Employees

Regular training will be conducted to educate the employees about safely, fire fighting and Disaster Management. A selected number will be given intensive training in first aid, evacuation and rescue operation so that they can be utilised as a part of Disaster Control Team.

Liaison with Police, District Administration & State Fire Services & Neighbouring Industries

Help of Police and District Authorities are essential for off-site Emergency such as evacuation, transportation and treatment of individuals etc. In case of On-Site Emergency help of Police, District Administration, local hospitals and also fire services at Haldia and other industries may be required depending on the severity of the situation.

PRE-EMERGENCY functions of Site Controller are mainly

a) Ensure implementation of Emergency Planning
b) Ensure that all drafted for emergency are undergoing regular training.
c) Ensure all disciplines are fully prepared for tackling emergency.
d) Ensure that simulation of emergency condition is regularly arranged.
e) Ensure preventive and pre-emptive measures.
f) Keep liaison with outside agencies, police, district authorities heads of other industries etc.

Pre-Emergency functions of other Incident Controllers and their team are

a) Keep all the team members ready for tackling emergency.
b) Ensure that all members understand their specific duties during emergency.
c) Ensure regular participation of their team in mock drills.
d) Ensure supply of adequate number of safety & fire fighting equipment in proper place and in good working condition.

Actions during Emergency

Actions to be taken by Chief Emergency Controller and other Incident Controller have been discussed in the Organization Plan. In short the actions are:

a) Declare Emergency by electrical siren.
b) Instruct total/partial shutdown.
c) Arrange the team for tackling emergency.
d) Ask for outside help, if necessary.
e) Keep liaison with outside agencies and provide authoritative information to news media and others.

Post Emergency Actions

These are directed towards termination of emergency, restoration of normalcy and rehabilitation.

It also includes identification of victims, information to their next of kin, notification to various government authorities, appointment of enquiry committee for identification of causes and suggestions to ensure that similar accident does not occur.

4B.11 DISASTER COMBATING ACTION PLAN WITH SPECIFIC REFERENCE TO THE TEAM

As already stated number of officers and staff within plant are less and Terminal Incharge has to prepare the plan with available officers & staff only.

A] DURING GENERAL SHIFT ON WORKING DAYS
(Chief Emergency Controller) : Terminal Incharge

ROLE

1] Take overall charge of the situation.
2] Rush to the spot where fire/explosion has occurred. Issue instruction for speedy combating of the incident and preventing of damage to other areas.

3] Stop all operations locally as well as in jetty area /shut down complete plant.
4] Declare emergency and operate electrical siren to inform employees, authorities and public.
5] Inform nearby factory authorities over phone and ask for assistance.
6] Inform local Fire Brigade.
7] Inform higher authorities and seek assistance for coordination of civil authorities, Fire Tenders from State/other agencies.
8] Inform Chief Inspectorate of Factories & Boilers, Haldia.

B] FIRE COMBATING TEAM

Incharge : AM/DM (Operation)

Assisted By :
i] Operation Officer (Fire)
ii] Section Incharge,
iii] Security Supervisor & Guards on duty.

ROLE

On hearing Fire Alarm –
1] Rush to the disaster spot and organize the team for combating fire as per direction of Chief Emergency Controller.
2] Security supervisor to ensure starting of Fire Engine and pressurisation of fire hydrant.
3] Stop all pumps and close all valves of the pumps as well tank body valves and join the team.
4] Operator of TLF section to stop loading operations, remove loading arm properly and join the combating team as per directions of control room incharge.

Section In-Charge TLF to ensure the above and act for combating emergency as per direction of Chief Emergency Controller.

C] EMERGENCY RESCUE TEAM

Incharge : Operation In-charge
Assisted By : Security Guards on duty

ROLE

On hearing the Fire Alarm –
1] Incharge to organize the team with office staff and other members as per direction of Chief Emergency Controller. If needed the Incharge should seek assistance of outside agencies.
2] Remove the injured from the spot after taking proper safety and personal protective appliances.
3] Arrange for First Aid of the injured and hospitalization, if necessary as per instruction of Chief Emergency Controller & Medical Aid Coordinator.

D] EMERGENCY TEAM (TRANSPORT & SECURITY)

Incharge : Operation Officer (OO)
Assisted By : Security Supervisor & Guards on duty

ROLE

1] Stop entry of all unauthorized personnel.
2] Arrange transport for taking the injured personnel to hospitals.
3] Seek assistance for vehicles/ambulance from outside agencies & hospitals nearby as per direction of Chief Emergency Controller.

E] EMERGENCY AUXILIARY TEAM

In-charge : Accounts Officer
Assisted By : One Security Guard

ROLE

On hearing Fire Alarm –

1] In-charge to rush to spot, coordinate with team as per direction of Chief Emergency Controller and organize the team and be ready for further instruction.
2] Get all the operations in the field stopped and all tank valves to be closed. Electric mains to be switched off.
3] The electrician to get ready with Fire Proximity Suit and other life saving equipment for any need.
4] To ensures that half-filled T/Ts do not run away with product and documents.
5] Take control of all employees in the field other than fire combating team.
6] Team In-charge to ensure uninterrupted supply of all available fire fighting equipments and materials as well as water to the combating team.
7] To supplement/replace injured or exhausted combating team persons.

F] FIRE DURING NIGHT TIME AND ON HOLIDAYS

In-charge : Shift Incharge
Assisted by : Security supervisor on duty
Security guards on duty.

ROLE

1] Shift Incharge Security Guard on duty seeing the fire, will shout **Fire! Fire!!** and shall need assistance from other guards on duty in different pockets and shall fight the fire with nearest available fire equipments.
2] Subsequently, Shift Incharge/Security Supervisor on duty will telephone to the residence of Terminal Incharge and Sr. Manager (T).
3] Immediately telephone to Chiranjibpur Fire Brigade and Police Station for assistance.
4] The Security Guards to control the gates and ensure that no unauthorized person enter the premises.

4B.12 ROLE ORDERS FOR DISASTER COMBATING ACTION PLAN

i] General Instructions

(a) The In-charge of the section/sections (TLF) / Administrative Office etc. affected shall ensure to take immediate action to isolate, close valves and mobilize enough equipment from nearby places.
(b) In-charge of stores shall keep the list of equipment available at various locations and coordinate with auxiliary team in-charge who mobilizes the materials.
(c) Auxiliary team in-charge shall ensure replenishment of water to fire water tanks from nearby other sources (HAD).
(d) Stores-in-charge to take inventory of all fire fighting items and to indent the shortfalls.
(e) All those moving towards scene of incident shall move with fire fighting equipment available.

ii] Pumps

Role Orders –

(a) Operator to stop all pumps.
(b) Close all valves including those of main tanks.
(c) Report combating team In-charge.

iii] Administrative Block

Role Orders –

(a) Section officers to ensure stop all loading operations.
(b) All T/Ts go out of TLF bays in orderly manner after closing T/T valves and manhole covers.
(c) Closing of all valves at TLF manifold.
(d) TLF officer to report to Fire Combating Team.
(e) Others to report to Auxiliary Team In-charge with available fire fighting equipment.

iv] Generator Room

Role Orders –

(a) Operator to remain in Generator House for instructions from Chief Emergency Controller.
(b) To switch off unwanted electrical connections as instructed by Chief Emergency Controller.

v] Stores

Role Orders –

(a) In-charge to keep ready all fire fighting/first-aid/personal protective materials and arrange speedy disbursement to the combating crews.
(b) To issue materials as per demand.
(c) To liaise among in-charges.

(d) To make proper inventory of all items and shortfall to be identified as early as possible.

vi] Security Guards on Duty

Role Orders –

(a) To control the gate by allowing contract labourers to go out, ordering, moving out of vehicles as instructed by Chief Emergency Controller in-charge with valid documents.
(b) To prevent unauthorized entry of outsiders.
(c) Security Guard posted at the main entrance gate to ensure proper control of traffic so that approach road is not blocked. Other security guards posted other than the gates, to report to their in-charge for further instruction.

4B.13 ACTION PLAN FOR SPECIFIC CASES

(A) FIRE/EXPLOSION IN TLF SHED

Facilities: 8 nos. of Filling Bays.

Product handled: LPG

Structure: Entire TLF structure is of elevated iron structures with proper roof, iron platforms and movable iron ladders with chains fixed to each bay.

HAZARD MINIMISER

(a) TLF in-charge with his officers and staff
(b) Fire Extinguishers (DCP)
(c) Fire Hydrant Points
(d) Water Jet
(e) Water Jel Blankets
(f) Alarm
(g) COMBATING AS PER DISASTER ORGANISATION CHART

SPECIAL REFERENCES

(a) Fire in filling shed should be attacked promptly with fire extinguishers.
(b) Close all valves promptly.
(c) Ensure orderly removal of TTs.
(d) Stop spreading over of fire and call for help.
(f) Use DCP extinguishers on burning LPG on the floor. Apply DCP extinguishers gently so as not to scatter the burning LPG and spread the fire. Apply DCP extinguishers from one side of the fire and with the DCP extinguishers blanket from that side across the LPG pool. Remember that water destroys the cover and water streams must not be turn on fire which is blanketed with foam.
(g) Apply water cooling to neighbouring T/Ts.
(h) Remove records/documents to safe place.
(i) When LPG is burning under the truck and tank is not leaking, remove the truck away from fire, if possible or cover the LPG with DCP. Use water to cool the tank truck.

(j) Use CO_2 extinguishers to fight fire around engine, raise the hood direct the stream of fluid at the base of fire.
(k) Use water or CO_2 extinguishers to fight fire in the cabin.
(l) Use water to fight fire on the tyres.
(m) Whenever the leak is seen in the bottom of tank, try to fill water into the tank so that LPG level will be above the leak.

(B) FIRE AT SMALL LEAK IN PIPELINE

1] Fire at a small leak in pipeline must be attacked promptly with the nearest fire extinguishers.
2] Shut off the flow of LPG in the line by closing valves and by stopping pumping.
3] Cover the LPG pool with sand and build up the sand so as to cover the leak.
4] Put DCP extinguishers on the burning LPG.
5] Build earth dykes around the LPG pool to prevent spreading of burning LPG.
6] Take care of the LPG dropping from the leak even after extinguishing fire as fire may occur again due to heating of LPG dropped. Try to collect the same in containers.
7] Wet down the adjacent structures to keep them cool.

(C) BURSTING OF GASKET/LEAKAGE THROUGH JOINTS

1] Stop pumping.
2] Stop flow of LPG through drain. Keep LPG within limited area.
3] Close line valves.
4] Dig pits to collect LPG.
5] Build earth dykes around the LPG to prevent spreading of burning LPG.
6] Take care of the LPG dropping from the leak even after extinguishing fire as fire may occur again due to heating of LPG dropped.
7] Wet down the adjacent structures to keep them cool.
8] Take action for replacement of gasket/repair leak with due care.

(D) FIRE IN ELECTRIC SUB-STATION / TRANSFORMER ROOM / SWITCH ROOM

Facilities: HT OCB, HT Switch, FUSE UNIT
TRANSFORMER: 450 KVA
GENSETS, PANELS: 1X250 KVA, 1X75 KVA
SWITCH ROOM, CONNECTION CABLES

ACTION PLAN AS PER DISASTER ORGANIZATION CHART

Special Reference –

(a) Cut off power supply by switching off the mains
(b) Apply DCP extinguisher or dry sand.
(c) Call for outside help if required.
(d) Do not allow anybody to touch any electrical appliances.

(e) Take action to prevent spreading of fire.
(f) If fire is not extinguished, extinguish by spreading water with fog nozzle only after ensuring complete isolation of electrical supply.

(E) POWER FAILURE AND CONSEQUENT FAILURE OF COMPRESSOR

Power failure will cause stoppage of compressors which will lead to pressure build up in storage tanks. However, safety valves are there which will pop-off to release pressure. The released LPG will come out through cold flare. As such DG sets should be immediately started in case of power failure.

(F) NATURAL CALAMITIES

(i) High Wind Storms/ Cyclones

All structures/ buildings in the terminal have been designed to withstand cyclonic storms and hence not much of damage is anticipated. Prior intimation about cyclone may be obtained from Haldia Dock Complex authorities who remain in contact with weather office at Kolkata.

Action Plan

(a) Switch-off all industrial electrical connections.
(b) Chief Emergency Controller will keep constant touch with Haldia Dock Complex authorities, District Magistrate, Purba Medinipur and Police authorities.
(c) Stop all operations and do not resume it till clearance is given by Chief Emergency Controller.
(d) Bring all vehicles to a halt and ensure that hand brake is applied.
(e) Evacuate persons from damaged buildings/structures.
(f) Avoid going on top of high structures/storage tanks.
(g) After the cyclone has struck, assess the situation and take necessary action as per the direction of Chief Emergency Controller.

(ii) Floods

In case of heavy rains during rainy season the rain water gets cleared through the drainage provided. Although the terminal is not expected to get flooded, some precautionary measures need to be taken to avoid any situation arising out of flood.

Action Plan

(a) Keep in touch with District Authorities
(b) Keep main gate closed
(c) Keep round the clock vigil and water level inside/outside the terminal.
(d) Evacuate personnel who are not in the team for DMP to safer places in consultation with District Authorities as well as with his help.

Evacuation Procedure

(a) Inform District Authorities about number of persons in the plant to be evacuated.
(b) District Authorities should arrange a shelter at a safer place.
(c) Arrange boat and persons who can drive a boat from Haldia Dock Complex.
(d) Evacuate non essential persons with the help of boat and inform District Authorities.
(e) Arrange food, drinking water for the evacuated personnel.

(iii) Earthquakes

All buildings/ equipment are designed to withstand earthquakes and therefore, major disaster is not expected. However in case of an earthquake of much heavier scale may lead to –

(a) Fall of structures/buildings
(b) Subsequent fire/explosion
(c) Release of LPG

Evacuation Procedure

(a) Inform District Authorities about number of persons in the plant to be evacuated.
(b) District Authorities should arrange a shelter at a safer place.
(c) Arrange transport to shift the personnel to the designated safer place.
(d) Arrange food & drinking water for the evacuated personnel.

Evacuation Plan

(1) During earthquake ESD should be operated to stop all operation.
(2) Employee should take shelter at assembly point made for this in the open space inside/outside the plant.
(3) Immediately after earthquake chief emergency controller should contact District Authorities or Haldia Dock Complex for arrangement of a dozer for clearing the debris and a crane to shift any fallen structure.
(4) Employee / Contract Labour who would be under debris / fallen structures shall be rescued and sent to hospital.
(5) Road Tankers with or without LPG are to be sent outside with proper formality.
(6) Chief emergency controller should ensure about the head quarter about the number of employee who are outside, who are to be rescued and who are inside the plant and to be given shelter. The information is to be given to district hazard management committees.
(7) Ensure food, drinking water and other necessities to the person who whould be given shelter outside by the plant authorities or district hazard management committee / state level hazard management committee.

(iv) Tsunami

Tsunami is a sudden flooding of water inside the plant from river Hooghly. Although the effect of Tsunami is not expected as sea is very far off and some minor effect with flooding of the plant cannot be ruled out as the plant is just on the bank of the river Hooghly. Some precautionary measures need to be taken to avoid any situation occurring due to Tsunami. In Tsunami high tidal waves at high speed strikes the shore inundating large areas of land and devastating objects in its path.

However, warming may be obtained from Haldia Dock Complex and National Disaster Management cell who can inform the District authorities. However the warming time and actual striking the waves is less (4 to 5 min). Hence, a proper planning can save live, property.

Action Plan

(a) Take shelter in the double storied administrative building.
(b) Keep in touch with District Authority.
(c) Keep the electrical power off by telephoning SEB.
(d) Keep the main gate closed.
(e) Keep round the clock vigil of water level inside and outside the terminal.
(f) If required non essential personnel should be evacuated to safer places in consultation with District Authorities and his help.
(g) In case of flood or Tsunami, it will take time to rehabilitate the plant to original condition.

Evacuation Procedure

(a) Inform District Authorities about number of persons in the plant to be evacuated.
(b) District Authorities should arrange a shelter at a safer place.
(c) Arrange transport to shift the personnel to the designated safer place.
(d) Arrange food, drinking water for the evacuated personnel.

Evacuation Plan

1. Buildings of higher height shall be earmarked where people can take shelter
2. The boundary wall and administration building of the plant should be sufficiently thick to withstand the impact of tsunami waves.
3. Storage tanks and other equipment should be anchored properly.
4. Evacuation routes from the plant should be earmarked.
5. Similarly evacuation route to buildings of higher height should be earmarked by police
6. Alarm signal to be given by Haldia Dock Complex / District authorities for Tsunami at Durgachuk and Other places.
7. On having the alarm chief controller will contact District authorities / Haldia Dock Complex and stop the plant. He will allow the employee & contract worker to go to designated buildings at the

shortest possible time or take shelter on the top of the administrative building.

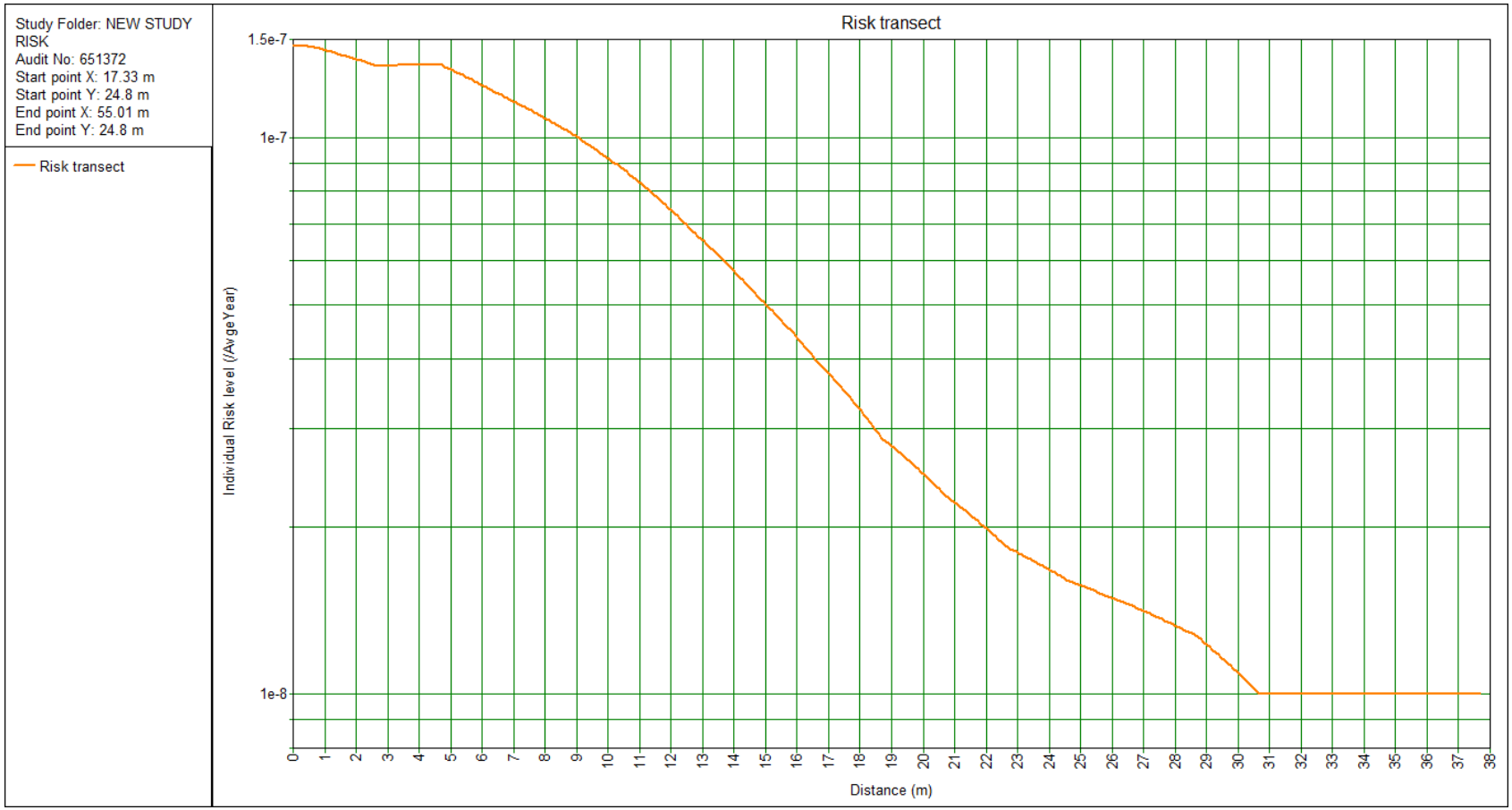
8. It is important that people including the employee of Ageis Logistics should be made aware of Tsunami, its effect and plan to save themselves.

(F) RIOTS / SABOTAGE / WAR

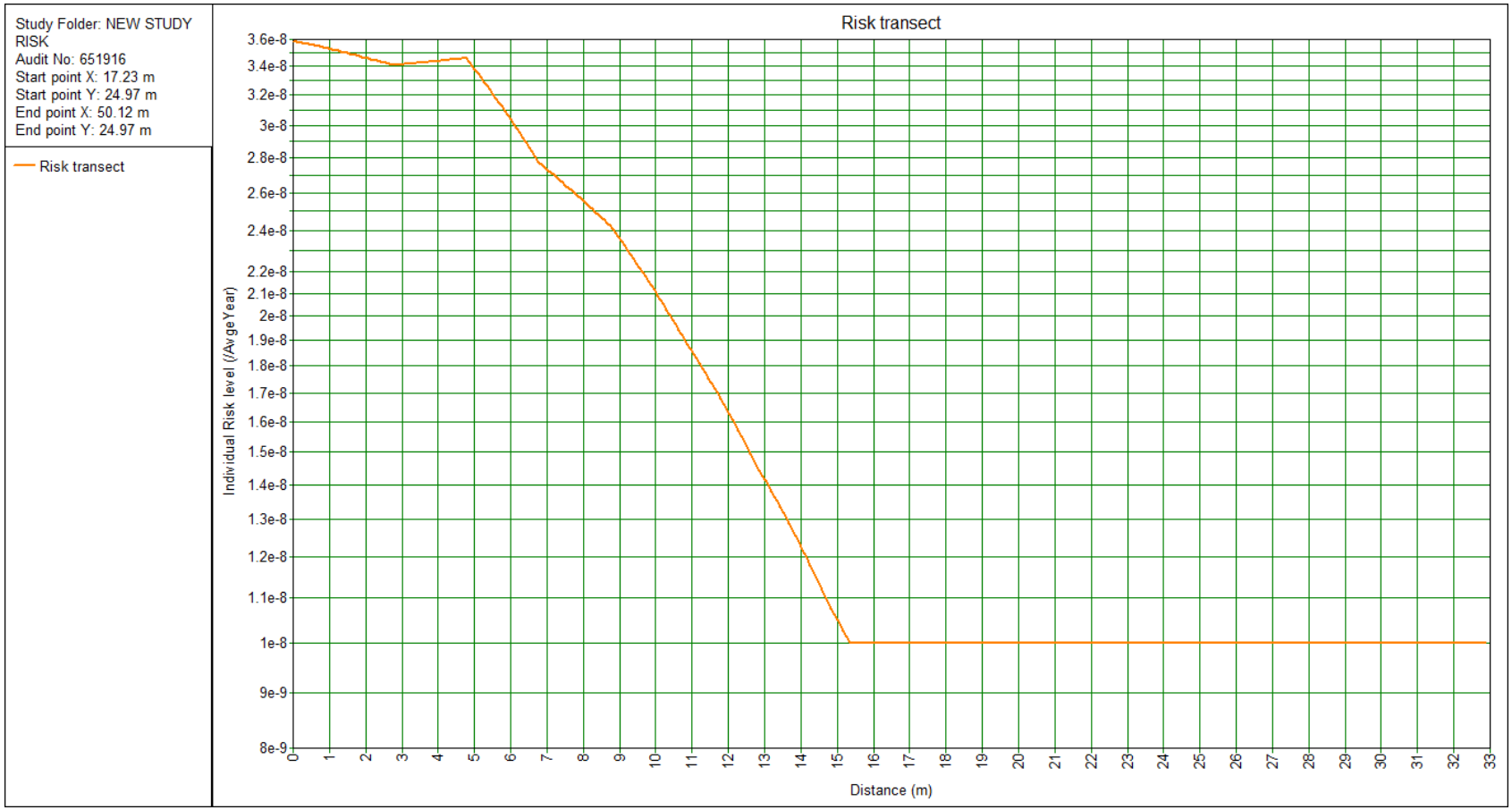
Action Plan

(a) Close all gates.
(b) Maintain tight security.
(c) Chief Emergency Controller to keep contact with local authorities.
(d) Keep round the clock patrolling.
(e) Alert all employees of disaster control action plan and activate in case of requirement.

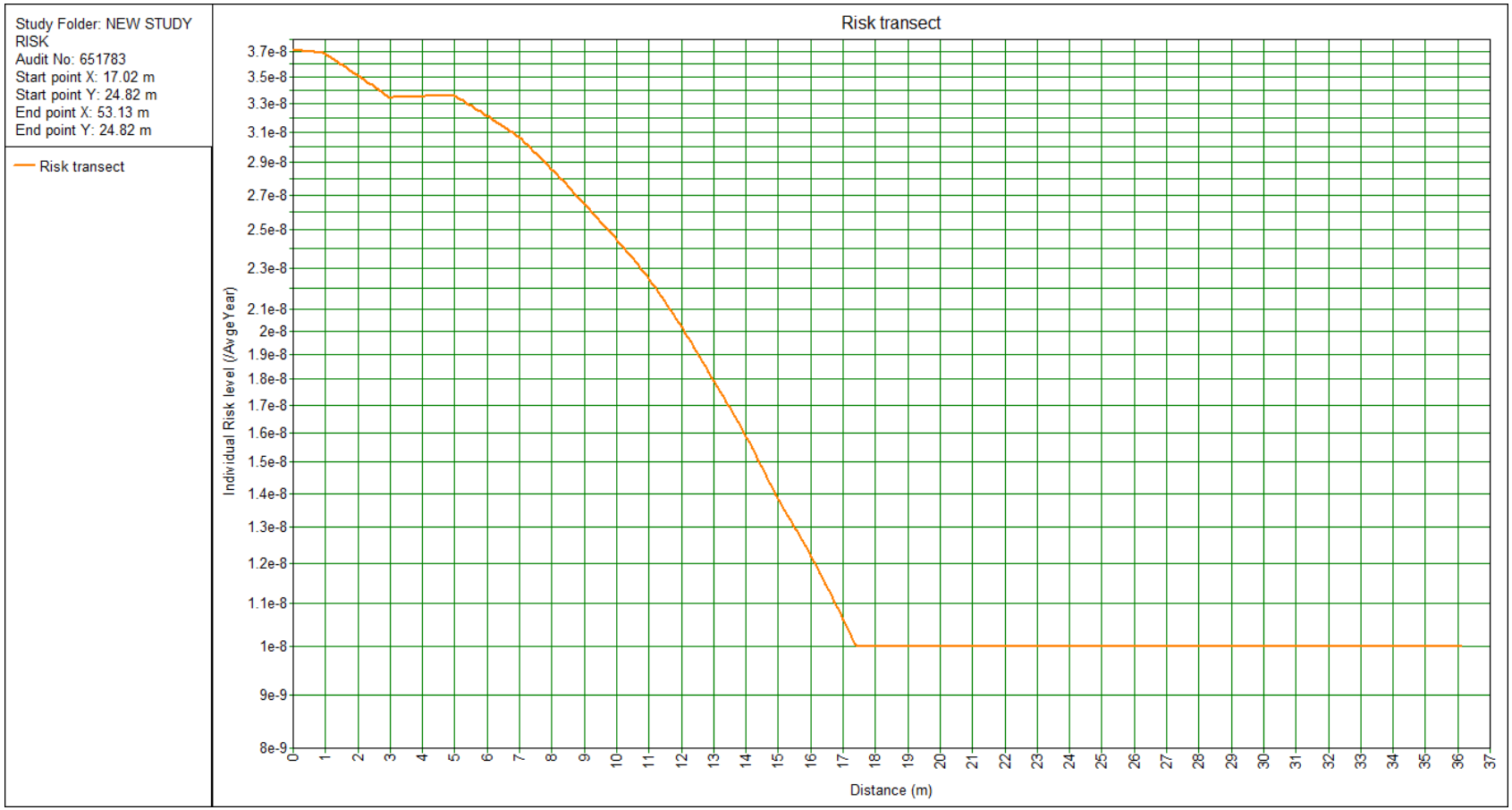

OPTION - 2
OPTION - 3
OPTION - 1
Durgachak
Aegis
HOJ - I
HOJ - II
HOJ - III
Drawing No. 01
Image © 2015 DigitalGlobe
© 2015 Google
Google earth
2006
Imagery Date: 12/1/2014 22°02'25.36" N 88°06'16.21" E elev 27 ft eye alt 25031 ft



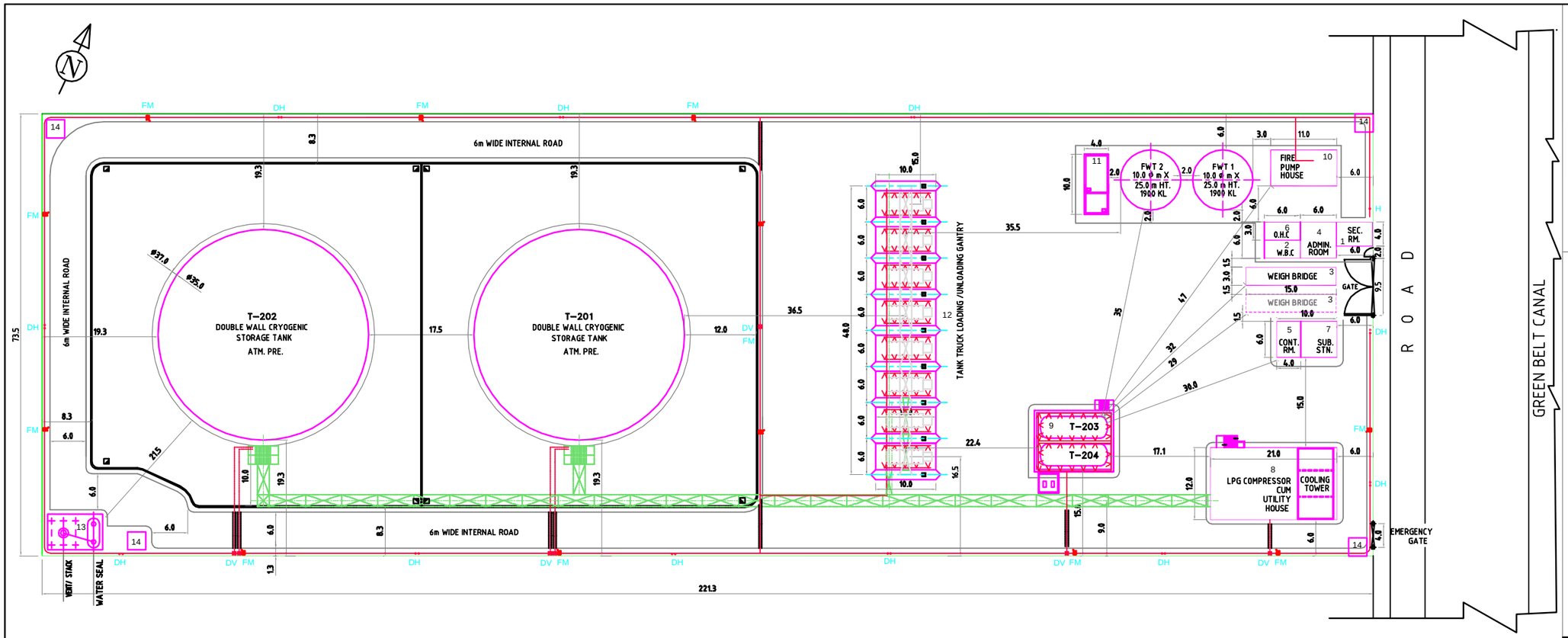
Drawing No. 2 (Risk Transect for the pipeline route of option I at Haldia of M/s Aegis Logistics)

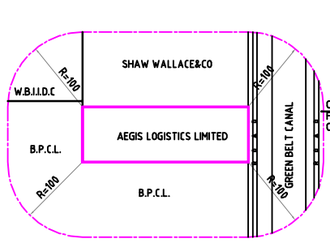


Drawing No. 3 (Risk Transect for the pipeline route of option I beside BPCL near patikhali creek at Haldia of M/s Aegis Logistics)



Drawing No. 4 (Risk Transect for the pipeline route of option I near IOCL refinery at Haldia of M/s Aegis Logistics)





KEY PLAN
SCALE= 1:4000

TANKS FOR LPG					
SR. NO.	TANK NO.	TANK SIZE IN MTR. DIAMETER x HEIGHT	CAPACITY	WATER CAPACITY	MATERIAL OF CONSTRUCTION
1	T-201	INNER 35.0x25.0	12,500 MT.	24,050 M^3	LOW TEMPERATURE CARBON STEEL ASTM A 537 CL.1/P 355 NL2 OR EQUIVALENT
		OUTER 37.0x26.0			
2	T-202	INNER 35.0x25.0	12,500 MT.	24,050 M^3	
		OUTER 37.0x26.0			
3	T-203	3.60 x 11.0 LG.	50 MT	105 M^3	ASTM A 516 GR. 60/70 OR EQUIVALENT
4	T-204	3.60 x 11.0 LG.	50 MT	105 M^3	
TANKS FOR FIRE WATER STORAGE					
SR. NO.	TANK NO.	TANK SIZE IN MTR. DIAMETER x HEIGHT	CAPACITY KL.	MATERIAL OF CONSTRUCTION	
5	FWT 1	10.0 x 25.0	1950	IS 2062 GR. A/B	
6	FWT 2	10.0 x 25.0	1950		

SR.NO.	DESCRIPTION	PROPOSED SIZE x NOS.	AREA
1	SECURITY ROOM	6M X 4M	24 SQ.M
2	WEIGH BRIDGE CABIN	3M X 6M	18 SQ.M
3	WEIGH BRIDGE	15M X 3M X 2NOS.	90 SQ.M
4	ADMINISTRATIVE ROOM	6M X 6M	36 SQ.M
5	CONTROL ROOM	6M X 4M	24 SQ.M
6	OCCUPATIONAL HEALTH CENTER	6M X 3M	18 SQ.M
7	SUBSTATION	6M X 6M	36 SQ.M
8	LPG COMPRESSOR CUM UTILITY HOUSE	21M X 12M	252 SQ.M
9	MOUNDED VESSELS	13.2M X 10.2M	134.64 SQ.M
10	FIRE PUMP HOUSE	11M X 6M	66 SQ.M
11	UNDERGROUND WATER TANK	10M X 4M	40 SQ.M
12	TRUCK LOADING STATION (LPG)	48M X 10M	480 SQ.M
13	WATER SEAL & VENT/ STACK	6M X 6M	36 SQ.M
14	WATCH TOWER (4 NOS.)	3M X 3M X 4	36 SQ.M

NOTES:-

1) ALL DIMENSIONS ARE IN METRES UNLESS OTHERWISE SPECIFIED.
2) PUF INSULATION WILL BE PROVIDED ON LPG CRYOGENIC TANKS OUTER WALL
3) EXTERNAL SURFACE OF MOUNDED VESSELS WILL BE SHOT/GRIT BLASTED CONFORMING TO SA 2 1/2 OF SWEDISH STANDARD & COATED WITH HIGH BUILD EPOXY POLYAMIDE PAINT SYSYTEM AS FOLLOWS
   a. SHOT BLAST TO SA 2 1/2 FINISH.
   b. PRIMER COAT _____ 50 MICRON.
   c. 1ST COAT OF COAL TAR 200 MICRON.
   d. 2ND COAT OF COAL TAR 200 MICRON.
   TOTAL = 450 MICRON
4) MOUNDED VESSELS WILL BE PROVIDED WITH ANODE FLEX TYPE IMPRESSED CURRENT CATHODIC PROTECTION SYSTEM
5) EXTERNAL SURFACE OF THE MOUNDED VESSELS WILL BE TESTED FOR SPARK TEST (HOLIDAY TEST)
6) NECESSARY FIRE PROTECTION SYSTEM AND GAS DETECTION SYSTEM WILL BE PROVIDED.
7) SUITABLE HAND RAILING WILL BE PROVIDED ON TANKS.

COMPUTATION OF FIRE WATER SERVICE

1. SURFACE AREA OF 2 NOS. MOUNDED TANKS = 2 X 125 = 250 SQ.M.
2. ROOF AREA OF 2 NOS. CRYOGENIC TANKS = 2 x 1033.58= 2067.16 SQ.M.
3. AREA OF GANTRY = 480 SQ.M.
4. AREA OF COMPRESSOR SHED = 174 SQ.M.
5. HENCE LARGEST AREA = 2067.16 SQ.M.
   A. WATER REQUIRED FOR 4 HOURS OPERATION OF FIRE WATER SPRINKLERS @ 3 LPM/SQ.M. = 1488.0 CU.M.
   B. WATER REQUIRED FOR OPERATING 2 NOS. FIRE MONITOR @ 114 CU.M./hr. EACH FOR 4 HOURS = 1152 CU.M.
6. THERE FORE TOTAL REQUIRED WATER CAPACITY = 1488 + 1152 =2640 CU.M.
7. 2 NOS. WATER TANKS PROVIDED ARE OF ø10 MTRS. x 25 MTRS. HT.
8. THERE FORE WATER CAPACITY = 3900 CU.M.
   HENCE WATER CAPACITY AVAILABLE IS LARGER THAN REQUIRED CAPACITY

SYMBOLS

BARBED WIRE FENCE	
CULVERT	
DYKE WALLS	
FIRE FIGHTING PIPE LINE OVER GROUND	
FIRE FIGHTING PIPE UNDER GROUND	
SPRINKLER SYSTEM	
FIRE HYDRANT (SINGLE) VALVE	
FIRE HYDRANT (DOUBLE) VALVE	
FIRE MONITOR	
DELUGE VALVE	
SLUICE VALVE	
FIRE HOSE STATION	
HUME PIPE	
CHAIN LINK	
RAIL GUARD	
DRAIN PIT WITH VALVE	
ROAD	

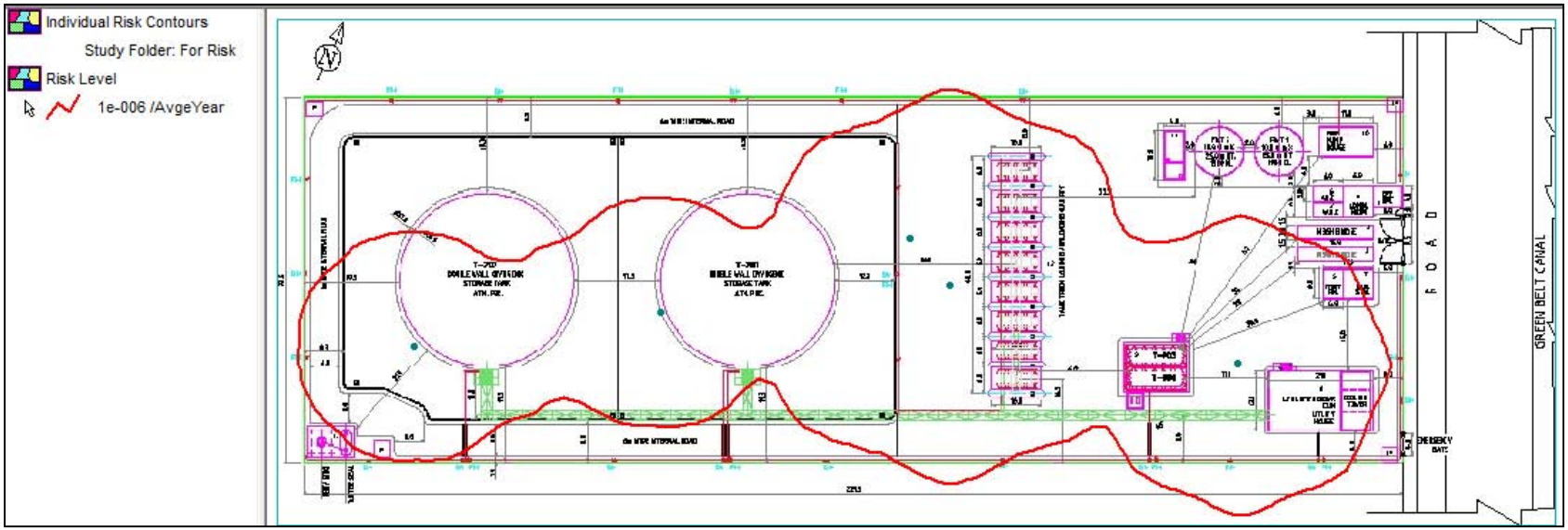
REV.	DESCRIPTION	BY	APPD.	DATE
0	ISSUED FOR APPROVAL	BBP	KSS	10-07-13

TITLE:- **LAYOUT PLAN FOR LPG TERMINAL AT HALDIA**

AEGIS LOGISTICS LIMITED

HALDIA DOCK COMPLEX. MOUZA-JAGAT CHAK J.L. NO.-140 AND BARKUMAR CHAK J.L. NO.-138, P.S.-SUTAHATA (NOW DURACHAK), DIST-MIDNAPUR (NOW PURBAMEDINIPORE), WEST BENGAL

DRN.	BBP	08-07-13		REV.
CHKD.	UPD/SC	08-07-13	DRG.NO. ALL-HLD-300	0
APPD.	KSS	08-07-13		
SCALE	1:400		SHEET 1 OF 1	ISSUE DATE: 10-07-13



Drawing No. 06 (Iso-Risk Contour of LPG Storage & Handling Facility at Haldia of M/s Aegis Logistics)

Drawing No. 07 (F/N Curve of LPG Storage & Handling Facility at Haldia of M/s Aegis Logistics)