1.1. RISK ASSESSMENT & HAZARD IDENTIFICATION

7.3.1. RISK ANALYSIS / ASSESSMENT

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.

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;

7.3.2. HAZARD IDENTIFICATION

Hazard identification is used as the first step in a process used to assess risk. The result of a hazard analysis is the identification of different type of hazards. A hazard is a potential condition and exists or not (probability is 1 or 0). It may in single existence or in combination with other hazards (sometimes called events) and conditions become an actual Functional Failure or Accident (Mishap).

Hazard Identification and Risk Assessment is a method, by which, we try to identify the main hazardous substance, and then try to reduce the effect of hazard.

This section deals with listing of various failure cases leading to various hazard scenarios, analysis of failure modes and consequence analysis.

AAI is planning the New Integrated Terminal Building (NITB) & Hazard occurrence at the proposed project may result in on-site implications, like:

- Leakage of flammable materials, like, HSD followed by fire;
- Bomb threat at terminal building, cargo terminal and aircraft; and
- Natural calamities like, earthquake, cyclone, high winds, etc.

Other incidents, which can also result in a disaster, are:

- Agitation/forced entry by external group of people; and
- Sabotage;
- Air raids; and
- Crashing of aircrafts i.e. while landing or take-off.

Risk analysis follows an extensive hazard identification and analysis. It involves the identification and assessment of risks to the people exposed to hazards present. This requires a thorough knowledge of failure probability, credible accident scenario, vulnerability of populations, etc. For emergency response planning, risk analysis is carried out for worst case scenarios.

7.3.2.1. Identification of Hazards Due to Storage of HSD and on-wheel refueling of aircraft at VSI Airport

At the airport, HSD is stored and handled for DG sets operation while on-wheel refueling of aircraft is done by IOCL which has its fuel tank farm outside AAI Premises.

It is essential to have comprehensive information on High Speed Diesel (HSD) and Aviation Turbine Fuel (ATF) being handled at the VSI airport. An understanding of the physico-chemical properties of fuel will help for hazard identification.

i. High Speed Diesel (HSD)

High speed diesel is a mixture of straight run product (150 °C and 350 °C) with varying amount of selected cracked distillates and is composed of saturated hydrocarbons (primarily paraffins including iso, and cycloparaffins), and aromatic hydrocarbons (including napthalenes and alkylbenzenes). Its exact composition depends on the source of crude oil from which it is produced and the refining methods used.

Physical properties of high speed diesel are as given below:

Boiling point/Range : 215 – 376 °C

Physical state : Liquid

Appearance	: Yellowish Brown
Vapour pressure	: 2.12 to 26mm Hg at 21 ^{o}C
Odour	: Perceptible odour
Solubility in water @ 30 deg.C	: Insoluble
Specific gravity	: 0.86 - 0.90 at 20 °C
Pour Point	: 6 - 18 °C
Flammability	: Yes
LEL	: 0.6%
UEL	: 6%
Flash point (deg C)	: 32 (°C)
TDG Flammability	: Class 3
Auto Ignition Temp	: 225 °C

HSD presents a moderate fire hazard. On heating, it can cause pressure rise with risk of bursting and subsequent explosion. It also forms explosive mixture with air particularly in an empty container.

ii. Aviation Turbine Fuel (ATF)

Aviation Turbine Fuel (ATF) is clear colourless to yellow liquid with slight petroleum odor. It is flammable liquid and highly flammable in presence of open flame and spark. The flammability of ATF is ranked as 2 by National Fire Protection Association (NFPA).

Physical properties of ATF are as given below:

Boiling Point: 160°C

Specific Gravity: 0.81 (Water = 1) at 15.6 ^{o}C

Vapor Pressure: 1 kPa (@ 37.8°C)

Vapor Density: 5.7 (Air = 1)

Auto-Ignition Temperature: 210°C

Flash Points: 38°C

Flammable Limits: Lower: 0.7% Upper: 5 %

Viscosity: 8 cSt @ -20.0 °C

Solubility: Low PPM range in water

7.3.2.2. Consequence analysis

Consequence analysis is basically a quantitative study of the hazard due to various failure scenarios to determine the possible magnitude of damage effects and to determine the distances up to, which the damage may occur in consequence analysis, a number of calculation models are used to estimate the physical effects of an accidental release and to predict the damage (lethality, injury, material destruction) of the effects. The calculations can roughly be divided in three major groups:

- Determination of the source strength parameters
- Determination of the consequential effects
- Determination of the damage or damage distances

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenarios occur. It also gives information to deal with the possible catastrophic events and an understanding of hazard potential and remedial measures to the plant authorities, workers and the public living outside in the vicinity of the plant.

7.3.2.3. Approach to the Study

Risk involves occurrence or potential occurrence of some incidents consisting of an event or sequence of events. Risk assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire (thermal radiation) and explosion;
- Assess the overall damage potential of the identified hazardous events and the impact zones from the accidental scenarios;
- Assess the overall suitability of the site from hazard minimization and disaster mitigation point of view;

- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of broad Disaster Management Plan (DMP), On-site and Off-site Emergency Plan, which includes Occupational and Health Safety Plan.

7.3.2.4. Aviation Turbine Fuel (ATF)

There are basically two types of aviation fuels viz. Jet A1 (K-50) as per IS-1571, RT fuel (K-60) and JP5 are all Class B POL products. These kerosene type aviation fuels have minimum flash point of 38 degrees C (for Jet A1), 28 degrees C (for K-60) and 60 degree C for JP5. At ambient temperatures they must be treated as flammable liquids and additional precautions should always be taken in handling them at these temperatures.

VSI airport has plans for ATF storage in the future however, presently, only on-wheel refueling is being done by IOCL which has storage facility outside of airport premises.

A. General Classification of Petroleum Products

Petroleum products are classified according to their closed cup Flash Point as given below:

- Class-A Petroleum: Liquids which have flash point below 23 degree C.
- Class-B Petroleum: Liquids which have flash point of 23 degree C and above but below 65 degree C.
- Class-C Petroleum: Liquids which have flash point of 65 degree C and above but below 93 degree C.
- Excluded Petroleum: Liquids which have flash point of 93 degree C and above.

Table 7.1: Composition / Information on Ingredients

Hazardous Components Name/ CAS No.	Concentration (%)	ACGIH Exposure Limits	OSHA Exposure Limits	NIOSH Exposure Limits
Kerosene 8008-20-6	100	200 mg/m^3 TWA-	-	-

Hazardous Components Name/ CAS No.	**Concentration (%)**	**ACGIH Exposure Limits**	**OSHA Exposure Limits**	**NIOSH Exposure Limits**
		Skin		
Hydrodesulfurized Kerosene 64742-81-0	0-100	100 mg/m^3 TWA Skin	-	-
Hydrotreated TWADistillate, Light 64742-47-8	0-100	100 mg/m^3 TWA Skin	-	-
Cat Cracked Distillate, Light 64741-59-9	0-30	100 mg/m^3 TWA Skin	-	-
Cyclohexane 110-82-7	< 1	100 ppm TWA	300 ppm TWA	300 ppm TWA 1300 ppm IDLH
Ethyle Benzene 100-41-4	< 1	100 ppm TWA 125 ppm STEL	100 ppm TWA 125 ppm STEL	100 ppm TWA 125 ppm STEL 800 ppm IDLH
Naphtalene 91-20-3	< 3	10 ppm TWA 15 ppm STEL Skin	10 ppm TWA	10 ppm TWA 15 ppm STEL Skin 250 ppm IDLH
Toluene 108-88-3	<1	50 ppm TWA Skin	200 ppm TWA 300 ppm Ceiling 500 ppm Peak-10 min	100 ppm TWA 150 ppm STEL 500 ppm IDLH
Xylene, all isomers 1330-20-7	< 1-2	100 ppm TWA 150 ppm STEL	100 ppm TWA 150 ppm STEL	900 ppm IDLH

B. Emergency Overview

This product is a clear to pale yellow liquid or red, if dyed, with a hydrocarbon odor. Keep away from heat, sparks, flames and other sources of ignition. It contains material that has caused cancer based on animal data. Never siphon this product by mouth. If swallowed, this product may be aspirated into the lungs and cause lung damage or death.

Table 7.2: Potential Acute Health Effects

Inhalation	Breathing high concentrations may be harmful. Mist or vapor can irritate the throat and lungs. Breathing this material may cause central nervous system depression with symptoms including nausea, headache, dizziness, fatigue, drowsiness or unconsciousness
Eye Contact	This product can cause eye irritation from short-term contact with liquid, mists or vapors. Symptoms include stinging, watering, redness and swelling. Effects may be more serious with repeated or prolonged contact.
Skin Contact	Mild to moderate skin irritant. Contact may cause redness, itching, burning and skin damage. Prolonged or repeated skin contact may cause drying and cracking of the skin, dermatitis (inflammation), burns and severe skin damage.
Ingestion	Ingestion may result in nausea, vomiting, diarrhea and restlessness. Aspiration (inadvertent suction) of liquid into the lungs must be avoided as even small quantities in the lungs can produce lung inflammation and damage.
Potential Chronic Health Effects	
Signs and Symptoms	Chronic effects of overexposure are similar to acute effects including central nervous system (CNS) effects and CNS depression, irritation of the respiratory or digestive tracts, nausea, abd diarrhea.
Carcinogenic Potential	This material may contain ethyl benzene and naphthalene at concentrations above 0.1%. IARC has identified dieseI (a product similar to kerosene) engine exhaust as probably carcinogenic to humans (Group 2A) and ethyl benzene and naphthalene as possibly carcinogenic to humans (Group 2B) based on laboratory animal studies.
Target Organs	May cause damage to skin, kidneys, liver, upper respiratory system, eyes and central nervous system (CNS).
Conditions Aggravated by Overexposure	Disorders of the following organs or organ systems that may be aggravated by significant exposure to this material or its components include the skin, respiratory system, liver, kidneys and CNS.

7.3.3. IDENTIFICATION OF HAZARDS BASED ON MSIHC RULE, 2000

Manufacturing, Storage, Import of Hazardous Chemicals Rules, 1989 (amended in 2000) has been enforced by Govt. of India under Environment (Protection) Act, 1986. For the purpose of identifying hazard installations the rules employ certain criteria based on toxic, flammable and explosive properties of chemicals. MSIHC Rule is applicable for storage of HSD at the VSI airport.

7.3.4. HAZARDOUS CONDITIONS

An accidental release of HSD for DG operation and ATF during filling in aircraft may result in formation of fixed or spreading pool of released qualities. In case of immediate ignition a pool fire will result. Delayed ignition may result in explosion or flash fire, if quantity of explosive mass is sufficient and some confinement is present.

i. Pool Fire

A leak or spill of sufficient quantities of petroleum product will result in an accumulation of petroleum product on the ground. If ignited, the resulting fire is known as spreading or fixed pool fire. In case any object comes in contact with the flame above the pool, it will be severely damaged or destroyed and personnel exposed to flame will suffer extensive burn injuries. Objects and personnel outside the actual flame volume may also be affected or injured by radiant heat. The extent of damage or injury depends on the heat flux and duration of fire and exposure. If a large area of the body receives second and third degree burns, it can result in fatalities.

The extent of injury to people depends on the heat flux and duration of exposure. The extent of damage to personnel and property depends on the size of the pool and the duration of fire.

ii. Thermal Effects

In case of fire, thermal effect is likely to cause injury or damage to people and objects. A substantial body of experimental data exists and forms the basis for thermal effect estimation. The consequence caused by exposure to heat radiation is a function of:

- Radiation energy onto the human body [kW/m2];
- Exposure duration [sec];
- Protection of the skin tissue (clothed or naked body).

The following damage distances for thermal radiation have been used:

- 37.5 kW/m^2: Damage to process equipment.100% fatality in 1 min. 1% fatality in 10 sec.
- 12.5 kW/m^2: First degree burn for 10 sec. exposure
- 4.0 kW/m^2: First degree burn for 30 sec. exposure

iii. Vapour Cloud Explosion/Flash fire

Vapour cloud explosion scenarios have been considered for confined (over pressure scenario) as well as non-confined scenario (flash fire). If released HSD are not ignited directly, the vapour cloud will spread in the surrounding area towards wind direction. The drifting cloud will mix with air. As long as the vapour concentration is between the lower and upper explosion limits, the vapour cloud may be set on fire by an ignition source. In case of delayed ignition of a vapour cloud, two physical effects may occur: a flash fire (non-confined) over the whole length of the flammable vapour cloud; a vapour cloud explosion (confined) which results in blast wave, with typical peak overpressures circular around the ignition source. For generation of overpressure effects, some degree of confinement of the flammable cloud is required. The extent of injury to people & damage to property or environment depends on the cloud size, explosive mass in the cloud and the degree of confinement at the time of ignition.

iv. Delayed Ignition & Explosion

In case of delayed ignition of a natural vapour cloud, two physical effects may occur:

- A flash fire (non confined explosion) over the whole length of the explosive vapour cloud;
- A vapour cloud explosion (confined explosion) that results in blast wave, with typical peak overpressures circular around the ignition source. For generation of overpressure effects, some degree of confinement of the flammable cloud is required.

Table 7.3: Damage Effects due to Overpressures

Peak Overpressure	Damage Type
0.830 bar	Total Destruction
0.350 bar	Heavy Damage
0.170 bar	Moderate Damage
0.100 bar	Minor Damage

The Table below gives an illustrative listing of damage effects caused by peak overpressure.

Table 7.4: Illustrative Damage Effects due to Overpressures

Peak Overpressure (Bar)	Failure
0.005	5 % Window Shattering
0.02	50 % Window Shattering
0.07	Collapse of a roof of a tank
0.07-0.14	Connection failure of panelling
0.08-0.1	Minor Damage to Steel Framework
0.15-0.2	Concrete block wall shattered
0.2	Collapse of Steel Framework
0.2-0.3	Collapse of self framing Steel panel building
0.2-0.3	Ripping of empty oil tanks
0.2-0.3	Deformation of a pipe bridge
0.2-0.4	Big trees topple over
0.3	Panelling torn off
0.35-0.4	Piping failure
0.35-0.8	Damage to Distillation Column

Peak Overpressure (Bar)	Failure
0.4-0.85	Collapse of pipe bridge
0.5	Loaded Train Wagon overturned
0.5	Brick walls shattered
0.5-1.0	Movement of round tank, failure of connecting piping

(Source: TNO)

Table 7.5: Preliminary Hazard Analysis For Process And Storage Areas And For Whole Airport

Source	Process	Potential Hazard	Provisions
DG Set	Production of Electrical Energy	Fire hazard in Lube oil system, cable gallery short circuit	Standard Cables to be used, Fire detection system to be used
Power Transfer unit		Fire and explosive	-do-
Switch Yard Control Room	220 KVA switch yard	Fire	-do-
ATF & HSD Storage Area	Fuel Storage for Aircraft, ground vehicles	Fire & Explosive	Precautions as per TAC, OISD to be followed. Fuel Hydrant system for Aircraft refuelling. Fire Detection alarm system.
Compressor House	Airport operation	Governor failure due o the failure of pins and springs leading to opening of safety valves & source ignition	Design precautions to be followed in manufacture and erection. Fire Detection Alarm system to be used.
Buildings	Electrical short circuit Eventually source ignition	Fire	All electrical fittings and cables will be provided of standard quality. All motor starters to be flame proof.
Chemical Store	Inflammable chemicals in Stores	Fire in Storage Areas due to inflammable nature of chemicals	Fire extinguishers at potential points. Fire Hydrant network as per TAC guidelines. Fire detection system.

7.3.5. MAXIMUM CREDIBLE ACCIDENT ANALYSIS (MCAA)

At the VSI airport, HSD may be released as a result of failures of hose pipe used for loading and unloading or catastrophic rupture of pipe or pipe connection, causing possible fire and explosion resulting damage human and property in the surrounding area. This section deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models. Maximum Credible Accident analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, vapor cloud explosion, etc. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed.

The VSI Airport may mainly pose flammable and explosion hazards due to unwanted release or leakage of HSD. Consequence analysis is basically a study of quantitative analysis of hazards due to various failure scenarios. It is that part of risk analysis, which considers failure cases and the damage caused by these failure cases. It is done in order to form an opinion on potentially hazardous outcome of accidents and their possible consequences.

The reason and purpose of consequence analysis are many folds like:

a. Estimation of consequence distances;
b. Design Criteria.
c. Protection of other installations; and
d. Emergency Planning;

The results of consequence analysis are useful for getting information about all known and unknown effects that are of importance when some failure scenario occurs and also to get information as how to deal with the possible catastrophic events.

7.3.5.1. Scenarios Considered For Consequence Analysis

The mode of approach adopted for consequence analysis is to first select the failure cases and then to conduct the consequence analysis of the selected failure cases. The failure cases selected are listed in Table No.-7.6.

Table 7.6: Selected failure cases

S. No.	Scenario	Failure Mode
1.	Tank containing an unpressurized	Leaking tank, chemical is not burning and

	flammable liquid	forms an evaporating puddle
		Leaking tank, chemical is burning and forms a pool fire
		BLEVE, tank explodes and chemical burns in a fireball
2.	Flammable chemical escaping from tank. Chemical is not on fire	Flammable area of vapour cloud
		Blast area of vapour cloud explosion

The above scenarios are made keeping in view the worst scenarios occurred in the past and likely disasters that could occur on a major scale and managing such risks by drawing a precedential scale of approach to minimize any such effects in near future.

7.3.6. MODEL USED FOR ANALYSIS

ALOHA® is the hazard modeling program for the CAMEO® software suite, which is used widely to plan for and respond to chemical emergencies.

ALOHA allows you to enter details about a real or potential chemical release, and then it will generate threat zone estimates for various types of hazards. ALOHA can model toxic gas clouds, flammable gas clouds, BLEVEs (Boiling Liquid Expanding Vapor Explosions), jet fires, pool fires, and vapor cloud explosions. The threat zone estimates are shown on a grid in ALOHA.

SITE DATA:

Location: Veer Savarkar International Airport, Andaman & Nicobar Islands, India

Building Air Exchanges per Hour: 0.95 (unsheltered double storied)

CHEMICAL DATA:

Chemical Name: HSD

CAS Number: 111-65-9

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 17 miles/hour from SW at 3 meters

Ground Roughness: open country Cloud Cover: 0 tenths

Air Temperature: 90° F Stability Class: D

No Inversion Height Relative Humidity: 50%

Scenario 1: Tank containing unpressurized flammable liquid

SOURCE STRENGTH:

Leak from hole in horizontal cylindrical tank

Flammable chemical escaping from tank (not burning)

Tank Diameter: 7 feet Tank Length: 8 feet

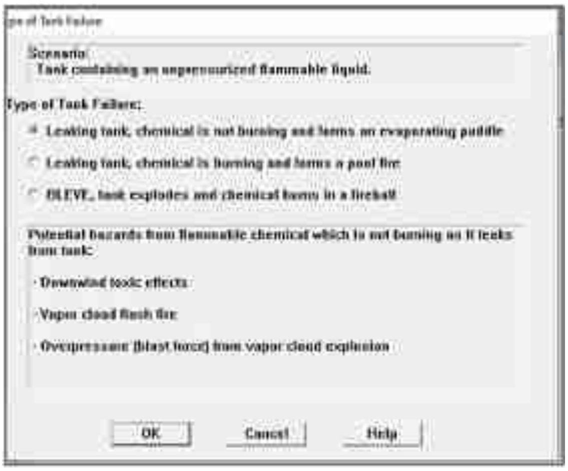
Tank Volume: 2,303 gallons

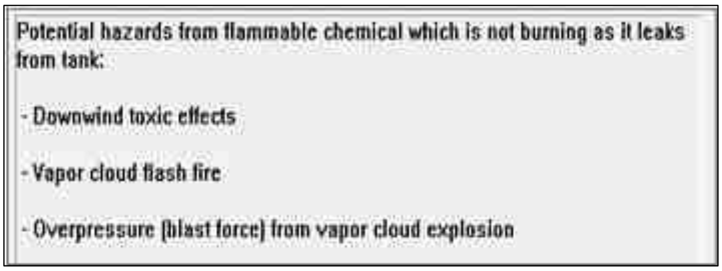
Tank contains liquid Internal Temperature: 90° F

Chemical Mass in Tank: 6.40 tons Tank is 96% full

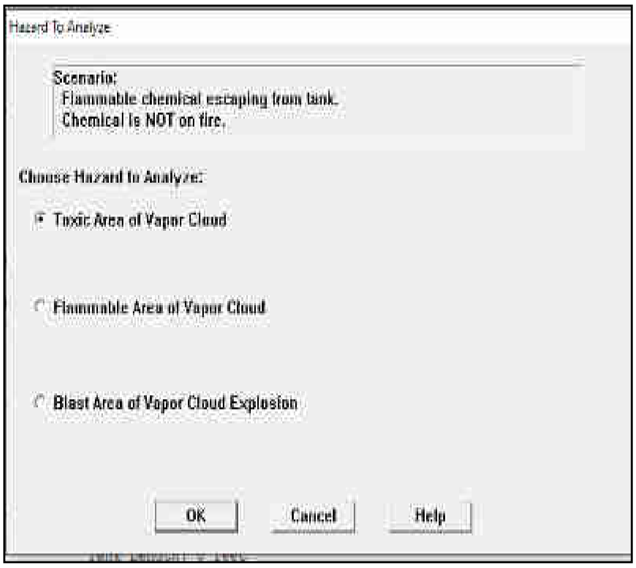
Type of tank failure:

a. Leaking tank, chemical is not burning and forms an evaporating puddle





b. Hazard to analyze: i. Toxic area of vapour cloud



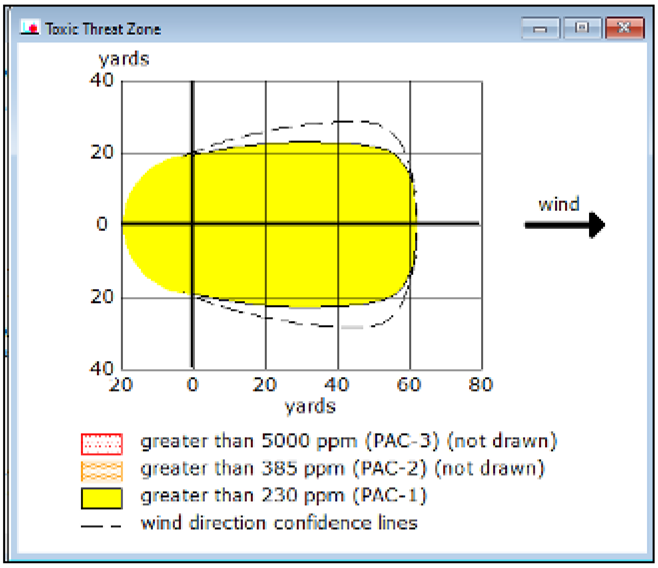
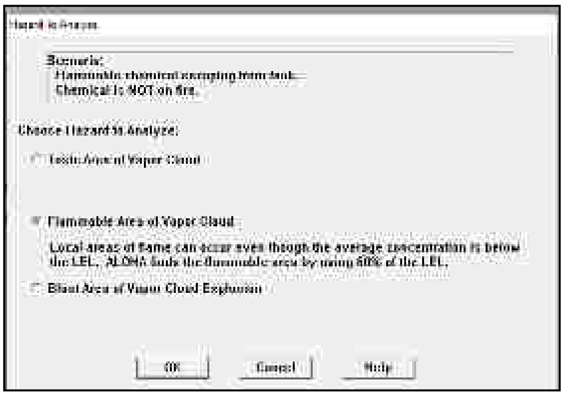


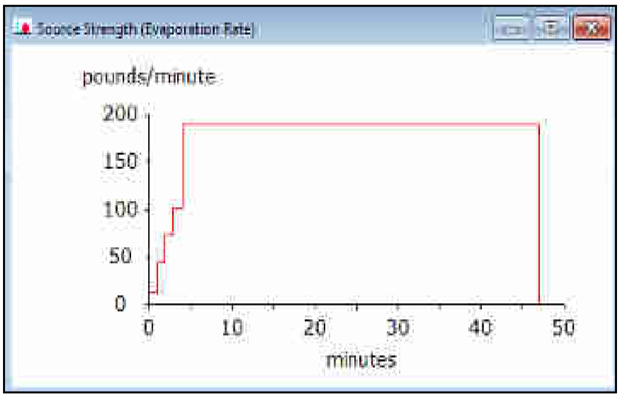
Figure 7.1 : Threat zone: Toxic area of vapour cloud

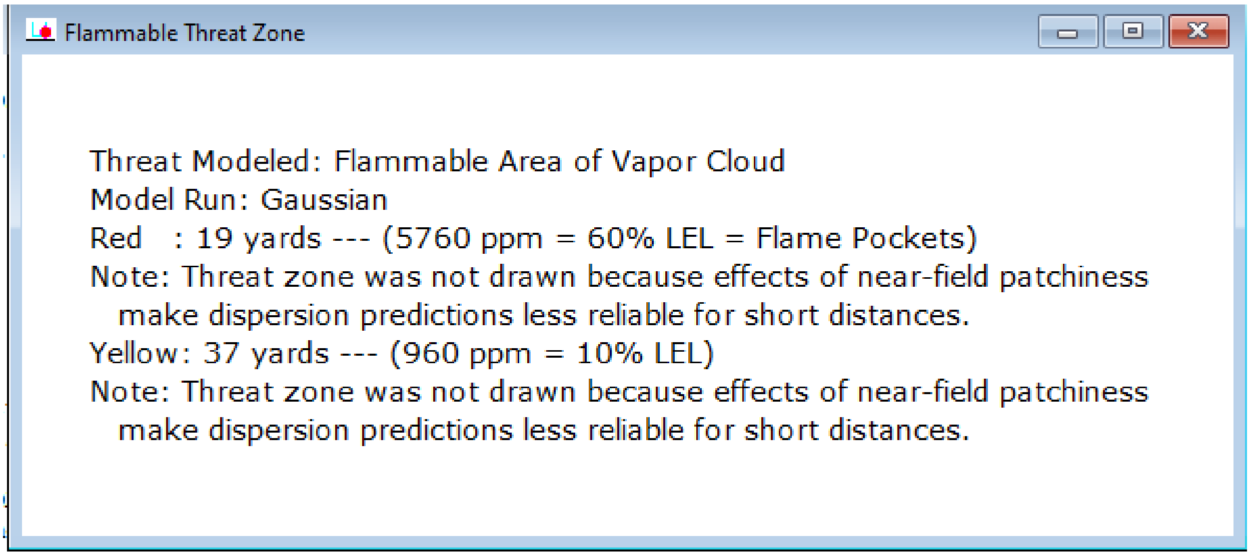
THREAT ZONE:

Yellow: 65 yards --- (2.0 kW/(sq m) = pain within 60 sec)

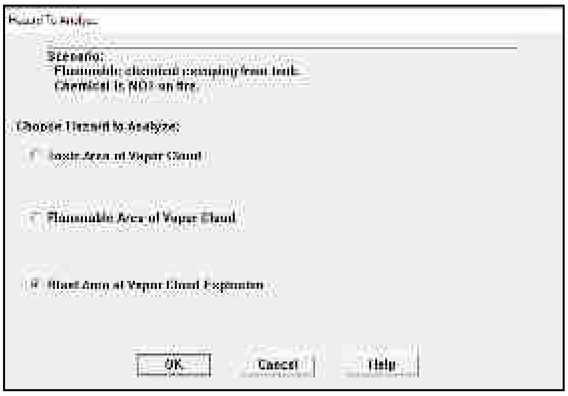
Hazard to analyze: ii. Flammable area of vapour cloud

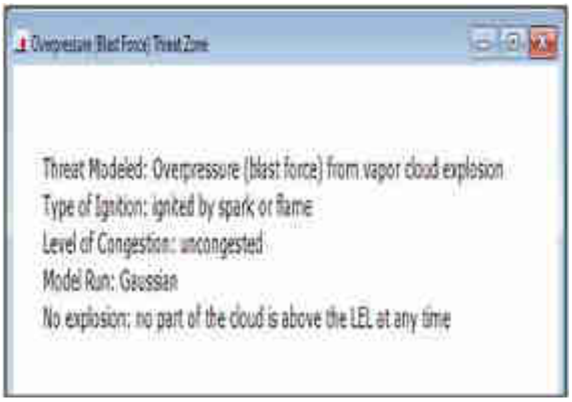


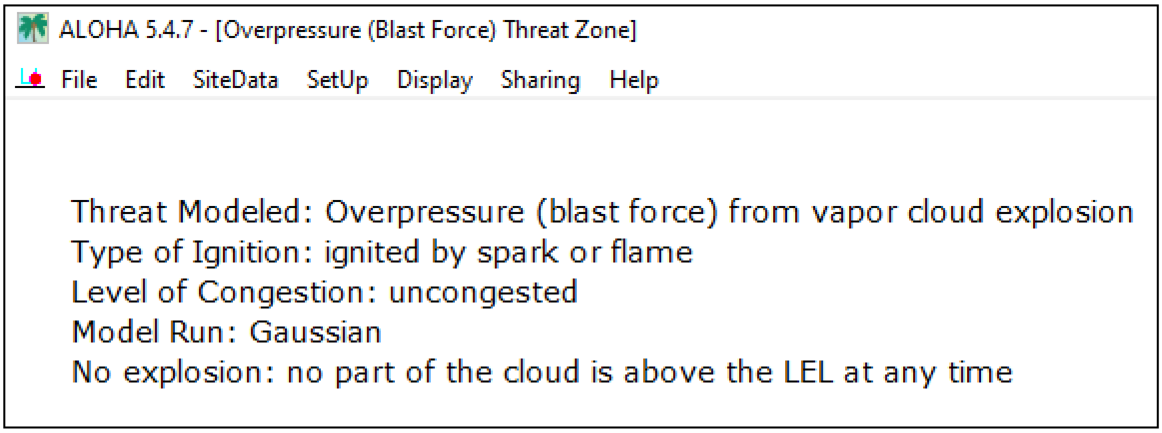




Hazard to analyze: iii. Blast area of vapour cloud explosion

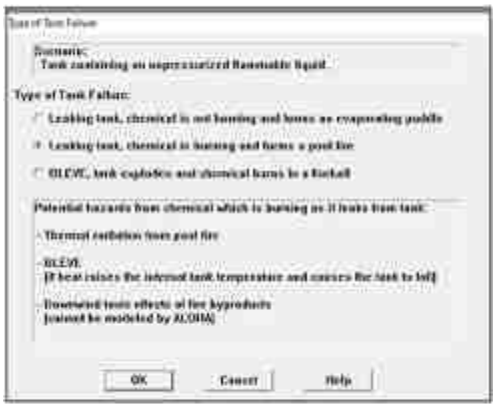


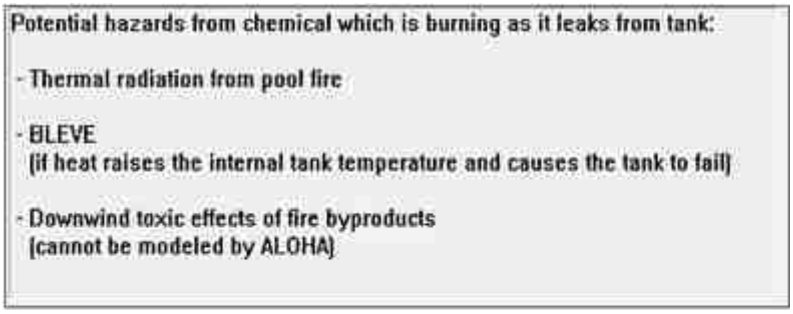




Type of tank failure:

a. Leaking tank chemical is burning and forms a pool





Thermal radiation threat zone

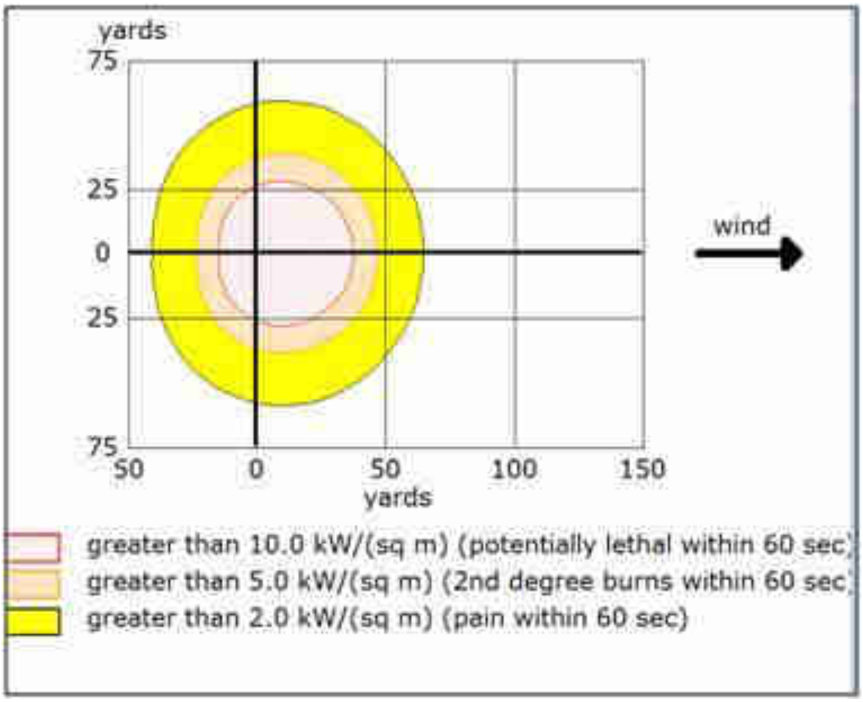


Figure 7.2: Chemical is burning and forms a pool (pool fire)

THREAT ZONE:

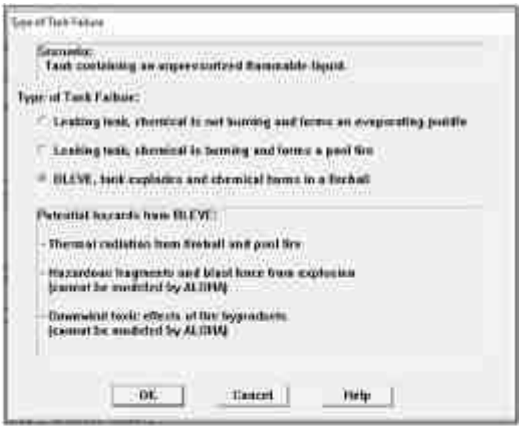
Red: 38 yards --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

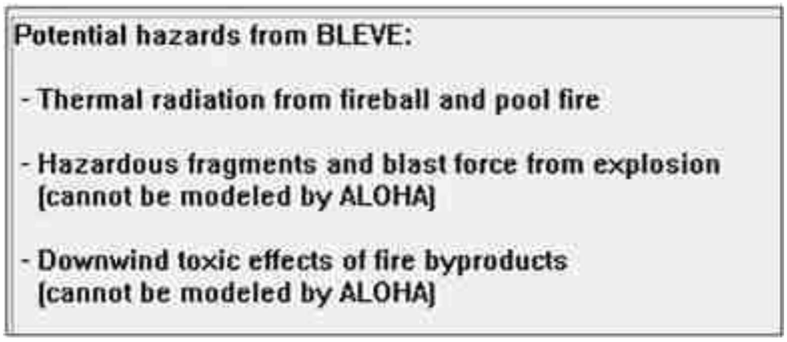
Orange: 47 yards --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

Yellow: 65 yards --- (2.0 kW/(sq m) = pain within 60 sec)

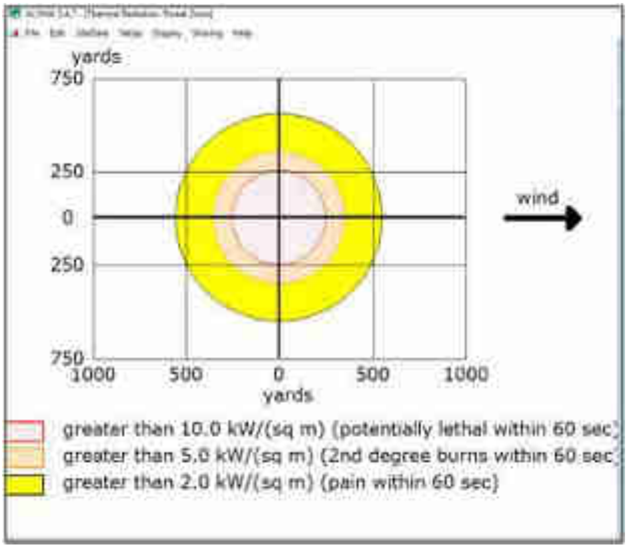
Type of tank failure:

a. BLEVE, tank explodes and chemical burns in a fireball





Thermal radiation threat zone



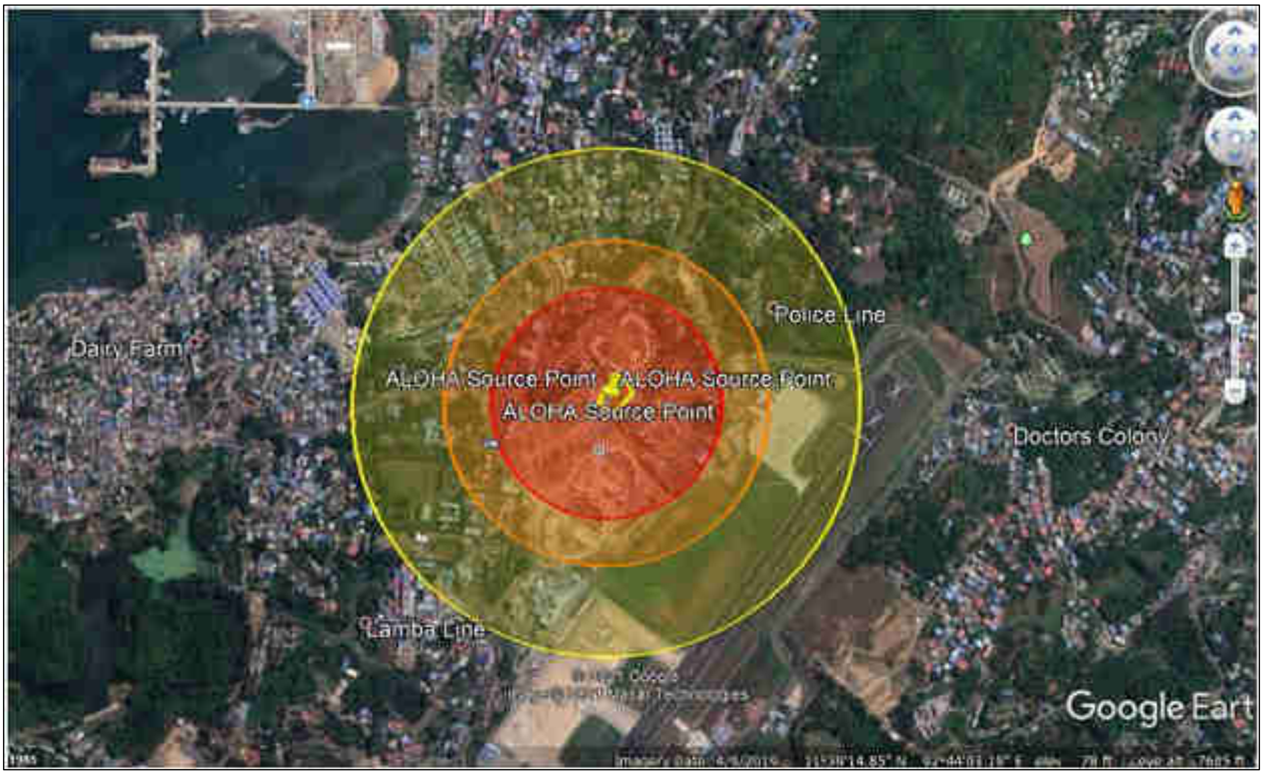


Figure 7.3: BLEVE, tank explodes and chemical burns in a fireball

7.3.7. HIGH SPEED DIESEL (HSD)

High speed diesel is a mixture of straight run product (150 °C and 350 °C) with varying amount of selected cracked distillates and is composed of saturated hydrocarbons (primarily paraffins including iso, and cycloparaffins), and aromatic hydrocarbons (including napthalenes and alkylbenzenes). Its exact composition depends on the source of crude oil from which it is produced and the refining methods used.

HSD presents a moderate fire hazard. On heating, it can cause pressure rise with risk of bursting and subsequent explosion. It also forms explosive mixture with air particularly in an empty container.

A. Inventory at Site

Table 7.7: Storage Capacity of HSD at project site

S. No.	Name of Hazardous Materials & Location	Nature of Hazard	No. of Storage Units	Capacity of storage (Liters)
1	HSD (High Speed Diesel) ; underground	Fire & Explosion	01	20 KL

Table 7.8: HSD Characteristics

Chemical	Codes/ Label	TLV	FBP	MP	FP	LEL	UEL
						%	
HSD (High Speed Diesel)	Flammable	800 ppm	215-3760 C	NA	320 C	0.6	6.0

TLV : Threshold Limit Value

FBP : Final Boiling Point

MP : Melting Point

FP : Flash Point

UEL : Upper Explosive Limit

LEL : Lower Explosive Limit

Table 7.9: Applicability of MSIHC Rules to Storage

S.	Chemical/	Listed in	Actual	Threshold Quantity

No.	Fuel	Schedule	Expected Quantity	for Application of Rules 5,7 – 9 and 13 - 15	For Application of Rules 10 - 12
1	HSD	3(2(e)(iii),5 and 6(1)(a) /)	20,000 lt.	2500 T	20,000 T

From the above table it can be inferred that HSD tank does not attract rules 2(e)(iii), 5 and 6(1)(a) and 7-15, as the stored quantities are less than that of the stipulated threshold quantities.

7.3.8. MAXIMUM CREDIBLE ACCIDENT ANALYSIS

Hazardous substances may be released as a result of failures or catastrophes, causing possible damage to the surrounding area. This chapter deals with the question of how the consequences of the release of such substances and the damage to the surrounding area can be determined by means of models.

A disastrous situation is generally due to outcome of fire, explosion or toxic hazards in addition to other natural causes, which eventually lead to loss of life, property and ecological imbalance.

MCA analysis encompasses certain techniques to identify the hazards and calculate the consequent effects in terms of damage distances of heat radiation, toxic releases, vapor cloud explosion, etc. A host of probable or potential accidents of the major units in the complex arising due to use, storage and handling of the hazardous materials are examined to establish their credibility. Depending upon the effective hazardous attributes and their impact on the event, the maximum effect on the surrounding environment and the respective damage caused can be assessed. Various models for calculating the physical effects of the incidental release of hazardous substances are detailed subsequently. First, attention is paid to the factors, which are decisive for the selection of the models to be used in a particular situation, after which the various effect models are discussed.

Table 7.10: Mathematical models and analytical models for Hazard Analysis

S. No	Explosions	
1.	Pool fire	Fire ball

Table 7.11: Damage criteria

Heat Radiation		Explosions		Toxic Gas Dispersion
Incident Flux KW/m^2	**Damage**	**Peak overpressure (bar)**	**Damage**	The extent of damage depends upon the concentration of the toxic compound in the atmosphere. The relation between percent of injuries and the toxic load is normally given in the form of probity function.
37.5	100% lethality, Heavy damage to equipment	0.3	Heavy - 90%	
25.0	50% lethality, non piloted ignition	0.03	Damage of glass	
12.5	1% lethality, piloted ignition	0.01	Crack of windows	
4.5	Not lethal, 1st degree burns			
1.6	No discomfort even after long exposure			

7.3.9. RISK REDUCTION / MITIGATION MEASURES

The risk mitigation measures are as given below:

- Prompt action in the event of an accidental release of HSD or ATF is essential.
- Where there is a possibility of a flammable liquid spill, provisions have been made to ensure as follows:
  i. The spread of the spill is limited;
  ii. Non-flammable absorbent material is available for immediate use;
  iii. Ignition sources can be quickly removed; and
  iv. The area is well ventilated.
- Routine testing and inspection are carried out for storage area, hoses and fueling tanker and record will be maintained.
- Leakages from tanker are prevented by a suitable regime of preventive maintenance and inspection.

- Heat and smoke detectors will be provided at strategic locations.
- Adequate fire fighting facilities have been provided near storage and handling of HSD
- Fire fighting facilities are tested as per schedule.
- Ground staff near aircraft has been trained to take measure in the event of spillage and during fire emergency.
- Fueling in Aircraft and DG sets 'day tank' is done under the supervision of trained operators.
- Open vents provided of goose neck type, covered with a 4 to 8 mesh screen to discharge the vapours of hydrocarbons from storage tanks.
- Every storage tank and tanker, including all metal connections, is electrically continuous and has been effectively earthed.
- Static grounding of aircraft is ensured whenever the aircraft is parked; including during refueling and defueling.
- Check list for operators for checking safety system and equipment is prepared and check records kept in safe custody.
- The critical operating steps are displayed on the board near the location where applicable.
- Standard Operating Procedure (SOP)" are followed while unloading or fueling the aircraft.
- Mock drills are conducted in every three months involving all concerned agencies.
- All concerned agencies are provided Disaster Management Plan and regular interaction are made.

7.3.10. RISK MITIGATION MEASURES FOR FUELING OF AIRCRAFTS

- Earthing and bonding connections are attached and mechanically firm.
- Equipment performing aircraft servicing function is not positioned within 3 m radius of aircraft fuel vent openings.

- Equipment other than that performing aircraft servicing functions are not positioned within 15 m of aircraft during fuel servicing operations.
- The accessibility to the aircraft by fire vehicles are established during aircraft fuel servicing.
- Handheld intrinsically safe communication devices used within 3 m from the fuel vent is intrinsically safe.
- For open hose discharge capacity of the aircraft fueling system, at least one listed wheeled extinguisher having a rating of not less than 80-B.
- Presence of at least 2 x 9kg ABC dry powder fire extinguishers at both sides of the refueling browser / dispenser is ensured.
- Spark plugs & other exposed terminal connections are insulated.
- All vehicles, other than those performing fuel servicing, are not driven or parked under aircraft wings.
- Electric tools, drills or similar tools likely to produce sparks or arcs are not used.
- The ground service activities do not impede the egress should there be an emergency.
- A clear area for emergency evacuation of the aircraft is maintained at the rear (or front) aircraft exit door.

7.3.11. DISASTER MANAGEMENT PLAN

The important aspect in emergency management is to prevent by technical and organizational measures, the unintentional escape of hazardous materials out of the facility and minimize accidents and losses. Emergency planning demonstrates the organization's commitment to the safety of employees and increases the organization's safety awareness. The format and contents of the Disaster Management Plan have been developed taking into consideration the regulatory guidelines, other applicable documents and accepted industry good practice principles formulated as a result of lessons learned in actual emergencies requiring extensive emergency response. A plan can work smoothly and effectively only if the instructions are correctly and promptly followed and action taken at various levels is well coordinated.

Objective of Emergency Planning The objective of the disaster management plan is to describe the emergency response organization, the resources available and response actions applicable. It deals with various types of emergencies that could occur at the VSI airport with the response organization structure being deployed in the shortest time possible during an emergency. Thus, the objectives of emergency response plan can be summarized as:

- Rapid control and containment of the hazardous situation;
- Minimizing the risk and impact of an event/accident; and
- Effective rehabilitation of the affected persons, and prevention of damage to property.
- To effectively achieve, the objectives of emergency planning, the critical elements that form the backbone of the plan are:
- Reliable and early detection of an emergency and careful planning;
- The command, co-ordination, and response organization structure along with efficient trained personnel;
- The availability of resources for handling emergencies;
- Appropriate emergency response actions;
- Effective notification and communication facilities;
- Regular review and updating of the plan; and Proper training of the personnel.

An appropriate DMP will be prepared for NITB, VSI Airport to contain and control emergency incidents, to prevent loss of life and minimize the risk of bodily injury to employees and transacting population, to minimize impact on environment, and to provide maximum possible safety for the emergency response personnel.

7.3.11.1. categorization of Emergencies

The emergencies at the VSI airport can be classified under several headings. These headings are listed below together with a description of the type of emergency.

i. Fires on the Ground

Fire on the ground can be aircraft related and non-aircraft related. Fire involving aircraft can be at any location on the taxiway or apron area where the aircraft is parked. Non-aircraft related fire involves mainly the terminal buildings, ATF tanker and HSD storage, etc.

Fire Safety and Protection System Plan:

The entire building shall be provided with a centralized fire suppression system comprising of underground and over head water storage tanks, dedicated fire pumps, hose reels, wet riser, yard hydrants and sprinkler system. Internal wet risers for the building shall be connected to the ring main with a non return valve and a three way fire brigade inlet connection with isolation butterfly valve for each wet riser pressurization.

The building shall be provided with a zoned public address system and a well-defined escape routes and staircases for evacuation in case of emergency. A centralized fire control room shall be reviewed along the kerb side for easy access to fire vehicles. Coordination with off-site emergency services will be determined. Emergency Response Plan (EPRs) will be developed in consultation with the airport authority management to complement the emergency services in the event of an emergency.

ii. Natural Disasters & management

The entire Andaman & Nicobar Islands lie in Zone V as per Seismic zones of India map IS: 1893-2002 BIS. The entire island chain is also susceptible to tsunamis both from large local quakes and also from massive distant shocks Therefore, necessary design measures have been taken for making structure earthquake & cyclone proof.

The seismic load shall be considered under the category applicable to the area while designing the building and proper assessments of such seismic effects shall be incorporated in the design of structures.

The building and its components shall be designed to withstand a wind speed based on the maximum wind speed in the area. The strategic actions during a wind storm shall be activated by receiving advance information from the local meteorological department.

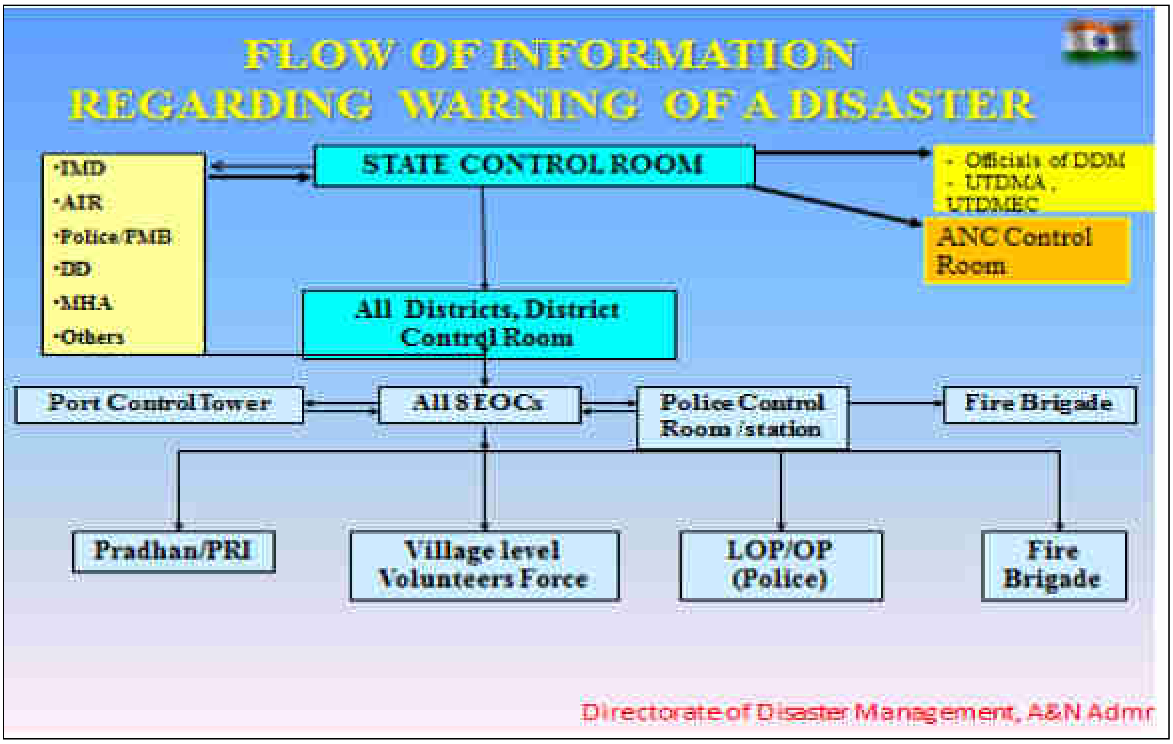


Figure 7.4: Trigger Mechanism for Response to Disaster

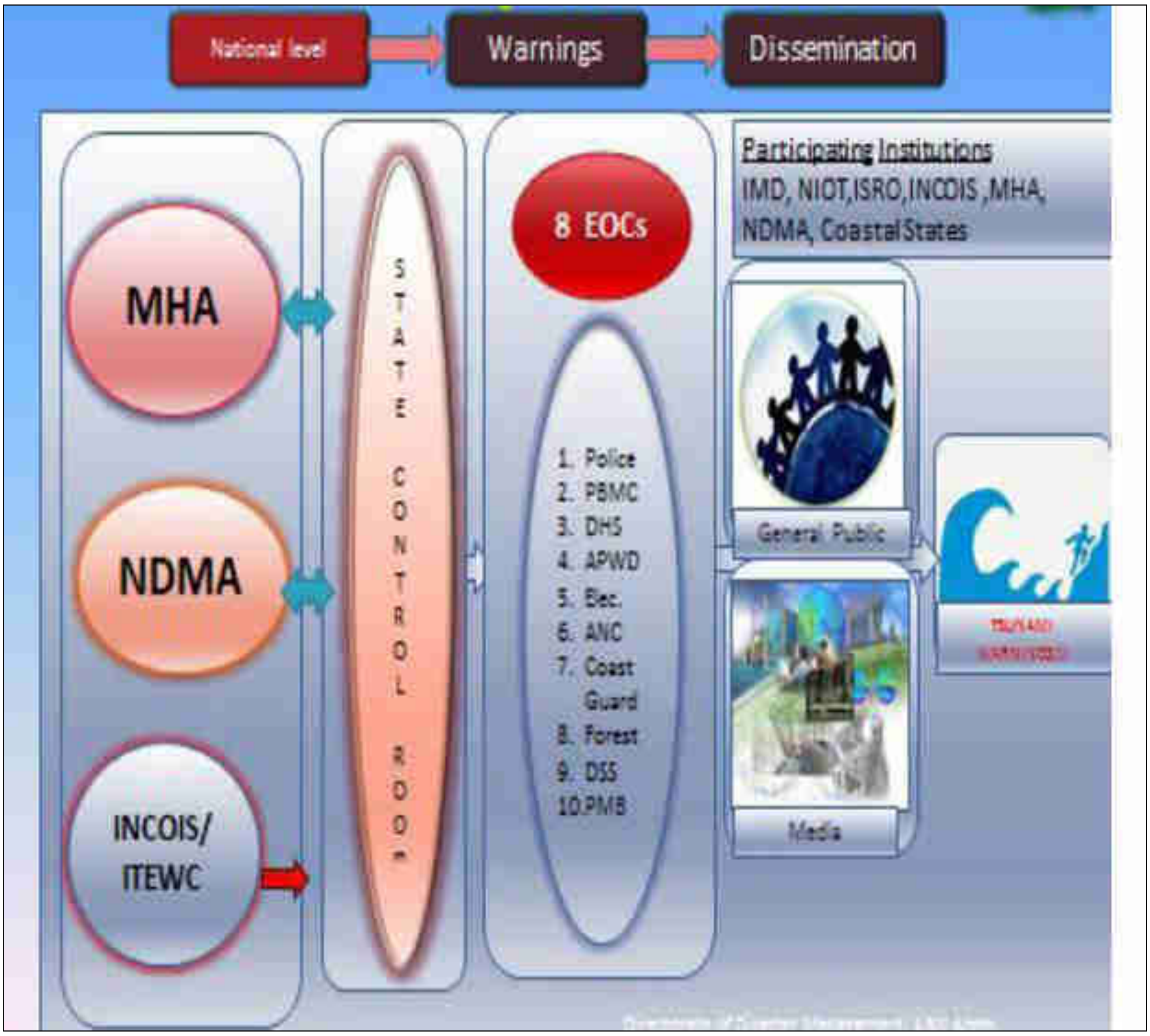


Figure 7.5: Dissemination Process of Information (24x7x365) from State Emergency Operation Centre

The Directorate of Disaster Management Department coordinates training for the staff and awareness campaigns for the benefit of the Islanders in coordination with National Disaster Management Authority to make State/District Level Disaster Management Authorities well prepared.

7.3.11.2. Institutional Arrangements

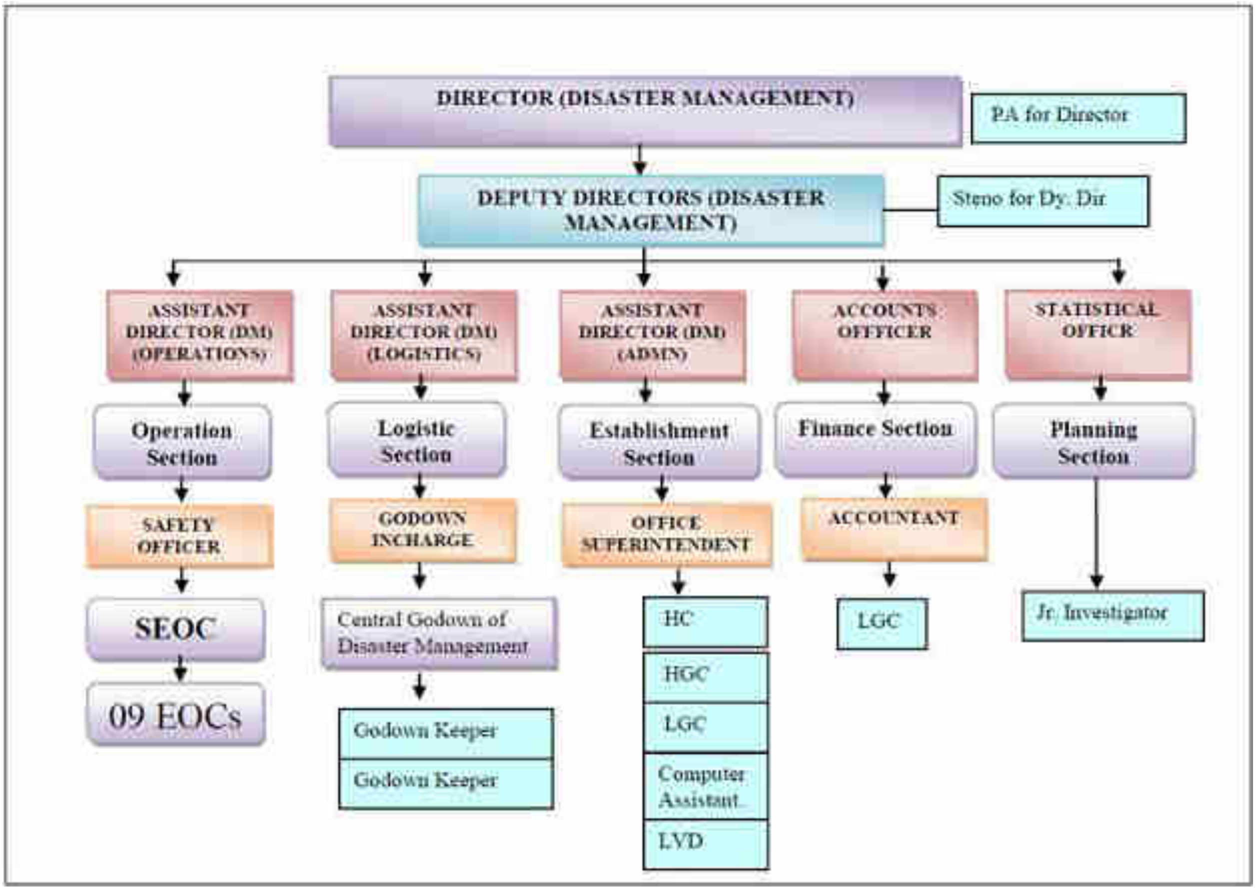
The A&N Administration has constituted the following Authorities under the powers conferred under sub-section (1) of the Section 14 , Section 20 & Section 25 of the Disaster Management Act, 2005:-

1. A&N Islands Union Territory Disaster Management Authority has been constituted vide Notification No. 01/2008 dated 9.1.2008.

2. A&N Union Territory Disaster Management Executive Committee has been constituted vide Notification No. 2/2008 dated 9.1.2008.

3. District Disaster Management Authorities have been constituted for all the three Districts vide Notification No. 03/2008 dated 9.1.2008.

PRESENT STRUCTURE OF DIRECTORATE OF DISASTER MANAGEMENT



iii. Mock Drills and Exercises

Mock drills constitute another important component of emergency preparedness. They refer to the re-enactment, under the assumption of a mock scenario, of the implementation of response actions to be taken during an emergency. Emergency drills and integrated exercises have the following objectives.

- To test, efficacy, timing, and content of the plan and implementing procedures;
- To ensure, that the emergency organization personnel are familiar with their duties and responsibilities by demonstration;
- Provide hands-on experience with the procedures to be implemented during emergency; and
- Maintain emergency preparedness.

The frequency of the drills would vary depending on the severity of the hazard. However, drills would be conducted once in a year. Scenarios may be developed in such a manner as to accomplish more than one event objective. Drills and exercises will be conducted as realistically as is reasonably practicable.

Planning for drills and exercises would include:

- The basic objectives,
- The dates, times and places,
- The participating organizations,
- The events to be simulated,
- An approximate schedule of events,
- Arrangements for qualified observers, and
- An appropriate critique of drills/exercises with participants.

Evaluation of drills and exercises would be carried out which would include comments from the participants and observers. Discrepancies noted by the drill observers during the drill shall be pointed out during the drill.

The individual responsible for conducting the drill or exercise would prepare a written evaluation of the drill or exercise. The evaluation would include assessments and recommendations on:

- Areas that require immediate correction;

- Areas where additional training is needed;
- Suggested modifications to the plan or procedures; and
- Deficiencies in equipment, training, and facilities.

The evaluation of a drill or exercise shall be submitted to the terminal manager for review and acceptance who shall then determine the corrective actions to be taken and assign the responsibility to appropriate personnel. The Safety In-charge would track all approved drill and exercise corrective actions as a means of assuring that corrections are made in a reasonable amount of time, and shall advise the Terminal Manager of the status of implementation of corrective actions. Records of drills, exercises, evaluations, and corrective actions would be duly maintained.

The building evacuation plan for existing domestic terminal building is enclosed as **Annexure IX.**

7.3.12. OCCUPATIONAL HEALTH & SAFETY

Aspect	Construction Phase		Operation Phase	
	Impact	Mitigation	Impact	Mitigation
Occupational Health & Safety	During construction phase, the personnel working at the site may be exposed to physical hazards, like, dust, noise, fugitive dust emissions, welding fumes, working at height, handling of heavy loads, falling objects	Provide effective dust suppression measures. • Dust-proof masks will be provided to personnel working in areas with high dust levels. • Standard Operating Procedures for machinery will be used. • Mandatory use of relevant Personal Protective Equipment (PPEs) for all workers. Employees will be provided with helmets, safety boots, eye and ear	Occupational health and safety issues associated with airport operation primarily include the following: • Physical Hazards Airport ground service personnel may be exposed to a variety of physical hazards depending on the specific worker function. The most significant occupational hazards may include strains due to carrying of heavy loads, repetitive motions from luggage and cargo handling activities / aircraft	Operators should provide safety signs and pavement markings for ground support vehicle circulation and parking areas in ramps, taxiways, and any other areas with a risk of collision between ground vehicles and aircraft. Delineated safety areas should include high risk locations such as jet engine suction areas to protect aircraft service workers. • Operators should train and certify all workers with access to airfield operations. Workers involved in the operation of aircraft support equipment shall be familiar with safety procedures applicable to ramp and taxiway traffic, including communications with the air control tower. • Safety features of ground support vehicles shall be maintained, including back-up alarms, moving

Aspect	Construction Phase		Operation Phase	
	Impact	Mitigation	Impact	Mitigation
	underneath of temporary structures, working on unguarded moving machine, hammering and cutting without PPEs, etc. These are most significant occupational hazards at the airport construction site and may have potential adverse impacts on the	protection and snug fitting gloves, safety belt goggles, as appropriate. • Elevated platforms, walkways on height and stairways shall be equipped with handrails, toe-boards and non-slip surfaces. • Periodic medical examinations will be conducted for all personnel and specific surveillance programs will be initiated for personnel potentially exposed to health hazards.	service operations; collisions with moving ground service vehicles or cargo, or taxiing aircraft; and exposure to weather elements. Workers may also be exposed to jet engine hazards. • Chemical Hazards Ground service providers may be exposed to chemical hazards, especially if their work entails direct contact with fuels or other chemicals. Working with fuels may present a risk of exposure to volatile organic compounds via inhalation or	part guards, and emergency stop switches. • All workers involved in luggage and cargo handling, whether as a regular or incidental aspect of their work function, shall be trained in the use of proper lifting, bending, and turning techniques to avoid back injury or extremities. Particular attention shall be placed on the handling of luggage and cargo in airplane holds which often do not have adequate standing height (requiring special lifting or pushing techniques) and which may present tripping and slipping hazards. Workers shall be provided with appropriate Personal Protective Equipment (PPE), such as knee pads when accessing cargo holds. • Operators shall evaluate the need to implement individual luggage weight restrictions in coordination with airlines, applying weight limits on individual luggage packages according to local

Aspect	Construction Phase		Operation Phase	
	Impact	Mitigation	Impact	Mitigation
	Occupational Safety and Health.		skin contact during normal use or in the case of spills. It may also present a less frequent risk of fire and explosions. • Noise: Airport ground service personnel may be potentially exposed to extremely high levels of noise from taxiing aircraft, the operation of aircraft auxiliary power units (APUs), and ground service vehicles. As most of these noise sources cannot be prevented, control measures should include the use of personal hearing protection	regulations or, in their absence. The frequency and duration of worker assignments to heavy lifting activities shall be mitigated through rotations and rest periods. • Operators shall train workers on the prevention of heat and cold stress, including the identification of early symptoms, and management techniques (e.g. hydration, rest). Workers shall be provided with the necessary clothing and fluids to prevent weather related stress and apply other relevant recommendations for working environment temperature • On observing accidental release of aviation fuel onto surface, the people residing in downwind direction will be evacuated based on concentration contours given in chapter of Risk and Safety.

Aspect	Construction Phase		Operation Phase	
	Impact	Mitigation	Impact	Mitigation
			by exposed personnel and implementation of work rotation programs to reduce cumulative exposure.	

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