# RISK ASSESSMENT DOCUMENT-BHOGAPURAM AIRPORT

## RISK AND HAZARD DURING CONSTRUCTION PHASE

Impacts of risk and hazard are higher during construction phase. Potential hazards for workers in construction include-

- Falls (from heights);
- Scaffold collapse;
- Electric shock and arc flash/arc blast;
- Failure to use proper personal protective equipment;
- Repetitive motion injuries.

**Table 1: Impact Rating for Risk Hazard during Construction Phase**

| Environmental Impact Rating | Criteria | Reason |
|---|---|---|
| Nature of Impact | Adverse | • Training of Workers<br>• Following strict construction procedures<br>• Supervision by Experienced workers |
| Duration of Impact | Long term | |
| Impacted Area | Localized | |
| Likelihood of Occurrence | Low | |
| Severity of Impact | Slight | |
| Significance of Impact | Negligible | |

To reduce the occurrence of risk & hazard at the construction site following are mitigation measures suggested:

- **Scaffolding**

A number of factors are often involved in falls, including unstable working surfaces, misuse or failure to use fall protection equipment and human error. When scaffolds are not erected or used properly, fall hazards can occur. Scaffold of sound, rigid and sufficient strength will be used. It will be equipped with guardrails, midrails and toeboards. A competent person will inspect the scaffolding and, at designated intervals, re-inspect it. Safety net will be to eliminate the fall casualties.

- **Ladders**

Ladders and stairways are another source of injuries and fatalities among construction workers. The correct ladders for task and of sufficient length will be used. Grease, dirt or other contaminants free ladders will be used. Ladders will not be loaded beyond the maximum intended load or beyond the manufacturer's rated capacity.

- **Head protection**

Hard hats will be provided where there is a potential for objects falling from above, bumps to their heads from fixed objects, or accidental head contact with electrical hazards.

- **Hazard communication**

A list of hazardous substances used in the workplace will be maintained and readily available at the worksite. Each container of a hazardous substance (vats, bottles, storage tanks) will be labeled with product identity and a hazard warning.

- **Electrical (wiring methods, design and protection)**

Work on new and existing energized (hot) electrical circuit will prohibited until all power is shut off and grounds are attached. Frayed, damaged or worn electrical cords or cables will be promptly replaced. All electrical tools and equipment will be maintained in safe condition and checked regularly for defects and taken out of service if a defect is found. All electrical tools will be properly grounded unless they are of the double insulated type.

- **Repetitive motion injuries**

Workplace pains and strains can be serious and disabling for workers, causing pain and suffering ranging from discomfort to severe disability. The consequences are far reaching and can affect every aspect of a worker's life. Prevention is, of course, better than treatment. Sprains and strains are a painful experience that we want to prevent from happening. To do that, we need a comprehensive prevention process to systematically identify and remove the risk factors present in your workplace and workforce through the use ergonomic and individual controls.

## HAZARD ASSESSMENT

### BACKGROUND

The proposed Bhogapuram airport plans to install and operate an Aviation Fuel Turbine (ATF) storage tanks facility. The airport fuel shall be received from nearby areas on a daily basis by tankers. Fuel farms are an efficient way to provide storage and dispensing of aviation fuels to multiple users at an airport. The fuel farm is the heart of an airport fuel delivery system. A fuel farm, however, is part of a larger fuel storage and distribution system that moves fuel from off-airport suppliers through storage tanks and into aircraft.

The report has been based on existing primary site information as well as different national and international guidelines on aviation turbine fuel storage, handling and distribution guidelines as well as reports issued by competent authorities as well as researched upon by consultants and different institutions.

### PROJECT SITE

The project site layout is provided showing various installations.

### Boundary of Risk Assessment Study

The present study limits itself to the hazards and risks arising from the storage of ATF in the tank farm area

### Methodology

The methodology for the risk assessment consist of literature survey, site data within the battery limit as well as information received on system build up and project description. All drawings and relevant information were obtained from client.

### Integration

As per the Environment Protection Act, Section 8 and rules under Manufacturing, Storage and Import of Hazardous Chemical rules 1989 4(2), *an occupier of an existing industrial plant shall have identified the major accident hazards and taken adequate steps to prevent such major accidents; occupier shall provide to the persons working on the site with the information, training and equipment including antidotes necessary to ensure their safety*.

**Risk assessment is a study to identify hazards at industrial site and take engineering and managerial steps to mitigate the same.**

Risk assessments supply information to decision makers and require practical data to provide a foundation for their validity and to establish confidence in their output.

Risk Assessment in such scenarios depends upon numerator and denominator data. Numerator data for risk assessments are based on counts of incidents and accidents that have occurred in the past and Denominator data indicate the level of exposure for hazardous materials.

SYSTEM DESCRIPTION

### Aviation Turbine Fuel (ATF) Tank Farm

The fuel depot has been proposed for having a storage capacity of 19600 KL capacity over an area of 60357 square meters (60.357 hectares). The jet fuel storage system shall consist of 14 overhead fixed roof cylindrical tanks made of carbon steel. Out of these 12 tanks shall be kept as buffer systems in case of any emergency or high demand. The tank farm shall be designed as per Petroleum Rules and shall be enclosed in a suitable bund.

The tanks shall have interconnected arrangements and isolation valves for any emergency. Tank farm shall have proper earthing provisions. The tanks are operated at atmospheric pressure. When the fuel is transferred from the tankers to the on-airport tank farm, it will be quarantined for 24 hours. During which fuel sample is drawn for quality check. When the fuel quality is confirmed, it is ready for use.

For delivery by fuel truck to an airport, IATA suggests adequate storage would provide reserves of 3 to 6 days.

Initially the refuelling to the aircrafts would be through refueller. In the future, the fuel tanks shall be connected to the hydrant network with auto-controlled hydrant pumps. Each pump is fitted with a filter to separate water from the fuel.

Applicable statutory regulations as per Petroleum Rules 2002 and OISD RULES: 117 & 118 shall be followed for the proposed facility. Initially the refuelling to the aircrafts would be through refueller, but at a later stage, the refuelling is proposed to be through hydrants.

As per Petroleum Act, Petroleum Class 'B' - means petroleum having a flash point of $23^{0}$C and above but below $65^{0}$C. (E.g. HSD, SKO, MTO etc.). **<u>Hence, ATF falls under Class B of petroleum.</u>**

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Aviation fuel storage tanks are typically designed to minimize the effects of particulate and water contamination that occur during fuel transfer. Tanks have a low point on the bottom, a *sump,* where water and particulate are collected and removed. Tanks also use *floating suction* to draw fuel off the top of the tank rather than the bottom where water and particulate concentrate. This, along with adequate settling time, helps prevent some of the particulates and water from being transferred further into the distribution system.

In case of multiple storage tanks of the same product interlocking isolation valves should be locked and sealed in desired position in order to prevent discharge of product into working tank wherever possible.

As per OISD guidelines, all tanks in a dyke shall be provided with sprinkler system for fuel stations storing more than 1000 KL in above ground tanks.

**Storage Stability**

Instability of jet fuel during storage is generally not a problem because most fuel is used within weeks or months of its manufacture. It can be an issue at small airports that don't use a lot of fuel. Jet fuel that has been properly manufactured, stored, and handled should remain stable for at least one year.

Jet fuel subjected to longer storage or to improper storage or handling should be tested to be sure it meets all applicable specification requirements before use. Because it is the more reactive fuel components that cause instability, storage stability is influenced by fuel composition. It is also influenced by storage conditions; instability reactions occur faster and to a greater extent at higher ambient temperatures. Antioxidants may be added to fuel to improve its storage stability.

## TRUCK REFUELLER DELIVERY SYSTEM

Another method of getting fuel to the aircraft is through a self-contained refueller truck or dispenser. The fuel is stored in a chassis-mounted tank with an integral pump, filter, and metering system. The vehicle receives a load of fuel from a rack or similar loading area and is driven to each aircraft requiring fuel. The design allows for flexibility, but the size of the vehicle limits the amount of fuel available and the amount of maneuvering space in proximity to an aircraft.

## SETTLING TIME

Settling time is a factor in the delivery and use of fuel. Settling time is the length of time the industry has established for allowing sediment and moisture to settle to the bottom of a fuel. For jet fuel, the normal allowable settling time is 1 hour for each foot of tank depth. Jet fuel storage tanks have a floating suction tube that draws fuel from several inches below the upper surface of the fuel.

The DGCA guideline also recommends the following

On completion of delivery and before any aviation fuel is dispensed from the receiving tank, the fuel should be allowed to settle for a period depending upon the type of fuel and its depth in the tank, the type of tank and its input filter arrangement, and the method by which fuel is drawn from the tank.

## DISPENSING

Presently, Aviation Turbine Fuel (ATF) is proposed to be dispensed from specially designed refuellers, which are driven up to parked airplanes and helicopters. Major airports have hydrant refueling systems that pump the fuel right up to the filling outlets on the tarmac through underground pipelines for faster refueling. Essentially, ATF is pumped into an aircraft by two methods: Overwing and Underwing. Overwing fuelling is used on smaller planes, helicopters, and piston-engine aircraft and is similar to automobile fuelling - one or more fuel ports are opened and fuel is pumped in with a conventional pump. Underwing fuelling, also called single-point is used on larger aircraft.

In the case of aviation turbine fuels an input microfilter, or a filter separator with a nominal 5 micron rating for solid particles and 15 parts per million for water, is fitted. It is recommended that in future operations will include dispensing fuel through hydrant points

## HAZARDOUS SUBSTANCE

## DEFINITION OF ATF

There are several definitions of Aviation Turbine Fuel (or Jet fuel)

Aviation turbine fuels (which include CAS RN 64741-86-2) consist primarily of aliphatic hydrocarbons with a carbon range of C9–C16.

MCX India defines Aviation turbine fuel (ATF) or jet fuel as a specialized type of petroleum-based fuel used to power aircrafts. Further, it is generally of a higher quality than fuels used in less critical applications such as heating or road transport.

Indian Oil defines Jet fuel as a colorless, combustible, straight-run petroleum distillate liquid with principal use as a jet engine fuel. The most common jet fuel worldwide is a kerosene-based fuel classified as JET A-1.The governing specifications in India are IS 1571: 2001 (7th Rev).

## COMMERCIAL TURBINE FUELS

There are two basic fuels included: a kerosene type and a wide-cut (kerosene and naphtha mixture) type. ASTM Jet A fuel is used exclusively in the United States with Jet A-1 being the primary fuel outside the United States. The International Air Transport Association (IATA) guideline specifications are basically the same as ASTM Jet A-1.

**CHEMICAL COMPOSITION OF ATF**

Aviation turbine fuels contain straight-chain *n*-alkanes, branched-chain isoalkanes, cycloalkanes, one-ring aromatics (alkylated benzene compounds) and very limited amounts of bicyclic aromatics (naphthalene and biphenyl). In general, there are approximately 25–30% each of *n*-alkanes and isoalkanes, 25% cycloalkanes and 15–20% aromatics. Kerosene, a substance used for read-across for aviation fuels, has a basic composition of at least 70% alkanes and cycloalkanes, up to 25% aromatic hydrocarbons and less than 5% alkenes (U.S. EPA 2011).

**PHYSICAL AND CHEMICAL PROPERTIES**

ATF is a clear to straw coloured liquid which is a blend of hydrocarbons, a product of petroleum refining which belongs to the middle distillate group. This is given in **Table 2.**

**Table 2: Physical Properties of Jet A-1**

| Property | Value |
|---|---:|
| Physical State | Mobile liquid at ambient temperature |
| Appearance | Clear water white/straw |
| Odour | Characteristic |
| Liquid Density | 775-840 kg/m$^3$ @ 15˚C |
| Initial Boiling Point | 150 ˚C |
| Final Boiling Point | <300 ˚C |
| Minimum Flash Point | >38 ˚C |
| Flammable Limits | 1-6 % Vol |
| Auto-flammability | 220 ˚C |
| Vapour Pressure | <0.1 kPa @ 20˚C |
| Viscosity | 1 to 2 cSt @ 40˚C |

**QUALITY OF JET A-1**

As the primary function of aviation turbine fuel (jet fuel) is to power an aircraft, energy content and combustion quality are key fuel performance properties. Other significant performance properties are stability, lubricity, fluidity, volatility, non-corrosivity, and cleanliness. Besides providing a source of energy to power the aircraft, fuel is also used as a hydraulic fluid in engine control systems and a coolant for certain fuel system components. There is only one type of jet fuel, kerosene type, in civil use worldwide. **Jet A-1 fuel** is suitable for use with most turbine engine aircraft. This kerosene grade fuel has a flash point above 38 Degrees C (100 Degrees F) and a freeze point maximum of (-)47 Degrees C.

So it's extremely important to fuel supplier to ensure fuel in high quality and internationally recognized standard accordingly.

JET A-1 is a petroleum distillate blended from kerosene fractions having Aromatics below 20% v/v, Total sulphur below 0.25% mass, Mercaptan Sulphur below 0.002% mass, freezing point below - 47$^0$C and a flash point above 38$^0$C. It contains Static Dissipator additive STADIS 450. It meets the requirement of:

- IS 1571: 2001 (Seventh Revision)

- DEF STAN 91-91 Issue 5
- ASTM D 1655 (JET A-1)
- IATA Guidance Material for Aviation Fuel Specification - 5th Edition 2005
- AFQRJOS – Issue 20, March' 2005

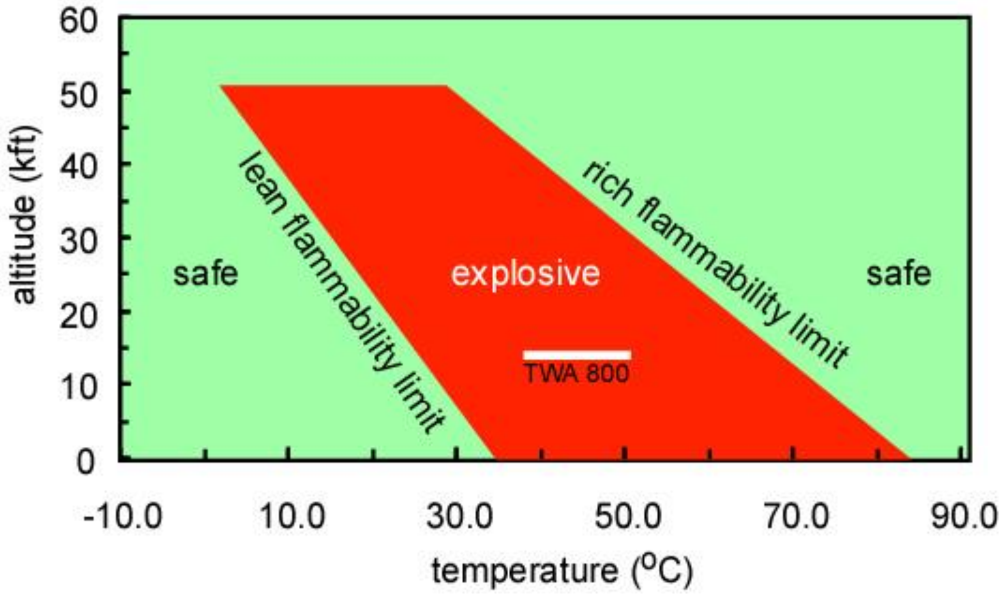
**FLAMMABILITY**

Kerosene is a mixture of aliphatic (straight-chain alkanes or saturated) hydrocarbons, usually beginning with octane (eight carbons in the chain) and going up to hexadecane (16-carbon hydrocarbon). he flash point of kerosene is controlled to be 100°F, or 37.8°C, to be classified as a combustible liquid. It has an auto-ignition temperature of 410°F (210°C). Its explosive limits are from 0.6 to 4.7 percent by volume in air. Commercial jet fuel has a vapor density of 5.7 (where air = 1.0), which means the vapors are extremely heavy relative to air.

**Table 3: Flammability Properties of Jet Fuel A-1**

| S. No | Property | Value | Unit |
|---|---|---|---|
| 1. | Distillation Range | 167-266 | °C |
| 2. | Magnitude of Distillation Range | 99 | °C |
| 3. | Vapour Pressure, 38 °C | 1.4 | kPa |
| 4. | Net Heat of Combustion | | |
| a | By weight | 43,240 | KJ/kg |
| b | By Volume | 35,060 | $MJ/m^3$ |
| 5. | Flammability Concentration Unit | | |
| a | Upper | 0.6 | % |
| b | Lower | 4.7 | % |
| 6. | Flammability Temperature Unit | | |
| a | Upper | 53 | °C |
| b | Lower | 77 | °C |
| 7. | Autoignition Temperature | 238 | °C |
| 8. | Minimum Electric Spark Ignition Energy | 0.2 | mJ |
| 9. | Average Burning velocity | 0.3-0.6 | m/s |
| 10. | Pool rate of flame spread | 30 | m/min |
| 11. | Flash point | 40 | °C |

Simple representation of Nestor's experimental data is to fit the flammability limits to a straight line in altitude v. temperature coordinates using the properties of the standard atmosphere to convert from pressure to altitude. The results are shown in the plot.




Numerical values for the flammability limits are given in the table below. Actual limits for an accident situation will depend on the amount of fuel, fuel flashpoint, weathering, temperature non-uniformity with the tank, and type of ignition source.

| Z | P | $T_{LFL}$ | | $T_{UFL}$ | |
|---|---|---|---|---|---|
| (kft) | (psia) | (C) | (F) | (C) | (F) |
| 0 | 14.7 | 35.0 | 95.0 | 85.0 | 185.0 |
| 5 | 12.4 | 31.8 | 89.2 | 79.6 | 175.2 |
| 10 | 10.4 | 28.6 | 83.4 | 74.1 | 165.4 |
| 15 | 8.5 | 25.3 | 77.6 | 68.7 | 155.6 |
| 20 | 6.9 | 22.1 | 71.8 | 63.2 | 145.8 |
| 25 | 5.5 | 18.9 | 66.0 | 57.8 | 136.0 |
| 30 | 4.3 | 15.7 | 60.2 | 52.3 | 126.2 |
| 35 | 3.4 | 12.4 | 54.4 | 46.9 | 116.4 |
| 40 | 2.6 | 9.2 | 48.6 | 41.4 | 106.6 |

**WIND DIRECTIONS**

The wind directions as obtained from IMD observatory provides predominant wind direction from SW. Predominant wind directions which have been estimated in different seasons are provided below in table. Calculation has been made on the basis of the summer season wind speed.

**HAZARDS IDENTIFICATION**

**ATF Hazards**

Jet A-1 (ATF) is a highly flammable liquid. The fuel has a low vapour pressure at ambient temperature, which makes the liquid less volatile. Hence, it evaporates slowly in case of fuel leakage and remains in the atmosphere posing threat of fire. Also, the fuel has a flash point lower than the ambient temperature of Mundra in summers. This means that the fuel will give off flammable vapour at a concentration sufficient to cause ignition. However, significant heat source is, required to ignite the fuel and therefore proper safety management has to be implemented.

Jet A-1 is classified for supply purpose as harmful as a result of the aspiration hazard and irritation to the skin. Toxicity following a single exposure to high levels (orally, dermally or by inhalation) of Jet A-1 is of low order; however exposure to high vapour concentration can lead to nausea, headache and dizziness. Accidental ingestion can lead to chemical burning of the mouth. Ingestion can lead to vomiting and aspiration into the lungs which can result in chemical pneumonitis which can be fatal. Prolonged and repeated skin contact can lead to defatting of the skin, drying, cracking and dermatitis.

**Storage Hazards**

Typical storage hazards are applicable for this type of tank farm systems. Sources of ignition can include lightning, open flame, electrical spark, static discharge, chemical reaction, or any heat source that can raise or ignite the fuel-air vapor mixture. The release of ATF could occur from transfer stations (gantry areas), storage to refueller systems, valve glands or pipelines due to several reasons. The most typical emergency relating to fuel handling is a fuel overflow or spill. Such events can be very minor in nature involving just a few liters of product, or they can be a catastrophic event involving hundreds of litres of fuel.

**Combustion Hazards**

The combustion products of aviation fuel include carbon dioxide, nitrogen oxides and sulphur oxides. Incomplete combustion will generate thick black smoke and potentially hazardous gases including carbon monoxide. However smoke from such fires is buoyant and does not tend to seriously impact people on the ground in the open air.

**Electrostatic hazards of ATF (Jet A-1)**

Jet A-1 has a low electrical conductivity. This provides for static electricity to be generated and charges to be accumulated. According to HSE, UK, the degree to which a static charge may be acquired by aviation fuels depends upon many factors such as

- Amount and type of residual impurities
- Dissolved water
- Linear velocity through piping systems
- Presence of static generating mechanisms e.g. filters and
- Opportunity for the fuel to relax for a period of time to allow any charge generated to dissipate safely to earth.

In order to reduce the accumulated amount of static electricity, antistatic additives are added to the fuel. This works by enhancing the conductivity of the fuel in order to shorten the time required for dissipating the static charge safely to earth.

**HEALTH HAZARD**

Jet A-1 is classified, for supply purposes as harmful, as a result of the aspiration hazard and irritation to the skin.

**Acute Health Hazards**

Toxicity following a single exposure to high levels (orally, dermally or by inhalation) of Jet A-1 is of a low order. However, exposure to higher vapour concentrations can lead to nausea, headache and dizziness. If it is accidentally ingested, irritation to the gastric mucous membranes can lead to vomiting and aspiration into the lungs can result in chemical pneumonitis which can be fatal.

**Inhalation**

Under normal conditions of use Jet A-1 is not expected to present an inhalation hazard.

**Skin**

Jet A-1 is slightly irritating to the skin, and has a defatting action on the skin.

**Eyes**

Jet A-1 may cause discomfort to the eye.

**Chronic Health Hazards**

Prolonged and repeated contact with Jet A-1 can be detrimental to health. The main hazards arise from skin contact and in the inhalation of mists. Skin contact over long periods can lead to defatting of the skin, drying, cracking and possibly dermatitis. Excessive and prolonged inhalation of mists may cause chronic inflammatory reaction of the lungs and a form of pulmonary fibrosis.

**Exposure Limit Values**

Jet A-1 does not contain any components to which exposure limits apply, however it is chemically very similar to white spirit, for which the following UK occupational exposure standards apply (HSE, 2000):

- Occupational Exposure Limit (OEL) = 575 mg/m3 (100 ppm) 8-hour TWA value
- Occupational Exposure Limit (OEL) = 720 mg/m3 (125 ppm) 10-min TWA value

(TWA - Time Weighted Average)

**ENVIRONMENTAL HAZARD**

**Air**

Jet A-1 is a mixture of non-volatile components, which when released into the air will react rapidly with hydroxyl radicals and ozone.

**Water**

If released into water, the majority of Jet A-1 will evaporate at a moderate rate but a small proportion will dissolve. Dissolved components will be either absorbed in sediments or evaporate into the air. In aerobic water and sediments they will biodegrade, but in anaerobic conditions they will persist. Jet A-1 is slightly toxic to aquatic organisms and contains components which have a high potential to bio-accumulate, but is unlikely to persist in the aquatic environment for sufficient time to pose significant hazards.

**Soil**

Small volumes released on land will evaporate at a moderate rate, with a proportion being absorbed in the upper layers of the soil and be subject to biodegradation. Larger volumes may penetrate into anaerobic soil layers in which it will persist. A spill of Jet A-1 may reach the water table on which it will form a floating layer, and move along with the groundwater flow.

In this case, the more soluble components, such as aromatics, will cause groundwater contamination. Mammalian toxicity is expected to be of a low order.

**PAST INCIDENTS**

Different incidents involving ATF has been reproduced below in **Table 4**.

**Table 4: Worldwide Historical Aviation Fuel Spillage Incident Records from 1982 to 2012**

| No. | Year | Location | Operation | Incident Description |
|---|---|---|---|---|
| 1 | 1982 | UK | Fuelling | Aircraft was being refuelled to 'full tanks' with a suspect contents gauge in one tank, resulted in spillage. |
| 2 | 1986 | West Indies | Hydrant Fuelling | Poor maintenance. Inlet hose burst at 125 psig. Spilt onto engine resulting in a fire. Hose in bad condition, noticed visually before the failure. |
| 3 | 1988 | USA | Fuelling | Fuel was leaked from an aircraft, the cause was thought to be a leaky fuel valve, a broken fuel gauge or overfilled tanks. 2,200 litres was spilt. |
| 4 | 1989 | UK | Hydrant Fuelling | Human error with a tug striking fuel hydrant causing fuel leak |
| 5 | 1992 | Moskva-omodedovo Airpor (Russia) | Hydrant Fuelling | A cigarette dropped during a refuelling operation caused a fire. The aircraft was broken up in March 1993 |
| 6 | 1993 | Nigeria | Hydrant Fuelling | Poor maintenance, dolly wheels had been fitted to a pit coupler. Not re-assembled correctly (wrong bolts used, too short). An estimated 17,000 litres of Jet A-1 spilt. |
| 7 | 1995 | New Zealand | Hydrant Fuelling | Poor maintenance, dolly wheels had been fitted to a pit coupler. Not re-assembled correctly (wrong bolts used, too short). Inexperienced maintenance technician. 2,000 to 3,000 litres spilt. |
| 8 | 1995 | UK | Hydrant Fuelling | Fuelling had been completed and pit valve had been closed with lanyard pulled. A tug reversed over pit, causing a crush to inlet coupler from the hydrant. No spill occurred |
| 9 | 1995 | Puerto Rico | Hydrant Fuelling | Failure of pilot valve |
| 10 | 1996 | UK | Hydrant Fuelling | Inlet coupler, problem with claws bending under load due to grade of material being used. The seal may have had a nick in it and a spray of fuel resulted. |
| 11 | 1997 | Australia | Hydrant Fuelling | A tug pulling a low profile dolly was driven to pass between the dispenser and an engine. The corner of the trailing cargo dolly struck a coupler. The impact force completely destroyed the pit valve. Operation of ESB stopped flow. 7,500 litres of Jet A-1 spilt. |
| 12 | 1997 | UK | Aircraft Maintenance | Self-sealing mechanism failed to close when a booster pump was removed from a fuel tank. 2,500 L fuel was spilt |
| 13 | 1997 | UK | Hydrant Fuelling | Pit valve was seriously damaged due to a reversing tug. Lanyard was pulled in time to stop fuel spilling |
| 14 | 1997 | UK | Hydrant | Baggage conveyor truck reversed into fuel hydrant. |

| No. | Year | Location | Operation | Incident Description |
|---|---|---|---|---|
| | | | Fuelling | Inlet coupler sheared off at the flange between the pressure regulator body and the coupling. Lanyard trapped under hydrant pit lid which was under the rear of the baggage truck. The fuel spillage is stopped by emergency shutdown button. 6,500 litres of fuel was spilt. |
| 15 | 1998 | UK | Hydrant Fuelling | Coupler seriously hit by reversing loader. Pit hydrant poppet closed stopping major flow. 15 litres spilt. |
| 16 | 1998 | UK | Hydrant Fuelling | Operating pressure during aircraft fuelling is higher than the design pressure, aluminium pipework on hydrant dispenser split. 1,000 litres of fuel had been spilt before lanyard was pulled |
| 17 | 1998 | UK | Aircraft Maintenance on a stand | Self-sealing mechanism failed to close when a low pressure pump was removed from a fuel tank. The other contributory factor was that the maintenance technician failed to follow the correct maintenance procedure. 3,300 to 7,000 litres spilt. |
| 18 | 1998 | New Zealand | Fuelling | Extensive fuel leak observed aircraft overflow. No ignition. |
| 19 | 1998 | Miami Airport, Florida | Fuelling | Fuel truck fire spread to a wing during fuelling. |
| 20 | 2000 | Minatitlan Airport (Mexico) | Hydrant Fuelling | Refuelling truck drove off whilst still connected to the aircraft, the hose ruptured and the fire ensued. |
| 21 | 2001 | Denver International Airport (USA) | Hydrant Fuelling | Based on the information provided by the National Transportation Board of the U.S., the fire started when the airplane was parked at the gate unloading passengers and being refueled. The captain, first officer, a third pilot, 13 cabin crew members, and 10 passengers who were on board at the time of the accident, but were not injured. However, the ground service refuellers was fatally injured because he was standing on the raised platform of the refueling track (i.e. next to the aircraft tank valve under the aircraft wing) while refueling was in progress.<br>The overstress fracture of the airplane's refueling adapter ring that resulted from the abnormal angular force applied to it. The applied angular force occurred due to the ground refuellers inadequately positioning the hydrant fuel truck (in relation to the airplane), and his inattentiveness while lowering the refueling lift platform, thus permitting the refueling hose to become snagged and pulled at an angle. The fracture of the adapter ring during the refueling led to the ignition of the pressurized (mist producing) spilled fuel and subsequent fire. |

| No. | Year | Location | Operation | Incident Description |
|---|---|---|---|---|
| 22 | 2003 | Minneapolis-St. Paul International Airport (USA) | Hydrant Fuelling | A significant leak from the fuel pipeline system at a concourse, which released jet fuel to the sanitary sewer |
| 23 | 2003 | Emmonak Airport (USA) | Fuelling Transfer | Jet fuel was spilled during a fuel transfer from its tank farm |
| 24 | 2006 | OR Tambo International Airpor (South Africa) | Hydrant Fuelling | Faulty gasket in a valve chamber in the hydrant fuelling system |
| 25 | 2007 | Oklahoma (USA) | Jet Fuel Transfer by Pipeline | On 14 July 2007, Explorer's 28 inch interstate refined petroleum products pipeline rupture near Huntsville about 70 miles north of Houston and jet fuel spilled on to the surrounding area and into nearby Turkey Creek. This incident caused a serious environmental damage but did not claim any injury. |
| 26 | 2008 | Timco Aviation Services (USA) | Aircraft Maintenance | A fuel filter on an airline was being changed and a flap designed to contain the fuel became lodged against another piece of equipment. The fuel spill occurred when workers attempted to dislodge the equipment |
| 27 | 2008 | Philadelphia International Airport (USA) | Fuel Transfer | Jet fuel were spilled from an Atlantic Aviation aircraft onto the tarmac of the airport during a fuel transfer operation |
| 28 | 2008 | Chicogo-Midway Airport, IL (USA) | Fuel Storage | Fuselage punctures by a ground service vehicle. |
| 29 | 2009 | Pologi, Zaporizhya Region (Ukraine) | Refuelling Operations | Caught fire and burned during a refuelling operation. |
| 30 | 2011 | Bichevaya, Russia | Fuel Transfer | The An-2 biplane caught fire while being fuelled. Fuel was split, which caught fire due to static electricity. |
| 31 | 2012 | Milwaukee (USA) | Jet Fuel Transfer by Pipeline | 2 mm hole of an underground jet fuel pipeline in the Mitchell International Airport caused a fuel spill in the creek near the airport. The incident caused a serious environmental damage but no injury resulted. |
| 32 | 2012 | Chicago (USA) | Jet Fuel Transfer by Pipeline | Pressure in the jet fuel pipeline exceeded an established maximum load for the aging line built in 1958. An estimated 42,000 gal. of jet fuel leaked from the 12 in. pipe 16 miles southwest of Chicago. The fuel flowed into a creek and caused a serious environmental damage, but no injury resulted in the incident. |

**FAILURE FREQUENCY**

**Jet Fuel Spillage on Land Surface**

The probability of ignition is estimated based on the OGP Risk Assessment Data Directory using the release type for tanks and low pressure transfer lines for combustible liquids stored at ambient pressure and at temperatures below the flash point (e.g. oil, diesel and fuel oil). The total ignition probability is as shown in Table 5.

**Table 5: Total Ignition Probability for Jet Fuel Spillage on Land**

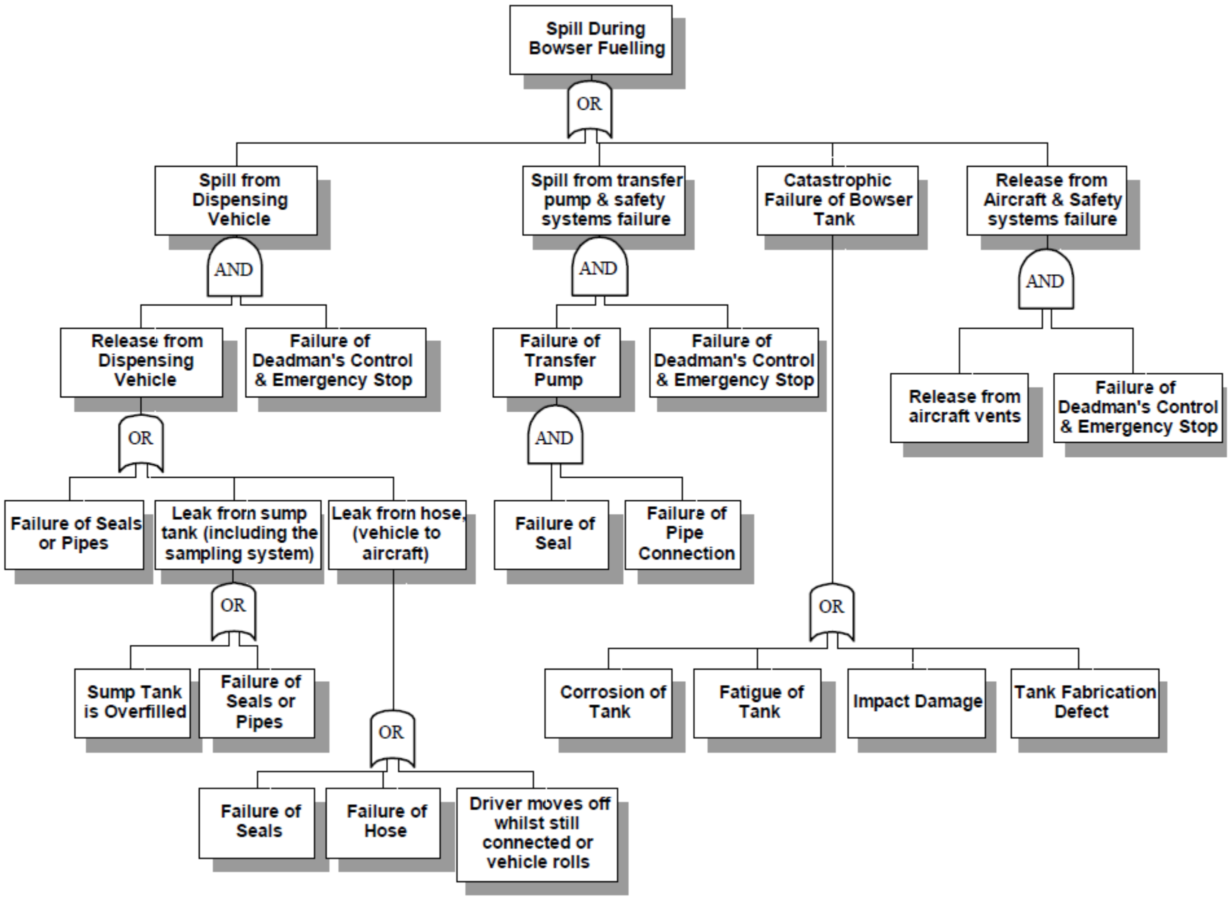
| Release Rate (kg/s) | Probability of Ignition |
|---|---|
| 0.1 - 1 | 0.0010 |
| 2 - 5 | 0.0011 |
| 10 | 0.0014 |
| 20 | 0.0021 |
| 50 - 1000 | 0.0024 |

The initial flame spread rate over a Jet A1 pool would be expected to be low (around 0.1m/s) but could increase to around 1-2m/s as radiation from the established flame heated the fuel surface in front of it to its flash point temperature.

Probability data for fuel spillage as reported by HSE, UK is provided below:

| Type of fuelling | Type of spill | Probability of a spill per fuelling operation |
|---|---|---|
| Hydrant Airport | High Pressure (HP) fuel spills | $1.5 \times 10^{-4}$ |
| | Low Pressure (MP) fuel spills | $9.1 \times 10^{-4}$ |
| Refueller Airport | Low Pressure (MP) fuel spills | $6.85 \times 10^{-4}$ |

Accidents of this nature involving the catastrophic failure of tanks used for the storage of hazardous liquids are rare, and the risk of such incidents occurring is estimated to be low, somewhere in the region of $5 \times 10^{-6}$ per tank year




**Events contributing to a spill during fuelling using a refueller**

**Estimate Failure frequency of storage facilities**

The release failure frequencies of storage facilities for ATF are based on BP facility estimates from release of ATF over 30 year period with a total tank volume of 24,00,000 cu. meter.

The Small and Medium Atmospheric Tanks (SMATs) have a capacity of less than 450m$^3$, and can be made of steel or plastic. Failure rates as provided by HSE, UK for such tanks are provided in **Table 6.**

**Table 6: Failure Rates of ATF and Small/Medium Storage Tanks**

| | Lower | Upper | Flammable Contents (per vessel year) |
|---|---|---|---|
| Release failure frequency per year (ATF) | $1.39 \times 10^{-9}$ | $4.86 \times 10^{-9}$ | |
| Catastrophic Release | | | $1.6 \times 10^{-5}$ |
| Large Release | | | $1 \times 10^{-4}$ |
| Small Release | | | $1 \times 10^{-3}$ |

Release Frequency for tanks smaller than 450 m$^3$. Tanks in the proposed tank farm are of 402 m$^3$.

| Type of Release | Non Flammable Contents (per vessel year) | Flammable Contents (per vessel year) |
|---|---|---|
| Catastrophic | $8 \times 10^{-6}$ | $1.6 \times 10^{-5}$ |
| Large | $5 \times 10^{-5}$ | $1 \times 10^{-4}$ |
| Small | $5 \times 10^{-4}$ | $1 \times 10^{-3}$ |

Notes:

- Large releases are defined as a rapid loss of most or all contents e.g. large hole in a vessel leaking over several minutes.
- Small releases are defined as smaller or much slower loss of contents e.g. through a small leak over 30 minutes.
- Hole sizes for tanks of unknown size (large holes are defined as 250 mm diameter and small holes as 75 mm diameter).

Several references of catastrophic release from storage tanks are provided below:

| Source | Type of Failure | Failure Frequency (per tank-year) |
|---|---|---|
| Batstone & Tomi | Catastrophic rupture | $3 \times 10^{-5}$ |
| COVO Study | Serious leakage (50 mm hole) | $1 \times 10^{-4}$ |
| | Catastrophic rupture | $6 \times 10^{-6}$ |
| Taylor | Large Leak | $8.8 \times 10^{-6}$ |
| | Catastrophic rupture | $1 \times 10^{-5}$ |
| E&P Forum | Major Release | $6.9 \times 10^{-6}$ |
| Davies (Prokop) | Catastrophic Rupture | $2 \times 10^{-7}$ |
| Christiansen & Eilbert | Catastrophic Rupture (All tanks) | $4 \times 10^{-6}$ |
| | Catastrophic Rupture (tanks > 10,000 barrels) | $9.2 \times 10^{-6}$ |

**Spill Size**

Any fuel spill presents a potential fire hazard. Pint size spills require no emergency action, other small spills involving an area from 45 cm to 2 meters in any dimension require, as a minimum of protection, the posting of a fire guard to maintain a restricted area around the spill and to keep out unauthorized persons. The fire guard shall be equipped with at least one dry chemical or carbon dioxide extinguisher. Dry chemical extinguishers are well suited to these circumstances and have a much greater effective range.

**CONSEQUENCE ANALYSIS**

**Human effects – Thermal Radiation**

The effects of fires on humans increase with the heat flux and exposure time. There is however, a threshold flux of 5 $kWm^{-2}$ suggested by various literatures for the same. The table below relates incident heat flux, Q and exposure time, to be effects on humans and for reference the limiting flux for secondary fires:

**Table 7: Thermal Radiation for Human Exposures**

| Q $kW\ m^{-2}$ | Time | Effects |
|---|---|---|
| 4 | Long(>1 min) | Limiting “safe’ flux for humans |
| 12.6 | Long | Limiting flux for ‘secondary fires |
| 6.5 | ~ 20s | Blistering of skin |
| 11 | ~ 10s | Blistering of skin |
| **20** | **~ 5s** | **Blistering of skin** |

This table indicates that for long exposures, people both indoors and out are at risk if the flux is greater than 12.6 $kWm^{-2}$ whereas only people outdoors are at risk if the flux is in the range 4-12.6 $kWm^{-2}$.

To simplify the analysis three assumptions are made:

a) Probability of a person being outdoors is 0.15;

b) Probability of a person outdoors taking cover is 0.5 for fluxes in the range 6.5-12.6 k W $m^{-2}$ (i.e. time to take cover 20 seconds);

c) Probability of a person outdoors taking cover is 0.9 for fluxes in the range 4-6.5 kW $m^{-2}$ (i.e. time to take cover < 1 minute).

**Human effects – Explosion**

Explosion damage consists of the effects of thermal radiation and the effects of pressure waves generated in the blast.

Vapor cloud explosions (VCEs) are most dangerous and destructive explosions that occur. These explosions occur by a sequence of steps. There is a sudden release of a large quantity of flammable vapor. Typically this occurs when a vessel, containing a superheated and/or pressurized liquid, ruptures, especially if the liquid being released changes to vapor form as the reduced external pressure presents itself. Then, dispersion of the vapor throughout an area occurs while the cloud mixes with air. Finally, ignition of the resulting vapor cloud occurs when a suitable ignition source presents itself.

The effects of thermal radiation were covered in the previous section. Humans are resilient to overpressures generated in an explosion as shown in the table below:

**Table 8: Explosion Overpressure for Human Exposures**

| psi | kPa | Human Effects |
|---|---|---|
| 5 | 34 | Threshold of eardrum damage |
| 10 | 69 | Threshold of lung damage |
| 40 | 276 | Threshold of mortality |

An explosion causes casualties primarily via damage to structures, eg house collapse, flying glass etc.

**Table 9: Peak Overpressure**

| psi | kPa | % C | Structural Damage |
|---|---|---|---|
| <1 | <7 | 0 | Window breakage |
| 1-3 | 7-21 | 10 | Walls collapse |
| 3-5 | 21-34 | 25 | Reinforced structures distort<br>Storage tanks (unpressurized) fail |
| 5-7 | 34-48 | 70 | Wagons and plant items overturned |
| **>7** | **>48** | **95** | **Extensive damage** |

*Where %C = percentage of people becoming casualties including fatalities.*

**Vulnerability Analysis**

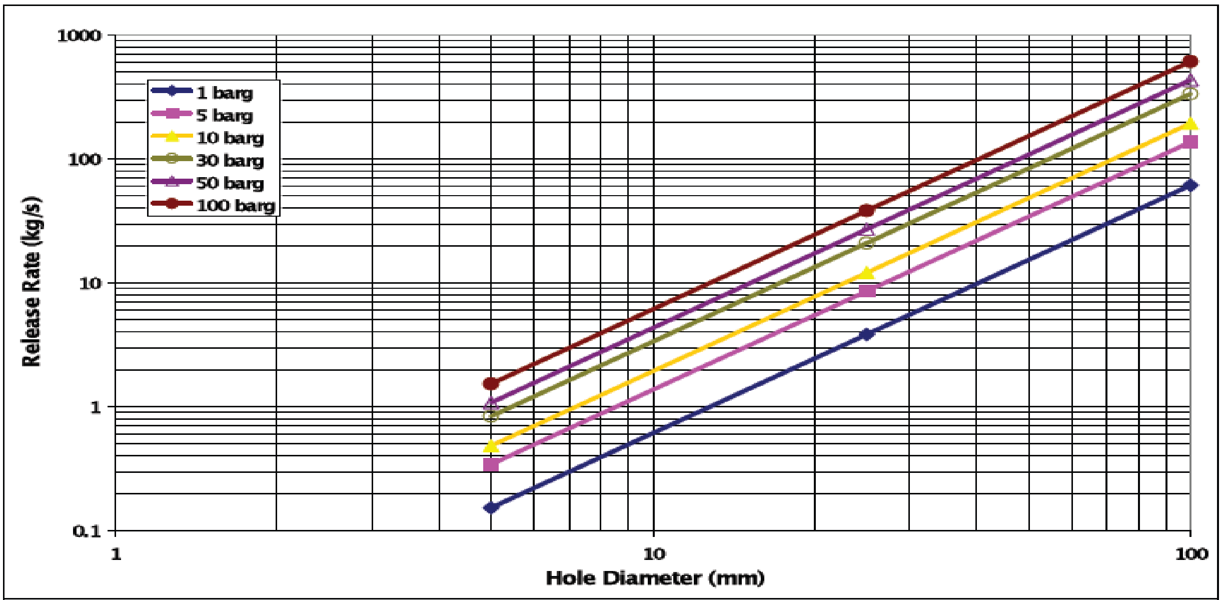
Aviation turbine fuel is a mixture of many different hydrocarbons. Kerosene-type jet fuel has a carbon number distribution between about 8 and 16 carbon numbers; wide-cut jet fuel, between about 5 and 15 carbon numbers

**Direct Release Scenario**

In this type of scenario, the Jet fuel is modeled assuming that due to certain actions, a fixed amount of the hazardous substance is released into the atmosphere at ground level. The scenario has been computed to show the Flammable Area of Vapour Cloud for two basic atmospheric conditions 5D and 2F with the range of release from 50 to 1000 litres.

| | LEL (meters) | | | | | |
|---|---|---|---|---|---|---|
| Litres | 10% | 60% | 100% | 10% | 60% | 100% |
| | 5D | | | 2F | | |
| 50 | 57 | 19 | 12 | 77 | 30 | 22 |
| 100 | 78 | 25 | 19 | 109 | 44 | 33 |
| 200 | 108 | 35 | 26 | 153 | 62 | 48 |
| 300 | 131 | 43 | 32 | 186 | 77 | 58 |
| 500 | 12 | 10 | 10 | 26 | 10 | - |
| 1000 | 12 | 10 | 10 | 26 | 10 | - |

The release rates at various hole diameter and pressure (1 barg = 0.98 atm) at 20°C and reproduced from OGP report is provided below




Release rates from above graph are provided below for selected scenarios at 1 barg.

| Hole Diameter, mm | Release Rates, kg/s |
|---|---|
| 5 | 0.18 |
| 10 | 0.6 |
| 15 | 1.5 |
| 20 | 2.5 |
| 50 | 16 |

As observed from above table, the release of Jet fuel A-1 at small diameter release is very less indicating that sufficient pools are not formed so as to threaten a scenario for pool fire or vapour cloud dispersion

**Vapour Cloud**

In case of release from a pipe, the consequence analysis takes into account release of Jet fuel from a 75 mm hole. In such a case, the flammable area of vapour cloud distances is provided as follows:

| | 10%LEL | 60%LEL | LEL |
|---|---|---|---|
| | Meters | Meters | Meters |
| 5D | 53 | 24 | 24 |
| 2F | 114 | 31 | - |

In case of top of the tank release, a scenario of 1 inch release from valve has been considered. In such as case, the flammable area of vapour cloud distance is provided below:

| | 10%LEL | 60%LEL | LEL |
|---|---|---|---|
| | Meters | Meters | Meters |
| 5D | 19 | 10 | <10 |
| 2F | 68 | 19 | - |

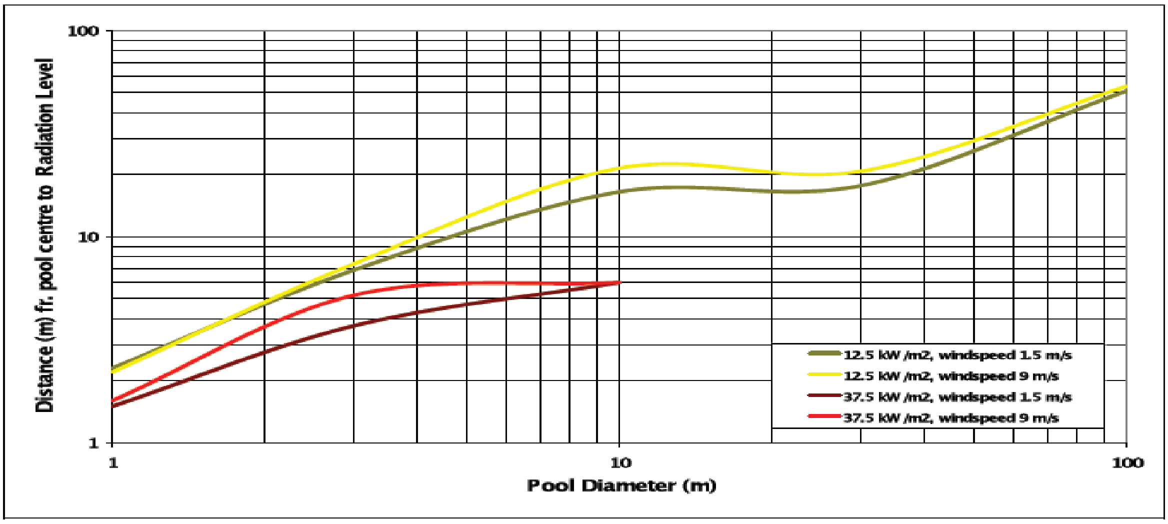
**Pool fire**

The Jet fuel-A1 could also release from the withdrawal point or from pipelines or valves and form puddle. The puddle diameter in this case has been taken to be 10 meters and 15 meters. It is believed that due to bund or containment provisions, the puddle would not spread beyond the dyke walls. In addition to the above, this scenario takes into account that the pool is on fire leading to thermal radiation of specific intensities. The modeled distances do not change after a certain volume release. In this case, results of a 2000 litre release and 5000 litre release for a given puddle diameter are similar. This is due to the fact that the puddle is contained within a specific diameter and only the burning time gets enhanced.

Pool fires can also be quantified by alternate methods from empirical relationships. The diameter of an equilibrium pool fire (i.e. where all the fuel is being consumed as it is released) is easily calculated by equating the mass release rate over the pool surface with the burning rate. Burning rate of Kerosene is 0.06 $kg/m^2s$. The corresponding pool diameters are provided below for various release rates

| Hole Diameter, mm | Release Rates, kg/s | Diameter of Pool Fire, m |
|---|---|---|
| 5 | 0.18 | 1.95 |
| 10 | 0.6 | 3.57 |
| 15 | 1.5 | 5.64 |
| 20 | 2.5 | 7.28 |
| 50 | 16 | 18.42 |

Thermal Radiation from pool fire as computed in the OGP report is provided below for Kerosene




**Note: The shape of the curves for 12.5 $kW/m^2$ is explained by the decreasing flame surface emissive power with increasing pool diameter.**

For large release, size of 250 mm hole has been considered. Results of pool fire with a puddle diameter of 10 meter are provided below for thermal radiation:

| | Intensity ($kW/m^2$) | | |
|---|---|---|---|
| | **2** | **5** | **10** |
| | **meters** | **meters** | **meters** |
| 5D | 55 | 40 | 31 |
| 2F | 53 | 33 | 22 |

10 kWm-2 is the surface emissive power of large Jet A1 fires, so the thermal flux outside the flame envelope will always be less than this and will reduce as someone moves away from the fire. Jet A1 pool fires are also predicted to take a significant time to develop, and during this time much lower thermal radiation levels would be experienced outside the pool.

The UK HSE defines a dangerous dose as that which would cause severe distress to all persons suffering it and could result in highly susceptible people being killed. The dangerous dose of thermal radiation for average members of society is given as 1000(kWm-2).

The exposure predicted here is significantly below this dangerous dose level, so no fatalities would be expected for people located in the vicinity of the highway from a bund fire at either the new extension or existing facilities, when escaping by foot.

| | $kW/m^2$ | | | | | |
|---|---|---|---|---|---|---|
| **Litres** | **10** | **5** | **2** | **10** | **5** | **2** |
| Puddle Diameter = 10 m | **5D** | | | **2F** | | |
| | **meters** | | | **meters** | | |
| 500 | 12 | 10 | 10 | 26 | 10 | |
| 1000 | 12 | 10 | 10 | 26 | 10 | |
| 2000 | 55 | 40 | 31 | 22 | 33 | 53 |
| Flame Length | 18 | | | 21 | | |
| Puddle Diameter = 15 m | | | | | | |
| 5000 | 45 | 58 | 81 | 34 | 50 | 79 |
| Flame Length | 24 | | | 28 | | |

**BLEVE**

This scenario shall occur only with the following conditions

| % Volume | Pressure, psia | Temperature inside tank (°C) |
|---|---|---|
| 25 | 18.8 | 134 |
| 50 | 23.4 | 143.3 |
| 80 | 29.5 | 152.7 |
| 100 | 33.8 | 158.6 |

In normal conditions and following standard and safe operating practices shall not lead to the above conditions. However, in case of intense abnormal condition, if BLEVE occurs, the worst case condition may result in a fire ball having a diameter of 373 meters.

**RISK ASSESSMENT**

Risk is a combination of consequence and probability. The latter is usually expressed in terms of frequency, frequently occurring events being more probable and less frequent events having a lower probability of occurrence.

Bearing in mind that that all risk analyses are only order of magnitude estimates and also considering the relative magnitudes of the consequence of various scenarios, it is felt as appropriate to lump the scenarios into two categories: those involving pipelines and those involving storage tanks. In the case of pipeline failures, it should be possible to stop leakage within 5 to 10 minutes and the consequences would be contained largely within the site boundary. In the case of storage tanks, identified scenarios such as full bore rupture of the outlet line between the tank and the first isolation valve or major/catastrophic damage of both inner and outer tanks will be of long duration and the consequence would spread beyond the site boundary.

The second category includes assessment of risk under two conditions: one storage tank on line and two storage tanks on line.

The above approach has the advantage of concentrating on the main issue of this exercise, namely the risk of one tank on line versus two tanks on line, rather than getting bogged down into smaller incidents, such as pipeline ruptures, which would have consequences of smaller magnitudes.

**RISK CRITERIA**

Individual Risk criteria and societal risk criteria followed by HSE, UK and other countries are reproduced below:

**INDIVIDUAL RISK**

HSE, UK, provides well established tolerability criteria for individual risk, both for workers and for members of the public, which are:

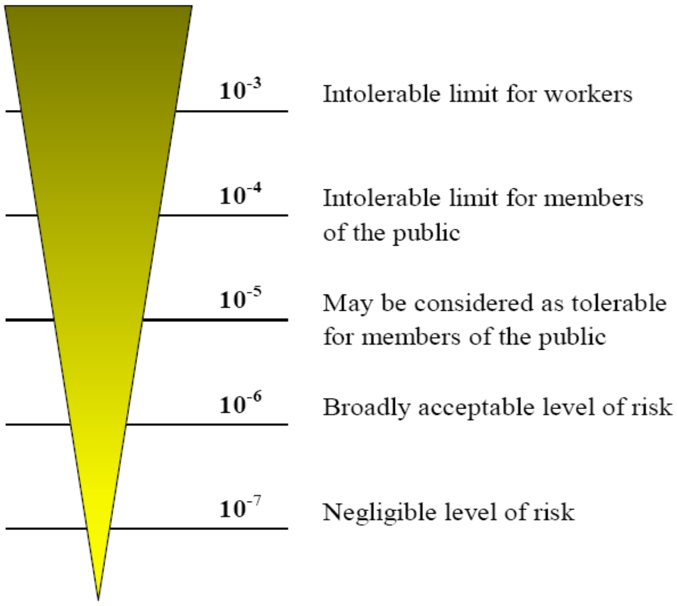
- *The annual risk of death for workers from work activities should be less than 1 in 1000 (i.e. 1 x $10^{-3}$).*
- *The annual risk of death for members of the public who are exposed to an involuntary risk from work activities should be less than 1 in 10,000 (i.e. 1 x $10^{-4}$).*

The HSE further states, that in practice, it should be noted, the actual fatality rates for the public and for workers in even the most hazardous industries are normally well below these levels. However, due to population near the site, the annual risk may be higher than those reported.

For both workers and the public, an annual risk of death from an industrial activity of below 1 in 1,000,000 is considered to be a very low risk and comparable with those that people consider insignificant or trivial in their everyday lives. However, it is the responsibility of an occupier to demonstrate that the risk to its employees, contract workers and public in general is as low as reasonably possible, also known as (ALARP).

**Table 10: Risk Criteria in different countries**

| IRPA | UK | The Netherlands | Hungary | Czech Republic |
|---|---|---|---|---|
| $10^{-4}$ | Intolerable limit for members of the public | | | |
| $10^{-5}$ | Risk has to be reduced to the level As low As Reasonably Practicable (ALARP) | Limit for existing installations. ALARA principle applies | Upper limit | Limit for existing installations. Risk reduction must be carried out |
| $3*10^{-6}$ | LUP limit of acceptability (converted from risk of dangerous dose of $3*10^{-7}$) | | | |
| $10^{-6}$ | Broadly acceptable level of risk | Limit for the new installations and general limit after 2010.ALARA applies | Lower Limit | Limit for the new installations |
| $10^{-7}$ | Negligible level of risk | | | |
| $10^{-8}$ | | Negligible level of risk | | |




**Acceptable Risk, HSE, UK[1]**

The Dutch parliament has approved criteria for new installation based on advisory committee on Major Hazards. The maximum possible risk has been taken as the risk level which increases the risk of death by all other causes by maximum 1% percent. The individual "natural death" risk for 10 to 14 years old of $10^{-4}$, per year has been taken as basis. Hence, the maximum allowable risk to an individual has been established as $10^{-6}$ per year. **Royal society's study group acceptable risk is 1 x $10^{-5}$**

**RISK RANKING SYSTEM**

Jet A1 is a flammable liquid with a flash point greater than 38°C. The maximum and minimum recorded temperatures in Bhogapuram are 33.1°C and 20.3°C. Therefore no flammable Jet A1 vapour hazard to neighbouring properties is expected during normal operations or from spills contained on site.

**Qualitative treatment**

A risk ranking has been carried out for the proposed storage system at Bhogapuram airport. This was based on HSE, UK's **Best practice for risk based inspection as a part of plant integrity management.**

***Risk = Probability of failure x Consequence of failure***

The **probability of failure** was derived based on following parameters:

| S. No | Parameter | Probability |
|---|---|---|
| **1.** | Internal corrosion | Very unlikely |
| **2.** | Fatigue | Unlikely |
| **3.** | Stress Corrosion cracking | Unlikely |

The probability corresponding to the above parameters have been derived based on physical inspection and guidelines provided, which also hold good for deriving consequence of failure. The highest probability among the above three is "**Unlikely**".

The **consequences of failure** were derived based on following parameters:

[1] HSE UK, RISK CRITERIA AND ALARP PRINCIPLES

| S.No | Parameter | Probability Rating |
|---|---|---|
| **1.** | Impact of production | 0 |
| **2.** | Location of Personnel | 2 |
| **3.** | Location of equipment | 1 |
| **4.** | Fluid Characterization | 3 |
| **5.** | Fluid Hazard- contents | 2 |
| **6.** | Fluid Hazard pressure | 1 |
| **7.** | **Total Points** | **09** |

Consequence ranking corresponding to 09 points is "**Low**".

The **risk ranking system** corresponding to the probability of failure and consequences of failure is: **LOW**

**Risk from Pool Fire**

Jet Fuel A-1 does give away very less flammable vapour under normal conditions as compared to petrol. Due to inherent physio-chemical conditions, the liquid does not self ignite unless heated to a minimum ignition temperature at which the vapour mixture with air burns.

A spill of Jet A1 is very hard to ignite, whereas a spill of gasoline is relatively easy to ignite, although an ignition source still has to be present. This distinction (based on flash point) is incorporated into international codes for storing fuel.

- Taking probability of ignition as 1%
- Frequency of a pool fire = 0.01 x 1.0 x $10^{-3}$ = 1 x $10^{-5}$ per year

Referring to risk criteria provided, the risk due to pool fire is small and well within acceptability.

**Smoke**

The combustion products of aviation fuel include carbon dioxide, nitrogen oxides and sulphur oxides. Incomplete combustion will generate thick black smoke and potentially hazardous gases including carbon monoxide. However smoke from such fires is buoyant and does not tend to seriously impact people on the ground in the open air. The composition of smoke plume of heavy hydrocarbons is estimated 11.8% $CO_2$ and 800 ppm of CO. At 800 ppm, the time required for incapacitation is about 48 seconds and at 300 ppm, the time required is 20 minutes.

| Time | Failure frequency (year) | Downwind frequency (year) | Population density (person/km) | Estimated potential frequency (year) |
|---|---|---|---|---|
| Day Time | 1.73 x $10^{-4}$ | 0.30 | 100 | 51.9 x $10^{-4}$ |
| Night Time | 1.73 x $10^{-4}$ | 0.30 | 100 | 51.9 x $10^{-4}$ |

Based on the potential frequencies of smoke impact, the smoke plume envelope from a fire at the facility in a 5 m/s wind is suggested for planning purposes to limit the height of buildings near to the tank facility.

**Catastrophic Release (BLEVE)**

In the case of catastrophic damage, the event may be initiated with any one tank but the consequence would escalate to the second tank as well. Hence, the frequency would be the same irrespective of whether one or several tanks are on line. However, BLEVE for fuel like jet fuel can only occur with either a very high pressurized system or with temperatures above 100°C, which should be rare in practice unless there is sabotage, external attack or a complete neglect of a pool fire

- Probability of BLEVE = 1%

- Frequency of Catastrophic Release = $1.6 \times 10^{-5}$ per year
- Risk from BLEVE = $0.01 \times 1.6 \times 10^{-5} = 1.6 \times 10^{-7}$

Referring to risk criteria provided, the risk due to BLEVE is negligibly small and well within acceptability.

**RISK REDUCTION STRATEGIES**

As jet fuel is a flammable liquid and the fuelling operation could result in hazardous events if performed incorrectly, therefore, safety provisions are incorporated in the design of the hydrant system and safety procedures are enforced to reduce the risk of the operation.

A fuel farm is the consolidated location of bulk fuel storage and equipment on or off an airport. The design of a fuel farm normally includes an area large enough to meet tank separation standards and contain all associated piping, filter assemblies, and pump equipment; a containment dike or bund; a fire protection system, including separate water storage for foam; a control room or similar building; security fencing; and a truck loading/unloading platform (also known as a rack system) to include adequate maneuvering area and room for the parking of service vehicles. Backup emergency generators can also be included.

Fuel spills represent the greatest fire hazard and every effort should be made to minimize spillage. Since it is not possible to prevent spills Altogether, proper steps should be taken to remove the spilled fuel at the Earliest. Every spill should be treated as a potential fire source and no Matter how small, it should be investigated as to its cause that remedial action may be taken.

**Transfer of fuel at high speeds constitutes a potential ignition source.**

During transfer operations all fuelling equipments shall, be earthed and during aircraft refuelling operations, the aircraft shall also be earthed and bonded to the refuelling equipment. Checks shall be carried out at regular intervals to ensure continuity of bonding wires (see Indian Standard: Code of practice for the control of undesirable static electricity)

**Flame traps shall be provided for refuellers to ensure safety.**

**NO SMOKING/MOBILE POLICY**

Operators are shall not be allowed to smoke in the tank farm and during fuelling operation. “no smoking” signs shall be prominently displayed near the aircraft and fuelling vehicles.

NO SMOKING’ sign shall be prominently displayed to prevent accidents, by painting them on the fuelling vehicles.

Mobile phone shall not be allowed in the tank farm and apron areas.

**Fire Extinguisher**

Each hydrant dispenser vehicle is equipped with two fire extinguishers which provide the operator an effective means to put out a small fire at the scene.

Adequate number of firefighting equipment should be provided and regular checks should be carried out to ensure that they are in working order whenever the need arises.

All personnel handling aviation fuels shall be thoroughly trained in all aspects of fire fighting and other safety precautions. Simulated fire drills shall be conducted at regular intervals and contingency plans shall be prepared.

### CATHODIC PROTECTION

Cathodic protection is a technique to protect the fuel pipeline from corrosion by connecting the pipeline with the cathodic protection transformer rectifiers. The cathodic protection transformer-rectifiers convert the AC power supply to a DC output for the impressed current cathodic protection systems.

### ALARMS

For safety purposes, fuel tanks shall be equipped with overfill level alarms, low level alarms, automatic product level gauging, manual gauge ports, sampling ports, floating suction units, access manways, and vents, as necessary to comply with standards and codes.

### Foam Systems

A special hazard project of this magnitude requires fixed foam system using fixed-foam discharge outlets for the protection of tanks and dike containment areas

There will be sufficient amount of fixed water monitor and potable water monitor. There will be also hydrant which is pressurized. First aid fire fighting facilities like DCP, Foam, $CO_2$, etc will also be provided at the site. Breathing Apparatus and Fire entry suite will be present at the site.

### PROPOSED LEAK DETECTION SYSTEM

A leak detection system shall be installed to monitor the pressure and temperature of the jet fuel in the hydrant system. A monthly check of any leakage in the hydrant system shall be carried out using the detection system.

Emergency Fuel Shutdown System

Emergency fuel shutdown system initiated by pressing the emergency shutdown button (ESB) shall be provided under the high mast light post nearest to each of the hydrant pit. Activation of the ESB closes the hydrant isolation valve located in the fuel farm and stops all hydrant fuel supply pumps. An audible and visual alarm is indicated on the fuel farm control panel. The design of the emergency shutdown system is fail-safe, if there is accidental damage to any part of the cabling, or if an open circuit failure occurred, the safety system will be activated.

### DUAL PILOT DEVICE/LANYARD

The dual pilot device provides a method for manually and pneumatically operating the pit valve, which closes the main isolation valve located in the lower half of the pit valve. The pilot device can be opened or closed manually by operating the deadman switch of hydrant dispenser, or remotely by pulling on the lever via a steel cable type lanyard. By releasing the deadman switch or manually pulling the lanyard, it operates the pilot valve which in turn closes the hydrant pit isolation valve within 2-5 seconds, thus stopping fuel from leaking out.

### DEAD-MAN SWITCH

The deadman switch operates the valves located inside the hydrant pit valve and hydrant coupler. This system is operated by a hand-held manual control which the fuelling operator grips in order to allow fuel to pass through the dispenser and into the aircraft. Releasing the deadman switch causes the pneumatic valve to close thus stopping the fuel flow. To protect against inadvertent use of deadman control by jamming the hand controller, a built in timer is fitted to alert the operator to release and re-close the switch at predetermined period, failing which the fuel flow stops automatically. This safety provision ensures the operator is monitoring the fuel operation at all time and can respond immediately to any fuel leakage incident.

### Brake Interlock System for Hydrant Dispenser Vehicle

The vehicle brake shall be tested before entering the aircraft parking stand and the brake is an integral part of an interlock system. The interlock system applies the vehicle brakes when any of the following occur:

- A pressure fuelling nozzle is removed from its stowage;
- The intake hose is being lowered;
- The intake coupler is removed from its stowage;
- The platform is in other than the fully down position; or
- The power take-off (PTO) mechanism is engaged. The PTO drives the hydraulic pump which powers the elevating platform, the hose reel rewind system and the dump tank emptying system pump.

**WARNING FLAG**

A four wing high visibility flag shall be placed next to hydrant pit when a hydrant coupler is connected to the pit valve. The flag serves as a warning signal to other drivers that the hydrant pit is engaged in a fuelling operation and all vehicles is kept in a safe distance away from the pit.

Illumination at Pit Valve and Inlet Hose

During the fuelling operation at night, the hydrant pit valve and inlet hose shall be illuminated. Light reflective collars shall be attached to the inlet hose at approximately 1 m intervals.

Speed Control

The airport speed limit of 35 km/h at the apron shall be imposed. All traffic signs and signal shall be obeyed.

**Refueller Safety Systems**

There are several safety features fitted to refueller dispenser as described below. The brakes have an interlock system which will automatically apply the brakes unless the delivery couplings (nozzles) are correctly stowed.

An inhibiting device shall be fitted to the chassis of the vehicle such that if the parking brake has not been applied the power take off (PTO) mechanism cannot be engaged. The PTO drives the hydraulic pump which powers the fuel transfer pump, the hose reel rewind system and the automatic dump tank emptying system pump.

A pneumatic safety interlock system which will automatically apply the brakes when an interlock is activated. In an emergency, an override lever is available which will release the brakes and allow the vehicle to be driven away.

The deadman’s control mainly acts by stopping the fuel transfer pump (in some cases the deadman may close an in-line valve instead of stopping the pump). This system is operated by a hand held manual control which the fuelling operator grips in order to allow fuel to be transferred into the aircraft. The control is an intrinsically safe electric switch, which provides a signal to a pneumatic valve. Releasing the control stops the transfer of fuel.

With this system, a fuelling operator could keep the deadman’s control closed by jamming or wrapping tape around the hand controller. This is dangerous because it allows the fuelling operator to move away from the fuelling vehicle. This would significantly increase the time taken to isolate a leak and result in an increase in the quantity of fuel spilt.

To protect against this, the deadman’s control system is sometimes fitted with an alert timer mechanism set for a predetermined period. This sounds an alert signal to the operator who then has to respond by resetting the system by releasing and re-closing the hand controller. If this is not done, the fuel flow stops automatically.

## EXIT ROAD REQUIREMENTS

Minimum two approaches from the major road shall be provided for normal movement and another for emergency exit. Both these approaches shall be available for receipt of assistance in emergency.

Roads inside the hazardous area of an AFS shall be restricted to vehicles required for operational, maintenance and safety/security reasons and allowed only with proper safety fittings and authorization from location in-charge/designated safety officer.

Alternative access shall be provided for each facility so that it can be approached for fire fighting in the event of blockage on one route.

Road widths, gradient and turning radii at road junctions shall be designed to facilitate movement of the largest fire-fighting vehicle envisaged in the event of emergency.

- The risk assessment study for the proposed ATF storage tank farm concludes that the overall risk arising from pool fire and combustion smoke are well within acceptable risk limits as prescribed by several international agencies.
- The occurrence of BLEVE is very remote considering the storage conditions as well as low volatility of product. Hence, the risk from the same is very negligible

## RISK ASSESSMENT AND DMP

Hazard Analysis involves the identification and quantification of various probable hazards (unsafe conditions) that may occur at the proposed Bhogapuram International Airport. On the other hand, risk analysis deals with the identification and quantification of risks, the equipment/facilities and personnel exposed, due to accidents resulting from the hazards present at the proposed Bhogapuram International Airport.
Hazard occurrence at the proposed airport may result in on-site implications, like:

- Fire and/or explosion at the storage of ATF and filling of ATF in aircraft;
- Leakage of flammable materials, like, ATF and DG sets followed by fire;
- Bomb threat at terminal building, cargo terminal and aircraft; and
- Natural calamities like, earthquake, cyclone, flood, etc.

Other incidents, which can also result in a disaster at the proposed airport, 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.

### APPROACH FOR THE RISK ANALYSIS

Risk involves the occurrence or potential occurrence of various type accidents consisting of an event or sequence of events. The risk analysis assessment study covers the following:

- Identification of potential hazard areas;
- Identification of representative failure cases;
- Visualization of the resulting scenarios in terms of fire 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 points of view;
- Furnish specific recommendations on the minimization of the worst accident possibilities; and
- Preparation of disaster management plan (DMP), on-site and off-site emergency response plan.

### FUEL STORAGE AT THE GREENFIELD INTERNATIONAL AIRPORT

The aviation fuel farm will be located on the western boundary of the airport on the south side of the main approach road to the airport. The fuel farm will cover an area of 60,357 $m^2$, including Jet A1 fuel tanks, AV gas Cisterns, maintenance, storage of water for fire fighting, fuel pumps, administrative offices and car and truck parking lots.

### HAZARD IDENTIFICATION

### INTRODUCTION

Preliminary hazards analysis is based on the philosophy "Prevention is better than cure". Identification of hazards at the proposed airport is of primary significance in the risk analysis, quantification and cost effective control of accidents. A classical definition of – hazard states that hazard is in fact the characteristic of system that presents potential for an accident. Hence, all the components of a system need to be thoroughly examined to assess their potential for initiating or propagating an unplanned event/sequence of events, which can be termed as an accident. Hazard identification has been carried out in the purview of following:

- Identification of hazards based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (as amended in 2000); and
- Identification of hazards due to handling and storage of HSD and ATF based on qualitative/quantitative techniques.

### IDENTIFICATION OF HAZARDS DUE TO STORAGE OF HSD AND ATF

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

### 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 oC |
| Physical state : | Liquid |
| Appearance : | Yellowish Brown |
| Vapour pressure : | 2.12 to 26mm Hg at 21 oC |
| 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.

**Aviation Turbine Fuel (ATF)**

Aviation Turbine Fuel (ATF) is clear colourless to yellow liquid with slight petroleum odour. 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 and chemical properties of ATF are as given below:

| | |
|---|---|
| Boiling Point : | 160°C |
| Specific Gravity : | 0.81 (Water = 1) at 15.6 oC |
| 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 |

**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 will be applicable for storage of HSD and ATF at the proposed airport.

**Hazardous Conditions**

An accidental release of HSD and ATF from tanks or piping during unloading and filling in aircraft would 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.

**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.

**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/m$^2$];

- 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 1min. 1% fatality in 10sec.
12.5 kW/m$^2$ : First degree burn for 10 sec exposure
4.0 kW/m$^2$ : First degree burn for 30 sec exposure

**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 a released HSD and ATF 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.

**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.

**RISK MITIGATION MEASURES**

The risk mitigation measures for the proposed Bhogapuram airport 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 will be 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 will be carried out for storage area, hoses and fuelling tanker and record will be maintained.
- Leakages from tanker may be prevented by a suitable regime of preventive maintenance and inspection.
- Heat and smoke detectors will be provided at strategic locations.
- Adequate fire fighting facilities will be provided near storage and handling of HSD and ATF.
- Fire fighting facilities will be tested as per schedule.
- Ground staff near aircraft will be trained to take measure in the event of spillage and during fire emergency.
- Fuelling in Aircraft and DG sets 'day tank' will be done under the supervision of trained operators.
- Open vents will be provided of goose neck type, covered with a mesh screen to discharge the vapours of hydrocarbons from storage tanks,.

- Every storage tank and tanker, including all metal connections, will be electrically continuous and be effectively earthed.
- Static grounding of aircraft will be ensured whenever the aircraft is parked; including during refuelling and defueling.
- Check list for operators for checking safety system and equipment will be prepared and check records kept in safe custody.
- The critical operating steps will be displayed on the board near the location where applicable.
- Thermal Safety Valve (TSV) will be provided at the operating manifold (outside dyke).
- Standard Operating Procedure (SOP) will be followed while unloading or fuelling the aircraft.
- Mock drill will be conducted in every three months involving all concerned agencies.
- All concerned agencies will be provided Disaster Management Plan and regular interaction will be made.

Risk Mitigation Measures for Fuelling of Aircrafts

- Earthing and bonding connections will be attached and mechanically firm.
- Equipment performing aircraft servicing function will not be positioned within 3 m radius of aircraft fuel vent openings.
- Equipment other than that performing aircraft servicing functions will not be positioned within 15 m of aircraft during fuel servicing operations.
- The accessibility to the aircraft by fire vehicles will be established during aircraft fuel servicing.
- Handheld intrinsically safe communication devices used within 3 m from the fuel vent will be intrinsically safe.
- For open hose discharge capacity of the aircraft fuelling 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 refuelling browser / dispenser.
- Spark plugs & other exposed terminal connections will be insulated.
- All vehicles, other than those performing fuel servicing, will not to be driven or parked under aircraft wings.
- Electric tools, drills or similar tools likely to produce sparks or arcs will not be used.
- Hot works within 50 / 75 metres of refuelling operations will be ceased (for 50m, a MOM approved Safety Officer shall be present)
- The ground service activities do not impede the egress should there be an emergency.
- One aerobridge or mobile step or integral stairs will be positioned with the aircraft door fully opened for evacuation of passengers.
- A clear area for emergency evacuation of the aircraft will be maintained at the rear (or front) aircraft exit door.

**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 proposed airport project 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.

**CATEGORIZATION OF EMERGENCIES**

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

**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 and HSD storage, etc.

**Natural Disasters**

The airport is located in Seismic Zone III as per seismic classification. Seismicity is a natural hazard for proposed airport project. Also the Airport is 500m from the Bay of Bengal, Cyclone and Tsunami are also natural hazards for the airport.

**KEY FUNCTIONS OF AIRPORT OPERATOR AND OTHER SUPPORTING STAFF**

Organizations/Agencies/Services for mitigation of emergency at proposed International Airport Concerned officers and other external supporting organizations/agencies/services will be called upon as necessary to mitigate crisis depending on the nature of emergency.

Table below summarizes the general key functions of Bhogapuram International Airport Co. Ltd. (BIACL)/Airport Operator and other supporting organizations/ agencies/services during crisis at proposed International Airport.

| S. No. | Organization//Agencies/Services | Key Functions |
|---|---|---|
| 1. | Proposed International Airport Fire Service | • Fire-fighting operations<br>• Post-accident fire protection<br>• Evacuate injured passengers to hospitals<br>• Support structural fire-fighting and evacuation<br>• Support mitigation of dangerous foods accidents/ |

| S. No. | Organization//Agencies/Services | Key Functions |
|---|---|---|
| | | incidents<br>• Inform fire brigade at Greenfield International Airport. |
| 2. | Terminal Building Management | • Activate key Officials and other external agencies/services such as hospitals, panel doctors, ambulance services,<br>• Activate the Emergency Response and Interaction Centre (ERIC) Group<br>• Set up the Emergency Coordination Centre (ECC), Friends and Relatives Reception Centre (FRRC)<br>• Passenger facilitation and business recovery at terminal buildings<br>• Support terminal building evacuation |
| 3. | Engineering | • Provide technical support and assistance<br>• Support recovery efforts |
| 4. | Local Police | • Guarding of site and preservation of evidence Greenfield International<br>• Airport including eye-witness accounts and photography.<br>• Maintain law and order at the site. |

**EMERGENCY OPERATIONS/COORDINATION CENTERS ESTABLISHED FOR MITIGATION OF EMERGENCIES**

During a major disaster such as severe fire outbreak at terminal building, the various emergency operations will be established immediately to mitigate the disaster. The emergency operations and coordination centers at proposed International Airport will comprise Crisis Management Centre (CMC), Emergency Coordination Centre (ECC), and Friends and Relatives Reception Centre (FRRC). Each of them has its own functions and roles to perform during the crisis:

**CRISIS MANAGEMENT CENTRE (CMC)**

Established by the Airport Operator, the Crisis Management Centre is to function as an overall overseeing and controlling authority of the crisis mitigating process during a major on ground fire. The committee of the Crisis Management Centre comprises the following permanent and supporting members:

Functions of the CMC include:

- Formulate strategic plans and policies, as well as engage in high level decision making for the mitigation of crisis.
- Control, coordinate and support operations during an Incident.
- Oversee the work and progress of protracted fire-fighting and rescue, and salvage operations.
- Liaise with the airline concerned, local authorities, ministries, and governmental departments for support.
- Arrange and provide welfare to the staff involved in the mitigation of crisis.
- Regulate the release of information to the public on the facts of the aircraft disaster.
- Issue press releases and organize press conferences.
- Ensure that the post-accident operations are completed expeditiously so that the proposed airport can resume normal operations in the shortest possible time.

**EMERGENCY COORDINATION CENTRE (ECC)**

Located near to Entry Gate, the Emergency Coordination Centre will be established by the Terminal Manager, Airport Operator, during a major disaster, to coordinate the response and functions of the external supporting organizations, agencies, and services involved in the mitigation of the emergency.

The committee of ECC comprises the following officials:

- Terminal Manager - Chairman
- Engineering In-charge - Alternate Chairman
- Manager - Civil
- Manager - Electrical
- Security Officer
- CISF representative
- IAF Representative
- Police representative

Functions of the ECC include:

- Support incident site fire-fighting and rescue operations through liaison and coordination with the external organizations/agencies/ services.
- Facilitate mobilization of external resources to the crash site, such as issuing emergency passes and arranging with Apron Control for "Follow-me" vehicles.
- Arrange and facilitate visits by the VVIPs to the site (if any).

**FRIENDS AND RELATIVES RECEPTION CENTRE (FRRC)**

The FRRC serves as a secure area, away from the attentions of the media, for the friends and relatives of those involved in an accident. The documentation process within the FRRC helps to confirm who was on the site/aircraft and facilitates the reunion.

On receiving the "Fire" message, Terminal Manager will set up the FRRC. The staff shall man the FRRC, and the police shall take charge of the security of the area.

At the FRRC, the airline staff shall:

- Attempt to verify the identity of the visitors on entry;
- Conduct documentation and briefing;
- Update with the latest information including passenger manifest, that has been officially cleared;
- Provide care and comfort including refreshments;
- Arrange for doctors and/or CARE officers through ECC on a need basis.

Command structure and communication flow among various emergency / coordination centers is given here:

**ASSEMBLY AREA (AA)**

Assembly area is an area set up near the incident site to temporarily receive the uninjured casualties until the arrangements to transport them to the Hospital is made. Two Assembly Areas (AA) will be near Grass Lawns in front of terminal building.

**MEDIA MANAGEMENT**

Terminal Manager – Chairman and his team shall take the lead to handle all press matters. They are single point media interaction. They will be responsible for developing the overall information management plan, with emphasis on strategies to manage the information flow. They will also be responsible for the preparation of press releases and the organization of press conferences.

All press personnel will first be directed to Airport Operator's Media Centre. At the Media Centre, press briefing, communications and transportation service for taking the press personnel to and from the accident site, when permissible, will be arranged/provided.

No unauthorized persons shall be allowed in the Media Centre. Only members of the press, free-lance reporters and photographers wearing a valid pass issued by Airport

Operator will be admitted to the Media Centre, or transported to the scene of the accident.

**EMERGENCY PROCEDURES**

**FIRES ON THE GROUND (AIRCRAFT RELATED FIRES OCCURRING IN AIRCRAFT MOVEMENT AREAS)**

An aircraft can catch fire while it is taxiing in the movement area or parked. Such a scenario can arise from a defect or malicious act, and may develop into a major disaster.

When the aircraft on the ground on fire is sighted, Airport Fire Service through the crash alarm communication system will be informed and provide details of the aircraft fire, for example:

- Location of aircraft;
- Nature of fire (e.g. undercarriage fire, engine fire);
- Number of POB; and
- Presence of dangerous goods, if known.

The Air Traffic Controller shall give clearance to the responding fire vehicles to enter the runway/taxiway as soon as possible. If the fire is large and has caused extensive damage to the aircraft and external resources are required to aid in the mitigation process, the Air Traffic Controller shall declare "Aircraft on Fire".

The standard text and format used for the "Aircraft on Fire" message shall be as follows:

AIRCRAFT ON FIRE:
Aircraft Operator;
Aircraft Type & *Flight Number; Location of Aircraft;
*Nature of Fire (e.g. undercarriage fire, engine fire);
*Number of Persons on Board (POB);
*Any Dangerous Goods on Board.
*(*The information shall be provided if it is available and applicable.)*

The use of the phrase "Aircraft on Fire" is to give distinction and therefore avoid confusion between aircraft crash and aircraft on the ground on fire.

**FIRES ON THE GROUND (FIRES INVOLVING AT PROPOSED AIRPORT PROJECT SITE, I.E. NON-AIRCRAFT RELATED FIRES)**

Fire may occur at any of the part of Greenfield International Airport. If out of control, such a fire may cripple the key proposed airport facilities and disrupt the normal operations.

During a fire occurrence, however small it may appear to be, any person discovering it shall:

- Raise the fire alarm via the nearest manual call point. If no manual call point is readily available, raise the alarm by other available means.
- Inform the Fire Service immediately of the exact location of the fire via the following telephone numbers.

*Operate a suitable fire extinguisher where readily available, or any water hose reel within range. [*Note: Attempt to put out the fire using a fire extinguisher shall only be carried out if the fire is small (i.e., at incipient stage) and does not pose any danger to the operator. Also take note that water shall not be used on fire involving liquid such as HSD, as well as on energized electrical equipment unless such equipment has been de-energized.)*

- On receipt of a structural fire call, the Fire Operator shall request the caller to provide the following details:
  - Location of fire;
  - Type of fire;
  - Name of caller;
  - Telephone number of caller.

#### TRAINING AND EDUCATION

Regular training would be provided to all personnel who have a role in planning and operational response to an emergency. The main goal of training for emergencies is to enable the participants to understand their roles in the response organization, the tasks associated with each position and the procedures for maintaining effective communications with other response functions and individuals.

The training objectives are:

- To familiarize personnel with the contents and manner of implementation of the plan and its procedures;
- To train personnel in the performance of the specific duties assigned to them in the plan and in the applicable implementation procedures;
- To keep personnel informed of any changes in the plan and the implementing procedures;
- To maintain a high degree of preparedness at all levels of the Emergency Response Organization;
- Train new personnel who may have moved within the facility organization;
- Test the validity, effectiveness, timing and content of the plan; and
- Update and modify the plan on the basis of experience acquired through exercises and drills.

#### 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.

#### UPDATING OF EMERGENCY PLAN

The Greenfield International Airport Emergency Plan and implementing procedures would be reviewed and updated to ensure compliance with relevant regulations and applicable state and local emergency plans.

The need for updating is based on following aspects:

- Written evaluations of mock drills exercises which identify deficiencies or more desirable methods, procedures, or organizations;
- Changes in key personnel involved in the organization;
- Changes in the facility organization structure;
- Changes in regulations;
- Recommendations received from other organizations and state agencies.

### ON-SITE EMERGENCY MANAGEMENT PLAN

The probability of inevitable residual risk, arising out of operations, capable of causing emergencies cannot be ruled out no matter how well a process is being controlled or safeguarded by instruments and process safety procedures. Such emergencies could be the result of malfunction, ignorance, non-observance of operating instructions or be the consequence of acts outside the control of people.

Hence the needs to prepare an ON-SITE EMERGENCY PLAN (OSEP) for dealing with accidents and natural calamities which could be catastrophic and are likely to affect health, safety, life, property and environment both at site and in the immediate neighborhood. An OSEM mitigates the effects of a major accident/emergency, when these effects are contained within the boundary of the site.

This plan is guideline for employees, workers, contractors, sub-contractors, visitors etc., informing about prompt rescue operations, medical treatment, coordination and communication among various internal & external members. The plan should be pro-active to avoid any confusion/panic and should direct to handle the emergency with clear instructions.

#### PURPOSE

BIACL has prepared a site specific Emergency Management Plan for implementation at the project site in the event of an emergency situation so that the loss of life and damage to the properties and natural resources are minimized. This plan will outline a series of emergency actions that will be executed by the BIACL and its contractors to ensure preparedness and response to emergency situations throughout the life-cycle of the project.

#### OBJECTIVE

The overall objective of a good emergency preparedness plan is for what to do and what not during an emergency. The following aspects shall be included in emergency preparedness plan:

- ❖ To assess what dangers could arise to people on and offsite as a result of these foreseeable emergencies and what the effects could it pose on the environment;

- To contain and control incidents;
- To assess the risk involved, and to mitigate the same by pre-planned remedial and rescue measures using, when necessary, the combined resources of the organization concerned and the public emergency services;
- To safeguard residents, employees and any one nearby who might be affected and to minimize the damage to property or the environment;
- The training of the individual personnel with duties under the plans will be familiarizing on site personnel with their roles, their equipment and the details of the plans;
- The onsite emergency plan should be based on the specific needs of each particular site for dealing with those emergencies which it is for seen may arise; and
- For an emergency plan to be successful, it should be tested, when first devised and thereafter to be rehearsed at suitable intervals.