1.0 Risk Assessment

Risk Assessment is a systematic process aimed at removing or minimizing hazards at work place to make it safer and healthier. Risk Assessment involves the following steps:

- Identify Hazard(s);
- Analyze / Evaluate the risk associated with the Hazard(s); and
- Determine appropriate measures to eliminate or control the Hazard.

1.1 Introduction

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

- Fire and/or explosion;
- Leakage of flammable material;
- Crash landing;
- Bomb threat; and
- Natural calamities like earthquake, cyclone etc.

Incidents having off-site origins can be:

- Air raids; and
- Crashing of aircrafts i.e. while landing or take-off.

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

- Agitation/forced entry by external group of people;
- Sabotage; and
- Hijacking.

In the sections below, the identification of various hazards, probable risks in the airport operation, maximum credible accident analysis and consequence analysis are addressed either qualitatively or quantitatively, which gives a broad identification of risks involved in the airport operation. Based on the risk assessment of various hazards, disaster management plan has been formulated and presented here.

1.2 Fuel Storage at the Airport

Fuel demand at IGIA is expected to approximately 101,250 kiloliters fuel storage capacity by 2034. Available open areas adjacent to the existing 4.7 hectare fuel farm site at IGIA can accommodate the 6 to 8 additional tanks that are required to increase the 5 day reserve to 2.4 to 3 times the current fuel consumption.

1.2 Hazard Identification

Identification of hazards at the proposed project is of primary significance in the 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. The following two methods for hazard identification have been employed in the study:

- Identification of major hazardous units based on Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989 (as amended in 2000) of Government of India; and
- Identification of hazardous units and segments of airports and storage units based on relative ranking technique, viz. Fire-Explosion and Toxicity Index (FE&TI).

1.2.1 Identification of Major Hazardous Units

1.2.1.1 Classification of Major Hazardous Substance

Hazardous substances may be classified into three main classes: flammable substances, unstable substances and toxic substances. The ratings for a large number of chemicals based on flammability, reactivity and toxicity have been given in NFPA Codes 49 and 345 M. HSD will be stored in the proposed restructuring and modernization project premises. Characteristics of HSD and ATF fuel are given in **Table-1.**

TABLE-1
PROPERTIES OF FUELS TO BE USED AT THE AIRPORT

Fuel	Codes/Label	TLV	FBP	FP	UEL	LEL
		°F			%	
HSD	Flammable liquid	Not listed	360	32	5.0	0.5
ATF	Flammable liquid	Not listed	572	38	7.0	0.2

TLV : Threshold Limit Value; FBP : Final Boiling Point
FP : Flash Point; UEL : Upper Explosive Limit
LEL : Lower Explosive Limit

1.2.2 Fuel Storage

The jet fuels are being stored in the fuel farm/yard located within the IGIA premises. The operator is assumed to store fuel to cover at least 5 days requirement:

- As operational stock to accommodate peak daily demand;
- As emergency stock to accommodate pipeline interruption; and
- To ensure fuel quality.

The details of storage capacity are given in **Table-2.**

TABLE-2
CAPACITY DETAILS OF FUEL STORAGES

Fuel	Total Storage Capacity
ATF	2 x 9000 m^3; 4 x 6000 m^3

1.2.3 Fire Explosion and Toxicity Index (FE&TI) Approach

Fire, Explosion and Toxicity Indexing (FE & TI) is a rapid ranking method for identifying the degree of hazard. The application of FE&TI would help to make a quick assessment of the nature and quantification of the hazard in these areas. However, this does not provide precise information. Respective Material Factor (RMF), General Hazard Factors (GHF), Special Process Hazard Factors (SPHF) are computed using standard procedure of awarding penalties based on storage handling and reaction parameters. For each separate storage, which contains flammable or toxic substances, a fire and explosion index 'F' and/or a toxicity index 'T' may be determined in a manner derived from the method for determining a fire and explosion index developed by the Dow Chemical Company.

1.2.3.1FE and TI Methodology

Dow's Fire and Explosion Index (F and E) is a product of Material Factor (MF) and hazard factor (F3) while MF represents the flammability and reactivity of the substances, the hazard factor (F3), is itself a product of General Process Hazards (GPH) and Special Process Hazards (SPH). An accurate plot plan of the Airport/storages, Fire and Explosion Index and Hazard Classification Guide published by Dow Chemical Company are referred to estimate the FE & TI of a storage unit.

The degree of hazard potential is identified based on the numerical value of F&EI as per the criteria given below:

F&EI Range	Degree of Hazard
0-60	Light
61-96	Moderate
97-127	Intermediate
128-158	Heavy
159-up	Severe

1.2.3.2 Toxicity Index (TI)

The toxicity index is primarily based on the index figures for health hazards established by the NFPA in codes NFPA 704, NFPA 49 and NFPA 345 m.

1.2.3.3 Classification of Hazard Categories

By comparing the indices F&EI and TI, the unit in question is classified into one of the following three categories established for the purpose as given in **Table-3.**

TABLE-3
FIRE EXPLOSION AND TOXICITY INDEX

Category	Fire and Explosion Index (F&EI)	Toxicity Index (TI)
I	F&EI < 65	TI < 6
II	65 < or = F&EI < 95	6 < or = TI < 10
III	F&EI > or = 95	TI > or = 10

Certain basic minimum preventive and protective measures are recommended for the three hazard categories.

1.2.4 Risk Quantification - Fuel Storage

Based on the storage of fuels and their properties, the following failure scenarios for the airport have been identified for quantification of risk, which are given in **Table-4.** The heat radiation contours are calculated around the source of failure to assess the extent of damage.

TABLE-4
SCENARIOS CONSIDERED FOR MCA ANALYSIS

Sr. No.	Fuel/Chemical	Total Quantity (m^3)	Model Considered
1	Failure of one ATF storage tank	9,000	Pool Fire

For the present study, the scenarios under consideration assume that the peak level of radiation intensity will not occur suddenly. Based on the past experience, it is found that 20-30 minutes time will be required before a tank fire grows to full size. For radiation calculations, pool fire has been considered. From the above considerations, the criterion of 4.5 kW/m^2 has been selected to judge acceptability of the scenarios.

1.2.5 Model Computations

The results of MCA analysis for ATF and HSD are tabulated indicating the distances for various damages identified by the damage criteria. Calculations are done for radiation intensities levels of 37.5, 25, 19, 12.5, and 4.5 kW/m^2 which are presented in **Table-5** for Instantaneous pool fire. The distances predicted for various scenarios are given in meters and are from the center of the pool.

TABLE-5
OCCURRENCE OF VARIOUS RADIATION INTENSITIES - POOLFIRE

Failures	Storage Capacity (m^3)	Radiation Intensities (kW/m^2)/Distances (m)					
		37.5	25.0	19.0	12.5	4.5	1.6
ATF Tank	9000	11.6	14.6	17.1	21.7	38.9	70.1

- ***Pool Fire Due to ATF Tank failure***

A perusal of the above table clearly indicates that 37.5 kW/m^2 (100% lethality), 25.0 kW/m^2 (50% lethality), 12.5 kW/m^2 (1% lethality) and 4.5 kW/m^2 (0% lethality with 1st degree burns) will be occurring at a distance of 11.6 m, 14.6 m 21.7 m and 38.9 m respectively. The thermal radiation of 1.6 kW/m^2 (No Discomfort even after long exposure) will occur at a distance of 70.1 m. Therefore, the impact on the airport surroundings is practically insignificant.

1.2.6 Effect of Thermal Radiation on Population

A perusal of Table-5 presented in above section indicates that radiation contours

(37.5 kW/m^2 and 25 kW/m^2) are restricted to DIAL boundary only and do not affect the surrounding human population.

In addition, the airport has watch towers to keep vigilance on all the activities occurring. The traffic movement is recorded by the security personnel. In case of any eventuality, the alarm is blown to alert the nearby work force.

The Passenger Terminal Building (PTB), cargo terminal etc. has adequate fire rescue system comprising of fire hydrants, emergency exits and assembly points for safety of the occupants.

1.3 Airport Emergency Plan (AEP) for Disaster Management

Under the Aircraft Rules 1937, Part XI, Rule 81 and Civil Aviation Requirements (CAR), Section 4, Series 'B', Part I, an aerodrome operator is required to establish an Airport Emergency Plan (AEP) commensurate with the aircraft operations and other activities conducted at the aerodrome. To meet this requirement and other necessary obligations stipulated by DGCA, Delhi International Airport Limited (DIAL), who operates Indira Gandhi International Airport (IGI AIRPORT), has established and promulgated this AEP based on the standard procedure set by DGCA in CAR, Section 4, Series 'B', Part I and ICAO's guidelines in Airport Service Manual, Part 7.

The purpose of this AEP is to set forth the procedures for coordinating the response of different agencies and services, both on and off the aerodrome, to handle various aircraft and non-aircraft related emergencies anticipated at IGI airport. AEP also spells out the duties and responsibilities of the various authorities /agencies associated with handling of airport /aircraft emergencies.

Procedures for the following emergencies are addressed in detail in Airport Emergency Plan. Report is enclosed as **Annexure-VII** in the EIA report.

1.3.1 Categorization of Emergencies

- Aircraft Accident on the Airport

Action initiated when an aircraft accident has occurred on the airfield within the airport boundary.

- Aircraft Accident off the Airport

Action initiated when an aircraft Accident has occurred outside the airport boundary, but within 8 km radius from the center of the Airport.

- Full Emergency

An emergency declared when an aircraft approaching the aerodrome is known or suspected to be in such difficulty that there is a possibility of an accident.

- Local Standby

Local Standby is declared when an aircraft approaching the aerodrome is known or is suspected to have developed some defect but the trouble is not such as would normally involve any serious difficulty in effecting a safe landing.

- In-Flight Mass Casualties

An emergency situation when mass casualties onboard will usually result from incidents such as an encounter with severe air turbulence during flight or mass food poisoning.

- Fires on Aircraft on Ground

Fire involving aircraft on ground at location on the runway, taxiway, hangar or apron area where aircraft is parked.

- Dangerous Goods Accidents/Incidents

Incident/ accident in aircraft having probability of posing a significant risk to health, property or environment.

- Natural Disaster

Severe storm, earthquake or any other natural calamity that can pose serious threat to life and property at airport.

- Removal/Recovery of Disabled Aircraft on the Aerodrome

Aircraft may become immobilized or disabled on an aerodrome for a number of reasons, ranging from major accidents such as accident-landing to more minor incidents involving runway excursions or tyre bursts. It is imperative to recover the aircraft quickly and in a safe manner so as to minimize disruption to the airport operations.

- Fire on the Ground (Airport Buildings and Installations)

Fire involving key and vital installation i.e. PTB, ASB where the Airport operations are affected.