# EXECUTIVE SUMMARY

## 1. THE INCIDENT

**1.1** In the evening shift of October 29, 2009, the Indian Oil Corporation's POL (Petroleum Oil Lubricants) Terminal at Sanganer in Jaipur was preparing to transfer Kerosine (SKO) and Motor Spirit (MS) to the neighbouring BPCL Terminal, a routine operation for these Installations. A crew of four (one shift officer and three operators) were manning the IOC Installation. Kerosine was "lined up" (pipeline made through) first and thereafter the operating crew proceeded to prepare the MS tank (tank 401-A) for pumping to BPCL installation.

**1.2** In the process of lining up the MS tank, at about 6.10 PM, a huge leak of the product took place as a jet of liquid from the "Hammer Blind Valve" on the delivery line of the tank leading to the MS pump.

**1.3** This liquid MS which rapidly generated vapours, soon overwhelmed and incapacitated the operator carrying out the "line up" operation. The shift officer, who was nearby, tried to help the operator, but he too was affected by the vapours and liquid, and had to be removed to hospital in a semi-conscious state. The 2$^{nd}$ operator, who was incidentally in the canteen at the time, also rushed to the spot, but he was also completely overpowered by the strong MS vapours and liquid and could not be rescued. The 3$^{rd}$ operator on the shift, who was supposed to be on site, had earlier left for home on some personal work and was thus not available to initiate any rescue or mitigating steps.

**1.4** With none of the operating crew being available any more for initiating any control actions, the leak continued unabated, and by the time the senior staff and civil authorities could reach the site, had already engulfed almost the entire installation, making their entry not only difficult but also dangerous.

**1.5** After about an hour and 15 minutes of the leak having started, there was a a massive explosion followed by a huge fireball covering the entire installation. It is estimated that in this one hour and 15 or 20 minutes of uncontrolled leak, about 1000 tons of MS could have escaped out, which would have generated enough vapour to cause an explosion with the equivalence of 20 tons of TNT.

**1.6** The source of ignition, which triggered the explosion and fire could have been from one of the non flame proof electrical equipment in the Administrative Block, or from a vehicle being started in the installation.

**1.7** The fire which followed the explosion soon spread to all other tanks and continued to rage for about 11 days. The management of IOCL had taken a considered decision to allow the petroleum products to burn out to avoid further possibilities of accident in the installation in the interest of public safety.

**1.8** Ultimately the entire, about 60,000 KL of petroleum products stored in the Terminal (equivalent of about 1000-1200 retail outlets) at the time of the accident was consumed in the fire, and the installation was totally destroyed. Buildings in the immediate neighbourhood were heavily damaged with minor damages and window panes breakages occurring up to around 2 Km from the site.

The total loss estimated on account of the fire and explosion as reported by IOC in the Press, which includes the loss for finished products, stores, fixed assets and compensation for third party losses, amount to approx., Rs. 280 crores.

**1.9** Eleven people lost their lives in the accident – six from IOC and five outsiders, and several others were injured.

**1.10** The Ministry of Petroleum & Natural Gas (MoP&NG) immediately thereafter i.e. on 30.9.2009 constituted a seven member Independent Inquiry Committee to inquire into the incident.

## IMMEDIATE CAUSES

**1.11** The immediate cause of the accident was the **non-observance of normal safe procedure** involving sequence of valve operation in the line up activity and an engineering design which permitted use of a "Hammer Blind Valve", a device which is used for positively isolating a pipeline. The design of the Hammer Blind valve allows a large area at the top of the valve (at the valve bonnet) to be completely open every time the valve position needed to be changed. It was through this open area that the liquid MS had gushed out, when the tank was being lined up (made ready for pumping to BPCL) because another valve connecting to the tank was also open when the Hammer Blind was in the changeover position

## ROOT CAUSE

**1.12** The basic or root causes were an absence of site specific written operating procedures, absence of leak stopping devices from a remote location (the facility for remote closing of the "Motor Operated Valve"

connecting to the tank side, which could have stopped the leak) and insufficient understanding of hazards and risks and consequences.

## CRITICAL FACTORS

**1.13** The critical factors which resulted in the Catastrophic Accident are:

- Loss of primary containment of Motor Spirit (Petrol)
- Loss of secondary containment
- Incapacitated Operating Personnel
- Inadequate mitigation measures
- Shortcomings in design and engineering specifications of facilities and equipment
- Absence of Operating Personnel from site and also from vital operational area

## RESPONSE

**1.14** Information about the leak and the hazard was conveyed by the Security staff on site to the Terminal senior management staff and others. The state and local civil authorities were alerted by IOC state level officers and within about 30-45 minutes almost all personnel and agencies in the city and around had come to the site. However, the sheer enormity of the unconfined vapour cloud which had by then spread till the gate of the installation, made the affected area unapproachable. Non-availability of a Self Contained Breathing Apparatus (SCBA) and Fire Suit immediately, left the entire response team as mere helpless spectators in preventing the incident.

However, the civic authorities took commendable steps in evacuating the injured and ensuring immediate medical attention and in redirecting

and controlling traffic and cordoning off areas thereby minimizing damages outside the Installation.

**RECOMMENDATIONS:**

**1.15** Immediate measures have been recommended keeping in view that there are a large number of Installations and Terminals existing in the country where improvements in technical and operational measures can ensure safety and emergency preparedness. Such measures include the ensuring of safety back up systems, modifications to make human error less likely, making emergency action possible from remote locations ensuring availability and observance of site specific operating procedures, improving operating discipline, communication facilities and ensuring availability and knowledge regarding the use of Personal Protective Equipment (PPE). Manning levels have also been recommended for a review. Other recommendations include enhancing automation levels, and other measures like design features such as dual level gauges and alarms to avoid possibility of a tank overflow, (which can create a similar hazard), installation of Hydrocarbon detectors,and CCTV with alarm feature. An important requirement is that for large sized installations and especially those in highly congested areas, a quantitative risk assessment exercise should be undertaken and based on the risk assessment, mitigation measures to reduce the risk should be initiated.

**1.16** Long term measures for planned implementation deal with the technical and operational issues for phased implementation and also wider issues at the managerial and industry level which can be considered.

**1.17** Major areas of recommendations in this category are:

a) Improving the design and layout for preventing loss of hydrocarbon containment and providing better monitoring of Terminal operations.

b) New terminal and installation should incorporate the state of the art technology for terminal automation which can improve reliability and safety of operation and reduce the chance of human error

c) Standardisation of the Marketing Terminal covering all aspects including design, marketing and operations on the lines of standards developed for LPG OISD:STD 144.

d) Augmenting fire fighting capabilities/automation and developing joint facilities of all Oil Marketing Companies wherever they are present in close proximity.

e) Improving human factor through better training, performance evaluation criteria and safety oriented corporate policies.

f) The Committee recommends the setting up of a dedicated group for Terminal operations as a separate joint venture or subsidiary organisation.

g) Strengthening the Safety function in the Corporation by professionalizing its cadre and making it directly report to the senior most executive (the CEO of the company) and for the Marketing and Pipeline functions, making Safety independent and autonomous of the functions (similar to the Vigilance and Internal Audit functions).

h) Strengthening the internal safety auditing functions by making it cross-functional and providing professional safety auditing training.

i) The recommendations also discussed the siting criteria and recommend that a quantitative risk analysis should be carried out for this purpose..

j) The Committee has also suggested legislation for preventing damage to life and property outside the boundary of such installations regarding appropriate land use surrounding such installations and the role of local and state governments in such matters.

k) The Committee also suggested for reviewing of all Major Accident Hazard Installations as defined under Manufacture, Storage and Import of Hazardous Chemicals Rules 1989 from security threat perceptions point of view.

l) As an illustration the report also indicates that if a leak such as this can be arrested within eight minutes, the impact zone would be about 200 meters from the point of ignition of any vapour cloud. Any delay in arresting the leak would increase the radius of the impact zone.

m) Safety considerations in siting of major installations and facility may also require amendments to the existing Petroleum Rules 2002 to empower the Government for ensuring a buffer safety zone around High Hazard Petroleum Installations.

## OVERALL LESSONS LEARNT

**1.18** Based on the Jaipur incident a few lessons learnt are highlighted:

a) Facilities and installations with inherently high hazards should incorporate redundancy in safety systems and ensure their upkeep at all times.

b) Management should ensure that reliable systems are in place to give timely feedback on the current practices and state of readiness in different facilities.

c) Management must ensure that identified actions are being carried out.

d) A high priority on safety from the senior and top management groups will send the right signals down the line to ensure safety and production.

e) High degree of operational competence should be maintained at all times by building on the combined knowledge and experience of all the professional groups. The lessons learnt from all major incidents should be shared and widely disseminated in the entire Industry preferably through an appropriate website..

## CONCLUSION

**1.19** Jaipur incident was first of its kind in India and the third one reported globally. Loss of containment in terms of time and quantity was never considered a “Credible Event” and accordingly not taken into account in “Hazard Identification”. HAZOP as well as Risk

Assessment for Petroleum Instalaltions. Notwithstanding this the incident would not have been occurred if the basic procedures of operating Hammer Blind valve before opening tank body valve (MOV) were followed. Further even after the leak started the “Accident” could have been managed if Safety Measures provided in the Control Room were not made and kept defunct. The lack of back up for emergency shut down from control room and absence of company official in the control room and lack of any “Emergency Response for long period (75 minutes or so)” allowed leakage to go uncontrolled resulting in the Massive Vapour Cloud Explosion.