



Risk Management for Chemical Industries

Chemicals have become a part of our life for sustaining many of our day-to-day activities, preventing and controlling diseases, and increasing agricultural productivity etc. An estimation of one thousand new chemicals enter the market every year, and about 100000 chemical substances are used on a global scale. These chemicals are mostly found as mixtures in commercial products. Over one million such products or trade names are available.

The chemical industrial sector is highly heterogeneous encompassing many sectors like organic, inorganic chemicals, dyestuffs, paints, pesticides, specialty chemicals, etc. Some of the prominent individual chemical industries are caustic soda, soda ash, carbon black, phenol, acetic acid, methanol and azo dyes. Chemical manufacturing sector in India is well established and has recorded a steady growth in the overall Indian industrial scenario. The Chemical and allied industries have been amongst the faster growing segments of the Indian industry. The Indian chemical industrial sector had a turnover of around Rs.1200 billion in 2001-2002. The chemical exports also accounts for more than 16.20% of the total Indian exports during 2001-2002.

The risks associated with the chemical industry are commensurate with their rapid growth and development. Apart from their utility, chemicals have their own inherent properties and hazards. Some of them can be flammable, explosive, toxic or corrosive etc. The whole lifecycle of a chemical should be considered when assessing its dangers and benefits. Though many of chemical accidents have a limited effect, occasionally there are disasters like the one in Bhopal, India, in 1984, where lakhs of people were affected and LPG explosion in Vizag refinery where huge property damage in addition to 60 deaths was experienced. Therefore chemicals have the potential to affect the nearby environment also.

- Design and Pre-modification review : Improper layout like location of plant in down wind side of tank farm , fire station near process area , process area very close to public road and wrong material of selection had caused severe damages to the work and outside environment
- Chemical Risk Assessment: Not assessed for new chemicals from the point of view of compatibility, storage, fire protection, toxicity, hazard index rating, fire and explosion hazards
- Process Safety Management: HAZOP, FTA, F&E Index calculation, reliability assessment of process equipment, incorporating safety trips and interlocks, scrubbing system, etc. not done before effecting major process changes, lack of Management of Change procedure (MoC), etc.

- Electrical Safety: Hazardous area classification , protection against static electricity , improper maintenance of specialized equipment like flameproof etc were ignored.
- Safety Audits: Periodical assessment of safety procedures and practices, performance of safety systems and gadgets along with follow up measures were not carried out.
- Emergency Planning: Lack of comprehensive risk analysis indicating the impact of consequences and specific written down and practiced emergency procedures along with suitable facilities had increased the severity of the emergency situations.
- Training: Safety induction and periodical refresher training for the regular employees and contract workmen were not carried out.
- Risk Management & Insurance Planning: Thorough identification and analysis of all risks and insurance planning were not done so that interruption risks and public liability risks could also be managed effectively.

A. Risk Management Consultancy

Following specialized risk management services are offered to chemical industries, considering the kind of risks that exists in these plant operations:

1. STANDARD CONFORMANCE and PERFORMANCE EVALUATION (SCOPE)

SCOPE would evaluate the existing measures / system based on applicable national / international standards.

A few SCOPE reviews that we recommend for chemical manufacturing plants are:

1.1 SCOPE-FP (Fire Protection)

Indian Standards

- IS 2189 - Standard for automatic fire detection and alarm system
- IS 2190 - Code of practice for selection, installation and maintenance of first aid fire extinguishers
- IS 3844 - Code of practice for installation and maintenance of internal fire hydrants and hose reels
- IS 6382 - Carbon dioxide fire extinguishing system - fixed, design and installation

TAC Standard

Tariff Advisory Committee recommendations on hydrant and sprinkler system for fire protection.

Oil Industry Safety Directorate

- OISD 117 - Fire Protection Facilities for Petroleum Depots and Terminals

- OISD 142 - Inspection of fire fighting equipment and systems
- OISD 158 - Recommended Practices on Storage and Handling of Bulk Liquefied Petroleum Gas

NFPA Standards

- NFPA 12 Carbon Dioxide Fire Extinguishing Systems
- NFPA 654 Prevention of Fire & Dust in Pharmaceutical Industries
- NFPA 1600 Disaster Management
- NFPA 921 Fire & Explosion Investigation
- NFPA 45 Fire protection for Laboratories using Chemicals

1.2 SCOPE - OHS (Occupational Health and Safety)

- IS 14489 Code of Practice for Occupational Safety & Health Audit
- NFPA 101 Life Safety Code

1.3 SCOPE-ER (Electrical Risk)

- Hazardous Area Classification (base standard: IS 5572)
- Selection of Electrical Equipment for Hazardous Areas (base standard: IS 5571)
- Lightning Protection (base document: IS: 2309 /NFPA 780 /BS 6651)
- **NFPA 70 B** Recommended Practice for Electrical Equipment Maintenance
- **NFPA 70 E** Standard for Electrical Safety in Employee Work places

2.0 PROCESS SAFETY MANAGEMENT

- Hazard & Operability (HAZOP) studies
- Failure Tree Analysis (FTA)
- Event Tree Analysis (ETA)
- Primary Hazard Analysis (PHA) using Dow Index
- Risk Assessment (with risk ranking technique)

3.0 ELECTRICAL RISK ASSESSMENT

- Review of Hazardous Area Classification
- Lightning Protection Risk Assessment
- Identification & Control of Electro-Static Hazards
- Review of electrical Preventive Maintenance System
- Electrical Risk Assessment (fire, shock explosion) using Semi-Quantitative Risk Ranking (SQRR) technique

4.0 FIRE RISK ASSESSMENT

- Identification & assessment of fire risks during operations in receipt, storage, transfer and handling of chemicals (raw materials and finished products)
- Identification & control of ignition sources in areas where flammable chemicals are stored / handled / transferred
 - Review of chemical compatibility in storage areas and to suggest appropriate fire loss control measures
 - Review of fire detection measures adopted in the plant & to suggest suitable improvement measures
 - Review of the various active (fire hydrant, sprinkler, portable fire extinguishers) and passive fire protection requirements for chemical storage and handling areas and to suggest improvements as necessary
 - Review of contractor safety awareness (chemical spill, fire fighting, emergency communication, knowledge of plant hazards & safety regulations) and to recommend suitable improvement measures to enhance contractor safety
 - Review of safety awareness and safety training requirements (training identification and efficacy) of plant employees with respect to hazards present in the plant

Fire risk assessment will be carried out based on techniques like *Matrix method, Hani Raafat Risk Calculator*. The consequence, likelihood and exposure of each hazard are arrived using a systematic approach and will help to determine the relative importance of hazard and focus on significant risks.

5.0 RISK ANALYSIS & EMERGENCY PLAN

- Identification of scenarios of potential disasters / emergencies leading to loss of life , property damage etc. and qualitative assessment of their likelihood.
- Quantitative risk assessment for selected scenarios of major credible events.
- Recommendations for risk control measures wherever applicable.
- Preparation of onsite emergency preparedness plan

6.0 RISK MANAGEMENT & INSURANCE PLANNING

- Identification of all major internal and external pure risks including the natural risks and analysis of the impact of above risks
- Review of existing risk control measures and offering comments
- Scrutiny of all existing major insurance policies in respect of:
 - Rationalization of basic rate of premium and widening of covers
 - Applicability / eligibility of discounts in premium
 - Application of suitable clauses, warranties and conditions
- Identification of possible areas for refund of premium and suggestions regarding procedure for the same
- Selection of insurance coverage on the basis of risk analysis
- Providing guidelines for fixation of sum insured and illustrate the same on a selected equipment
- Evaluation of business interruption exposure due to identified risks
- Providing guidelines on documentation requirements, procedures for claims under various policies, evaluation of insurers

B. Risk Management Training

Specialized and focussed training, if imparted effectively, can contribute significantly to Risk Management. Expert faculty, carefully selected training module, interactive and participate approach, useful training material, case studies and syndicate exercises could help in having effective risk management system in place. The training topics for bulk drug industry could be:

- Chemical Safety
- Safety with Compressed gases
- Solvent Safety
- Hazard Identification Techniques
- Industrial Risk Management
- Fire Prevention and Protection
- Electrical Risk Management
- Emergency Preparedness
- Safety Management system
- Accident Prevention
- Personal Protective Equipment

C. Choramandalam MS Risk Services & Expertise in Chemical Risk Management

Choramandalam MS RISK SERVICES has a team of risk management professionals who understand the **special risk profile** of every type of industry, especially the Chemical manufacturing due to their wide experience in the field of consultancy, fire investigations and training at chemical plants after their hands on operating experience in the relevant sector.

Some of our team members have presented papers in National seminars and international work shops on Chemical Safety.

Choramandalam MS Risk Services Ltd. has executed risk management projects for several process plants. A few of them are listed below:

- Shasun Chemicals, Cuddalore, Tamil Nadu
- ITC - ILTD, R&D Lab
- Chambal Fertilizers and Chemicals, Kota, Rajasthan
- Mangalore Chemicals and Fertilizers, Mangalore
- BASF Styrenics, Dahej
- TANFAC Industries Ltd. , Cuddalore
- Mangalore Refinery and Petrochemicals Limited, Mangalore
- Hindustan Petroleum Corporation Limited, Vizag Refinery
- SPIC , Tuticorin
- LPG bottling plants of HPCL & BPCL , Mangalore & Coimbatore
- POL terminals of HPCL & BPCL, Mangalore & Coimbatore

- POL terminal of Indian Oil Corporation, Mangalore & Coimbatore
- Coromandel Fertilisers Ltd., Vizag & Ennore

MAJOR CHEMICAL DISASTERS IN INDIA

Origin of accident	Year	Date	Location	Products involved	Number of		
					Deaths	Injured	Evacuated
Bulk cargo handling terminal	1997	00.01	Mumbai*	Sulphur			
Explosion	1983	29.09	Dhulwari	Gasoline	41	>100	..
Explosion (warehouse)	1992	29.04	New Delhi	Chemicals	43	20	
Fire	1983	03.11	Dhurabari	Oil	76	>60	-
Fire	1985	01.11	Padaval	Gasoline	>43	82	..
Fire at a chemical store	1994	13.11	New Delhi	Toxic cloud (chemicals)		500	
Fire in refinery	1988	09.11	Bombay	Oil	35	16	..
Leakage	1984	03.12	Bhopal*	Methyl isocyanate	2800	50 000	200 000
Leakage	1989	05.05	Britannia Chowk	Chlorine	-	200	..
Leakage	1990	05.11	Nagothane*	Ethane and propane	32	22	
Leakage	1988	22.12	Jhurkully	Sulphur dioxide	-	500	..
Leakage	1989	17.01	Bhatinda	Ammonia	-	500	..
Leakage	1987	24.06	Bhopal	Ammonia			200 000
leakage (transport accident)	1997	21.01	Bhopal	Ammonia		400	
Leakage from a pipeline	1991	00.12	Calcutta	Chlorine		200	
Leakage in an Ice Factory	1990	00.07	Lucknow	Ammonia gas		200	
Plant explosion	1980	03.05	Mandir Asod	Explosives	50	..	-

Refinery fire	1997	14.09	Vishakapatnam		34	31	150000
Release	1985	14.05	Cochin	Hexacyclo-pentadiene	-	200	..
Release	1985	04.12	New Delhi	Sulphuric acid	1	340	>10
Transport	1985	09	Tamil Nadu	Gasoline	60
Transport accident	1994	00.01	Thane District	Chlorine gas	4	298	
Transport accident	1991	00.01	New Bombay	Ammonia gas	1	150	
Transport accident	1995	12.03	Madras	Fuel	~100	23	
Transport accident	1995	00.12	Maharashtra	Ammonia gas		2 000	
Transport accident (leakage)	1991	00.11	Medran	Inflammable liquid	93	25	
	1985		India	Chlorine	1	150	-

* disasters involving damage in excess of \$10 US to third parties

Source: OECD, MHIDAS, TNO, SEI, UBA-Handbuch Stoerfaelle, SIGMA, Press Reports, UNEP, BARPI.

Inclusion Criteria

- 25 death or more; or
- 125 injured or more;
- 10000 evacuated or more; or
- 10 thousand people or more deprived of water;

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