

# 8<sup>th</sup> CCPS Asia Pacific Regional Meeting

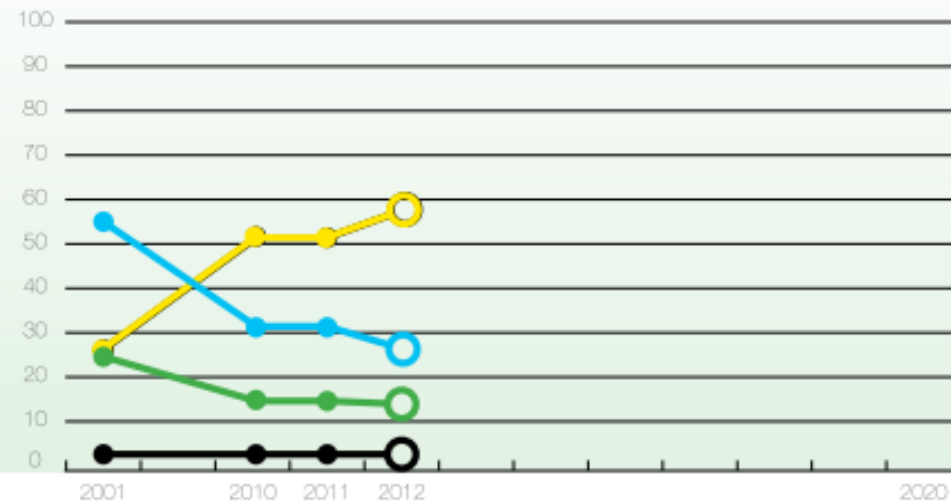
**22<sup>nd</sup> September, 2014**

Chennai

Challenges in influencing Process Safety  
Culture in Chlor-Alkali Industry

# A step in the right direction

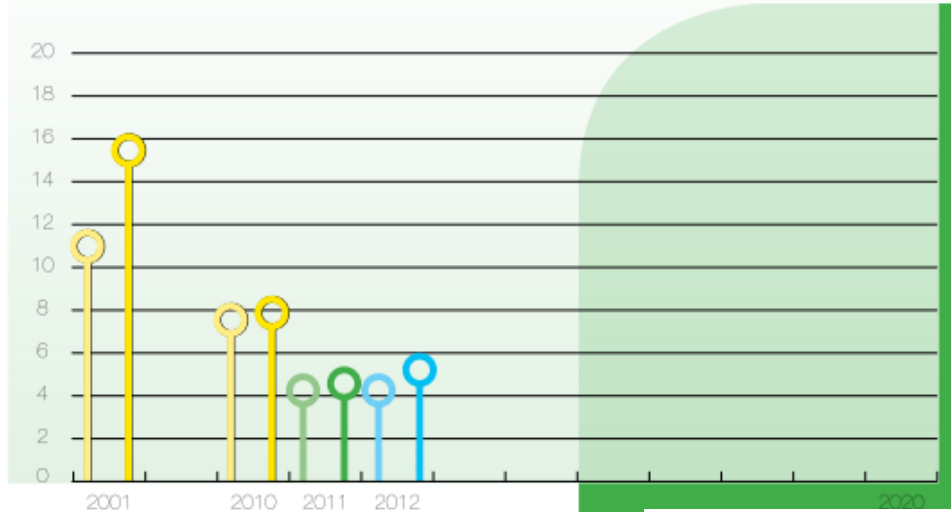
Chlorine manufacturing process  
(% of total installed capacity)



- Membrane
- Mercury
- Diaphragm
- Others

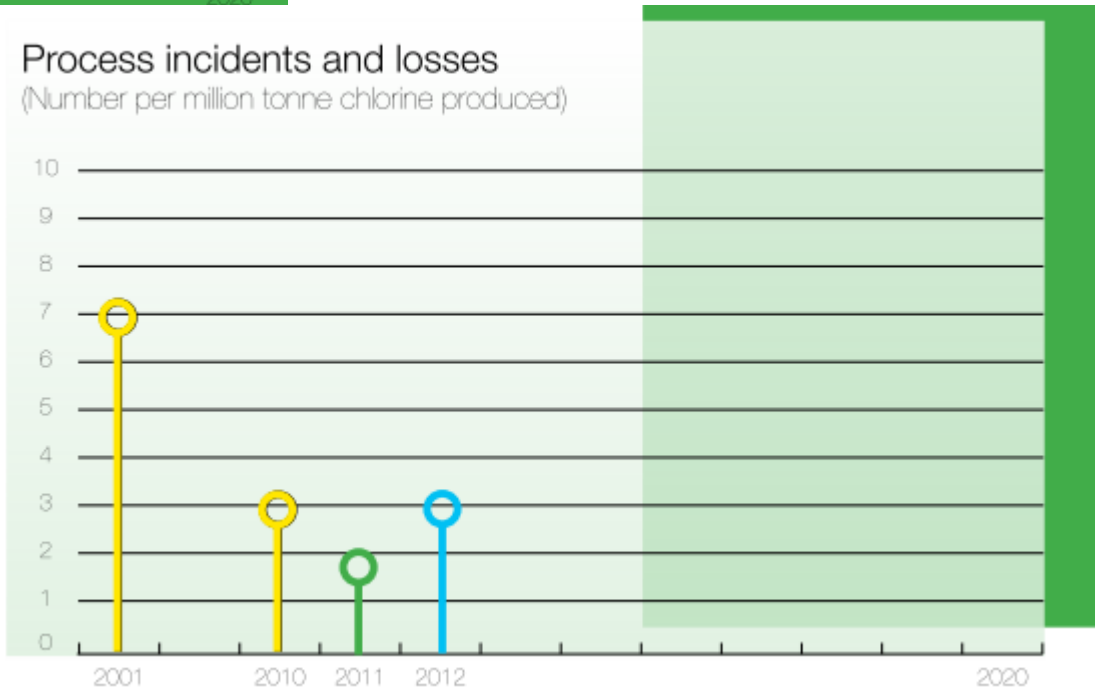
# LTI and PSI

### Chlor-alkali Lost Time Injuries frequency rate (number of LTI incidents per million working hours)



- Companies
- Contractors

### Process incidents and losses (Number per million tonne chlorine produced)



# Mumbai: More hazardous Chlorine cylinders found

Cities | Press Trust of India | Updated: July 25, 2010 10:45 IST



MUMBAI: The National Disaster Response Force (NDRF), which is undertaking neutralisation of chlorine gas from cylinders at Mumbai Port Trust (MPT) following the gas leakage incident, said 80 more hazardous gas cylinders were found in the MPT premises in south Mumbai.

Among the 136 cylinders lying untouched in the MPT since 13 years - one of which leaked on July 14 when over 120 fell sick after inhaling the gas - not only six but nearly 100 cylinders contained chlorine gas, the NDRF said.

It had claimed that among the 136 containers, only six cylinders contained gas and one of them had leaked.

"MPT officials told us that there are another 80 more cylinders, with small quantity hazardous gas, inside the premises.

Initially they said there were 136 cylinders and on week," Shahbuddin Ahmed, Assistant Commandant

"But now they say there are 80 more containers were added.



## Major accident averted due to chlorine gas leak from cylinder

Express news service Posted online: Sun Oct 20 2013, 02:57 hrs

**Chandigarh :** There was high tension in Sector 24 Saturday morning after chlorine gas leaked from a cylinder that was being ferried by a municipal corporation (MC) truck. The defective cylinder was being taken from Water Works department in Sector 12 to the corporation's treatment plant in Mohali Phase-11 to stop the leakage.

A small amount of leakage was observed when the cylinder was kept at the Water Works department. It was decided to transfer the cylinder to a treatment plant to stop the leakage. However, mid way near Park View hotel in Sector 24, the leakage increased significantly and a makeshift arrangement was made to diffuse the gas by digging a pit, filling it with water and submerging the cylinder in it. About 15 kg gas was left in the cylinder having a capacity of 90 kg, the police said.

The driver of the truck ferrying the cylinder had informed the police when he found that the leakage had increased. The police reached the spot along with three fire brigades, an ambulance and a bomb disposal squad.

The cylinder was submerged in water filled in a five-foot deep pit dug up nearby for the purpose. The pit was later covered with mud after the gas was completely diffused.

A few police personnel present at the spot suffered nausea and vomiting due to the gas leakage. Some of them were taken to Government Multi Speciality Hospital, Sector 16 for treatment.

The fire brigade first shot water at the cylinder to bring down its temperature. Then, five foot-deep pit was dug with the help of a JCB machine. The pit was filled with water and the cylinder was submerged in it to diffuse the gas. Meanwhile, the police blocked the traffic coming from both sides of the Sector 24/15 dividing road.

# 35 fall ill after chlorine gas leak in Orissa

All India | Press Trust of India | Updated: June 21, 2010 13:59 IST

BERHAMPUR, ORISSA: At least 35 people were taken ill, some of them fell unconscious, on Monday after chlorine gas leaked from a cylinder of urban water supply department here.

The affected persons included some school children, women and employees of the drinking water supply department.

"They were admitted to MKCG Medical College Hospital here and their condition has been improving," Sub-collector of Berhampur, Ajit Mishra told PTI.

The cylinder, procured from neighbouring Paralakhemundi division to purify water, leaked when someone allegedly tried to remove the brass nozzle, executive engineer of urban water supply (Berhan) Mohapatra said.

Locals complained of respiratory problem and leaves turning brown following the gas leak.

The district administration has ordered closure of all schools in the area and officials of the chlorine supplier have been informed, he said.

## Business Standard

### Chlor alkali industry volunteers to handle chlorine emergency

**All-India Chlorine Emergency Network, established by Alkali Manufacturers' Association of India (AMAI), aims to reduce losses due to accidental release of chlorine**

Rakesh Rao | Mumbai January 09, 2014 Last Updated at 17:37 IST

On 19 October, 2013, panic gripped Chandigarh when dysfunctional chlorine gas cylinders loaded on a truck started leaking profusely near Sector 15 and 24. Fortunately, there was no casualty, but many people had to be given preliminary treatment. Could accidents such as this be handled professionally to minimise the loss? Perhaps yes, had the police and concerned government officials knew about All-India Chlorine Emergency Network, a voluntary initiative started by Alkali Manufacturers' Association of India (AMAI) aimed to promptly respond to any emergency situation due to release of chlorine during its transportation and its usage at consumers' end.

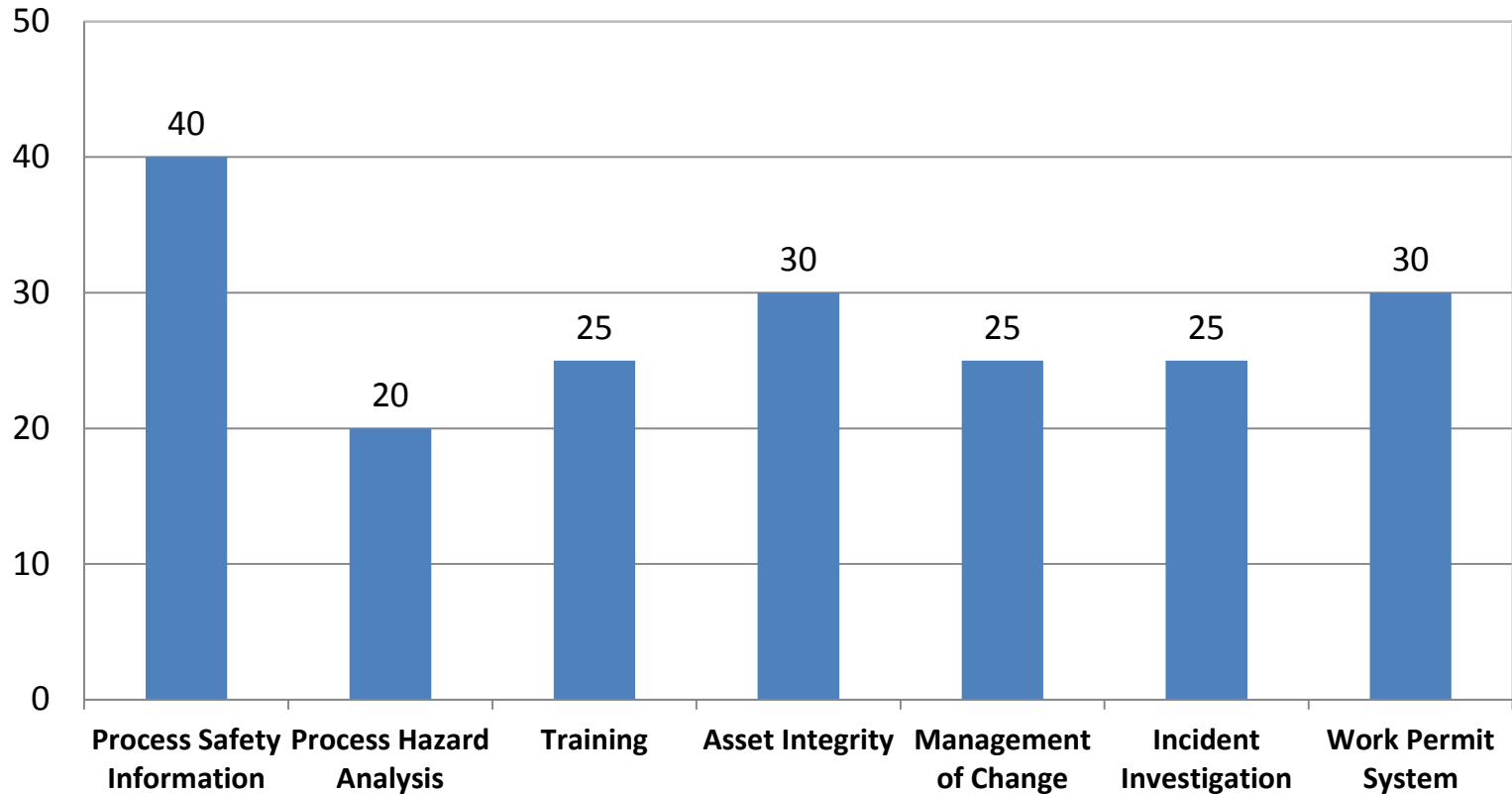
The chlorine emergency response network, which was initially implemented region-wise in May 2010, has been subsequently integrated on a nation-wide level in May 2012. Today, the network covers 32 chlor-alkali plants, and is functional in 20 states and three Union Territories all over India.

# Current Scenario in Chlor-Alkali Industries

- More focus on Chlorine safety
- Hazards of H<sub>2</sub> less understood
- Work permits issued > 300 / month
- MOC not followed in the facilities
- Breakdown maintenance Vs PM
- Electrical classification not conducted
- Process safety information not documented
- HAZOP – only PHA technique in chlor-alkali
- Safety training focused only on injury prevention



# % Compliance to OSHA PSM Requirements – Chlor Alkali



# Challenges in influencing Process Safety

## Challenges

PSM Guidelines

Lack of Training - PS  
Competency

Ageing Facilities

Unstructured Asset Integrity  
Program

MOC

Process Hazard Analysis

Work Permit System

Lack of Reporting Process  
Incidents



# OHSAS 18001 vs OSHA PSM Elements

## OHSAS 18001

4.2 OH&S Policy

4.3.1 Hazard Identification and Risk Control

4.3.2 Legal and other requirements

4.3.3. Objectives and Targets

4.4.1 Responsibility and Accountability

4.4.2 Training and Competency

4.4.3 Communication and Consultation

4.4.4 Documentation and Data Control

4.4.6 Operation Control

4.4.7 Emergency Preparedness and Response

4.5.1 Monitoring and measurement

4.5.2 Evaluation of Compliance

4.5.3 Incident Reporting and investigation

4.5.3 Internal Audits

4.5.4 Safety Records Management

4.6 Management Review

## OSHA PSM

1. Employee Participation

2. Process Safety Information

3. Process Hazard Analysis

4. Operating Procedures

5. Training

6. Contractors

7. Pre-Startup Safety Review

8. Mechanical Integrity

9. Hot Work Permit

10. Management of Change

11. Incident Investigation

12. Emergency Planning and Response

13. Compliance Audits

14. Trade Secrets

# PSM Guidelines

- PSM is not mandated by law in India
- Comprehensive PSM framework is not available for Chemical industries in India
- National level database on incidents and the lessons learned from incidents are not available
- System available for Oil & Gas industry - OISD GDN 206 - Guidelines on Safety Management System in Petroleum Industry



# Ageing Facilities: >30 Years

- Asset integrity, maintenance and inspection are important factors as plant ages
- Lack of critical process safety information in the older facilities
- Challenge of compiling the process safety documentation and reviewing Process Hazard Analysis studies for older facilities.

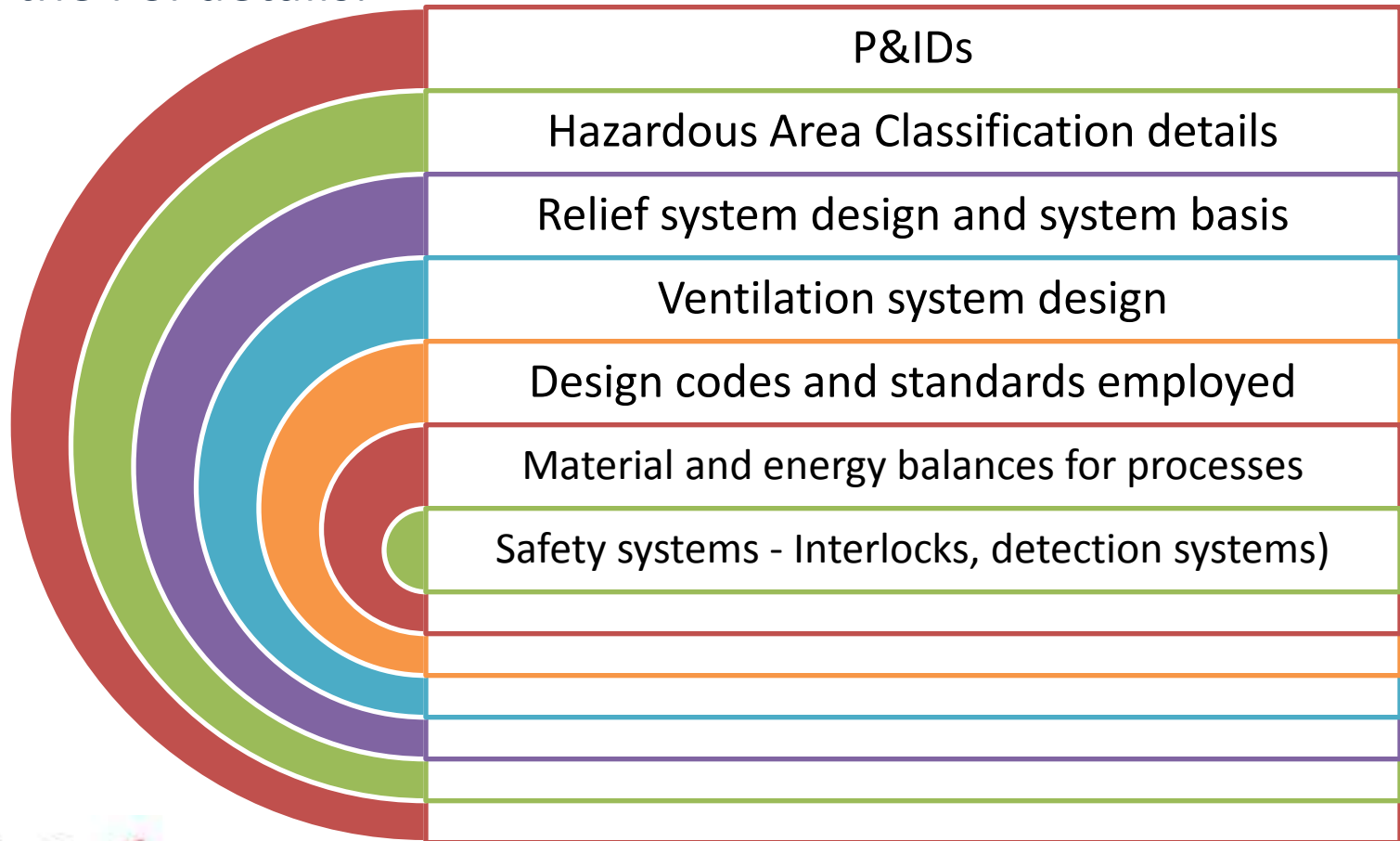
# Ageing Facilities: >30 Years...

- PSM is not integrated during design stage in Chemical industries (non-oil& gas).
- Lack of consideration on process safety factors / information during design stages
- Facility siting concerns were not adequately covered at the time of construction in older facilities.
- Difficulty in incorporating safety changes in design of package units (e.g. membrane cell technology)



# Process Safety Information - PSI

- No system to address the aspects related to most of the PSI details.



# Process Hazard Analysis - PHA

- PHA techniques not defined based on the processes
- Frequency of PHA study is not defined
- Lack of internal competency on PHA
- No documented system to follow up implementation status of PHA study recommendations

	Safety Review	Checklist	Relative Ranking	PHA	What-If	What-if/Checklist	HAZOP	FMEA	Fault Tree	Event Tree	CCA	HRA
Research & Development	○	○	●	●	●	○	○	○	○	○	○	○
Conceptual Design	○	●	●	●	●	●	○	○	○	○	○	○
Pilot Plant Operation	○	●	○	●	●	●	●	●	●	●	●	●
Detailed Engineering	○	●	○	●	●	●	●	●	●	●	●	●
Construction/Start-up	●	●	○	○	●	●	○	○	○	○	○	●
Routine Operation	●	●	○	○	●	●	●	●	●	●	●	●
Expansion or Modification	●	●	●	●	●	●	●	●	●	●	●	●
Incident Investigation	○	○	○	○	●	○	●	●	●	●	●	●
Decommissioning	●	●	○	○	●	●	○	○	○	○	○	○

○ Rarely used or inappropriate

● Commonly used

CCPS

# Process Hazard Analysis - PHA

- Difficulty in building internal competencies on various PHA techniques

PLANT	PHA TECHNIQUES				
	CHECKLIST	WHAT IF	FMEA	FTA	HAZOP
Brine Plant	✓	✓	✓	✓	✓
Cell House	✓	✓	✓	✓	✓
Hypo Plant	✓	✓	✓		✓
HCl Plant	✓	✓	✓	✓	✓
Concentration Plant	✓	✓	✓		✓
Lichlor	✓	✓	✓	✓	✓
Lichlor Filling		✓			
Hydrogen Bottling		✓			
Product Filling	✓	✓			
Boiler Circuit	✓	✓	✓		✓
DM water Plant	✓	✓	✓		✓
Cooling Tower Circuit	✓	✓			
Instrument Air Compressor Circuit	✓	✓			
Expansion/Modification	✓	✓	✓	✓	✓
Conceptual Design	✓	✓			
Detailed Engineering	✓	✓	✓	✓	✓
Construction/Start-up	✓	✓			

# Asset Integrity Program

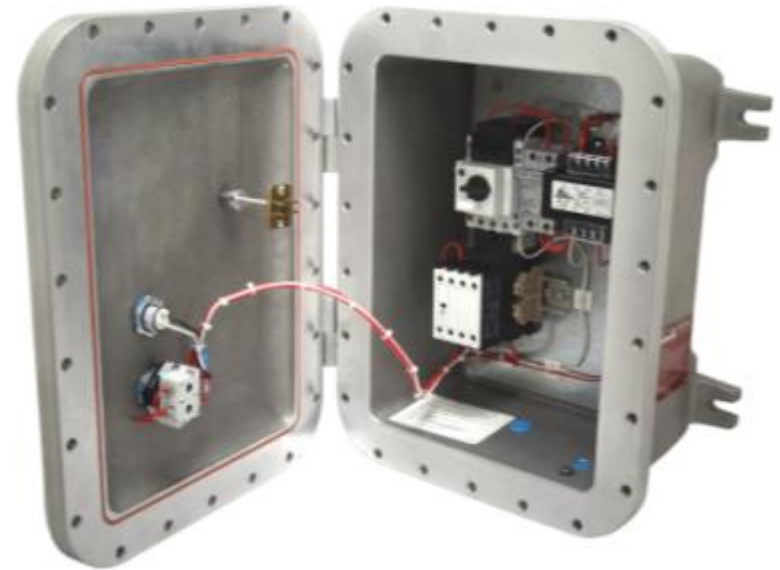
- Standards on inspection, testing and maintenance for its assets are not clearly defined.
- Static equipment integrity program not adhered
- Lack of comprehensive maintenance guidelines leading to *risk based* approach.





# Asset Integrity Program...

- Asset integrity performance indicators not derived.
- Maintenance of flame proof equipment – gaps exist
- No comprehensive Pipeline Integrity Program defined



# Management of Change (MoC)

- Inadequate understanding of the terminology change across the organization
- No clear differentiation between a temporary change and a permanent change
- Project activities are excluded from MOC process leading major layout and risk acceptability issues



# Management of Change (MoC)...

- One technique fits all approach leads to inadequate assessment of risk
- Lack of participative approach by various functions
- Documentation requirements are not fully understood and complied.



# Process Safety Training

- Constitutes only general safety aspects
- Training Need Identification is not focused on process safety skill mapping and enhancement
- Effectiveness of training program not ensured
- No formal refresher training conducted
- Contractor safety training = Induction

SAFETY EXCELLENCE =

$$\sum_{1}^{n} P_e + P_s + T_e \times \left[ \begin{array}{l} \text{Operational Risk} \\ \text{Design Risk} \end{array} \right]$$

Pe = People  
Ps = Process  
Te = Technology

The chalkboard image shows the equation above. The terms 'Operational Risk' and 'Design Risk' are enclosed in large square brackets. A horizontal line is drawn under 'Operational Risk'.

# Work Permit System

- Definition of hot work is not defined and permit authorities are not clearly defined.
- Procedures are not developed for work permit system and work planning is not documented.
- Job Safety Analysis (JSA) is not followed as part of the Work Permit System.

Electrical isolation



# Hot Work Permit...

- Permit validity is not defined and no shift change over procedure in place.
- Lack of responsibility and accountability for work permit.



# Incident Investigation

- Lack of participation of field level staff in reporting incidents
- Lack of understanding on what constitutes a process safety incident
- Lack of motivation on incident reporting



# Incident Investigation...

- Perception of being targeted if an incident is being reported
- Absence of adequate feedback mechanisms
- Transparency in sharing root cause between management team and field level staffs





# Incident Investigation...

- Process Safety Incident Threshold Values - CCPS

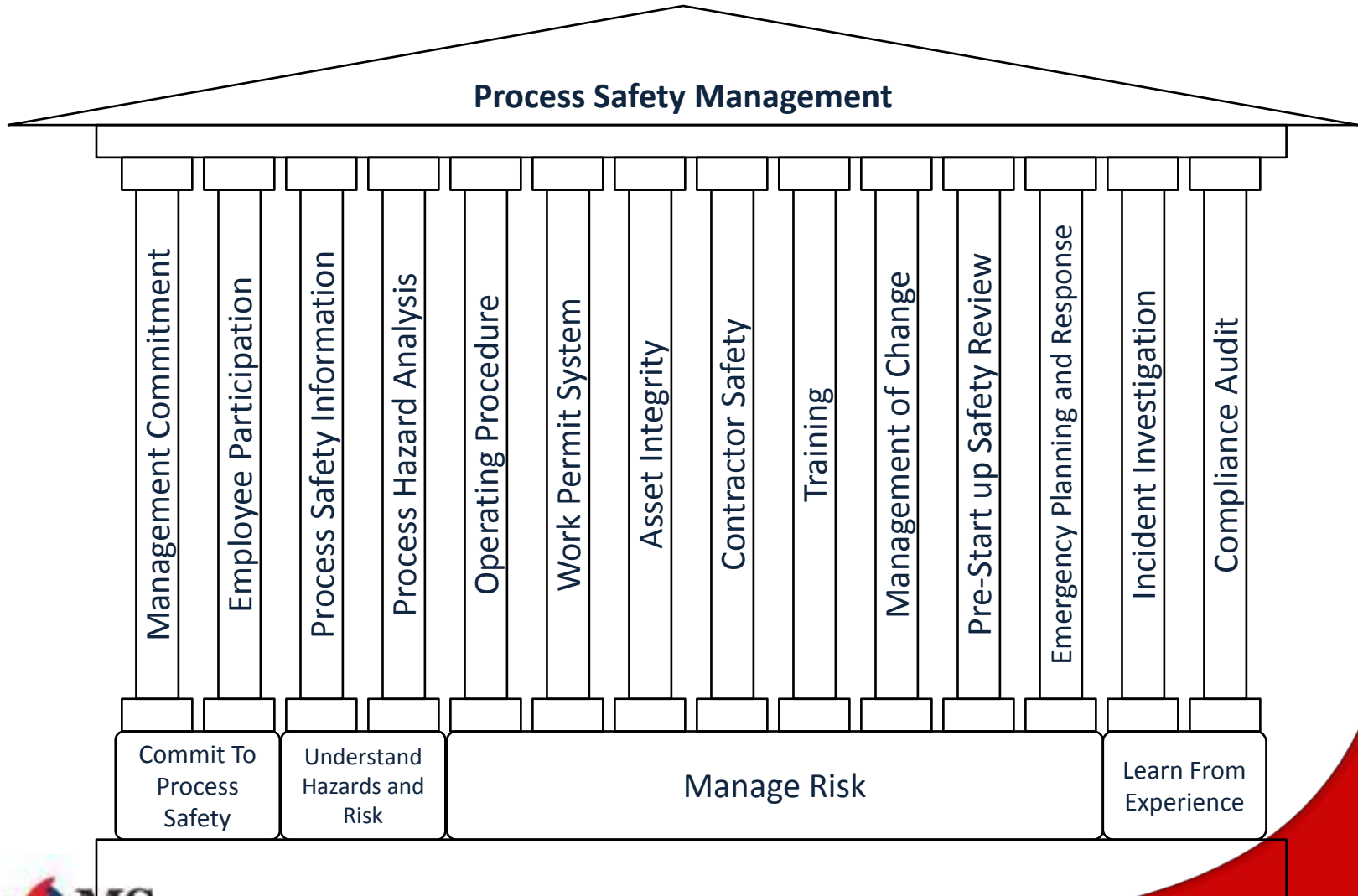
SNo	Material	Material Hazard Classification	Threshold Quantity
1	Liquid Chlorine	TIH Zone B Materials	25 kg
2	Hydrochloric Acid	TIH Zone C Materials	100 kg
3	Hydrogen Gas	Flammable Gases or Liquids with Initial Boiling Point $\leq$ 35 °C	500 kg
4	Caustic Soda Lye Sodium Hypochlorite Barium Sulphate	Nonflammable, Nontoxic Gases	2000 kg

# PSM Implementation

- The following activities are taken
  - PSM Gap Analysis (OSHA PSM)
  - Process safety perception survey among employees
  - PSM Framework (manual) based on CCPS –RBPS Elements



# PSM Implementation...



# PSM Implementation...

- Process Safety Policy
- PSM Committee
  - Core committee members – 16
  - Sub committee
    - Manager (1 member)
    - Engineers (2 members)
    - Technicians (3 members)
    - Total 70 members
- Training Modules for Top Management
- Training Modules for PSM Core Committee and Sub-Committee
- Training via Case Studies using CSB Videos

## Process Safety Policy

### operation & maintenance

The Management of Chemical Plants (M) is committed to

- ▶ Encourage **employee participation** in **gathering safety information** concerning the process chemicals, process technology, process equipment and performing **process hazard analysis** to identify potential hazards associated with processing and handling of highly hazardous chemicals in the facility for **continually improving the process safety** by minimizing the consequences of **unwanted process incidents**.
- ▶ Develop and implement **operating procedures** for phases including initial start-up, routine and non-routine activities and emergency operations.
- ▶ **Train our employees**, including maintenance and contractor employees on Process safety hazards and **rendering protection to all stakeholders**.
- ▶ Ensure **competency of contractors & train them** to perform tasks without compromising the process safety.
- ▶ Develop and implement process equipment **integrity maintenance** procedures that preserve the integrity of each piece of equipment and instrumentation, & **train personnel to perform this task as per standard**.
- ▶ Develop and implement **Management of change** procedure for all modifications to assess impact of change and implement control measures to ensure process safety.
- ▶ Develop and implement **Pre-Start up safety review** procedure for all new or modified processing/manufacturing plants/facility to ensure that there is no deviation from the original design intent.
- ▶ Conduct **Compliance audit** to review the effectiveness of all elements of the PSM system, including the policy.
- ▶ **Investigate all process related incidents** to identify root causes and implement recommendations to prevent/reduce the likelihood of recurrence of **similar incidents**.
- ▶ Develop and implement **Emergency preparedness and response** procedures for preventing and mitigating the impacts of **any emergency situation**.



# PSM Implementation...

- To give wide spread and publicise the PSM program amongst employees the following activities are initiated
  - PSM Mascot
  - PSM Newsletter



# PSM Implementation...

- On-site support for implementation of PSM (Handholding)
  - Element-wise workshop
  - Preparing the next plan of action
  - Development of PSM Element specific templates and procedures
  - Periodical review of procedures / records





*Thank You*

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## List of Chlor Alkali Plants in India

List of Chlor Alkali Plants in India			
<b>Andhra Pradesh</b>			
1	Rayalseema Alkalies & Allied Chemicals Ltd	Kurnool	92600 MTPA
<b>Gujarat</b>			
1	Gujrat Alkalies & Chemicals Ltd	Bharuch	116500 MTPA
2	Gujrat Alkalies & Chemicals Ltd	Vadodara	153500 MTPA
3	Shriram Alkali & Chemicals	Bharuch	62500 MTPA
4	Indian Rayon & Industries Ltd	Junagarh	37950 MTPA
			<b>370450 MTPA</b>
<b>Kerala</b>			
1	The Travancore- Cochin Chemicals Ltd	Kochi	52250 MTPA
<b>Madhya Pradesh</b>			
1	Grashim Industries Ltd	Nagda	108000 MTPA
<b>Orissa</b>			
1	Jayshree Chemicals Ltd	Ganjam	225000 MTPA
<b>Pondicherry</b>			
1	Chemfab Alkalies Ltd	Kalapet	38700 MTPA
<b>Punjab</b>			
1	Punjab Alkalies & Chemicals Ltd	Ropar	99000 MTPA
2	Siel Chemical Complex	Patiala	82500 MTPA
			<b>181500 MTPA</b>
<b>Rajasthan</b>			
1	Shriram Vinyl & Chemical Industries	Kota	39550 MTPA
<b>Tamil Nadu</b>			
1	DCW Ltd	Tuticorin	60000 MTPA
<b>Uttar Pradesh</b>			
1	Kanoria Chemicals & Industries Ltd	Sonebhadra	52000 MTPA
<b>West Bengal</b>			
1	Durgapur Chemicals Ltd	Burdwan	10050 MTPA
15	<b>India (15 Plants)</b>		<b>1250200 MTPA</b>

PSM Framework (manual) based on CCPS –  
RBPS Elements