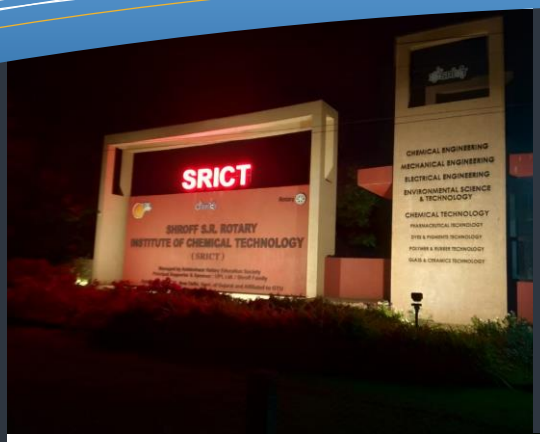
ISSUE 03 January 2021

BIMONTHLY NEWSLETTER ON PROCESS SAFETY

SAFEXCELLENCE



THIS ISSUE

Significant Accidents in November-December 2020

Fire at textile godown in Ahmedabad claims 12 lives.

People in periphery of around 5km of area from Ganeshnaga heard the six blasts as explosion occurred in a chemical processing unit on 4th Nov 2020 Piplaj-Pirana road in the Narol area where 12 persons including five women were either charred to death or died as they buried in debris of three collapsed industrial units

Two killed, Six injured in explosion at chemical factory in Raigad.

Two persons were killed and six others injured in an explosion on 5th Nov 2020 at a chemical factory in Maharashtra's Raigad district in the wee hours of Thursday, a police official said.

Fire at Tata Chemical in Mithapur

Fire broke out in coal storage unit of Tata Chemical Ltd's (TCL) factory on 8th Nov 2020 in Mithapur town of Devbhumi Dwarka district on Saturday afternoon. However, there were no reports of any casualties in the incident.

EDITORIAL

Dear Readers,

Greetings for the New Year!!

SAFEXCELLENCE family wishes you with a message, **"Work Safe, Stay Safe, Save others".**

"What else can be a better way to enter 2021 than by setting safety resolutions for the year 2021".

SAFEXCELLENCE suggests a few safety resolutions below, for our esteemed readers.

1. **First Resolution: Learn from the past**

COVID-19 taught us important lessons. The unprecedented shutdowns caused many organizations stumbled and forced to quickly modify their business models.

Resolve this year to put a pandemic plan into place that guarantees your survival if your organisation is faced with another unprecedented situation.

2. **Second Resolution: Adjust to a new normal**

Resolve to make new adjustments to thrive within the new normal. Alter safety in the workplace. Add new protocols for keeping the workplace clean and tidy. Modify policies and procedures that are aimed at keeping employees safe. Continue exploring new ways to keep all operations remain safe despite of any pandemic.

3. **Third Resolution: Revitalize your Safety Program**

Resolve to give your organisation's safety program a new face. Review the health, safety and environment policies, procedures, and processes. New year beginning is the time to identify the deficiencies and make improvements.

4. **Fourth resolution: Motivate your employees for 'Joint Health Safety Environment Committee (JHSEC)'.**

Resolve this year to ensure that your JHSEC is motivated and operating at peak efficiency, by setting goals, offering following incentives.

- Lower injury and illness rates in the workplace, resulting in less lost time.
- A more positive safety culture, resulting in proactive safety initiatives and programs.
- Happier and healthier workers with better productivity rates.

5. **Fifth resolution: Never Stop Learning**

Resolve that employees taking requisite training, to keep them compliant, safe and well at work.

This issue brings you the activities conducted by SRICT-CoE, articles related to process safety, Bhopal gas tragedy after 36 years, accidents in Nov-Dec 20 and the certified training courses & services offered. SRICT-CoE is committed to start many-more programs on process safety, shortly.

All the best.

GEXCON UPL SRICT

Fire breaks out at Chemical factory in Bengaluru

A godown, where around 1,800 cans of chemicals used to manufacture sanitisers and paint thinners were stored, caught fire on 11th Nov 2020 around 11 a.m. in Bapuji Nagar. It took 200 Fire Services personnel and 15 tenders over eight hours to bring the blaze under control.

Major fire at chemical company in Raigad, no casualty

A major fire broke out at Sudarshan Chemical Company in Dhatav Industrial Estate of Dhatav MIDC in Roha of Raigad district around midnight on 12th Nov 2020.

One killed, 15 hurt in Bhushan Steel mishap

A deadly fire accident at the blast furnace no. 2 of Bhushan Steel plant at Meramudali in Dhenkanal has killed at least one person and injured 15 others, many of them seriously on 13th Nov 2020.

Dai-ichi Karkaria intimates of fire incident at Dahej factory

A fire incident took place at one of the plant in Dahej factory of Dai-ichi Karkaria Ltd. on 21st Nov 2020. There was no loss or injury to human life.

CoE ACTIVITIES

FLACS-CFD V.20 x TRAINING PROGRAM

FLACS V.20 x is the latest version of 3D-CFD advanced tool that performs engineering calculations to predict reliable consequences of Fire, explosion & dispersion scenarios**. Dr. Franz Zdravitsch (Principal Engineer / Chief Training Officer, Gexcon)** conducted an online hand on training for the CoE members of SRICT who have successfully completed the FLACS V.20 x - Software training. These certified members are **NOW** available at SRICT to carryout 3D Consequence Analysis Study for any hazardous scenario, having potential of fire, dispersion and explosion.

PROCESS HAZARD ANALYSIS (PHA) SESSION FOR CoE MEMBERS

(Mr. Amol Lakare, UPL Ltd.)

(SRICT-GEXCON-UPL CoE Members)

(Mr. Pratik Shinde, Gexcon India)

The CoE members received an introductory session on **Process Hazard Analysis (PHA).** The session included introduction to **Quantitative Risk Assessment (QRA), Hazard Identification (HAZID), Hazard Operability Study (HAZOP), Hazard Area Classification (HAC) and BOW TIE Analysis (BTA).** It was jointly Conducted by **Mr. Amol Lakare (Process Safety Manger, UPL Ltd.)** and **Mr. Pratik Shinde (Business Development Manager, Gexcon India).**

GEXCON UPL SRICT

Fireman from Ambernath dies while combating chemical fire in Taloja

Fireman was died on 5th Dec 2020 during the fire fighting operation after inhaling the toxic fumes emanating from Mody Chemi-Pharma Pvt Ltd , which was on fire.

One dead, three rescued in Himachal Pradesh factory fire

One person died and three have been rescued so far in the fire incident which broke out at a factory in Baddi industrial area of Solan district on 7th Dec 2020 morning.

Major fire breaks out in Vatva GIDC, 3 chemical units shut

On 10th Dec 2020 at Matangi Industries, a chemical factory at Vatva GIDC phase-2 area near Vatva Vinzol railway crossing. It soon spread to two adjacent factories — Jagson Colorchem Limited and Bhavin Industries, officials said.

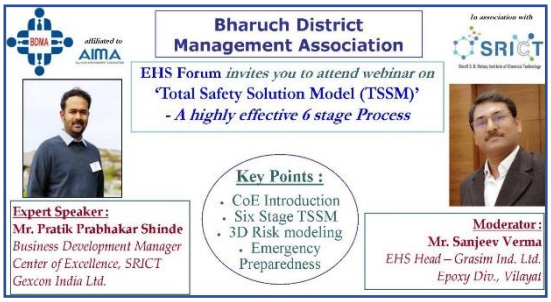
8 injured in massive fire accident at pharma company in Sangareddy

Ten persons sustained serious injuries in a massive blast in a pharmaceutical company on 12th Dec 2020 at IDA Bollaram in Sangareddy district. Due to the heavy intensity of the blast, fire spread all over Vindhya Organics Limited within no time.

MoU Signed Between DISH , Government of Gujarat and UPL CoE at SRICT

MoU has been Signed between Directorate of Industrial Safety and Health (DISH), Government of Gujarat and UPL Centre of Excellence for Safety Studies (CoE) at Shroff SR Rotary Institute of Chemical Technology (SRICT) MoU has been signed on 16th December 2020 at Gandhinagar by Mr. P. M. Shah ,Director of DISH and Mr. Ashok Panjwani, Vice Chairman of SRICT in presence of Mr. Vipul Mitra, IAS, Additional Chief Secretary, Labour and Employment, Government of Gujarat. As per MoU, CoE will undertake the work of generating an Accident Reporting System which will be unique in the country to provide any information related to fatal accidents in the state of Gujarat on a single click. This will help create a data / information system for Root Cause Analysis and Corrective & Prevention Action on a single click for Industrial fraternity which would help dramatically reduce accidents in industry in the state of Gujarat. The said system is being developed on Public Private Partnership model.

Introduction of CoE -TSS Model to Authorities



On 28th November 2020, BDMA Organised a Webinar for EHS Forums and Gujrat State Chemical industries, Mr. Pratik Shinde was invited as an Expert Speaker to represent SRICT- CoE TSS Model and 3D Consequence Modeling.

On 5th November 2020, Mr. Pratik Shinde delivered an introductory session on SRICT- CoE TSS model and 3D Consequence Modeling to Disaster Prevention & Management Centre (DPMC), Ankleshwar.

Mr. Govind K. Patil and **Mr. Pratik Shinde** delivered a session to Ahmedabad Chemical Industries Cluster on introduction, services and Certifying Process Safety Courses offered by SRICT- CoE.

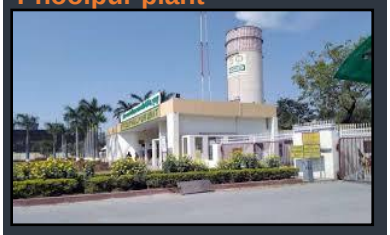
One killed, two injured and houses destroyed in a gas pipeline blast, Gujarat

A blast at a gas pipeline in Gujarat's Gandhinagar has killed one person and injured two others early on 22nd Dec 2020.

Fire in Vadodara chemical unit triggers panic

A major fire broke out in a company making a series of chemicals at Popatpura near Godhra on 22nd Dec 2020. Residents of nearby villages had to vacate their homes as a series of explosions were heard along with the fire. The fire broke out at around 11.30am at Kusa Chemicals Pvt Ltd's plant one where it manufactures lubricant oil additives.

Two dead after Ammonia gas leak at IFFCO's Phoolpur plant



At least two officers of the Indian Farmers Fertilizer Cooperative Limited lost their lives in Prayagraj, Uttar Pradesh while at least 15 others are undergoing treatment at a city hospital following an Ammonia gas leak at the Phulpur-based IFFCO plant on 23rd Dec 2020 around midnight.

PROCESS SAFETY MANAGEMENT – HUMAN FACTOR

Conduct of Operation and operational discipline (COO-OD) is one of key elements of Process Safety Management (PSM) that explains human factor.

A Case of Sleeping Workers: COO-OD can help resolving this issue by implementing the key attributes. – (Part I)

My industrialist friend looked disturbed discussing about workers sleeping at workplace during night shift, in his organisation. I was wondering whether PSM elements can be of any assistance to resolve this problem faced by most of the industries where night shift operations are involved. I found the HUMAN FACTOR element very close to this subject which I explored further to deal with this subject.

Workers in chemical companies are constant variables that just aren't going to change and are needed to work in the night also. it can take fatigued workers longer to react when something unexpected happens, and their judgment is impeded. Problem solving processes are disrupted due to lack of focussing and their spatial orientations are skewed.

What's An Employer To Do?

The key is individualized education that aligns with each person's own personal sleep and health goals. When individuals can personally experience the positive effects of sufficient sleep off the workplace, the buy-in becomes immediately apparent. This will benefit the organisation with increased workplace safety. Conscientious employers can engage in "Incident Analysis," investigating "near misses and accidents to determine the role, if any, of fatigue as a root cause or contributing cause to the incident". If the employer effectively implements COO, workers on duty will not sleep.

1. COO- FOUNDATIONS

Without understanding the significance of risk, the COO system can deteriorate to the point where leaders enforce policies simply because they exist.

1.1. Understand Risk Significance

Risk understanding starts with hazard identification. Analysing these risks determine whether existing safeguards are adequate. Recommendations appropriate process changes, additional safeguards, or improvements to existing safeguards that significantly impact risk. COO system ensures implementation of PHA, re-identifying hazards and carrying out risk analysis studies over the life cycle of the process.

1.2. Establish Standards

Standards allow an organization to continuously evaluate individual and organizational performance against a fixed bar, and helps provide early warning, if performance appears to be slipping. Some examples of standards;

- Processes are not intentionally operated outside of established operating limits, and if they are outside of established limits, prescribed actions are followed.
- Limiting conditions for operation (LCOs) are observed, and if an LCOs is not met, the activity is not started, or the process is promptly brought to a prescribed safe/stable state.
- Decisions to defer maintenance, training, and other periodic activities are based on risk, not on budgets or resource availability.

1.3. Ensure Competency

Process safety incidents often involve a lack of hazard awareness, failure to communicate information to key personnel, or organizational changes that cause the entire organization to forget what it previously knew. High-performing organizations continuously learn, freely and regularly share information with key personnel, and remember the lessons they have learned. Knowledge is treated as a valuable corporate asset. Have designated technology guardians who will maintain and advance the knowledge in their subject area, share the information with people who need it, and document the information in a manner that it will survive and continue.

1.4. Take Corrective Actions

“Weak Signals” (that often precede loss events) and periodic management reviews (that self-examine the performance), both seek to learn from the past so that real corrections can be made.

2. COO- PEOPLE

Human errors are differences between acceptable and actual behaviour or performance. They can result from

- Workers receiving incomplete, inaccurate, or conflicting written or oral instructions (or muddled communications)
- Failure to provide adequate training or work environments, and/or
- Structural breakdowns such as failure to detect and address worker fatigue or fitness for duty.

COO strives to promote high levels of human reliability.

2.1. Clear Authority / Accountability

Some organizational changes are poorly managed, and some important responsibilities are not reallocated, allowing critical PSM activities to languish. In other cases, supervisory positions are eliminated, leaving members of self-managed work groups unclear about their authority, accountabilities, or responsibilities. Conflicting instructions will lead to frustration and maybe to incidents. Staff personnel should work through the line of authority. During an emergency, the operations group typically turns over control of a facility to the incident commander. A policy needs to be established regarding control of assets whenever they are shut down, de-inventoried, prepared for maintenance, repaired, and subsequently returned to service. Any task that is assigned to "all of us" and can be done by "any of us" is most often done by "none of us." It simply never gets done. Accountability flows upward as well as downward. Effective leaders proactively track the progress of important activities, invest their time in face-to-face meetings to review progress and discuss concerns, and help remove roadblocks. "If anyone fails, we all fail" should be the message for completing any task.

2.2. Communications

Any activity that involves the coordinated activities of multiple people depends on effective communication. COO focuses on ways to minimize errors involving each of the four elements.
Examples:

- Using structured protocols, checklists, and logs to supplement written instructions
- Preceding special or nonroutine activities with a pre-job briefing for the entire work crew and a field walkdown by people with appropriate knowledge/experience.
- Developing a management system that triggers routine review of the current night orders, forcing their cancellation or incorporation into standard procedures or policies.
- Keeping a record of the unexpected events, even when no loss event occurs.

2.3. Training and Individual Competence

A high degree of hardware redundancy can minimize the frequency or consequence of single component failures; however, human error can account for over 90% of system failures. Effective training, based on initial training needs, at right time, verification of trainee performance, refresher training, can reduce the human errors to great extent. Training should reinforce process limits and limiting conditions of operations (LCOs); and, regardless of one's knowledge, these limits should not be intentionally breached. A thorough understanding of the process is a precondition for "thoughtful compliance,".

2.4. Compliance With Policies and Procedures

Compliance with procedures helps ensure quality, overall reliability, and organizational effectiveness. When improvements are suggested to procedures, policies, or practices, a formal MOC system is used to evaluate the suggestions. The scope of the review includes both normal/anticipated conditions and credible abnormal conditions. Management and supervision diligently ensure that improved outcomes are not based on shortcuts or unauthorized modifications to established procedures, policies, and practices.

2.5. Safe & Productive Work Environment

Good housekeeping of the plant is the first impression. A clean and organized facility is safe & efficient. 5S approach fits into COO program. Maintaining a safe and productive work environment should be the minimum expectation from operating staff.

2.6. Intolerance of Deviations

Situations like operating processes outside of established limits or operating equipment with safety systems out of service, involves the loss of a layer of protection, which can result into catastrophic consequences. An effective COO system will help establish an organizational culture that refuses to tolerate deviations and where workers hold peers accountable for adhering to policies, procedures, and standards. A critical step in promoting intolerance of deviations is to make the standards very clear.

2.7. Assigning Qualified Workers

New hires (and reassigned workers) should have the basic aptitude and education needed for their new position. Workers become qualified through training, experience, oversight, and corrective feedback. Workers vary in their ability to absorb certain concepts, and some are better able to perform certain skill -based tasks than others. These inherent differences should be used to the work group's advantage. In addition, specific qualifications are required in some jurisdictions for performing certain activities, such as welding. Placing highly motivated but unqualified workers in a hazardous situation is a recipe for disaster. Turning knowledge-based activities into rule-based procedures or skill-based habits typically improves human reliability.

2.8. Routines Worker Fatigue/Fitness For Duty

Impaired, ill health, distraction due to personal issues and mental state or fatigue worker should be moved out to safe location as they influence factors like fitness for duty. Protocol should be clear for inattentive worker (includes taking nap or sleeping) or remaining absent from workplace. Policies for overtime, working without a day-off, substance abuse prevention, employee's personal assistance program should be implemented and known to the workers.

3. COO- PROCESS

Processes need to be stable and controllable by operating team under all expected conditions and transitions. The safety margin should allow for some level of human error and machine failure.

3.1. Process Capability

Human performance is variable, and it is unfair to expect the average worker to control a process that will only remain safe in the hands of an expert operator who performs flawlessly. The process should be capable of safe operation by the least qualified operator. An inherently unstable process places unusually high demands on operators to maintain control, sometimes requiring very quick decisions, precise adjustments, or unusual actions in response to upset conditions. Process industries should strive to develop processes that are fault tolerant - processes that will operate safely and under control even if one or more systems fail or the operator makes an error.

3.2. Safe Operating Limits

Procedures should clearly state the limits, specify the actions to take to avoid exceeding the limits and dictate the response to a process that is outside of the established safe limits. Except under extraordinary conditions, operation outside of prescribed limits should be unacceptable. Prioritization of emergency response actions should be thought through well in advance.

3.3. Limiting Conditions For Operation (LCOs)

LCOs apply when a safety system has been deemed so important that continued operation (or at least certain activities) is prohibited when the system is not available. LCOs might include flares, scrubbers, fire-detection and suppression systems, emergency cooling, and a host of other systems that mitigate the effects of a release of process materials. If minimum staffing/qualification requirements cannot be met, the activity is not started. Some LCOs apply to non routine activities for **Example:**

- Hot work is not authorized when sprinklers and other fire-protection systems are out of service.

- Confined space entry is not permitted unless there is a sufficient number of trained emergency response personnel on site to conduct a confined space rescue.
- Nonessential personnel are not allowed in a unit, or adjacent units, during start up.

4. COO -PLANT

Maintaining equipment to be fit for service is as important as the attention paid to the people and process aspects of COO.

4.1. Asset Ownership/ Control of Equipment.

Ensure that there is a clear "owner" at all times. In addition, it sets out standards for monitoring and controlling equipment.

4.2. Equipment Monitoring and Maintenance Control.

For a successful COO system, proactive maintenance to reactive one is the logical choice for most components. However, regardless of the maintenance strategy, monitoring process conditions and equipment is an important duty within COO. Equipment monitoring cannot always be left solely to the field operator's five senses. Some critical operating parameters, such as vibration and small flange and packing leaks, can only be reliably detected with electronic sensors. Maintenance work needs to be controlled at multiple levels. Sometimes, it becomes a joint responsibility, with independent overlapping safeguards embedded in operating, safe work, and maintenance procedures.

Understanding that errors can lead to unacceptable consequences, verification becomes the norm, example; adding oil in a car without verifying the level by dip stick is unacceptable. If human errors and the resulting incidents are deemed unavoidable, the facility will sustain a much higher number of incidents.

4.3. Management of Subtle Changes

Ongoing operations often introduce subtle changes for continuously improving machine parts and materials or sometimes making changes to reduce costs that actually degrade quality. Sometimes, these improvements can increase the risk of equipment failure or other process hazards.

4.4. Maintaining Capability of Safety System

Failure to maintain the capability of backup or safety systems causes unreliable operation and at worst the final failure in a chain of events that lead to disaster. Too often, this intent is defeated when these systems are not maintained At times, the safety systems trip spuriously, leaving the facility to decide whether to impair or bypass the system, or to leave the process down pending repair. In many cases, and for a variety of good reasons, these systems are bypassed for a period of time It should not be an easy ask to override or impair safety systems. These activities should require formal written requests for a temporary change; authorization for a short period of time; and, preferably, special tools, keys, or passwords for execution. If a system can be easily overridden by the team assigned to operate the facility, the COO/OD system will be challenged to ensure that overrides do not become a common practice.

5. MANAGEMENT SYSTEMS

COO cannot be separated from organizational culture, particularly in the areas of leadership, empowerment, communication, learning, timely response and monitoring of performance. The margin of safety at a facility quickly erodes once management stops taking an interest in the conditions and programs necessary to support safe operation.

5.1. Related Programs.

A high level of compliance with procedures is an indicator of lower risk, assuming, of course, that the procedures accurately describe how to do the task.

5.2. Necessary Conditions

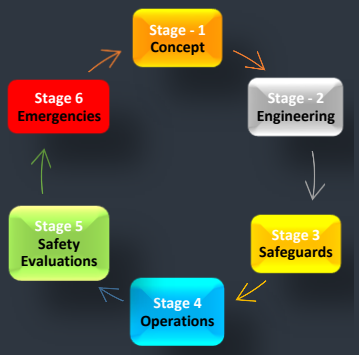
COO provides opportunities to measure conformance to a standard, thereby tracking early warning of increasing risk for examples; number of incidents due to lack of training, number of non-routine and emergency work-orders or unplanned shutdowns, percentage of overtime hours, number of unplanned safety system activations for valid and/or for invalid reasons, number of PHA recommendations balance, etc.

An efficient team carries out process hazard analysis (PHA) and identify critical hazards, however, without the management commitment to resolve the PHA team's recommendations in a timely and effective manner, little good comes from the effort.

Understanding the key attributes of COO, few tips suggested to resolve sleeping issues:

- Mark the individual ‘habitual sleepers.
- Study the processes they handle, identify the process hazards. Understand the risk significance.
- Carryout LOPA and determine additional safeguards if existing safeguards are not sufficient.
- Publish the protocol that includes ‘sleeping on duty is considered as intolerance of deviation’ & communicate.
- If the risk tolerance, initial and mitigative risk frequencies of the scenario/s high, then appoint a competent person for the job. Ensure he is adequately trained in understanding the process hazards, their consequences and severity, actions required during process upsets conditions and emergency procedures.
- Attempt to resolve his workplace related, personal (psychological), health or family problems, if any.
- Take stepwise actions like; taking photograph, making to agree and accept the fault, counsel & give hint for the future penalties, communicate the risk significance for not remaining attentive, issuing a warning letter, cutting the wages, temporary discontinuation, etc, etc.
- Create a safe work culture. Induce employee participation and motivate them. Take the feedback.
- Review the COO system on regular basis and improve.

CoE - TOTAL SAFETY SOLUTION MODEL (TSSM)



STAGE-1: CONCEPT

- Inherently Safety Review
- Design Basis
- Chemical Compatibility
- Layout & Plot Plan
- Process Flow Diagram
- Process & Instrument Diagram
- Process Description
- Material Safety Data Sheet

STAGE – 2: ENGINEERING

- Equipment Engineering Details
- What If Analysis
- Hazard Identification (HAZID)
- Hazard and Operability (HAZOP)
- Hazardous Area Classification (HAC)
- Process & Instrument Diagram (P&ID)
- Quantitative Risk Assessment & Facility Siting (QRA)

STAGE – 3: SAFEGUARDS

- LOPA – SIL
- 3D Consequence Analysis

STAGE – 4: OPERATIONS

- Operating Procedures (SOPs -Check Sheets)
- Safe Working Practices
- Management of Change
- Asset Integrity Management
- Pre-Start up Safety Review Training
- Conduct of Operations (Human Behavior)

STAGE – 5: SAFETY EVALUATIONS

- What if – Checklist
- Failure Modes & Effect
- Analysis (FMEA)
- Fault Tree Analysis
- Event Tree Analysis
- Cause & Consequence with Bow Tie

STAGE – 6: EMERGENCIES

- Pre-Incident Plan (PIP)
- Scenario Video
- Rescue Team
- 3D – Animations – Virtual Reality Based Training

ACCIDENTS STATISTICS IN INDIA (NOVEMBER - DECEMBER 2020) & PROBABLE ROOT CAUSES, ATTRIBUTED TO PSM ELEMENTS

SAFEXCELLENCE team collects information on industrial accidents that are taking place in India, using published news information sources and collate to create data, analyses the available data & assesses the probable root causes. The data of the months Nov-Dec'20 shows 14 reportable accidents. Though the monstrous and incredible numbers are frightening, the causes are attributed to PSM elements as shown in the table below. Our readers are advised to implement PSM/ TSS model, being offered by SRICT-CoE in their organisation to ensure the process safety.

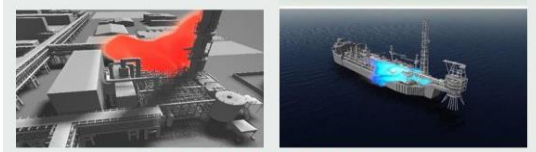
ACCIDENTS	PSM MISSING ELEMENTS																
Fire – Ahmedabad Textile Godown	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Explosion – Raigad Chemical Factory	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – TATA Chemical	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire - Chemical factory, Bengaluru	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Major fire at Chemical Company, Raigad	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Explosion – Bhushan Steel	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Daichi Karkaria	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Taloja Chemical Factory	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Himachal Pradesh Factory	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Chemical Units, Vatva GIDC.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Pharma Company, Sangareddy	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Explosion – Pipeline blast, Gujarat	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Fire – Vadodara Chemical Unit	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17
Ammonia gas leak – IFFCO's	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17

CoE ADVANCED SERVICES

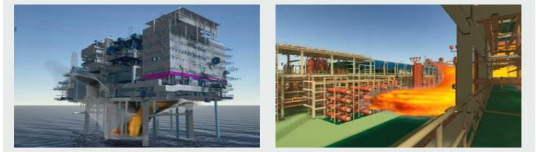
3D CONSEQUENCE ANALYSIS

The major objective of implementing the Process Safety during design stage is to identify locations that could expose employees, environment and property to serious hazards. 3D Consequence modelling refers to the calculation or estimation of numerical values (or graphical representations of these) that describe the credible physical outcomes of loss of containment scenarios involving flammable, explosive and toxic materials with respect to their potential impact on people, assets, or safety functions.

Gas and Dust Explosion Modelling



Dispersion Modelling



Fire and Smoke Modelling

VIRTUAL REALITY (VR) SAFETY TRAINING

3D based VR Safety Training is an advanced technology used by many countries worldwide to experience hazards related to gas dispersion, liquid release (pools), fire and gas explosions in industrial environments. The VR based Safety Training is realistic CFD based dispersion, fire and explosion simulations in a virtual reality environment using head mounted display (HMD). The main application area for a 3D based VR Safety Training is to enhance risk awareness and improve emergency response through education / training in a virtual reality environment as a replacement to traditional book-based education and real practical training.

GEXCON UPL SRICT

REVISITING BHOPAL GAS TRAGEDY – THE AGONY CONTINUES EVEN AFTER 36 YEARS!!

THE INCIDENT HISTORY

Early morning **December 3, 1984**, tons of the dangerous gas **Methyl Isocyanate (MIC)** escaped from an insecticide plant that was owned by the firm Union Carbide Corporation - Bhopal. The gas drifted over the densely populated neighbourhoods around the plant, killing thousands of people immediately and creating a panic as tens of thousands of others attempted to flee Bhopal. **The final death toll was estimated to be between 15,000 and 20,000**. Some half a million survivors suffered respiratory problems, eye irritation or blindness, and other maladies resulting from exposure to the toxic gas.

ANAYSIS OF FAILURES, ANTECEDENTS, LINKING TO PSM STANDARDS AND LEARNING

Though the immediate cause has never been determined with certainty, many events contributed to the release. Hazardous antecedent conditions and proximate failures occurred both inside and outside the company amplified the consequences to more severe. List of significant failures/antecedents is given below, indicating the areas of PSM elements in which they fall.

Sr.no.	Area of PSM Elements	Failures / Antecedents
1	Management Commitment	• Lack of investment in the plant safety • Cut back in operating and maintenance personnel • Cost cutting • Ignorant of hazards associated with plants • Insufficient Scrubber capacity
2	Hazard Identification and Risk Assessment	• No automatic sensors to warn temperature increase • No online detectors, monitors for MIC tank • No indicator for monitoring of position of valves in C/R
3	Operational	• Lack of tank refrigerant coolant (chillers shutdown) • Vent scrubber out of service+ caustic lye strength not maintained • Vent-pipe leading to flare was dismantled for repairs • Water spray lacked sufficient pressure to douse the gases at height • Partly leaking isolation valve • Omission of insert a slip plate where required • A remotely operated valve being open while it should have been shut • Faulty pipe washing procedure • Contaminants in the MIC tank • Lack of on-sight emergency/crisis management plans
4	Learning	• Operational Safety Survey (OSS) recommendations not implemented

(PSM Elements Reference : Safexcellence)

Haphazard urbanisation with dense population around the plant who were unaware and thus unprepared, lack of infrastructure (like; scarcity of water, no sewage treatment system, frequent electrical power cuts, no adequate medical facility) are some of the notable causes outside the company.

LEARNING: Our readers can take the benefit of this information and take effective steps to ensure no incident takes place due to the causes stated in the table above.

SUPPLIMENT POINTS AFTER 36 YEARS:

- A report released in April 2019, by International Labour Organization (ILO) dubbed the 1984 Bhopal Gas Tragedy as one among the world's 'major industrial accidents' of the 20th century.
- The Highly Toxic **Methyl Isocyanate (MIC)** gas can cause death within minutes of inhalation if its concentration exceeds 21 ppm (parts per million).
- "The National Library of Medicine, USA has recently collated health effects of MIC and diseases caused as a result of exposure to MIC. They have established that Hyperglycemia (Diabetes), Uremia (kidney diseases), Pulmonary fibrosis, lung diseases, blindness, cancer, immune & neurological disorders and acidosis are associated with the long-term damage caused by it".
- Survivors, their children and grandchildren are struggling with chronic health problems as a result of the leak and toxic waste left behind.
- A preliminary study ''Assessment and Remediation of Hazardous Waste Contaminated Areas in and around M/s Union Carbide India Ltd., Bhopal'', conducted by the National Environmental Engineering Research Institute (NEERI) and the National Geophysical Research Institute (NGRI) shows that "The total quantum of contaminated soil requiring remediation amounts to 11,00,000 MT".
- According to the health department official record, the Covid-19 death rate is 6.5 times higher among the gas exposed population of the Bhopal district.
- A cabinet minister holding portfolio as Minister for 'Bhopal Gas Tragedy Relief and Rehabilitation'. The matter of compensation is still pending before the apex court. Medical facilities are still being provided to survivors in dedicated hospitals which the affected one claim, highly inadequate.

India marks National Pollution Control Day on December 2 in the honour of people who lost their lives during the horrific 1984 Bhopal Gas Tragedy

References: 1. Long-term recovery from the Bhopal crisis- Paul Shrivastava, 2. An analysis of the Bhopal accident - B. Bowonder. 3. Information recently published in newspapers of India.

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