ISSUE
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BIMONTHLY NEWSLETTER ON PROCESS SAFETY

SAFEXCELLENCE

THIS ISSUE

Significant Accidents in March-April 2021

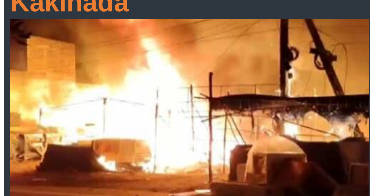
Fire Breaks Out At Pharmaceutical Unit In Nagpur

Major fire broke out at Snehal Pharmace Company in Nagpur's Butibor industrial area on 1st March 2021.

Major Fire In A Plastic Company In Maharashtra's Thane

A major fire broke out in a plastic company located at Asangaon, Shahapur, on 9th March 2021.

Two Burnt Alive And Six Injured After A Fire Broke Out In Tyke Industry In Kakinada



The tragic incident took place in Sarpavaram of Kakinada of East Godavari district where 2 were burnt alive in a gas leak at a private factory and 6 others were seriously injured. Going into details, a fire broke out at a tyke industry on 11th March 2021 due to toxic gas leak.

EDITORIAL

Plan the Disaster – Improve Plant's Resilience

Become proactive

Dear Readers,

First and foremost, the ***Safexcellence*** team hope you and your family are healthy and safe. While writing this editorial, the covid-19 seems to have bounced back in our country hitting the new numbers every day. It is imperative that all of us follow the laid down protocols as precautionary measures. The massive vaccination drive is underway, and we trust the concerted effort from all quarters will overcome this worst phase.

Another concerned area is the rise in industrial accidents **(Fire – Explosions - Toxic Gas Release)** in India. Unfortunately, the news is shadowed due to covid-pandemic. The data collected by ***Safexcellence*** team shows **60 accidents** this year between **January to April** taking **death** toll of **95 and 125 injuries**. This implies every other day there is one accident resulting in one death and two injuries. To counter this trend, chemical manufacturers must immediately re-assess their plant risk posed by the current hazards, consider adaptive actions to reduce and bring the risk inacceptable region where required and prepare changes for future as well as mitigative moves to address the root causes to secure long term solution. Improving resilience by adaptive actions to correct these root causes should be a strategic priority.

This ***Safexcellence*** issue brings you two special articles along with the regular features. These are ***''Implementing Process Safety Management''*** and **'' CFD based 3D Gas Optimization for Chemical Facility''.** The first article will guide you in implementing PSM without taking any external assistance while the second article is a study giving significant advantage of carrying out 3D simulations over 2D studies and provide a precise method for placement of the detectors.

Trust you will enjoy this issue. Safexcellence will be happy to read your comments and suggestions to continuously give you information of your choice.

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Fire Breaks Out In Biscuit Factory In Thane

A major fire broke out in a biscuit manufacturing factory at Ambernath in Maharashtra's Thane district on 11th March 2021.

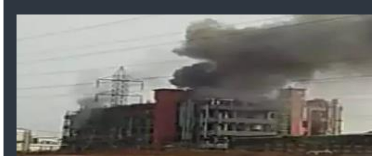
Fire In Plastic Goods Factory In Daman

A major fire broke out in a factory engaged in manufacturing plastic goods in Daman Union Territory on 16th March 2021 morning, fire officials said.

Major Fire Breaks Out At Vatva GIDC Firm

A major fire broke out at a plastic packaging manufacturing firm in the phase - 4 of Vatva GIDC area on 19th March 2021.

Six Killed In Blasts And Fire At A Chemical Company



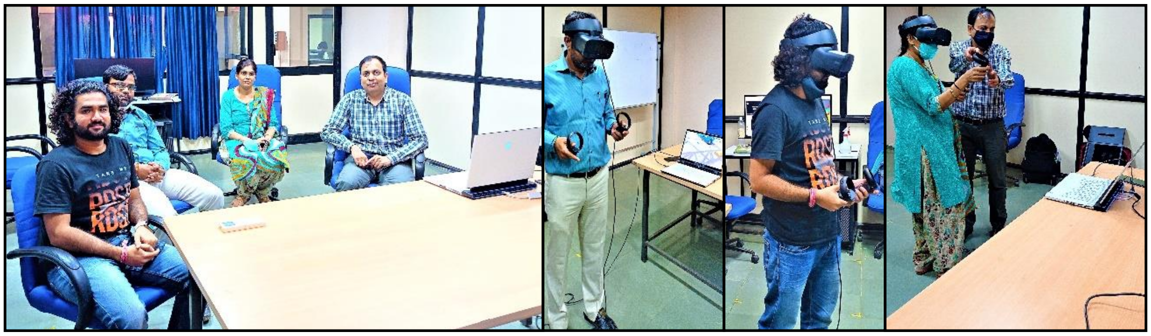
At least six persons were killed in blasts and fire at a chemical company in Ratnagiri's Lote MIDC area. The incident took place at Gharda Chemicals early morning on 20th March 2021, 6 people died after suffering severe burn injuries.

Fire At Petrochemical Unit, 5 Injured

5 workers of Shivam Petrochem Industries in Gothda village of Savli taluka of Vadodara district suffered burns after a fire broke out reportedly due to increased pressure on a reactor during a process of manufacturing a pharmaceutical chemical, on 20th March 2021.

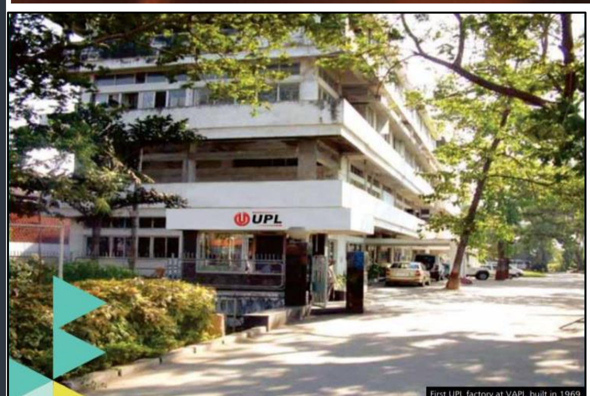
CoE ACTIVITIES

Introduction of Virtual Reality to CoE Members



CoE at SRICT organized a demonstration of the Augmented Reality (AR) and Virtual Reality (VR) tools for the members of CoE to create an exclusive and interactive learning environment. This will help to develop application platforms for specific skill development programs based on the industry needs and relevance. This demonstration was given by Sr. Manager- Business Development of FEAST Software Pvt. Ltd. On 7th April 2021.

Plant Visit to UPL – Unit 0, Vapi, By CoE Members



The UPL Vapi plant visit was planned on 8th April 2021 to understand the actual facility plant layout and congestion for Current CoE 3D CFD Project Activity. [From Right: Mr. Govind K. Patil (Gexcon India), Mr. Vijay Parmar (UPL), Dr. Ravindra Kanwade (SRICT), Mr. Dhaval Patel & Others (UPL)]

Introduction of CoE -TSS Model to Authorities

Mr. Pratik Shinde delivered a session to Angre Port Authority, on Introduction, services and Process Safety Certification courses offered by SRICT-CoE

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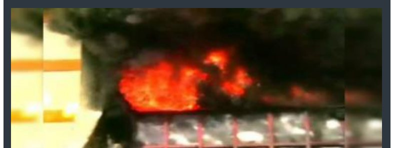
Fire At Shopping Complex, 1 Injured

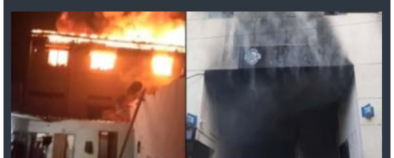
One person was injured after a fire broke out at Spectrum Tower shopping complex on Relief Road in old city area of Ahmedabad on 23rd March 2021.

Massive Fire Breaks Out At Plastic Godown In Kanpur



A massive fire broke out a plastic godown in the Collector ganj area of Uttar Pradesh's Kanpur district on 24th March 2021.

Huge Fire In Incense Stick Factory In Vadodara



A massive fire broke out in an incense sticks-making factory in Gujarat on 24th March 2021. The blaze erupted at Shreeji Agarbatti unit located in Makarpura industrial area.

450 LPG Cylinders Explode After Lightning Strikes Truck

Around 450 domestic LPG cylinders explode for hours after the truck carrying them was hit by a lightning near Tikad village on Jaipur-Kota highway on 27th March 2021. The incident triggered a 10-km snarl between Deoli and Sarwar for 18 hours.

Trio Killed By Toxic Gas

The three labourers suspected to have died after inhaling toxic fumes while trying to enter a chemical tank at Vadol MIDC on 28th March 2021.

ROTARY EHS, E-CONCLAVE 2021

Rotary international has added Environment as 7th Focus area to improve the environment across the globe. Considering this, Rotary club of Dahej has organized two days EHS Conclave to create awareness amongst industrial professional of Bharuch district.

In past 2-3 years many industrial disaster have occurred in Chemical Industries of India. Bharuch district is huge hub of Chemical Industries in India and carrying very high risk. Process safety is very much important element to prevent disasters in chemical industries. Rotary club of Dahej has covered important topics in this conclave through renowned speakers for the benefits of the participants. Members of CoE has activity participated in this two days e-conclave by sharing and updating the knowledge related with process safety to make industry as a safer place for working.

EXPERT TALK

Mr. Gokul V. Mahajan (Principal Engineer & Trainer) delivered an expert talk entitled "Chemical Reactivity Hazards: Basic Concept and Case Study" at AICTE Sponsored Faculty Development Programme (FDP) organized by Department of Petroleum Technology, Laxminarayan Institute of Technology (LIT) ,Nagpur. His session was so informative, introducing the basics of reactivity hazards with recent industrial accidents & it's consequences

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13 Injured As Boiler Explodes At Thermal Power Plant In Sonbhadra

As many as thirteen labourers were injured following an explosion in a boiler in the Lanco Anpara thermal power plant on 4th April 2021. The incident was reported from Uttar Pradesh's Sonbhadra.

Fire Breaks Out At Rourkela Steel Plant In Odisha

A fire broke out at the Rourkela Steel Plant in Odisha at around 3 am on 5th April 2021. No casualties were reported in the incident.

Fire Breaks Out At Scrap Unit In Visakhapatnam

A fire accident took place in the premises of M/s.Pooja Scrap Industries in Visakhapatnam Special Economic Zone (VSEZ) under Duvvada police station limits here on 12th April 2021.

4 Workers Killed As Boiler Bursts In Chemical Factory

4 workers were killed while 10 others were injured after a boiler burst at a chemical factory near Pipardi village in Wankaner taluka of Morbi district on 14th April 2021.

3 Killed, 8 Injured In Fire At Chemical Firm In Ratnagiri

3 people were killed and 8 others injured after a fire broke out in a chemical company in Maharashtra's Ratnagiri district on 18th April 2021.

IMPLEMENTING PROCESS SAFETY MANAGEMENT (PSM)

1. Introduction

This article is written with an intention to assist to those small, medium & large-scale industries where most operations (receipt-storage-transfer-use and processing) handle hazardous materials and thus it is required to design, develop, and install management systems within their plants or companies to ensure process safety at each stage.

The task of process safety management implementation is complex because it crosses over several functional areas of a company's organization. For example, comprehensive process safety management systems influence research, development, and engineering; facility and process construction, operation, and maintenance; training throughout the organization; procurement; and information management.

Though regulations in India do not enforce it, it is a must to install PSM because of the existence of hazardous operations from an industrialist standpoint. The article provides practical assistance in how to implement the ideas and concepts while installing the system.

2. Implementation Plan

2.1. Management Commitment and Defining the Goal

PSM installation starts with understanding the ***background*** of the company like how big the company is (Small-Medium-Big), number of operating groups (divisions) and sites (in India and outside India) it operates with, how old and vulnerable each division is, the core management group (Organograms – Centralized, De-Centralized) etc. The next step is the official endorsement ***(Management Commitment)*** for developing approach to implementing PSM. The top management agrees to proposed fundamentals of PSM, achieving goals as a commitment to continuous and safe improvement by understanding benefits of systematic approach and potential downfall of maintaining the status quo.

The HSE Director is nominated as ***PSM Champion***. He finalizes the most appropriate and suitable process safety model for the company. He moves on to develop specific criteria for PSM initiative by setting up an ***Inter-Disciplinary Core Team*** as ***PSM Task Group***, ensuring that the result satisfies full range interest of the company. For task group, he sketches the skills Matrix by picking up professionals from design engineering, operations, maintenance (Mechanical, Electrical, Instrument And Civil), safety, and health within the company and the ***PSM Advisory Group***, which is comprised of managers and safety specialists. The ***Task Group*** will develop the recommendations and circulate to the ***Advisory Group.***

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PSM goals are established in the first meeting of task group. In this, the group studies the existing laid down systems to finalize what systems will be considered as central and others as de-centralized. The group also ensures that the PSM model exceeds the regulatory requirements. The task group will finalize the timetable of 18 to 24 months which should be appropriate to meet the PSM objective.

2.2. Evaluate Present Study

As a next step, the task group determines what components are already in place and their effectiveness. The team organizes the full list of sources the selected PSM standard asks for and ensures that no key components are overlooked. The group prepares questionnaire and arrange for interviews if required. The team starts and finishes this activity very systematically with prior information to the members, circulating the information required, with advance questionnaire within two weeks and estimates a two-month timetable for completion. The audit protocol is prepared, and audit is conducted in two weeks or so.

2.3. Develop Plan

A detailed PSM implementation plan is developed (by the task group, reviewed by advisory group and approved by PSM Champion) based on the findings and analysis of base level assessment. PSM champion also prepares a progress report format which discusses activity to date, broad direction and next steps. Here, an important aspect is kept in mind that the primary data collection is relatively easy to manage, however, the planning process is much more complex that requires a sophisticated analysis and subjective judgement. Thus, it is vital that the goals are clearly understood by the task group.

As a next step the task group leader decides an implementation strategy defining priorities and develop a program plan with schedule and resources required. It is advantageous to develop a centralized or companywide strategy. The facility management must be involved if the plan is to be effective. Thus, a companywide centralized plan is developed.

2.4. Develop Specific PSM System

As soon as the management approves the PSM plan, the task team develops the PSM system. The approach would be to emphasize incremental improvements rather than business process redesign. Both the techniques, centralized and decentralized can be adopted. The team can accept a consistent mechanism and establishing several key parameters for system design phase including structure, methods, and communications, to ensure a diligent review prior to installation.

Because the PSM plan is more complex, the task group establishes ***Sub-Teams*** to focus concurrently on a number of PSM elements. The sub-teams may include outside consultants and selected facility managers. One sub-team can research and evaluate model programs for consideration. The sub-teams report to task leader who is appointed by PSM Champion, for system design. The work product will be a series of Standard Operating Procedures (SOPs) that strictly conforms to laid down approved format. The forms may be developed by de-centralized facilities based on the guidelines of centralized direction.

2.5. Place PSM System into Practice

The team completes the system design phase and moves to the next phase of pilot tests so as to create workable templates – models throughout the facilities. The pilot testing can help reinforce management's buy-in and yield detailed information about resource requirement for full installation. ***Pilot test is performed for all locations and for each element of PSM. The test period is minimum two months. During Pilot Testing the team assures that procedures are clear and do not conflict with other procedures.***

For pilot test, the team defines the scope of PSM pilot in terms of information and experience it expects to gain. Thus, a test site is selected that offers the opportunity to test a meaningful range of system components. The team also agrees to incorporate common mechanisms for measuring and monitoring progress, soliciting participants feedback, and assessing results.

The team agrees that the realistic approach involves a staged installation beginning with priority PSM elements. During pilot test the facility managers would play an active role at every step of the process. The task team will take on an advisory and monitoring role to assure consistency and timeliness but would less involve in day-to-day activities once installation has begun. The task team develops a plan for pilot test where they estimate 6 to 8 weeks of operation, plus another two weeks for assessment and reporting.

The PSM Champion drafts a circular, informing facility managers that the PSM system is ready for testing, and describing what this may involve. The facility managers ensure to reinforce employee's awareness of PSM and generate enthusiasm for the implementation.

Once the pilot test is complete, the task team meets to assess the results. The team makes some minor revisions in PSM systems and installation schedule, based on the assessment

2.6. Measuring and Monitoring

Once the pilot test is completed, installation schedule is discussed with PSM Champion who may raise an issue for the need for quality assurance at this stage. At this point the role of champion and the task & advisory teams changes. During installation the responsibility shifts from teams to field. The PSM champion ensures that this last milestone is achieved and urges the team to device monitoring methods for ongoing maintenance of PSM system. The team recognizes two levels of monitoring; local and system wide. The facility managers generate monthly report of PSM monitoring, detailing exception report. For systemwide monitoring, the task group create a in-house audit group, who conducts site visits at three key points; Initiation, Midpoint and Closeout. The regular audit program is incorporated to ensure the working and effectiveness of PSM system and its continuous improvement.

A monthly status report is generated during PSM installation process. Once the system is implemented, the status can be reviewed on quarterly basis by the management.

2.7. Expand the Scope

The initial implementation of PSM is achieved in two years and in two stages ***(shown in table I and Table II below)*** and integrated into all local operations with regular monitoring through PSM audits to assess improvement for further refining. This process gives assurance that the standards are met.

PSM become a regular agenda point for ***Core Management Group***, and at this point the ***PSM Champion*** proposes that management consider expanding the initiative beyond its original scope. Based on experience to date, he believes the PSM system could be effectively applied to a range of other activities within the company (like, industrial hygiene, distribution system) and feels that doing so would reinforce the company's overall safety performance keeping the concept of continuous improvement. He also proposes to expand PSM coverage beyond minimum requirements. He makes the case for expansion based on the interrelationships among the various operations and staff functions, and their collective impact on overall safety performance. He also points out that the expansion could be achieved with a relatively modest investment of staff time, since the system is now up and running and model exist for all of the major tasks.

Reference: CCPS Book – Guidelines for Implementing Process Safety Management Systems.

Table I: Implementation of PSM: Phase I

Sn.	Activities	Month →	1	2	3	4	5	6	7	8	9	10	11	12
1	Finalize Project Plan		■											
2	Fix accountability	Design PSM System		■	■									
		Pilot Test				■								
		Install					■	■						
3	Compliance with Standards	Design PSM System		■	■									
		Pilot Test				■	■							
		Install						■	■					
4	Process Safety Information	Design PSM System		■	■									
		Pilot Test				■	■							
		Install						■	■					
5	Risk Management	Design PSM System			■									
		Pilot Test				■	■							
		Install						■	■					
6	Asset Integrity Management (AIM)	Design PSM System			■	■								
		Pilot Test					■	■						
		Install							■	■	■			
7	Operating Procedures	Design PSM System		■	■									
		Pilot Test				■	■							
		Install						■	■	■				
8	Safe Work Practices	Design PSM System				■	■							
		Pilot Test						■	■					
		Install								■	■	■		
9	Contractor Management	Design PSM System					■	■						
		Pilot Test							■	■				
		Install									■	■		
10	Training & Performance	Design PSM System					■	■						
		Pilot Test							■	■				
		Install									■	■	■	
11	Management of Change	Design PSM System						■	■					
		Pilot Test								■	■			
		Install										■	■	
12	Pre-Strat up Safety Review	Design PSM System						■	■					
		Pilot Test								■	■			
		Install										■	■	■

Table II: Implementation of PSM: Phase II

SN	Activities	Month →	13	14	15	16	17	18	19	20	21	22	23	24
13	Conduct of Operations	Design PSM System	Assessment of Implemented PSM Elements	■	■									
		Pilot Test				■								
		Install					■	■						
14	Emergency Management	Design PSM System		■	■									
		Pilot Test				■	■							
		Install						■	■					
15	Incident Investigation	Design PSM System			■									
		Pilot Test				■	■							
		Install						■	■					
16	Measurement and Metrics	Design PSM System			■	■								
		Pilot Test					■	■						
		Install							■	■	■			
17	Audit and Corrective Actions	Design PSM System		■	■									
		Pilot Test				■	■							
		Install						■	■	■				
18	Management Review	Design PSM System				■	■							
		Pilot Test						■	■					
		Install								■	■	■		
19	Competence	Design PSM System					■	■						
		Pilot Test							■	■				
		Install									■	■		
20	Stake holder outreach	Design PSM System					■	■						
		Pilot Test							■	■				
		Install									■	■	■	
21	Process Safety Culture	Design PSM System						■	■					
		Pilot Test								■	■			
		Install										■	■	
22	Final PSM Audit	Design PSM System						■	■					
		Pilot Test								■	■			
		Install										■	■	■

REMOTE IMPLEMENTATION OF PROCESS SAFETY & REMOTE AUDITING FOR PROCESS SAFETY

RIPS & RAPS
AFFORDABLE IMPLEMENTATION AND AUDITING OF PROCESS SAFETY

Based on our experience and expertise, we assist our clients in implementing process safety, beginning with 'online base level audit' to find out the gaps. We then recommend the safeguards for each process section after studying and analysing the risks in detail. We also provide them tailormade process wise document which help them in carrying out day to day operation in a very safe manner. Not only this, we also provide them a systematic procedure for 'emergency response for plant and for community in the vicinity.

Thus, we guide our client in bringing the process risks to reasonably acceptable level with the existing hazards, adopting the most advanced techniques of hazard evaluations thereby minimising the possibility of an undesired event.

FEATURES

- No client site visit- saves time
- No extra financial burden on client for making travelling - lodging- boarding arrangement

THE CLIENT BENIFITS

- Evaluating a Linear Process Safety System (LPSS) and recommending protection of layers
- Protocols and Procedures
- Hazard Area Classification (HAC)
- Standards and Codes requirement for equipment.
- Independent Protection Layers (IPLs) for each process.
- Plant and Community Emergency Responses.

CONTACT US

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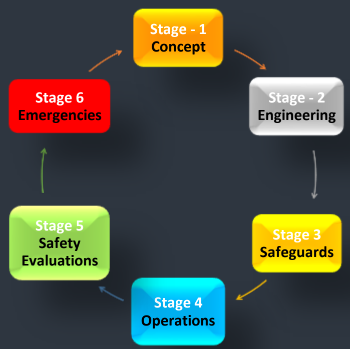
CoE - Total Safety Solution Model (TSSM)



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

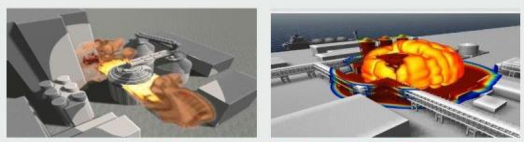
Stage – 6: Emergencies

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

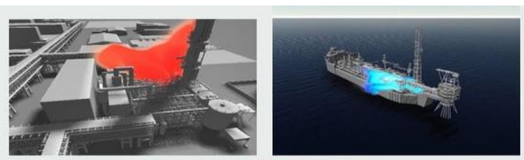
CoE Advanced Services

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

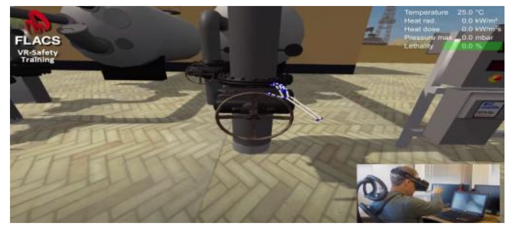


Dispersion Modelling

Fire and Smoke Modelling

Virtual Reality 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.



Safexcellence All Issues at one place

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OXYGEN DISASTER AT ZAKIR HUSSAIN HOSPITAL – NASHIK ON 21 APRIL 2021

Introduction

At least 24 COVID-19 patients on life support died after a leak due to valve disruption of medical oxygen tank at Zakir Hussain Hospital in Nashik- Maharashtra on 21 April 2021 at 10 AM (or 12.30 PM? – not clear). As per the statement of Nashik Collector, Mr. Suraj Mandhare, Nashik Municipal Corporation (NMC) awarded a part of contract to build and operate a 13 Kilolitre liquid Oxygen tank to a private vendor – Taiyo Nippon Sanso Pvt.Ltd. (TNSPL) on rental basis (in two Covid-19 facilities in the city). The tank was commissioned on 31st March this year . One of the valves in liquid Oxygen tank malfunctioned during unloading. The technician tried to fix the valve. Some mis-operation caused low pressure in the tank resulted in low pressure in ventilators which were being used by the patients on life support in the hospital.

As per the preliminary report the socket (of the valve of oxygen tank) broke. State government announced a probe by a seven-member committee which will throw more light for ascertaining the direct – root causes and the antecedents which were responsible for this disaster to happen.

(Ref – Indian Express 21st and 22nd April 2020).

Following questions still remain unanswered:

1. Was the **Design Intent** for all mechanical equipment carried out by a competent engineer and evaluated and approved by a competent authority.
2. Was **Hazard Evaluation** while designing – and before starting the plant carried out? If yes, whether the recommendations given were implemented?
3. Was **Pre-Start Up Safety Review (PSSR)** carried out? Recommendations implemented?
4. What **direct failure** caused the leakage (valve, cork, or socket).
5. Was the unloading being done in the tank which was in service to ventilators or was there a **Standby Tank** too? Why the Oxygen not being unloaded in standby tank?
6. **Direct - Reason of Pressure Drop of The Tank** (resulting in drop of ventilators pressure.)
7. Who carried the **Transfer Activity**? Connection of hose (its MoC, testing before unloading), operation of valves etc. Was he a hospital staff or the tanker driver or TNSPL technician? Was the person trained (approved unloading procedure available – followed?) in unloading activity?

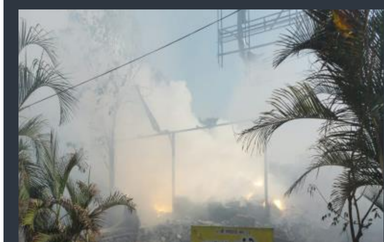
Analysis of The Accident

While all awaiting the seven members committee report, based on the information available (through television news, new papers, internet media) and some assumptions, analysis of the incident is carried out using established elements of process safety. The analysis is shown in the table below.

Fire At Covid-19 Hospital In Vasai Kills 13

At least 13 Covid-19 patients in intensive care unit died and 21 other patients in hospital were rushed out after a fire broke out in the air conditioning unit of Vijay Vallabh hospital in Virar, on 23rd April 2021.

Magnesium Powder Blast At Chemical Factory



Pune, 24 April 2021: A high-intensity blast occurred at a chemical factory in Thergaon which sent shockwaves in the area.

Huge Fire Breaks Out At Pharmaceuticals Company In Ratnagiri

The fire broke out at MR Pharma Private Limited's plant at MIDC in Ratnagiri district at 11 am on 28th April 2021.

Two Killed In Factory Blast In Jammu And Kashmir's Kathua

2 labourers were killed and another injured on 28th April 2021 in an explosion at a zinc and copper factory in Kathua district of Jammu and Kashmir.

SN	Area - Process Safety Management (PSM) Elements	PSM Elements	Failure
1	MANAGEMENT COMMITMENT	1	▪ COMPLY WITH STANDRADS ➢ Regulations, Standards and Codes not complied for basic designing of plant.
		2	▪ PROCESS SAFETY COMPETENCE ➢ Staff (design and operational) not competent
		3	▪ WORK FORCE INVOLVEMENT ➢ Skilled resources for design, installation and operation not appointed.
2	UNDERSTANDING HAZARDS AND RISK	4	▪ PROCESS SAFETY MANAGEMENT ➢ Process Safety information was not known to the person who carried Oxygen unloading operation
		5	▪ HAZARD IDENTIFICATION AND RISK ASSESSMENT ➢ No identification of hazards to reduce or eliminate potential consequences. Thus, no evidence of automatic sensors, detectors or excess flow valve.
3	OPERATIONAL	6	▪ OPERATING PROCEDURES ➢ Procedure for unloading and check-sheet to inspect before unloading was not available.
		7	▪ SAFE WORK PRACTICES ➢ No evidence of laid down practices for safely repair of failed equipment.
		8	▪ ASSET INTIGRITY AND RELIABILITY ➢ Lack of inspection, testing, preventive maintenance (PM), to maintain basic design intention of equipment.
		9	▪ CONTRACTOR MANAGEMENT ➢ If the job was carried out by a contract person appointed by company, there was a substantial failure for established safety systems and procedures for contractors.
		10	▪ TRAINING AND PERFORMANCE ASSURANCE ➢No evidence of having trained and verified skilled labour for carrying safe operation.
		11	▪ OPERATIONAL READINESS ➢ No evaluation of plant looks to have in place before starting to unload. It is more crucial when the plant is in client's premises.
		12	▪ CONDUCT OF OPERATIONS ➢ No evidence to know that the worker/s carried expected performance as per management guidelines, policies, procedures and protocols.
		13	▪ EMERGENCY MANAGEMENT ➢ Absence of Planned Incident Emergency Plan (PIEP). ➢ Training to driver about actions during emergency.
4	LEARNING	14	▪ INCIDENT INVESTIGATION ➢ No evidence of using process safety using leading and lagging indicators as well as metrics for improvement.
		15	▪ AUDITING ➢ Total failure of periodical review for finding gaps in PSM Systems to improve.
		16	▪ MANAGEMENT REVIEW AND CONTINUOUS DEVELOPMENT ➢ No process seems to exist of periodical review the PSM performance against the set GOAL.

Conclusion

A remote investigation of the incident with part of information available, it can be concluded that total 16 PSM elements were lacking to cause this disaster. It is vital that all the establishments constructed and operated by this vendor should be inspected, audited by competent authorities of process safety, and risk need to be eliminated as per the recommendations on war foot basis, by the vendor.
Similar operations need to be evaluated on this basis.

Regulatory authorities should make it mandatory to all oxygen manufacturing operators to strictly follow process safety elements.

CFD based 3D Gas Detector Optimization for Chemical Facility - A Case Study

The case study was carried out for gas detector optimization at a chemical facility. The analysis was based on the 3D CFD "FLACS" software.

What is FLACS ?

It is a CFD code developed for the modeling of ventilation, gas dispersion and gas explosions in industrial settings. FLACS solves complex conservation equations and provides a detailed 3D representation of release and dispersion of gas.

What are advantages over 2D Optimisation?

FLACS gives precise 3-dimensional representations of flow and the interaction between the flow and complex geometries such as structure, equipment, and pipework.

1. Introduction

The 3D CFD study was requested by an industry to evaluate existing gas detector layout derived from 2D analytical software application. The principal idea of using CFD was to test the detection system's performance against many realistic gas releases. A system's ability to detect gas then can be tested, measured, and compared using CFD. The performance of different system configurations can be quantified in an explicit and accurate manner.

The simulations were performed with existing gas detector layout. During simulations studies, it was noted that the existing detectors were unable to detect all the gas release scenarios which were simulated. Thus, additional detectors were planned to get accurate numbers of detectors at facility. The simulations were then repeated with recommended modified gas detector layout and the resultant data was analyzed with the modified detectors layout, detector set point and voting requirements to calculate the time for detection for each individual scenario as well as the cloud size at the time of detection. The task was also to identify scenarios which were not detected.

2. Simulations

Simulations were performed with various release locations, release orientations, release rates, gas compositions and wind conditions. Release scenarios (leak direction, wind condition, impingement etc.) were chosen presuming difficulty in detection for some releases. This typically involved combinations of release direction, wind direction and jet impingement that may result on clouds forming away from the leaks, penetrating in between buildings or areas not intuitively expected to see gas exposure. The conditions initially chosen for scenarios were often altered in order to produce gas cloud with relevant size (i.e., significant volume yet small enough to potentially escape detection). The analysis also included scenarios which were selected to be representative i.e., not particularly adverse conditions. For example, a downward directed jet will typically create a regular exposure around the release location. Such a release is generally unaffected by surrounding obstruction and the same exposure

The analysis also included scenarios which were selected to be representative i.e., not particularly adverse conditions. For example, a downward directed jet will typically create a regular exposure around the release location. Such a release is generally unaffected by surrounding obstruction and the same exposure pattern can then be expected also when the same type of release occurs in another location with similar wind conditions.

Butadiene and LPG simulated scenarios were simulated as high momentum jet releases while Acrylonitrile and Styrene simulated scenarios are diffuse releases (no momentum).

Releases not likely to produce significant exposure at manned areas (ground level) - such as Jet leaks directed upward, were not included in the study, but the diffuse leak (pool evaporation) directed upward was a part of detection analysis.

3. Analysis

Designing a detection system with satisfactory performance needs a clear understanding of hazards present in the area and the end event against which the system needs protection. Strict requirements for detection, i.e. a low tolerance for risk, will mandate higher detector density. Industry standards and legislation provide a little guidance on appropriate detect capacity. It is largely up to facility owner to define the detection density. The suggestions made by Gexcon were aligned with typical detection requirements.

Some chemicals involved in this study show substantial flammable hazards as well toxic hazards e.g. Styrene (STY) & Acrylonitrile (ACN).

4. Detection criteria

Figure 1 below shows that the hazard associated with Acrylonitrile is predominant toxic rather than flammable. Releases above 85 ppm were considered toxic for the personnel present in the area and thus detection was considered a must with an alarm system.

Some scenarios created a very small regions with ground exposure above 85 ppm. For example, a small downward oriented leak from tank produced >85 ppm within the dyke but otherwise represent little hazard. Thus, scenarios which caused 85 ppm in an area exceeding

100 m2 were considered critical events and have been detected. This implies the equivalent cloud of 10% LFL concentration should have been detected by flammable gas detector. This is not a very strict criteria (implicit), it can be "accepted "that 99 m2 exposure may go on for an indefinite period without requiring detection. i.e. a pragmatic criterion in an area where likelihood of personnel present is low.

Figure 2 shows the hazard associated with Styrene is predominant toxic as well as flammable. The same criteria were applicable to Styrene. i.e. scenarios causing 700 ppm in an area exceeding 100 m2 were considered critical events and must be detected i.e. the equivalent cloud of 4% LFL concentration must be detected by flammable gas detector. The equivalent criteria were applicable for Styrene and Butadiene for flammable exposure.

Figure 1 shows that the toxic hazard of Acrylonitrile is far greater than the flammable hazard (10% LFL plume reached 6 meters while IDLH plume travelled up to 35 meters). 10% LFL cloud of Acrylonitrile contained within the bund but the toxic cloud of IDLH concentration from same release reaches the Compressor house(utility), Nitrogen plant, Coal Storage shed, Toilet block etc., where the frequent presence of personnel is expected. Exposure to IDLH concentration of Acrylonitrile can cause harm (ranging from mild effect to lethal effect) to exposed personnel. This kind of scenarios may pose big threat to people and must be detected immediately after accidental release. The Hydrocarbon (HC) detectors were placed for gas detection but considering the toxic hazard of Acrylonitrile compared to flammable hazard, widespread toxic exposure can occur before the HC detectors would warn. In this case, dedicated toxic detectors should be considered for early detection of toxic hazard. Acrylonitrile can be smelled at a concentration of 19 ppm when dissolved in water but that does not provide adequate warning of hazardous levels.

5. Conclusion

The 2D software study had shown 90% detection with existing detector layout but after performing 3D CFD simulations in FLACS software, it is found that there is only 40% detection capacity with existing detector layout. The modified gas detector layout was then used to find the more percentage detection. Finally the modified gas detector layout giving more than 90% scenarios detection were recommended to implement.

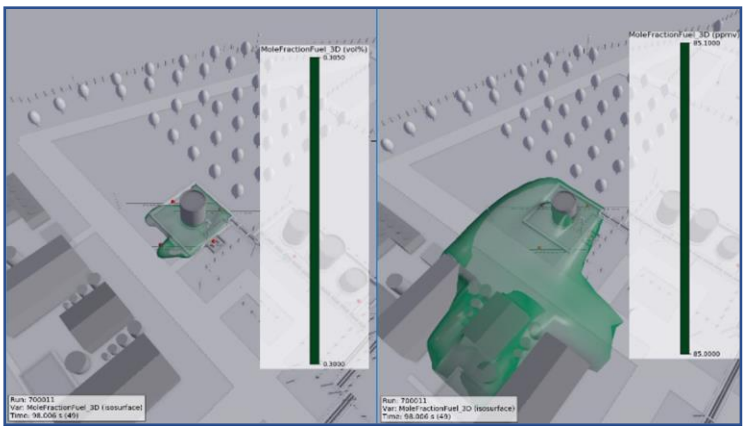


Figure- 1: Toxic & Flammable effect of ACN – Left: 10 % LFL cloud crossing the dyke. Right: IDLH 85 ppm toxic cloud exposing manned area of facility

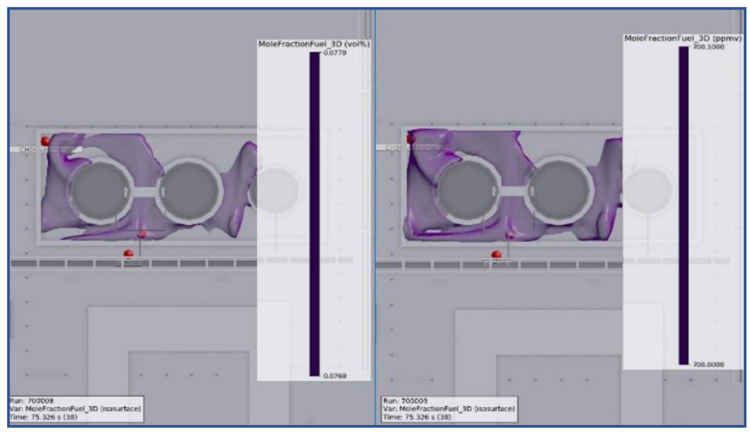
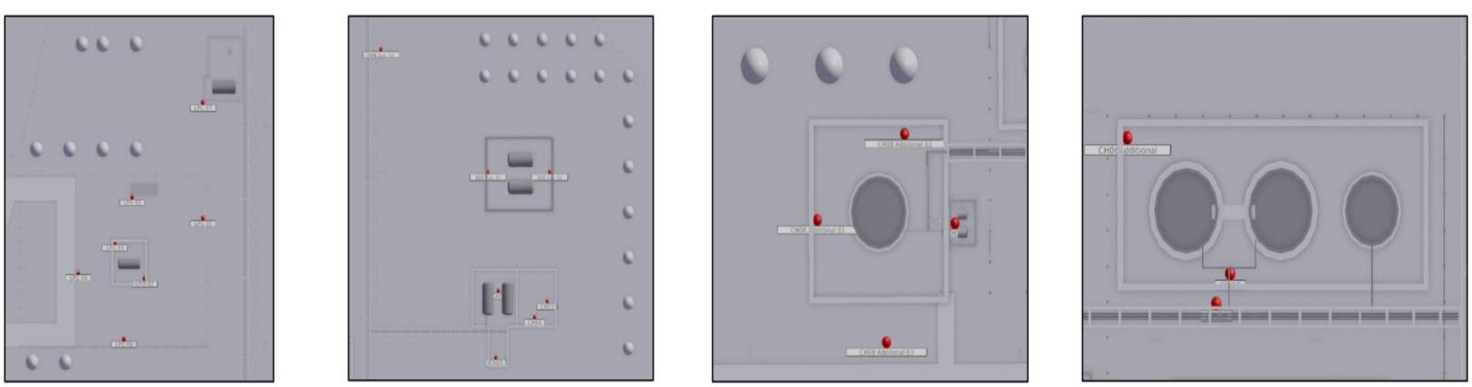


Figure- 2 : Toxic & Flammable effect of STY- The left plot shows volume with flammable gas at 4 % LFL (i.e., set point of flammable detector). The right plot shows volume with IDLH concertation at 700 ppm of STY.

Chemical wise recommended layout for Gas detection is shown below



a) LPG gas detector layout **b) Butadiene gas detector layout** **c) Acrylonitrile gas detector layout** **d) Styrene gas detector layout**

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For More Information About Total Safety Solution Model, Contact Us

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