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SEA (INDIA)

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Tenth Anniversary of SEA (India)

The Tenth Anniversary of SEA (India) was celebrated on Saturday, 18th June 2011 at Hotel Benzz Park, T Nagar, Chennai.

Mr S Ulaganathan, President, SEA (India) welcomed the invitees and the members and briefed the activities of SEA India.

Mr.William Satterfield, Technical Director, Hardy Exploration & Production (India) Inc. in his keynote address emphasized the relevance of safety for all walks of life with special reference to family setting. Dr. R. Babu Rajendran from Dept. of Environmental Biotechnology, Bharathidasan University, Trichy delivered the special address. He gave a detailed description of the safety practices and the commitment of safety from the people in Japan which he observed during his visits to Japan.

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Sitting L-R: Mr. Janardhanam, Dr. R. Babu Rajendran, HOD of Environmental Biotechnology, Bharathidasan University, Trichy, Mr. CGS Babu Rao, JCIF Chennai & Mr. William Satterfield, Technical Director, Hardy Exploration & Production (India) Inc.

A section of participants

Inside....

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NEBOSH Course Update

Mr Matthew, Accreditation Manager, NEBOSH, UK visited SEA India office on March 30, 2011.

The methodology and procedure followed by us in the conduct of International General Certificate Course of NEBOSH was audited by him. They have three grades, Satisfactory, Improvement needed and Breach of Accreditation. SEA India has been awarded Satisfactory Grade.

The contact classes for the September 2011 batch will be conducted from August 25th to September 4th 2011. The examination will be conducted on Wednesday, September 7th 2011 followed by practical examination on Thursday, September 8th 2011 for which admission is in progress.

NEBOSH has also revised the elements and examination pattern of International General Certificate course and the revised pattern will be followed from next year.

SEA India encourages its members and other safety professionals to pursue this course to enhance their professional knowledge and career prospects. All those aspiring to join this course are requested to contact Secretary by mail, info@seaindia.org for getting admission.

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Chief Guest of the occasion Mr. Babu Rao, Joint Chief Inspector of Factories, Government of Tamilnadu appreciated the efforts taken by the association in developing the professional skills. He also explained the efforts taken by the government agencies in preventing the accidents in industry.

Chief guest presented a certificate and shield to Mr. Vasu Srinivasan and Mr. K. Deepan Kumarasamy who scored the highest mark in the September 2010 and December 2010 respectively, and to Mr. Jitender Kumar Arya of March 2011 batch in the International General Certificate Course of NEBOSH conducted by the SEA (India).

Mr. P. Janardhanam, Vice President of SEA India, proposed vote of thanks.

Large number of SEA members participated in the function.

As a part of the anniversary functions, two special technical lectures were organized.

Mr. H. Karthik of BS & B safety system (India) Ltd gave a lecture on "Managing Dust Explosions and Over pressure Relief in Industries" and Mr. Selvakumar of Cholamandalam MS Risk Services Ltd., gave a lecture on "Layers of Protection Analysis & Safety Integrity Level".

FROM THE DESK OF PRESIDENT

Dear Members,

Safety Engineers Association is now 10 years old!. It's time to cherish our growth since we were born in the year 2001 and rejoice. Our Tenth Anniversary function was held on 18-06-2011 in a befitting manner. On this joyous occasion let us rededicate ourselves to the cause and well being of the safety fraternity at large.

Annual General Body Meeting held soon after the anniversary function took care of the annual rituals. Members who were present for the AGM gave their valuable suggestions for improvement and also deliberated on the ways and means to motivate more members to actively participate in the activities of the association.

In the last quarter, our 54th Executive Committee meeting was held on 30-04-2011 and the 27th Technical Meet was held on 14-05-2011. Our journal "Indian safety Engineer" for the first quarter 2011 was released in time and hopefully the next one will also reach you soon, and in time.

Mumbai Chapter, our new born offshoot of SEA had a couple of meetings to chalk out their activities for the year and thereafter. Their primary focus seem to be a membership drive in order to set up a strong base for the chapter. Their enthusiasm and dynamism gives me hope and confidence that they will soon be serving their region and contribute to the cause of safety.

After some issues in the renewal process, SEA website, www.seaindia.org is now working. But the site still needs to be updated with the latest activities and the service provider is urged to do it on priority.

SEA India Group mail under Yahoo Groups of Emails is now fully functional and all the members are advised to enroll themselves by making a request to Mr. Kamarajan, Moderator on his email ID: krajan@etaascon.com. Becoming a part of the group will enable the members to share their knowledge and experience towards mutually enriching their collective wisdom.

Ninth batch of Nebosh IGC course is scheduled to be conducted during Sept 2011 and the remaining few seats are getting filled up.

Membership cards are made available for the corporate grade life members and the same are being distributed.

Best Wishes!

S. Ulaganathan
President, SEA India

LAYER OF PROTECTION ANALYSIS AND SIL FOR SAFETY

During the Tenth Anniversary Function of SEA India, Mr Selvakumar, Cholamandalam M S Risk Services Ltd delivered a special Technical talk on **"Layer of Protection Analysis and SIL for Safety"**. The contents of his talk is given in this article.

INTRODUCTION

On 29th October 2009, at about 7:30 pm a devastating explosion occurred in the POL installation of IOCL, Jaipur killing 11 persons and injuring 45. The product loss of around 60,000 KL has been reported. In this accident the entire installation was totally destroyed and buildings in the immediate neighborhood were also heavily damaged. Catastrophic events like Jaipur fire, Buncefield, Texas City and Bhopal are what the information in this article is meant to prevent. The technology is getting more and more sophisticated, additional protection measures are required to bring the down the risk within acceptable limits. The critical causal factors identified for the Jaipur fire incident are, Loss of primary containment, Loss of secondary containment, inadequate mitigation measures, shortcomings in design and engineering specifications of facilitates and equipment, defunct vital emergency shutdown system, absence of operator in control room, absence of on-site and off-site emergency measures. This reveals that though protection layers were available the integrity of the system is poor. So it is not enough to have protection layers alone, the reliability of the system is also equally important for bringing down the risk to as low as reasonably possible.

INTEND OF LOPA

Layer of Protection Analysis (LOPA), a semi quantitative Process Hazard Analysis (PHA) is found to be the potential semi quantitative tool for statutory compliance purposes in UK and effective Process Safety Management tool satisfying OSHA requirements in USA. It is a simple tool and identifies the safeguards to be considered for risk assessment and risk reduction. Process Hazard Analysis utilizes various tools viz Check lists, Hazard and Operability study, Failure Mode and Effect Analysis, Fault Tree Analysis, Event Tree Analysis to identify the Hazards involved in the chemical operations. While some of them like such as HAZOP and What-if are qualitative, others such as Fault Trees and Event Trees are quantitative. Layer of Protection Analysis (LOPA) is the newest methodology for hazard evaluation and risk assessment. The LOPA methodology lies between the qualitative end of the scale and the quantitative end. It provides a method for evaluating the risk of hazard scenarios and comparing it with risk tolerance criteria to decide if existing safeguards are adequate and if additional safeguards (layers of protection) are needed.

WHEN TO APPLY LOPA

LOPA is typically applied after a qualitative hazard evaluation (e.g., PHA) using the scenarios identified by the qualitative hazard review team. However, "typically" means just that— LOPA can also be used to analyze scenarios that originate from any source, including design option analysis and incident investigations. LOPA can also be applied when a hazard evaluation team (or other entity),

- believes a scenario is too complex for the team to make a reasonable risk judgment using purely qualitative judgment, or
- the consequences are too severe to rely solely on qualitative risk judgment.

The hazard evaluation team may judge the "scenario as too complex" if they

- do not understand the initiating event well enough,
- do not understand the sequence of events well enough, or
- do not understand whether safeguards are truly Independent Protection Layers (IPLs).

LOPA PROCESS

The flow chart given below shows the steps involved in determining the Safety Integrity Levels for a Safety Instrumented Function.

1. Identify the consequence

The consequence is typically identified during a qualitative hazard review (such as a HAZOP study) is entered in column 1 of Fig.-4

2. Severity Level

Severity levels of Minor (M), Serious (S), or Extensive (E) are

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next selected for the impact event according to the following Table and entered into column 2 of Fig.-4.

Severity Level	Consequences
Minor (M)	Impact initially limited to local area of event with potential for broader consequence, if corrective action not taken.
Serious (S)	Impact event could cause serious injury or fatality on site or off site
Extensive (E)	Impact event that is five or more times severe than a serious event

3. Initiating cause

All of the initiating causes of the impact event are listed in column 3 of Fig.-4. Impact events may have many initiating causes, and it is important to list all of them.

4. Initiation likelihood

Likelihood values of the initiating causes occurring, in events per year, are entered into column 4 of

Low	A failure or series of failures with a very low probability of occurrence within the expected lifetime of the plant EXAMPLES – Three or more simultaneous instrument, or human failures – Spontaneous failure of single tanks or process vessels	$f < 10^{-4}$, /yr
Medium	A failure of series of failures with a low probability of occurrence within the expected lifetime of the plant EXAMPLES – Dual instrument or valve failures. – Combination of instrument failures and operator errors. – Single failures of small process lines or fittings.	$10^{-4} < f < 10^{-2}$, / yr
High	A failure can reasonably be expected to occur within the expected lifetime of the plant. EXAMPLES – Process leaks – Single instrument or valve failures – Human errors that could result in material releases	$10^{-2} < f$, / yr

Fig.-4. Table given above shows typical initiating cause likelihood. The experience of the team is very important in determining the initiating cause likelihood.

5. Protection layers

Each protection layer consists of a grouping of equipment and/or administrative controls that function in concert with the other layers. Protection layers that perform their function with a high degree of reliability may qualify as Independent Protection Layers (IPL).

Process design to reduce the likelihood of an impact event from occurring, when an initiating cause occurs, are listed first in column 5 of Fig.-4. An example of this would be a jacketed pipe or vessel. The jacket would prevent the release of process material if the integrity of the primary pipe or vessel is compromised.

The next item in column 5 of Fig.-4 is the Basic Process Control System (BPCS). If a control loop in the BPCS prevents the impacted event from occurring when the initiating cause occurs, credit based on its PFDavg (average probability of failure on demand) is claimed.

The last item in column 5 of Fig.-4 takes credit for alarms that alert the operator and utilize operator intervention. Typical protection layer PFDavg values are listed in Table below.

Protection layer	PFD
Control loop	1,0 x 10–1
Human performance (trained, no stress)	1,0 x 10–2 to 1,0 x 10–4
Human performance (under stress)	0,5 to 1,0
Operator response to alarms	1,0 x 10–1
Vessel pressure rating above maximum challenge from internal and external pressure sources	10–4 or better, if vessel integrity is maintained (that is corrosion is understood, inspections and maintenance is performed on schedule)

6. Additional mitigation

Mitigation layers are normally mechanical, structural, or procedural. Examples would be:

– pressure relief devices;

– dikes (bunds); and

– restricted access.

Mitigation layers may reduce the severity of the impact event but not prevent it from occurring.

Examples would be:

– deluge systems for fire or fume release;

– fume alarms; and

– evacuation procedures.

The LOPA team should determine the appropriate PFDs for all mitigation layers and list them in column 6 of Figure 4.

7. Independent Protection Layers (IPL)

Protection layers that meet the criteria for IPL are listed in column 7 of Figure 4.

The criteria to qualify a Protection Layer (PL) as an IPL are:

– the protection provided reduces the identified risk by a large amount, that is, a minimum of a 100-fold reduction;

– the protective function is provided with a high degree of availability (0,9 or greater);

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– it has the following important characteristics:

a) Specificity: An IPL is designed solely to prevent or to mitigate the consequences of one potentially hazardous event (for example, a runaway reaction, release of toxic material, a loss of containment, or a fire). Multiple causes may lead to the same hazardous event; and, therefore, multiple event scenarios may initiate action of one IPL;

b) Independence: An IPL is independent of the other protection layers associated with the identified danger.

c) Dependability: It can be counted on to do what it was designed to do. Both random and systematic failures modes are addressed in the design.

d) Auditability: It is designed to facilitate regular validation of the protective functions.

Proof testing and maintenance of the safety system is necessary.

Only those protection layers that meet the tests of availability, specificity, independence, dependability, and auditability are classified as independent protection layers.

8. Intermediate event likelihood

The intermediate event likelihood is calculated by multiplying the initiating likelihood (column 4 of Fig.-4) by the PFDs of the protection layers and mitigating layers (columns 5, 6 and 7 of Fig.-4). The calculated number is in units of events per year and is entered into column 8 of Fig.-4. If the intermediate event likelihood is less than your corporate criteria for events of this severity level, additional PLs are not required. Further risk reduction should, however, be applied if economically appropriate.

If the intermediate event likelihood is greater than your corporate criteria for events of this severity level, additional mitigation is required. Inherently safer methods and solutions should be considered before additional protection layers in the form of Safety Instrumented Systems (SIS) are applied. If inherently safe design changes can be made, Fig.-4 is updated and the intermediate event likelihood recalculated to determine if it is below corporate criteria.

If the above attempts to reduce the intermediate likelihood below corporate risk criteria fail, a SIS is required.

9. SIF integrity level

If a new Safety Instrument Function (SIF) is needed, the required integrity level can be calculated by dividing the corporate criteria for this severity level of event by the intermediate event likelihood. A PFDavg for the SIF below this number is selected as a maximum for the SIS and entered into column 9.

10. Mitigated event likelihood

The mitigated event likelihood is now calculated by multiplying columns 8 and 9 and entering the result in column 10. This is continued until the team has calculated a mitigated event likelihood for each impact event that can be identified.

LIMITATIONS OF LOPA

LOPA is just another risk analysis tool that must be applied correctly. The limitations imposed on LOPA result in a work process that is much less complex than quantitative risk analysis, while generating useful, somewhat conservative, estimates of risk. LOPA is subject to the following limitations:

- Risk comparisons of scenarios are valid only if the same LOPA method (i.e., using the same methods for choosing failure data), and comparisons are based on the same risk

#	1	2	3	4		5		6	7	8	9	10	11
				PROTECTION LAYERS									
	Impact event description	Severity level	Initiating cause	Initiating likelihood	General Process Design		BPCS	Alarms, etc.	Additional mitigation, restricted acess	IPL additional mitigation dikes pressure relief	Mitigated event likelihood	SIF Integrity level	Notes
1	Fire from distillation column rupture	S	Loss of cooling water	0.1	0.1	0.1	0.1	0.1	PRV 01	10^{-7}	10^{-2}	10^{-9}	High pressure causes column rupture
2	Fire from distillation column rupture	S	Steam Loop failure	0.1	0.1		0.1	0.1	PRV 01	10^{-6}	10^{-2}	10^{-8}	Same as above

Figure 4. LOPA Template

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tolerance criteria or to the risk of other scenarios determined by LOPA. The numbers generated by a LOPA calculation are not precise values of the risk of a scenario. This is also a limitation of quantitative risk analysis.

- LOPA is a simplified approach and should not be applied to all scenarios. The amount of effort required to implement LOPA may be excessive for some risk-based decisions and is overly simplistic for other decisions.
- LOPA requires more time to reach a risk-based decision than qualitative methods such as HAZOP and What-if. This extra time is offset by the improved risk decision compared to using only qualitative methods for moderately complex scenarios. For simple decisions, the value of LOPA is minimal. For more complex scenarios and decisions, LOPA may actually save time compared to using only qualitative methods, because LOPA brings focus to the decision making.
- LOPA is not intended to be a hazard identification tool. LOPA depends on the methods used (including qualitative hazard review methods) to identify the hazardous events and to identify a starting list of causes and safeguards. The more rigorous procedure of LOPA frequently clarifies ill-defined scenarios from qualitative hazard reviews.
- Differences in risk tolerance criteria and in LOPA implementation between organizations means the results cannot normally be compared directly from one organization to another.

BENEFITS OF LOPA

Some general benefits of LOPA include:

- LOPA requires less time than quantitative risk analysis. This benefit applies particularly to scenarios that are too complex for qualitative assessment of risk.
- LOPA helps resolve conflicts in decision making by providing a consistent, simplified framework for estimating the risk of a scenario and provides a common language for discussing risk. LOPA provides a better risk decision basis compared to subjective or emotional arguments based on "the risk is tolerable to me." This is particularly beneficial for organizations making the transition from qualitative to more quantitative risk methods.
- LOPA can improve the efficiency of hazard evaluation meetings by providing a tool to help reach risk judgments quicker.
- LOPA facilitates the determination of more precise cause–consequence pairs, and therefore improves scenario identification.
- LOPA provides a means of comparing risk from unit to unit or plant to plant, if the same approach is used throughout the company.
- LOPA provides more defensible comparative risk judgments than qualitative methods due to the more rigorous documentation and the specific values assigned to frequency and consequence aspects of the scenario.
- LOPA can be used to help an organization decide if the risk is "as low as reasonably practicable" (ALARP), which may also serve to meet specific regulatory requirements.
- LOPA helps identify operations and practices that were previously thought to have sufficient safeguards, but on more detailed analysis (facilitated by LOPA), the safeguards do not mitigate the risk to a tolerable level.
- LOPA helps provide the basis for a clear, functional specification for an IPL [ISA S84.01 (ISA, 1996) and IEC 61508 and IEC 61511 (IEC, 1998;2001)].
- Information from LOPA helps an organization decide which safeguards to focus on, during operation, maintenance, and related training.

For instance, many companies decide to focus their inspection, test, and preventive maintenance activities on the IPLs identified during LOPA; these companies often decide to run the remaining safeguards (those not identified as IPLs) to failure or subject them to less rigorous test and maintenance schedules.

Therefore, LOPA is a tool for implementing a wise PSM, mechanical integrity or risk-based maintenance system, and it aids in the identification of "safety critical" features and tasks. ■

MANAGING DUST EXPLOSION & OVERPRESSURE RELIEF IN PROCESS INDUSTRIES

*During the Tenth Anniversary Function, **Mr H Karthik,** B S & B Safety Systems (India) Ltd., delivered a special Technical talk on "Managing Dust Explosion & Overpressure Relief In Process Industries". The contents of his talk is given in this article.*

ABSTRACT

The potential for combustible dust hazards and abnormal chemical reactions in industrial processes is increasingly recognized. International Standards clearly define that owner / operators of processes handling such materials have responsibility for providing a safe workplace. The recognition is fundamental in the development of an appropriate risk management strategy. Quantifying risk is the first step towards cost effective implementation of prevention and protection measures as the foundation of risk management of combustible dust and abnormal chemical reactions. A disciplined approach to **'management of change'** that includes re-evaluation of these risks whenever a process is changed, is desired and to be adopted.

Casualty insurance companies and various inspection agencies at national, state and local levels require pressure systems to be designed, manufactured and tested in accordance with an accepted code(s).

INTRODUCTION

Personnel responsible for the design or safe operation of pressure systems should evaluate these following objectives when determining the quantity, type(s) and arrangement of pressure relief devices:

- Provide maximum safety for personnel
- Guard against damage to equipment.
- Comply with applicable code(s), rules and regulations
- Minimize loss of product during normal operation
- Cut maintenance by extending the time period between major maintenance of relief systems

Applicable Standards and Codes – NFPA 68, 654- Dust Explosion-Prevention & Protection and ASME Sec VIII – Unfired Pressure Vessels guidelines provide a thorough understanding of "Appropriate Safety Devices" that can be installed.

In response to increased global demand for materials such as foodstuffs, chemicals, pharmaceutical preparations, wood & metal products, the processing of combustible materials on an industrial scale is growing rapidly. The February 2008 accident at a sugar refinery in Savannah, Georgia, USA, which resulted in 14 fatalities serves as a reminder that **an everyday material** can present a risk to the safety of personnel and **plant in developed as well as developing industrial nations**. With the global thirst for affordable energy with an acceptable Carbon footprint, increased investment in prevention and protection technologies is encouraging economic and environmental stimulus on the industrial landscape.

BS&B Safety Systems in India is creating awareness of installation of Explosion Vents, Rupture Disks and Suppression Systems and through this article outlines the concept of providing a safe working place in the process industries handling DUST, LIQUID, GAS AND VAPOUR media.

DUST EXPLOSIONS

Understanding Dust Explosion Risks

Initiatives commenced in October 2007 by the United States Occupational Safety & Health Administration (OSHA) provide an up to date appraisal of the ambient state of combustible dust safety in Industry. OSHA wrote to the owners of 30,000 facilities processing combustible dust under its 'Combustible Dust National Emphasis Program', which began in October 2007 and implemented a systematic program of site inspections. In March 2009, an interim summary of audit findings over a 16-month period identified the following:

- 3,662 safety violations issued from 813 inspections; 4.5 violations per inspection
- 74% of violations cited as 'serious'
- 18% of inspections 'in compliance'
- Nature of violations:
  - * Unacceptable housekeeping
  - * Electrical Code not met
  - * Indoor dust collectors without proper explosion protection
  - * Absence of 'isolation systems' between items of equipment to arrest propagation of dust explosion
  - * Rooms with excessive dust build up not provided with explosion relief venting

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* Bucket elevators not provided with explosion protection
* Explosion venting directed into work areas
* Dust tight equipment operation not practiced, creating housekeeping challenges
* Pulverizer systems not explosion protected
* Ductwork lacking explosion protection
* Propane heating with open flame in an area grinding agricultural products
* Lack of preventive maintenance on mechanical equipment creating heat & friction
* Explosion protection not provided on hoppers, silos, bucket elevators, dust collectors

This snapshot of findings from the United States is the only survey of its kind. Other surveys of combustible dust risks are based upon the analysis of accident and loss *history* – this survey is pro-active to enable industry to better protect it ***before*** the destructive power of a dust explosion arises. The specific violations identified are found globally and therefore provide an important 'lesson learned' giving an opportunity for the combustible dust handling and processing industry to focus on and redouble its efforts in risk management.

Normal & abnormal conditions

Typically abnormal processing conditions present the greatest risk of combustible dust explosions. Whenever normal operation by automated equipment must be replaced by manual intervention, new hazards are present that must be reviewed and controlled. The abnormal presence of a plant operator already increases the risk consequences of a dust explosion event. Where the operator can impact or bypass the intended safety measures, abnormal risk scenarios arise.

As a consequence, the owner / operator receives what is intended to be a fully protected process that has safety flaws for which the owner / operator is responsible. For example, a dust collector protected by explosion vents that have been correctly sized for the dust hazard appears to present a well protected application (Figure 1). However, the operating condition of this vent arrangement changes in an instant at the moment of vent activation. A powerful flame ball will be ejected from the dust collector that may extend over 30 meters in reach and 10 meters in diameter (Figure 2). Any personnel in the path of the flame ball would perish. Any equipment of building structures in the path of the flame ball would be damaged or destroyed.

As illustrated above, a vented dust explosion application, each process needs to be considered both alone and as a component of a production facility to ensure implementation of the right explosion protection and prevention technology. Usually a hybrid of prevention and protection measures is required to achieve required levels of safety.

Figure 1. Outdoors Explosion Vent Installation On Dust Collector

Turning to prevention, the appropriate use of process control, dust explosion safety driven facility procedures & the deployment of modest technology can insulate a facility from combustible dust hazards. Some of the most successful strategies are:

Figure 2. Flame Ball arising from activation of Explosion Vent

- Housekeeping to limit combustible load (< 1mm dust accumulation)
- Management of electrostatic build-up, especially for low minimum ignition energy dusts
- Management of spark ignition sources (e.g. grinding, milling) by use of Spark Detection + Extinguishing technology.
- Maintaining a process dust loading below half the minimum explosible concentration
- Maintaining a reduced oxygen concentration with dual redundant interlocked sensing.

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OVER PRESSURE RELIEF

Understanding Abnormal Over-pressure Situations

Chlorine leak in a chemical plant, Ammonia leak in a urea production facility, Explosion and fire in a paint manufacturing plant, Leak and ignition of toluene in a pharmaceutical production facility, Atmospheric pollution generated by a refinery, Leak on a LPG storage tank/ Horton Spheres and Fire in Solvent Tanks in Tank Farm Areas are some real world realities and have to be protected.

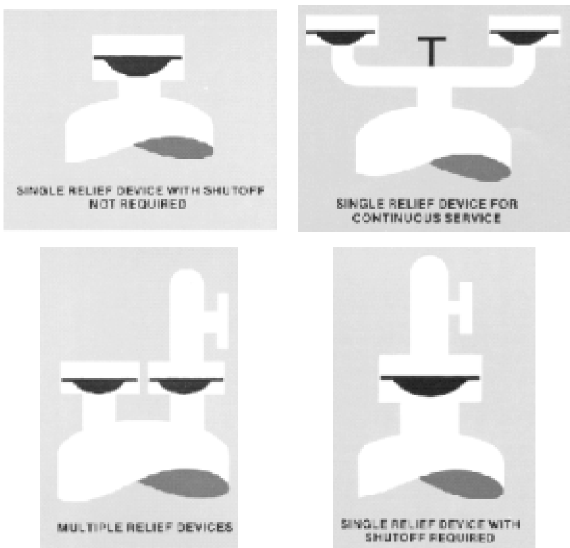

Figure 3. Rupture disks installation

Overpressure Relief in Pressure Vessels - Don't Gamble with Safety

Relief devices in a secondary classification are not discussed in any code. Although codes mention capacities for primary relief devices by defining permissible overpressure, **the unknown from an exothermic or runaway reaction dictates the need for greater capacity.** This extra capacity comes from one or more secondary relief devices.

Non-mechanical fast-acting Rupture Disks will provide the needed relief area should an abnormal overpressure develop.

The major factors to be considered when determining the pressure rating for secondary relief devices are normal system pressure, product in the process, and type of rupture disk.

Rupture disks (also known as "bursting disks") shall be considered:

- To accomplish a fast response time, which cannot be achieved with a Pressure Relief Valve (PRV). This could be required to cope with a sudden gas breakthrough due to a heat exchanger tube burst or malfunctioning of a level control valve into a liquid-filled system;
- To prevent PRVs in vacuum service from drawing gas or air back into the process;
- To protect PRVs from being in continuous contact with a corrosive, solidifying, or polymerizing process fluid;
- To protect PRVs from accumulation of solids and dusts;
- To prevent leakage of very toxic substances through the PRV.

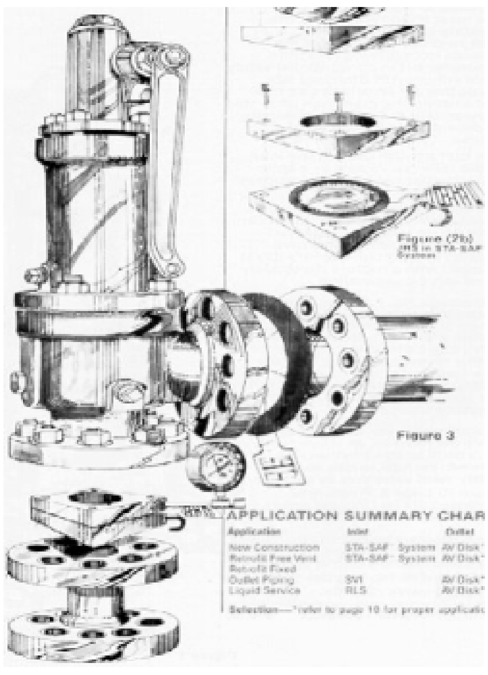

Figure 4. Rupture disk is installed upstream & downstream of a PRV

Tank Farm Protections:

The API 2000 is a standard that covers the normal and emergency venting requirements for aboveground storage tanks and vessels. These tanks are normally operated at very low pressures (inches of water column) but can have Maximum Allowable Working Pressures up to 15 PSIG. They store a variety of raw, intermediate and finished materials.

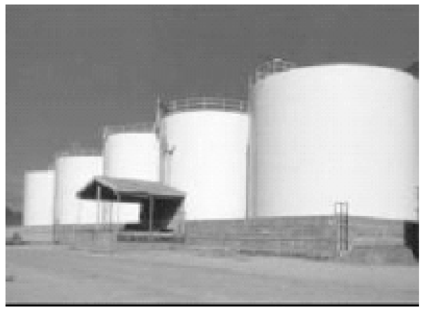

Figure 5. Tank farms

API 2000 sizing includes the effects that environmental cooling and heating may have on the tank- Low flash or low boiling point? Or High flash or high boiling point? Rupture Disk is the answer.

CONCLUSIONS

With improved Standards to aid the owner / operator of a combustible dust and/or abnormal chemical reactions in the process industries, risk evaluation and risk management can be effective. Explosion Vents, Explosion Suppression Systems, Rupture Disks can be effective safety relief devices to mitigate risks. BS&B will guide to prevent, protect and isolate from hazardous & explosive dusts, gases, vapors, liquids that are toxic, fugitive emissions as required by latest Codes & Standards. ■

THE MANY FACES OF FIRE HAZARDS IN INDUSTRIAL SETTINGS

Fire and explosion accidents are of major concern to the owners and operators of refineries and petrochemical, gas processing, terminal, and offshore facilities. Statistics have shown that the majority of monetary loss in these types of complexes is due to fire and explosion. According to statistics, 77 percent of the monetary loss in refinery and petrochemical complexes is due to fire and explosion. The breakout of accidents due to fire and explosion is 65 percent vessel (container) and vapor cloud explosion and 35 percent fire. The causes of these accidents are mostly attributed to mechanical issues, process upset, and operator error.

Fire in an industrial setting can pose a number of hazards for the facility, its personnel, and the surrounding communities and can result in an assortment of damage. The release of a flammable material may result in several scenarios: a fireball, pool fire, flash fire, flare or jet fire, and an unconfined vapor cloud explosion.

Two of the main inherent hazards associated with fires are thermal radiation and smoke. Smoke is defined as the products of combustion, including toxic gases, water vapor, and carbon soot particles. The smoke created from fire poses two types of danger. Soot particles may obscure visibility, and hazardous chemicals may constitute a health hazard due to inhalation and eye irritation.

A fire also may present indirect hazards. One is, its possible impingement on a vessel containing liquid, such as a large storage tank. In this circumstance, a condition called BLEVE (Boiling Liquid Expanding Vapor Explosion) may occur. Boilover is a second indirect hazard caused by the effects of a fire. Boilover is especially dangerous when water is used to put out oily hydrocarbon liquid fires from a vessel. In the following paragraphs, we describe each of the above items in more detail.

Types of Fire Hazards

- **Thermal radiation.** One of the main dangers of fire is its thermal radiation and the effect of that radiation on people and property. Thermal radiation diminishes with the inverse square of distance. The American Petroleum Institute and TNO, a Dutch research group, have published books explaining how to estimate the thermal radiation impact and the radiation's estimated damage potential based on distance from a fire. According to these guides, the thermal radiation necessary to generate second degree burns on exposed skin is 9500W/m2 (~370° C), given an exposure duration of more than 20 seconds.
- **Smoke.** Fires generate smoke, which is a mixture of soot particles, toxic gases, and water vapor. Factors such as smoke yield, fire size, particle size, and ambient conditions dictate smoke's transport into the environment. Studies show that soot particles can be generated in a range of 0 to 20 percent of fuel by weight during a pool fire. However, the air-to-fuel ratio and the amount of carbon in the molecular structure of chemicals play a major role in soot yield.

A higher soot rate is expected for a large pool fire with heavy hydrocarbon fuels. Soot particles in a range of 0.01 to 10 microns are respirable and can penetrate into the alveolar region of the lungs. A mean soot particle size for the majority of these fuels can be considered 5 microns. The generated soot particles may adsorb toxic gases from the products of combustion, which present public health concerns due to the inhalation potential of these toxic particles. Given this, the downwind dispersion and deposition of these particles and their effects on the environment and humans is of major concern.

For example, consider a pool fire of 4500 Kg crude oil in a diameter of 40 meters that generates a soot particle plume. The soot particles yield a maximum of 20 percent of crude oil mass. The weather conditions are assumed to be unstable with a wind speed of 5 m/s and ambient temperature of 70° F.

Soot particle concentrations are considered in the three isopleth levels of 1, 10, and 100 mg/m^3. In this case, the soot particles are rising to high elevation due to high temperature and buoyancy. Thereafter, the soot particle plume starts to touch the ground about 1,200 meters distance from the fire source. In this example, calculations show soot particles can expose a region of 4,500 meters distance, after two hours of simulation, which would represent the area to be notified of possible evacuation or shelter-in-place.

Ground-level soot particle deposition occurs in a wide area with a distance of 8,000 meters. The isopleth concentrations on the ground are defined in the three levels of 1, 10, and 100 mg/m^2. This mapped information helps hazmat and emergency responders to identify the high impact areas of

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soot particle deposition for immediate evacuation. However, it should be noted that wind speed and direction, pool fire size, soot yield, and soot particle size can change the impact of the soot plume on the environment and the population located near the fire.

Deliberate ignition: Fire can sometimes be a great tool for mitigating a hazardous chemical's potential impact. The technique of igniting gases containing hazardous chemical substances has been successfully used for many years at oil and gas well sites. A prime example is the sour gas from wells; considerable amounts of hydrogen sulfide (H_2S) are contained in the natural gas.

Hydrogen sulfide smells like rotten eggs and is extremely toxic and irritating, even in a lower concentration such as 100 ppm. The dispersion of 40,000 ppm H_2S in the sour gas can create a large hazard zone in the ambient. However, igniting the sour gas will produce CO_2, CO, and a small amount of SO_2, plus unburnt H_2S, with no ground-level impact of the H_2S. Therefore, fire can sometimes serve as an effective mitigation technique for hazard reduction.

BLEVE (Boiling Liquid Expanding Vapor Explosion): BLEVE is a phenomenon that is caused by an external fire impinging on a storage vessel, causing the heating of the liquid contents with a resulting pressure buildup. If the vessel's relief valve is not designed to vent the vapor as fast as it is generated or the relief valve malfunctions, then the vessel may fail completely, resulting in an explosion with vessel fragments being projected over the surrounding area. These fragments have the real potential to puncture pipes or other vessels in the vicinity of the explosion, causing a domino effect. Fragment projectiles traveling distances of up to one mile have been reported in a BLEVE.

Boilover: When fighting semi-enclosed oil or petrochemical fueled fires using water, a secondary hazardous event called boilover may occur that is extremely dangerous. Some of the water will sink to the bottom of the tank or other vessel due to density differences, which will result in the formation of a water layer. The heat from the fuel will ultimately boil the water, creating steam. The rapidly expanding steam expels the fuel upward to boil over and out of the container, discharging the still-ignited fuel onto a large and uncontrolled area outside the container. The best way to prevent this phenomenon is to open the valve at the bottom of the tank to drain the water.

A common household example of this phenomenon can occur when water is used to put out a burning pan of cooking oil.

Vessel Venting/Flare: When dealing with a vessel that is about to explode, one option is to vent and burn the discharging material, basically turning the explosive event with its uncontrolled disaster potential into fire which has a lower hazard impact and is more controllable.

Conclusion: This article has exposed the many faces of fire hazards and fire damage possible in an industrial setting. The details presented, highlight the need for effective and rapid consequence modeling of hazardous materials emanating from a fire. Such modeling can help firefighters, hazmat teams, and other emergency responders properly study and better understand the impact of the many hazards associated with fire, such as thermal radiation, toxic smoke, and particulates, thus enabling better situational analysis and more informed decision making during and after a fire event.

Such analysis and decision making permits faster life-saving measures to be undertaken regarding evacuation, shelter-in-place, and other essential response actions. In the end, these measures help to reduce the potential for injury, loss of life, and property and environmental damage. ■

HEALTH TIP

The Chinese and Japanese drink hot tea with their meals, not cold water, maybe it is time we adopt their drinking habit while eating.

It is nice to have a cup of cold drink after a meal. However, the cold water will solidify the oily stuff that you have just consumed. It will slow down the digestion. Once this 'sludge' reacts with the acid, it will break down and be absorbed by the intestine faster than the solid food. It will line the intestine. Very soon, this will turn into fats and lead to cancer. It is best to drink hot soup or warm water after a meal.

CASE STUDY

CASE STUDY 1

Natural gas causes explosion in a building

Description: In a meat processing plant a new natural gas line had been installed to supply fuel to a water heater. The new pipe was being purged with natural gas to remove air. The natural gas from the purge was released into a building intermittently over a 2 ½ hour period. An explosive mixture had formed inside the building and got ignited. The explosion destroyed the building, killed 4 workers, injured 67 people, and caused a release of 18,000 pounds of ammonia.

Causes for the accident: Natural gas is considered to be only as a fuel but it can also cause an explosion. The release of any flammable gas or volatile flammable liquid from piping or equipment has the potential to cause an explosion if any ignition source is available.

The purged natural gas which was let into the building got ignited and has caused the explosion.

Remedial Measures:

- A small amount of flammable gas or vapor can create an explosive vapor cloud in a building or room. For example, it only takes about 5 Kg of propane to create a flammable mixture in a room 2 6 m. x 6 m. x 3.5 m. 5 Kg of propane packs as much energy as 50 Kg of TNT!
- Any closed space such as a building or room can allow a released flammable material to accumulate to an explosive concentration.
- It is better to have a Risk assessment to understand the presence of fire and explosion hazards of the materials natural gas, propane, and other fuels!
- When purging equipment and piping (for example, when preparing equipment for maintenance), make sure flammable materials are vented to a safe location, away from personnel and ignition sources. Follow your plant procedures for safely purging flammable materials.
- Whenever possible, purge flammable vapors and gases to collection systems which go to flares, scrubbers, or other treatment systems. Avoid purging indoors, and conduct a thorough hazard analysis to identify job specific precautions to protect personnel if this is unavoidable. \

Use flammable gas detectors to monitor areas where flammable materials may be vented or purged

CASE STUDY 2

Fall of walkway Grating

Description: At a construction site, a walkway grating weighing around 15 Kg was provided at a height of 20 m and it was used as a Toe Guard at the builder hoist access platform.

As the walk way grating was not rigidly tied , it has fallen from a height of 20 m on a worker who was standing at ground level. The binding wire tied with grating gave away due to contact with the moving bucket of builder hoist has caused the accident and the worker who was working underneath could not withstand the impact, succumbed to injuries even though he was wearing a safety helmet.

Causes for the accident: The binding wire tied with the grating might have been damaged due to contact with the moving bucket of builder hoist and caused the accident.

Remedial Measures: Risk aseessment should be conducd before undertaking any risky job.

The walkway grating should be fastened rigidly instead of being tied with wire.

The grating with static load of 15 Kg falling from a height of 20 m will lead to an impact of nearly 3 tons of load and hence merely wearing a safety helmet will never be a safe method of work and it is only a secondary line of defence.

IN THE NEWS

How Do Workers Perceive Chemical Risks

According to a new study, workplace hazard communication might not always be as effective as we'd like to believe New research from Belgium has made some very important findings about chemical safety in the workplace.

The study, entitled "Workers' Perception of Chemical Risks: A Focus Group Study" was published in a recent issue of Risk Analysis, the journal of the Society for Risk Analysis.

Findings indicate that there's a lot of room for improvement in hazard communication.

The study was based on interviews with 7 focus groups, each consisting of 5 to 10 blue-collar workers. The objective of the study was to examine how employees view the chemical risks they face daily on the job.

The scientists who conducted the study believe their research reveals important new findings about chemical safety in the workplace in particular, and safety in a general sense as well.

Key Findings:

These are the key findings of this study:

Workers view working with chemicals as dangerous and are seriously concerned about long-term health effects, but they nevertheless accept safety risks as part of job and don't think there's much they can do about it.

There is a fundamental lack of trust among rank-and-file employees for managers and supervisors.

Communication barriers often exist between management and employees, which pose serious obstacles to effective hazard communication.

Workers feel management doesn't listen often or seriously enough to their concerns and suggestions for improving workplace safety and health.

Workers' perceptions about chemical risks are insufficiently taken into account when workplace safety and health programs are developed.

Employees frequently fail to refer to the MSDS or label because they say this information is often too hard to understand and not easy to use.

When workers have a question about chemical hazards or precautions, they are more likely to turn to co-workers for answers than their supervisor or the MSDS.

Findings suggest training programs intended for supervisors and safety personnel should be substantially revised to include topics such as listening to and understanding workers' perceptions, the usefulness of a participatory approach, and various communication and education skills. This will allow supervisors and safety personnel to communicate information about chemical hazards and precautions in a more "worker-friendly" manner.

Companies should include more input from experienced workers in training programs. "By passing on information to our [co-workers] we feel like we're contributing to our own safety," says an employee from one of the focus groups. "It's a much better idea to ask those people who are actually doing the job for information, rather than [those who are] just sitting at a desk. The folks working on the shop floor have a different view and have more experience."

HAZARDOUS WASTE

CRT: CRT monitors and TVs contain and average of 4 pounds of lead each. Excessive lead and other toxins pose a problem in landfills because they can leach into groundwater or, in the case of a lined landfill, force expensive leachate treatment. In combustors, the lead winds up on the ash residue, which in turn disposed of in landfills. Lead exposure has been linked with learning disabilities, behavioral problems and at very high levels, seizures, coma and even death.

BATTERIES:

Lead-Acid/Automotive Batteries: Lead batteries are this country's principal source of power for automobiles, trucks, motorcycles, boats, forklifts, golf cats, lawn and garden tractors, and wheelchairs. These heavy, rectangular batteries contain sulfuric acid, which can burn skin on contact.

Alkaline Batteries: Alkaline batteries are standard household batteries. They are used in product from walkmans and clocks, to smoke detectors and remote controls. Since -1994, most types contain no added mercury or only contain trace amounts. These batteries are market as in the "no added mercury" or may be with a green tree logo.

Button Batteries: These batteries are named for being small round and silver-colored. They are most commonly found in watches and hearing aids. Many button batteries contain mercury or silver oxide. Both metal that are toxic to humans when inhaled or ingested.

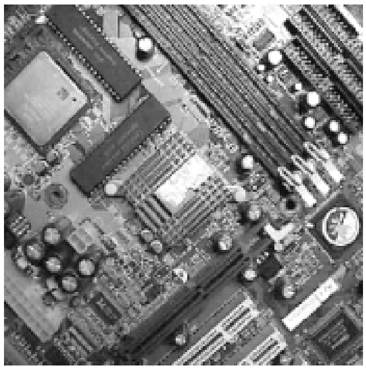
Nickel-Cadmium Rechargeable Batteries: These batteries are marked "Rechargeable" and are found in many products including: cell phones, cordless phones, laptops, power tools, camcorders and remote controlled toys. NiCads contain cadmium, a metal that is toxic to humans when inhaled or ingested.

Lithium Batteries: These batteries are mainly used in computer, camcorders, laptop and cameras, lithium ignites when in contact with water and has been notorious for causing serious fires.

Printers: Most printer cartridges are easily recycled, refilled or re-built. But printer vendors sell the printer cheap, and make their real money selling supplies. The "right" environmental solution is to sell new cartridges with a postage paid mailer for returning the old one. Some advanced companies, such as Hewlett-Packard, have been known to do this especially for laser printers.

Old Refrigerators, Heat Pumps and Air Conditioners: Mostly, old refrigeration equipment contains Freon, a chemical known as a Chlorinated Fluorocarbon or "CFC" Each molecule of a CFC can destroy over 100,000 molecules of the earth's protective ozone coating, leading to increased risk of sunburn, cataracts and skin cancer for the entire population of the planet (human and animal)

Motor Oil: Used motor oil contains heavy metals and other toxic substances and is considered hazardous waste. One quart of oil can kill fish in thousands of



gallous of water. Motor oil containers should mention the danger of used oil to humans and the environment.

Paper: Most types of paper can be recycled. Newspapers have been recycled profitably for decades and recycling of other papers is rising. Virgin paper pulp prices have soared in recent years prompting construction of more plants capable of using waste paper. The key to recycling is collecting large quantities of clean, well-sorted, uncontaminated and dry paper.

Glass, Steel Aluminum Cans and Foil: Glass, steel and aluminum are easy to recognize and recycle. Glass bottles must not be mixed with other types of glass such as windows, light bulbs, mirrors, glass tableware, Pyrex or auto glass. Ceramics contaminate glass and are difficult to sort out. Clear glass is the most valuable. Mixed color glass is nearly worthless and broken glass is hard to sort out.

Plastic: With a little bit of care, plastic can be recycled. The awareness of recycling plastic is increasing rapidly. However, there is one drawback. Different types of plastics must not be mixed together while recycling. This can ruin the entire process of recycle.

Tenth Anniversary of SEA (India)

Chief Guest Mr. Babu Rao, Joint Chief Inspector of Factories, Government of Tamilnadu addressing the gathering

Dr. R.K. Elangovan, Director, Regional Labour Institute, Chennai receiving Fellowship Certificate from the Chief Guest

Mr. K. Deepan Kumarasamy, topper of the NEBOSH December 2010 batch receiving the Shield and certificate from the Chief Guest

Jitender Kumar Arya, topper of the NEBOSH March 2011 batch receiving the shield and certificate from the Chief Guest

POISONING OUR AIR

Burning coal is one of the leading sources of human-caused global warming. But did you know that coal-fired power plants are also the single largest source of mercury pollution in the United States?

Mercury exposure can attack the nervous system, affecting everything from brain development to muscle coordination.

Newborns are especially susceptible to mercury exposure. Mercury released into the atmosphere settles into rivers, lakes and oceans, where it is absorbed and ingested by fish. When expectant mothers eat the tainted fish, they pass the mercury on to their children. In fact, as many as one in six U.S. women of childbearing age may already have enough mercury in their bodies to harm a pregnancy.

Toxins like mercury, along with dioxins, acid gases, and other heavy metals, are poisoning our air.

27th Technical Meet

27th Technical meet was held on Saturday, 14th May, 2011 at Chennai. Mr K N Sen, Head – HSE, L & T, Chennai delivered the talk on **"Excellence in Safety – Learning from London".**

Large number of SEA India members attended the Technical Meet.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