



**SLP**

**SOCIETY of**

**LOSS PREVENTION**

**news**

*In the Oil, Chemical & Process Industries (Singapore)*

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# SLP TECHNICAL TALK

## Lessons Learned from an Accident Investigation

Mr. Kenneth Harrington, Senior Process Safety Adviser, Chevron Phillips Chemicals Company (CPCChem) presented a talk on "Lessons learned from an accident investigation" to about 30 SLP members and guests on March 23, 2005 at the Jurong Country Club.

A contributory cause was the inadequate oversight (inspection/monitoring) of the plant by the regulatory body.

The full investigation report is available on the Chemical Safety Board (CSB) USA website.

As for the lessons learned from this accident, Ken stressed that effective operator training and technical management of process safety are critical to prevent catastrophic events such as the Sierra Chemical Company explosion. These root causes were serious system problems and pointed to management failures within the organization.

In his presentation, Ken also elaborated on the requirements for effective accident investigation. He highlighted the following key points:

**Preparation – have everything ready well ahead of time**

- "Go bag" – investigation supplies
- Trained personnel
- Investigation technique
- Interviewing skills
- List of specialists and specialty laboratories

**Competing Objectives** – bias of investigation body will skew the results. For this accident, there were several investigations going on.

- Sierra Chemicals
- Local police
- Occupational Safety and Health Administration (OSHA)
- Bureau of Alcohol, Tobacco, and Firearms (ATF)

**Analysis Method** – choose an analysis method appropriate to the complexity of the accident.

- US Department of Energy Accident Investigation Procedure
- MORT (Management Oversight Risk Tree)
- TapRoot®
- Why-Tree
- Checklist

**Prioritize Investigation** – Choose analysis detail based on risk assuming failure of the most critical safeguard is credible or probable.



*Ken Harrington illustrating his talk with an overview of the Kean Canyon Facility*

The primary purpose of accident investigation and analysis is to determine the root cause of the accident so that a repeat of the accident can be avoided. As such, the accident investigation must produce factual information leading to the basic/root causes that can reasonably be identified. These basic/root causes ideally should also be in areas that a manager/owner has control over and can put right.

Mr Harrington cited the Sierra Chemical's Kean Canyon Explosive Manufacturing Plant accident investigation, with which he was personally involved in. Ken shared the lessons learned from this investigation. He presented the following root causes, mostly process safety system issues, established by the investigation team on the Sierra explosion:

- **Process hazard analysis was inadequate**
- **Training programs were inadequate**
- **MOC (management of change) of personnel was inadequate**
- **Written operating procedures were not available**
- **The facility was built with insufficient separation distances**
- **There was no systematic safety inspection or audit program**
- **Employee participation was inadequate**

# Editorial

**Protect evidence** – rescue and emergency responders have different concerns from accident investigation

- Take pictures – early and often
- Look at the crowd
- Cover evidence
- Limit access until investigation complete
- Look in fire water run-off

**Stay the Course** – don't jump to conclusions

- Examine evidence, interview people, review records
- Conflicting goals
- Look for possible management system failures
- Don't stop at "the" root cause
- Analyst integrity

Ken concluded the talk by quoting the Columbia Accident Investigation Finding 3

*"Organizations must learn from "small" incident (weak signals) and not wait until a major catastrophe occurs to deal with operational or safety issues"*

*The main lesson from the Columbia Accident Investigation -- The power of a company's culture to influence behavior for good or ill*



The talk was followed by a very interesting discussion between Ken and members of the audience.

Our President, Richard Gillis, ended the proceedings by thanking Kenneth Harrington for his interesting presentation and presented him with an SLP memento.



*It's not all serious business -- Ken Harrington with Richard Gillis and SLP members enjoying dinner after the talk*

*By Tay Cheng Pheng*

Note : SLP members who like to have a soft copy of Ken's presentation may obtain one by contacting Ms Lylian Law at the SLP Secretariat.

This issue is the last one before our Annual General Meeting (AGM). This important event is being held on June 30. Normally, your Executive Committee would be elected at the AGM. This year is, however, our in-between year. This means that we will not be electing any council member except for the Hon. Treasurer who is elected every year. The other council members are elected to serve two-year terms. You should use the upcoming AGM as a way to stimulate some thinking about where you want your SLP to go. Can we do more? Can we do better? Obviously, the answer is yes to both questions. No organization can stand still and hope to survive. SLP, being a voluntary professional society, is dependent on its members' voluntary contributions for its well being. How can members contribute? They can serve on its executive committee and sub-committees. They can present technical talks. This is our most frequent activity. Our members have wide and useful experience to share. Without blowing our own trumpet too much, we can point to the outstanding SHE performance of the industries we work in. As we all know, the performance did not come about miraculously. It points to the fact that we do know something quite precious. Let's share this wealth. In past technical talks, the question and answer session that followed each talk had been as enlightening as the talk itself. So everyone present had enriched the proceedings and had benefited. Even if you do not present the talk, you can share your experience and most definitely increase your knowledge. Our next technical talk is on May 25 on Bio-remediation as a means to decontaminate oily residues. It is by Mr Gregory Poi, an SLP member, who is a lecturer at the Singapore Polytechnic School of Chemical and Life Sciences.

Members can present papers at our conferences and seminars. This year, we are having our local conference, "New Initiatives in Loss Prevention", on September 21 and 22. Many of our members are not only presenting papers, they are also leading workshops. See the article on this conference for more details.

Members may conduct training courses. The training course on May 18 on Job Safety Analysis (JSA) is taught by Mr John Lockwood, an SLP member and a well known safety professional. Members have received the details of this course through our announcements. Attendees can expect a very rewarding experience. As stated in our second announcement, the **MOM has awarded 7 SDU's** for this course. At the time of writing we are expecting a full house. Members and others who are hesitating about signing on may still do so because we are planning a second course for those who cannot be accommodated in the first one.

Members may offer their work sites for plant visits. On April 20 a group of members visited Glaxo Smith Kline (GSK) at Pioneer Sector 1. Mr Alan Loh, EHS Director for GSK and an SLP member, was our very hospitable and knowledgeable host. See the article by Michael Yan for more details.

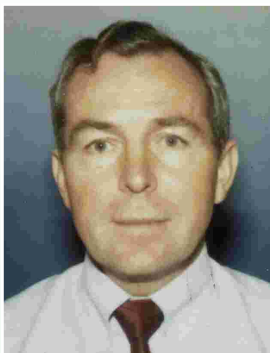
What about our executive committee and sub-committees? There is no need to say too much about the executive committee except to say that it manages the affairs of SLP. The sub-committees should receive more attention than they do. We have the following sub-committees:

- a) Technical
- b) Education and Training
- c) Conference
- d) Publication, and
- e) Social

We invite members to volunteer to serve on these sub-committees. We guarantee that members will find the experience very rewarding. The time commitment is not much because we can do much of the business via e-mail.

Finally, members know that SLP members not only work, they also know how to play. Jacob Soh and his Social sub-committee put on their super party on April 16. If you missed it, you can enjoy it vicariously by reading Jacob's article and be consoled by the thought that there will be a better party next year.

# President's Message



It is unfortunate that the investigation reports about most incidents in the oil, chemical and process industries are never made public. We have to speculate as to the root causes of these incidents. However there are organisations, such as NASA, that are so highly visible that any incident is public knowledge. Their incident investigation reports are in the public domain<sup>1</sup>. In our industries in the USA, incidents that are considered to be of sufficient public concern are investigated by the Chemical Safety Board and its reports are placed in the public domain<sup>2</sup>.

Even when the individual reports are not made public the root causes are. The US EPA have summarised the root causes they and OSHA have seen in their investigations<sup>3</sup>. Recurring causes of these accidents include inadequate process hazard analysis, use of inappropriate or poorly-designed equipment and inadequate indication of process conditions. Of particular note, installation of emission or pollution control equipment has preceded several significant accidents, highlighting the need for stronger systems for management of change. Other accidents have been preceded by a series of similar accidents, near-misses, or low-level failures, pointing to the need for more attention to be paid to lessons that can be learned from such incidents. This serves to demonstrate the need for a more thorough company investigation of near-misses and low-level failures. The effective follow ups from these investigations are good ways of avoiding major accidents.

One common factor is present in all these reports - Process safety incidents are the result of management system failures<sup>4</sup>.

Singapore is not immune to this failure.

Recent reports on incidents in Singapore imply the same conclusion and, I suspect, the Nicoll Highway enquiry will reach the same conclusion.

Singapore has recognised that change is necessary. The recent publication of SS 506 Occupational Health & Safety Management System (OHSMS) by SPRING Singapore sets out requirements for a management process. The recent announcement by Dr Ng Eng Hen, Minister for Manpower<sup>5</sup>, regarding the Workplace Safety and Health Act and the management of chemicals implies that effective management systems will be required in the future. Factory occupiers will be required to conduct comprehensive risk assessments and then to implement a risk management plan that will eliminate or mitigate the risks that have been identified.

This means that companies must have competent people to perform the risk assessments and to determine the most practicable risk management solutions to protect the health and safety of their employees and 3rd parties.

These activities are perfectly aligned with the objectives of the SLP. We intend to keep providing you, our members, with the processes and the knowledge to be these competent professionals. To this end, we have organized and will continue to organize relevant training programs for you and other SHE professionals. If you feel that a particular training course is needed, please let us know.

<sup>1</sup> For example see the reports on the Columbia and Challenger disasters at <http://www.nasa.gov/columbia/home/> and <http://science.ksc.nasa.gov/shuttle/missions/51-l/docs/rogers-commission/table-of-contents.html> respectively.

<sup>2</sup> See <http://www.csb.gov/>

<sup>3</sup> James C. Belke, International Conference and Workshop on Reliability and Risk Management, September 15-18, 1998

<sup>4</sup> Guidelines for Technical Management of Chemical Process Safety, CCPS

<sup>5</sup> <http://www.mom.gov.sg/MOM/CDA/0,1858,3669-----7442----,00.html>

## Bio-remediation of oil contaminated soil and sludge

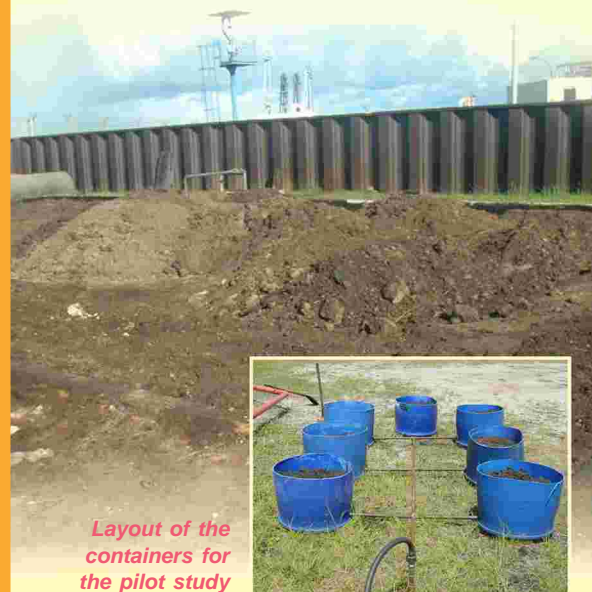
This is the title of the Technical Talk to be held on May 25 at Jurong Country Club.

Mr Gregory Poi, an SLP member and a lecturer at Singapore Polytechnic School of Chemical and Life Sciences, will talk on his experience of successfully using bio-remediation as a means of decontaminating soil and sludge. His work with micro-organisms and conditioners has demonstrated that it is both technically and economically feasible to use bio-remediation, on an industrial scale, in Singapore. The technique he has developed can reduce oil/petroleum contaminated soil and sludge from a starting contaminant level of 50,000 ppm to less than 1000 ppm in nine weeks. This performance is a major improvement over other bio-remediation techniques that may take many months or even years to achieve the same degree of effectiveness. The cost is also very competitive when compared to costs of S\$ 250 to over S\$ 400 per ton for alternative technologies such as incineration and thermal desorption.

Mr Poi is also very knowledgeable about treatment of industrial waste water. He is prepared to discuss this subject both before and after the talk.

Members have already received announcements about this talk from our Secretariat. If they have not yet registered, they can still do so by e-mailing our Secretariat (Ms Lylian Law).

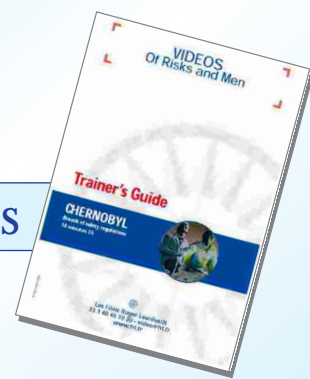
*An industrial sized biotreatment pit being filled. Note the mounds of contaminated material in the pit. The capacity of the pit is 250 m tons.*



*Layout of the containers for the pilot study*

# BOOK REVIEW

## Trainer's Guide on CHERNOBYL - Breach of Safety Regulations



### INTRODUCTION

**Trainer's Guide on CHERNOBYL - Breach of safety regulations**, a 15-page booklet, is part of a 10- minute safety training video of the same title published by **Les Films Roger Leenhardt**. The guide contains a summary of the Chernobyl accident, a script for the safety trainer to explain each scene in the video and the lessons learned from the incident.

While it is about the nuclear industry, the lessons are universally applicable. The guide can be used, i) for general safety training, ii) as a refresher prior to a new procedure implementation, iii) as a topic at a safety meeting, iv) to generate discussion at a seminar, v) as an awareness tool for a site inspection and vi) as a refresher prior to an audit. It deals with:

- The safety culture (or the absence of it)
- Probable situations where the operating teams may not be familiar with the operating principles, mechanisms and the limits of their system
- Errors due to lack of knowledge, qualifications and training and the use of under-qualified and even untrained personnel
- Poor design eg. lack of a containment chamber
- Failure to do a proper Job Safety Analysis (JSA) eg. preparation for a test
- Blatant breaches of safety regulations
- Managing the trade-off between security/ safety and managerial authority
- Judgements made without an adequate analysis of risks
- An individual's role in decision-making
- Situations when an individual might rightfully refuse to obey an instruction
- Individual responsibility for public safety and the environment when operating a hazardous installation



### SUMMARY

At 1.24 AM on Saturday 26 April 1986, a massive explosion destroyed the core of the fourth reactor of the Chernobyl nuclear power plant in the former USSR. The accident occurred when the operators were conducting an electrical test that required the reactor power to be cut back to about one-third of its rating.

Under pressure from the management to complete the test, the operation teams breached several safety regulations:

- Operated the reactor for a long period at reduced power
- Operated for a long period in manual control

- Disabled alarms
- Disconnected emergency shutdown systems
- Shut OFF the backup cooling system
- Raised too many control rods and
- Switched ALL the pumps ON simultaneously

The test started at 01:23:04. Water flow rate into the reactor dropped causing a critical excursion in the reactor. At 01:23:40, the supervisor panicked and activated the emergency shutdown system. The control rods began to descend. This caused a sudden increase in the reactor power. The core temperature shot up within a few seconds and the core was distorted. The control rods jammed mid-way and cooling water pipes burst. The graphite, water and zirconium in the fuel ducts reacted violently. At 01:23:58, the reactor exploded.

32 people were killed instantly. Many more died from radiation poisoning. 70 tons of radioactive materials were scattered around the power plant. In addition, 50 tons of radioactive gas and dust swept across the skies of Europe for several months.



### THE SCRIPT

The script consists of four parts:

- Description of the Installation
- Preparing for the Test
- The Accident
- Explaining "Breaches of Safety Instructions"

#### 1. Description of the Installation

The following are shown: An aerial view of the Chernobyl complex, photos of the plant before and after the explosion and animated diagrams of the various sections of the reactors.

#### 2. Preparing for the Test

In this section, the sequence of events in the preparation for the test is shown. In each scene, an explanation is given about how the operator reacted to the situation leading to a series of safety regulation breaches that subsequently caused the fatal explosion

#### 3. The Accident

The accident is described. Aerial photographs taken at various angles show the devastation

#### 4. Explaining "Breaches of Safety Instructions"

This is a discussion section where the trainees are guided to discover the "breaches of safety instructions"



Today - Chernobyl encapsulated in a sarcophagus

### LESSONS LEARNED

The Guide highlighted three fundamental lessons.

**FIRST** - disasters of this type can happen. Safety managers, department managers, operators and ordinary people need to be aware that our complex technological systems are not protected from failures of these kinds no matter how remote it is. So disaster scenarios have to be imagined. Personnel must be trained so that they know how to react and manage the system as best they can. They should be wary of soothing words uttered on the subject; these are counter-productive for industrial safety.

**SECOND** - The barrier between us and any disaster is the safety culture of the designers and operators. Safety culture is an awareness of the danger and the desire to take steps to minimize the risks. It is a combination of attitudes, procedures, behavior and reflexes that remove the danger. The first prerequisite for eliminating the danger is an in-depth knowledge of the system being operated, i.e. technology, laws and the physical, chemical and regulatory rules of the processes. It is the manager's duty to ensure that the operators possess this knowledge and are fully qualified. At Chernobyl there was no safety culture. The technicians in charge of the test were not fully familiar with their nuclear system. They were unaware of its dangers. They were oblivious to the impending accident when they succumbed to pressure by their management to do the unthinkable.

**THIRD** - A breach of safety instructions is not to be taken lightly, even if at first it does not have any serious consequences. Company employees must always combat this type of behavior and not hesitate to make it clear to a colleague tempted to breach safety instructions that they disapprove. These types of behavior must also be analyzed in order to understand what causes them and how they can be corrected.



City of Pripyat near the Chernobyl – deserted

### WHAT THE GUIDE DID NOT COVER

The guide did not adequately cover the original design flaws that resulted in an inherently unsafe plant.

### CONCLUSION

This short video did not cover the root cause. This is a disappointment. However, it has its uses as stated in this review.

The Guide and a 2-minute trailer can be downloaded free of charge from the website but the video is chargeable. The URL is available in the SLP website.