Process Safety Management System

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RISK CONSULTING | EDUCATION SERVICES | SAFEGUARD PROFILER | SAFEGUARD SENTINEL

Presenter

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Mr. Guillermo Pacanins is an Electrical Engineer with over 27 years of experience with knowledge in Process Controls and Functional Safety in the process industry. He has taught several courses in Process Automation to some of the largest companies in the world. With Mr. Guillermo's excellent communication and leadership skills, combined with his in-depth understanding of Process Safety Engineering makes him a successful functional safety analyst/educator. Guillermo is a TÜV Functional Safety Engineer / Expert and teaches several functional safety workshops globally for ACM. Also, Guillermo has a Process Safety Practice Certificate from Texas A&M university, Mary Kay O'Connor Center for Process Safety.

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Outline

Process Safety Management System

1) What is the purpose of a Process Safety Management System? (PSM).
2) PSM background
   Regulations - guidelines: OSHA, HSE, AIChE - CCPS, Canadian perspective.
3) PSM and the professional engineer – APEGA
4) Process Safety and Personnel Safety differences
5) Process Safety Management Framework, and elements
   Risk Based Process Safety Guidelines, RBPS
6) Application – implementation of PSM strategy and Safety Culture
7) Auditing and Assessment of PSM system
8) Conclusions – Closing arguments

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What is the purpose of a Process Safety Management System?

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Process Safety

Process

To perform a series of mechanical or chemical operations on matter in order to change or preserve it.
A series of operations performed in the making or treatment of a product.

Process engineering

Focuses on the design, operation, control, and optimization of chemical, physical, and biological processes

Process Safety

Focuses on the application of safe engineering and design principles, safe operating practices, proper preventing controls, and safe optimization of chemical, physical, biological, etc. processes that have the potential to cause harm by uncontrollably releasing hazardous materials or energy.
(e.g. release of hazardous materials, (loss of containment), uncontrollable release of energy, (explosion, fire)).

Process Safety Management System

Thomas More (1478-1535).
Management consists of the interlocking functions of creating corporate policy and organizing, planning, controlling, and directing an organization's resources in order to achieve the objectives of that policy.

Management of Process Safety consists of the interlocking functions of creating corporate process safety policy and organizing, planning, controlling, and directing organization's resources in order to achieve process safety.

To Manage, in an organization, is the function that coordinates the efforts of people to accomplish corporate policy objectives using available resources efficiently and effectively.
Management comprises planning, organizing, coordinating, leading or directing, and controlling an organization to accomplish corporate policy objectives.

Managers have the responsibility to make decisions to accomplish corporate policy objectives (achieve process safety).

Decisions have uncertainties and risks comes from uncertainties.

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Process Safety Management System

Process Safety Management is a is a set of values, assumptions, concepts, and practices that form a structure for supporting the management and integrity of hazardous operating systems and processes by applying good design principles, engineering and operational practices.

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Risk Management

Risk management is a prioritization process in which the risks with the greatest loss, (severity), and greatest probability of occurring are given first priority, and risks with lower probability of occurrence and lower loss are given lower priorities. Evidence of frequent occurring mishaps shows that assessing overall risk can be difficult, and that managing resources used to mitigate risks with a high probability of occurrence but lower loss versus mitigate risks with high loss but lower probability of occurrence are often be very hard to manage.

Typical Risk Management steps:

- Identify, characterize process hazards
- Assess the risk exposure of critical assets to specific hazards
- Determine the risk (i.e. assess the expected likelihood and consequence)
- Identify controls and resources to reduce those risks
- Prioritize risk mitigation measures based on a define criteria.

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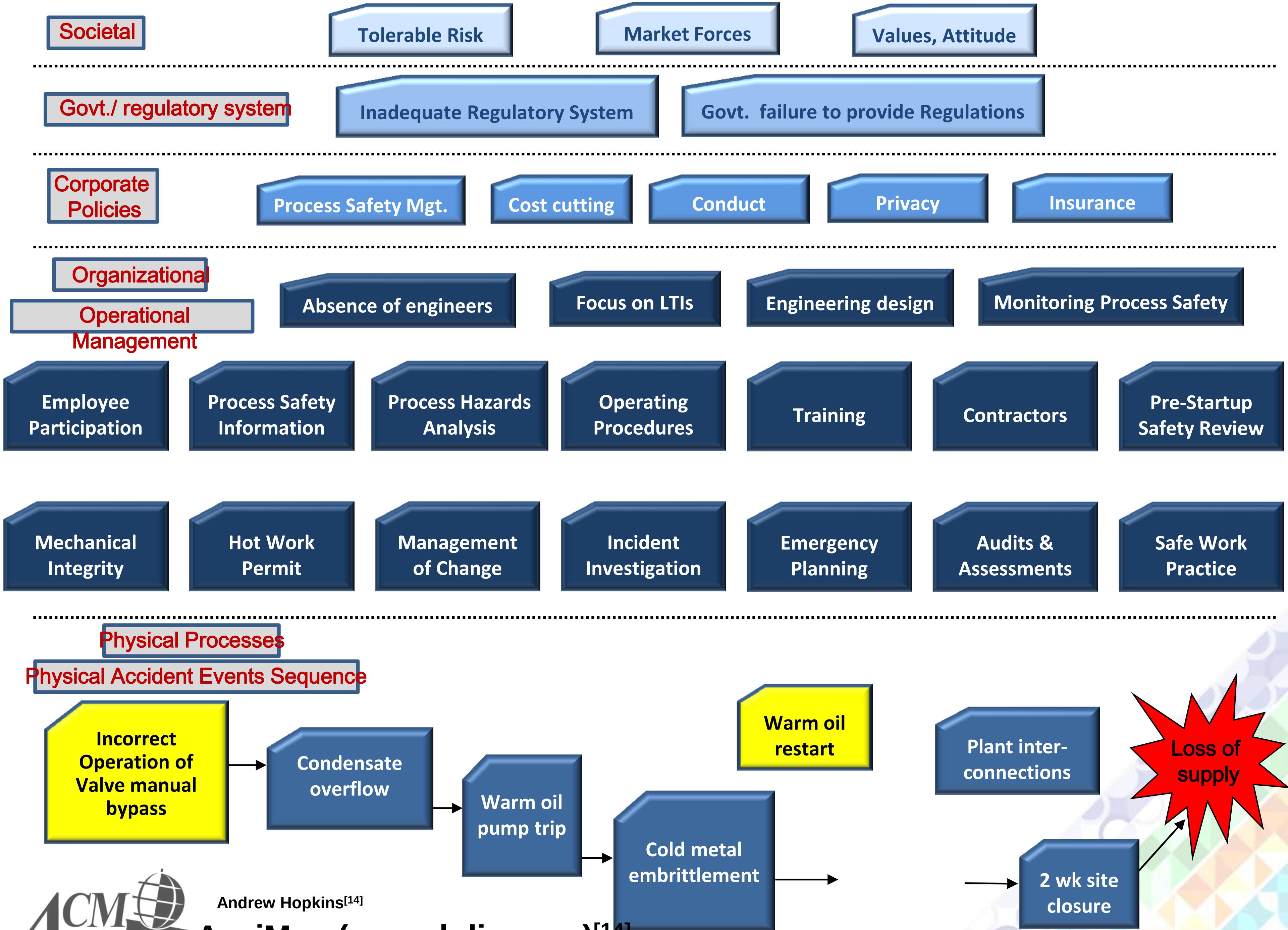

Andrew Hopkins[14]

AcciMap (causal diagram)[14]

What is the purpose of a Process Safety Management System?

The Amoco Lodgepole Blowout, outside Drayton Valley in west Central Alberta

At 2:30 p.m. on Oct. 17, 1982, near Lodgepole, 130 kilometres southwest of Edmonton, a well blew out after piercing a natural pressure cooker of methane, hydrogen sulphide and oily hydrocarbon vapours 3,000 metres beneath the drilling rig.

Energy Resources Conservation Board (or ERCB, now the Alberta Energy Regulator).

It took 67 days to stop the blowout. Two wild well tamers from Texas were killed. Estimates of economic costs, from lost production to wrecked equipment and evacuation expenses for Lodgepole area residents, ran into hundreds of millions of dollars.

http://www.calgaryherald.com/business/Part+Modern+industry+leaders+shaped+trials+fire/9823694/story.html

The Amoco Lodgepole Blowout

Marked by an unmistakable rotten egg-like smell, deadly hydrogen sulphide spewed across the countryside reaching as far as Saskatchewan. Some residents and livestock were evacuated, those who weren't were exposed to a suite of toxic gases causing many to fall ill.

A group of school teachers, farmers and 250 other concerned citizens banded together to ensure such an accident would never happen again. They forced a public inquiry and secured more than 80 regulatory changes.

Great emphasis was placed on changing industry and regulatory attitudes and habits. “It is clear that the major area of deficiency relates to the ‘human factor’,” concluded the Lodgepole inquiry.

The ERCB directed an industry renowned for boldness and speed to learn new ways: “An effective means of reducing the impact of human factor problems would be to require ... a very cautious and careful manner,” said the board.

All the right hardware to prevent blowouts was on hand at Lodgepole, the inquiry found. But the gear was neither kept in good working order nor used properly.

The ERCB formulated new personnel requirements: better training, risk awareness, readiness for unexpected problems, technical support, safe drilling plans, and improved working conditions such as relief staff to let ’round-the-clock well site bosses get some sleep.

Dwayne Waisman, a retired ERCB public safety and field surveillance manager, summed up the radical change in industry culture after Lodgepole in an interview for a 2013 anniversary book (Steward: 75 Years of Alberta Energy Regulation).

“Cautious and careful was a new thing,” said Waisman.

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Ocean Ranger Marine Disaster

On the night of the disaster, a severe storm pounded the rig with hurricane-force winds and 15-metre high waves. Seawater broke through a porthole in the ballast control room and damaged equipment. The rig tilted forward and water flooded the forward chain lockers; it capsized in the early hours of 15 February 1982.

84 lives and the rig itself were lost

Compounding structural flaws were low standards for worker training. "For example," wrote the commission, "persons assigned to operate the ballast control system, which is critical to the stability of the semisubmersible, were not required by any regulation to have formal training." (Report Two, p. 71)

No nationally recognized standards existed for safety training and government did not require industry to prove that employees were qualified for offshore work. Many workers learned through on-the-job training.

Ocean Ranger was designed and owned by Ocean Drilling and Exploration Company, Inc. (ODECO) of New Orleans. Constructed for ODECO in 1976 by Mitsubishi Heavy Industries in Hiroshima, Japan

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www.heritage.nf.ca/law/or_response.html

Royal Commission on the Ocean Ranger Marine Disaster

A month after the rig capsized on 15 February 1982, the federal and provincial governments jointly appointed a Royal Commission on the Ocean Ranger Marine Disaster. Chaired by Chief Justice T. Alex Hickman, the commission's mandate was to investigate three questions: why the Ocean Ranger sank?, why none of the crew survived?, and how similar disasters could be avoided?

The commission found a number of factors contributed to the disaster – severe weather conditions, flaws in rig design, and the industry's inattention to worker training and safety. The rig had been built in the Gulf of Mexico and was not tested for the much harsher waters of the North Atlantic. The ballast control system (which controlled the depth and angle of the rig) was unnecessarily complicated and located too close to the water. Thin porthole glass could not withstand stormy waves, and chain lockers near the front of the rig were not watertight and vulnerable to flooding.

CBC News, 2002 – Westray mine fire and explosion

On May 9, 1992, at 5:18 a.m., far beneath the small town of Plymouth, N.S., a sudden gush of methane gas escaped from the Foord coal seam and erupted into flames. Within seconds, a huge fireball raced through the mine, stirring up coal dust that exploded in a thundering blast.

A blue-grey flash lit up the pre-dawn sky. Homes more than a kilometre away shuddered as the shock wave rumbled through the earth.

In all, there were 26 men underground at the time, most of them in the final hours of a four-day shift.

"The Westray story is a complex mosaic of actions, omissions, mistakes, incompetence, apathy, cynicism, stupidity and neglect," said Mr. Justice Peter Richard in his report on the explosion and fire at the coal mine in Pictou County that day.

"As I stated in the report," the judge said, "compliance with safety regulations was the clear duty of Westray management. To ensure that this duty was undertaken and fulfilled by management was the legislated duty of the inspectorate. Management failed, the inspectorate failed, and the mine blew up"

http://www.cbc.ca/news/canada/nova-scotia/westray-remembered-explosion-killed-26-n-s-coal-miners-in-1992-1.1240122

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CBC News, 2002 – Westray mine fire and explosion

Ramsey Hart, a co-ordinator with Mining Watch Canada, says Westray's legacy can be measured in the application of the so-called Westray Act, a federal law enacted in 2004 that provided new rules for attributing criminal liability to corporations and representatives when workers are injured or killed on the job.

The law has been used in criminal prosecutions several times, but the courts have registered just two convictions.

"We don't seem to have switched the mentality to these being issues of criminality," Hart says. "Unfortunately, we are still seeing an unacceptable number of fatalities in mines. There are some disturbing indications that we may be losing some ground."

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THE WESTRAY MINING DISASTER

20 YEARS LATER

A TIMELINE OF KEY EVENTS IN THE WESTRAY INCIDENT

Since 1976, the Ontario mining industry's lost time injury rate has improved by **96%**.

"The mining workplace is inherently dangerous. It is not a muffin shop. Everyone who works at a mine site recognizes the dangerous nature of the work."
— Judge B.A. Bruser, R. v. Supreme Steel Ltd.

Sept. 11, 1991: the mine officially opened

Oct. 2, 1991: the drive to unionize the miners officially began

Spring 1992: the union drive succeeded, although it wasn't certified until after the explosion

April 29, 1992: a government inspector gave oral and written orders to clean up and treat coal dust immediately and produce stonedusting and dust sampling plans

May 6, 1992: the inspector revisited the mine but didn't follow up on his prior orders

May 9, 1992: an explosion killed 26 miners; only 15 bodies were recovered

May 15, 1992: Justice K. Peter Richard was appointed to head the Royal Commission of Inquiry's investigation of the incident

March 1993: OHS violations against the mining company were dropped to protect the integrity of pending criminal charges

Feb. 1995: two mine managers went on trial for criminal negligence and manslaughter

March 1997: the Supreme Court of Canada ordered a new trial because the prosecution failed to disclose certain evidence

June 30, 1997: the prosecution dropped the criminal charges, saying there wasn't enough evidence to win

1998: the Royal Commission's report was released

March 31, 2004: passed in response to Westray, Bill C-45 took effect, making it easier to hold companies and corporate officers criminally liable for serious workplace safety incidents

The BC mining industry hasn't experienced a mine operations fatality since **Sept. 2009**, the longest period of time without fatalities since 1898.

DEATHS in the Mining, Quarrying & Oil Well Industries

- 2008: **87**
- 2009: **69**
- 2010: **82**

Source: AWCBC

C-45 AT A GLANCE:

1. You can be prosecuted for **both criminal negligence and OHS violations** for the same incident.
2. There's **no time limit** on when the government can bring criminal negligence charges.
3. C-45 applies to **all workplaces** across Canada.
4. **Criminal negligence charges** may apply not only when there's a fatality but also when someone has been injured;
5. **Due diligence** is essentially a defence to criminal negligence, although not in the same way as to OHS violations.
6. What the Crown has to prove for a criminal negligence charge depends on whether the defendant is an **individual or an organization,** such as a company.
7. The definitions of **"representative"** and **"senior officer"** for C-45 purposes are very broad.
8. You can't assign or contract out of **C-45 liability.**
9. **Insurance** won't cover your fine for a criminal negligence conviction.

C-45 COMPLIANCE CENTER

For more information on C-45, including the elements of a criminal negligence charge and how to protect your company and individuals, such as officers and directors, supervisors, and JHSC members, from facing such a charge, go to the OHS Insider's C-45 Compliance Center.

CBC News, 2002 – Westray mine fire and explosion

On March 31, 2004, nearly 12 years after the incident, Bill C-45 - Amendments to the Criminal Code, C-21, Affecting the Criminal Liability of Organizations, often referred to as the “Westray Bill,” came into force and became law. In short, Bill C-45 significantly lowers the threshold for organizations to be charged and convicted of criminal negligence.

Criminal Code C-21, Section 217.1

217.1 Everyone who undertakes, or has the authority, to direct how another person does work or performs a task is under a legal duty to take steps to prevent bodily harm to that person, or any other person, arising from that work or task.

The impact of a conviction using Criminal Code C-21, Section 217.1.

- Following an incident, companies will have a legal requirement to demonstrate that the measures taken to prevent the incident from occurring were reasonable and that the circumstances which led to the incident were extremely unusual and could not have been foreseen and therefore prevented.

- It also highlights the importance of documentation. Records of current and accurate operating and maintenance procedures and up-to-date worker training, for example, may either help or hurt companies should incidents occur.

http://www.cbc.ca/player/Shows/Shows/The+National/Canada/ID/22323202

http://www.parl.gc.ca/About/Parliament/LegislativeSummaries/bills_ls.asp?ls=c45&Parl=37&Ses=2

Ontario, Sunrise Propane property massive explosions

Several massive explosions rocked a Sunrise Propane property just after 3 a.m. Aug. 10, 2008, killing employee Parminder Saini, 25, and raining poisonous asbestos and debris on neighbourhoods in the Keele St. and Wilson Ave. area.

Two company managers, Shay Ben-Moshe and Valery Belshov, were also found guilty of failing to take proper safety measures before the explosion, which occurred during an illegal truck-to-truck propane transfer.

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Thestar.com

Ontario, Sunrise Propane property massive explosions

Former Sunrise truck driver Felipe De Leon survived the blast and testified that he saw strange smoke or fog — later identified as propane vapour — during a truck-to-truck transfer just before the explosion.
An Ontario Fire Marshal's report, completed two years later, said this kind of transfer was illegal.
"We were told to do truck-to-truck transfers. I had no idea it was illegal to do that," De Leon said during the trial.
A class-action lawsuit on behalf of those living in the surrounding neighbourhoods claims the industry's self-regulating body, the Technical Standards and Safety Authority (TSSA), was aware that truck-to-truck transfers of propane were occurring and failed to take action.
In Thursday's decision, Justice Leslie Chapin agreed, writing that TSSA inspector Don Heyworth did not enforce an order instructing Sunrise to stop the truck-to-truck transfers after he learned they were still going on.

City Councillor Maria Augimeri said the decision proves that industry should not be allowed to regulate itself.
"People pay the cost when industry cuts corners," she said in a statement.
"The province privatized community safety by allowing the TSSA to regulate this dangerous industry, and this is the result — a completely negligent act that was directly responsible for lives lost."

http://www.thestar.com/news/crime/2013/06/27/verdict_expected_in_sunrise_propane_trial_over_deadly_2008_toronto_explosion.html

Quebec, Lac-Mégantic Railway accident, Fire and explosion

The transport of volatile crude oil by rail poses a serious risk and urgent action is needed to minimize risks, the Transportation Safety Board warns.

On 5 July 2013, at about 10:50 p.m., after arriving in Nantes, Quebec, a Montreal, Maine & Atlantic Railway (MMA) locomotive engineer parked a train on a descending grade on the main track.

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Quebec, Lac-Mégantic Railway accident, Fire and explosion

When a fire began in the engine of the lead locomotive, in keeping with railway instructions, emergency responders shut off the engine, which subsequently caused the air holding the locomotive air brakes to leak off. Without enough force from the handbrakes, the train began rolling downhill toward Lac-Mégantic, just over seven miles away. As it moved down the grade, the train picked up speed, reaching a top speed of 65 mph. It derailed near the centre of town at about 1:15 a.m.

Almost all of the derailed tank cars were damaged, and many had large breaches. About six million litres of petroleum crude oil was quickly released. The fire began almost immediately, and the ensuing blaze and explosions left 47 people dead. Another 2000 people were forced from their homes, and much of the downtown core was destroyed.

http://www.tsb.gc.ca/eng/enquetes-investigations/rail/2013/r13d0054/r13d0054.asp

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International disasters

International disasters that have defined the need for process safety management regulations.

- Flixborough, United Kingdom, 1974
- Seveso, Italy, 1976
- Bhopal, India, 1984
- Pemex LPG Terminal, Mexico City, Mexico, 1984
- Grangemouth, Scotland UK, 1987
- Piper Alpha Platform (Offshore), UK Continental Shelf, 1988
- Arco, Channelview, Texas, 1991
- Esso Longford Gas Plant, Victoria, Australia, 1998
- Texas City, Texas, Marathon 1987, BP 2005
- Buncefield Oil Depot Fire, Hertfordshire UK, 2005
- ConAgra Foods, North Carolina, 2009
- Macondo (Offshore), Gulf of Mexico, 2010

Process Safety in Canada – Canadian Perspective

- The initial process safety efforts in the 1980s and 1990s stressed the importance of rule-base regulations.

  Later-on process safety efforts shifted to management systems for process Safety.
- In Canada, (1985 – 1988), the Chemistry Industry Association of Canada (then the Canadian Chemical Producers' Association) drafted the first Responsible Care® Codes, (Bhopal, 1984)
- Canada responded to Bhopal by creating the Major Industrial Accident Council of Canada (MIACC) in 1987. MIACC was officially dissolved in 1999 due to governance issues and lack of funding.
- MIACC intellectual property, was split between the Canadian Association of Fire Chiefs (CAFC) and a newly formed Process Safety Management Division of the Canadian Society for Chemical Engineering (CSChE).
- Major Industrial Accidents Council of Canada (MIACC) PSM Committee produced the first two editions of the "PSM Guidelines" and the "Site Self-assessment Tool" (1999)
- The Process Safety Management (PSM) Division was formed as a subject division of the Canadian Society for Chemical Engineering (CSChE) October 14, 2000.
- Documentation issued by the PSM Division

  Process Safety Management Guidelines, 3rd ed., 2002

  Managing the Health & Safety Impacts of Organizational Change, 2002.

  Guidelines for Site Risk Communication, 2005

  Risk Assessment – *Recommended Practices* for Municipalities and Industry, CSChE 2005

Today's attention is being placed on:

Distinction from Rule-Based to Performance-Based Regulation

Distinction between Personal Safety and Process Safety

Increased Attention on Corporate "Safety Culture"

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Process Safety Management Today

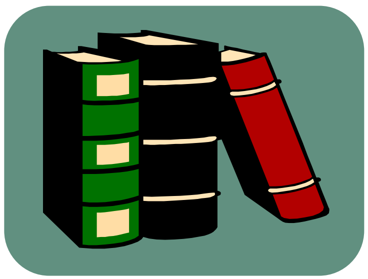
Standards-based Strategy → Compliance-based Strategy → Continuous Improvement-based Strategy → Risk-based Strategy

What should I do?

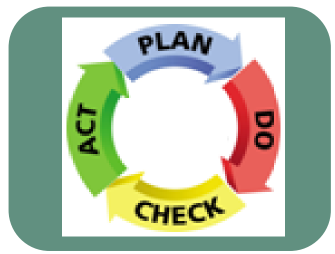
What do I have to do?

What can I improve based on my experience?

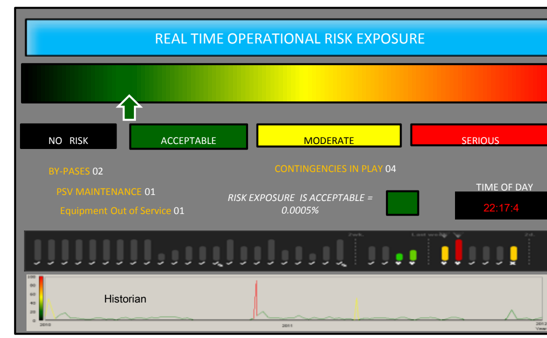
How can I better manage risk?



Assure Compliance with legal requirements and commitments



Achieve and sustain Continuous Improvement in operational performance



Monitor adequate Risk Control and Management

Today's attention is being placed on:

Distinction from Rule-Based to Performance-Based Regulation

Distinction between Personal Safety and Process Safety

Increased Attention on Corporate "Safety Culture"

Decision making under uncertainty (Risk Based Strategy)

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Process Safety Management (PSM)
and
the professional engineer – APEGA

CODE OF ETHICS

(established pursuant to section 19(1)(j)of the Engineering, Geological and Geophysical Professions Act)

Preamble

Professional engineers, geologists and geophysicists shall recognize that professional ethics is founded upon integrity, competence, dignity and devotion to service. This concept shall guide their conduct at all times

Rules of Conduct

1 Professional engineers, geologists and geophysicists shall, in their areas of practice, hold paramount the health, safety and welfare of the public and have regard for the environment.

2 Professional engineers, geologists and geophysicists shall undertake only work that they are competent to perform by virtue of their training and experience.

3 Professional engineers, geologists and geophysicists shall conduct themselves with integrity, honesty, fairness and objectivity in their professional activities.

4 Professional engineers, geologists and geophysicists shall comply with applicable statutes, regulations and bylaws in their professional practices.

5 Professional engineers, geologists and geophysicists shall uphold and enhance the honour, dignity and reputation of their professions and thus the ability of the professions to serve the public interest.

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APEGA - Professional Practice Guidelines

Through the Practice Standards Committee, APEGA provides members and the public with guidance on the roles and responsibilities of professional members through the development of guidelines and practice standards and the publication of practice articles in The PEGG and on line. On a day-to-day basis, Professional Practice Department staff also respond to individual inquires and requests for assistance with practice issues.

Documents:
GuidelineEthical.pdf
ManagementofRisk.pdf "Guideline for Management of Risk in Professional Practice"
http://www.apega.ca/regulatory/PStandards/toc.html

APPLICATIONS OF RISK MANAGEMENT
The risk management process can be applied, either informally or formally, to any professional practice or organization, at any level, to any decision.

Canadian Centre for Occupational Health and Safety, CCOH&S

Why does due diligence have special significance?

"Due diligence" is important as a legal defense for a person charged under occupational health and safety legislation. If charged, a defendant may be found not guilty if he or she can prove that due diligence was exercised. In other words, the defendant must be able to prove that all precautions, reasonable under the circumstances, were taken to protect the health and safety of workers.

What is meant by due diligence?

Due diligence is the level of judgement, care, prudence, determination, and activity that a person would reasonably be expected to do under particular circumstances.

Applied to occupational health and safety, due diligence means that employers shall take all reasonable precautions, under the particular circumstances, to prevent injuries or accidents in the workplace. This duty also applies to situations that are not addressed elsewhere in the occupational health and safety legislation.

To exercise due diligence, an employer must implement a plan to identify possible workplace hazards and carry out the appropriate corrective action to prevent accidents or injuries arising from these hazards.

Due diligence is demonstrated by your actions before an event occurs, not after.

http://www.ccohs.ca/oshanswers/legisl/diligence.html

Professional Engineer “Due Diligence”

Why does due diligence have special significance?

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Due diligence is the level of judgement, care, prudence, determination, and activity that a person would reasonably be expected to do under particular circumstances.

Applied to engineering health and safety, due diligence means that professional engineers must take all reasonable precautions, under the particular circumstances, to prevent injuries or accidents as a result of their work. This duty also applies to situations that are not addressed elsewhere in the legislation.

To exercise due diligence, a professional engineer must implement a plan to identify possible engineered hazards and carry out the appropriate corrective action to prevent accidents or injuries arising from these hazards.

Due diligence is demonstrated by your actions before an event occurs, not after.

http://www.ccohs.ca/oshanswers/legisl/diligence.html

"Defense of Due Diligence"

Reasonably Practical [16]

It is not practicable to reduce risk to a tolerable level with respect to the risk posed by a hazard which is not known to exist.

As soon as the hazard is known to exist it must become reasonably practicable to eliminate, or reduce the risk it poses to a tolerable level.

It is an strict obligation to eliminate, or control the known hazards.

It would be considered to be an act of negligence to proceed knowing that a hazardous situation is present and there are no controls to reduce the risk of the harmful situation to a tolerable level.

Negligence occurs when the following concepts are not met:

duty of care

Reasonably foreseeable that another individual will suffer harm

standard of care

What would a reasonable person have done in a similar circumstance

causation

Both the plaintiff and defendant equally at fault

remoteness

The resulting injury or damage could be reasonably foreseen at the time of the incident

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Alberta Legislation, The Right to Know

Occupational Health & Safety Act

Occupational Health & Safety Code 2009

Hazard Assessment

Part 2, Section 8(2) of Alberta OH&S Code

8(2) An employer must ensure that workers affected by the hazards identified in a hazard assessment report **are informed of the hazards and of the methods used to control or eliminate the hazards**

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How does a professional engineer establish due diligence?

The conditions for establishing due diligence include several criteria:

- The professional engineer must have in place written policies, practices, and procedures. These policies, etc. would demonstrate and document that the professional engineer carried out audits, identified hazardous practices and hazardous conditions and made necessary changes to correct these conditions, and provided information to enable safe work by the user.
- The professional engineer must have the appropriate training and education to carry out work according to the established polices, practices, and procedures.
- The professional engineer must monitor his workplace and ensure that policies, practices and procedures are being followed. Written documentation of progressive disciplining for deviation of pre-established safety rules is considered due diligence.
- There are obviously many requirements for the professional engineer but users of their work also have responsibilities. They have a duty to take reasonable care to ensure the safety of the public and environment - this includes following safe work practices and complying with regulations.
- The professional engineer should have an accident investigation and reporting system in place. Users should be encouraged to report "near misses" and these should be investigated also. Incorporating information from these investigations into revised, improved policies, practices and procedures will also establish the professional engineer is practicing due diligence.
- The professional engineer should document, in writing, all of the above steps: this will give the professional engineer a history of how his work and procedures have progressed over time. Second, it will provide up-to-date documentation that can be used as a defense to charges in case an accident occurs despite an professional engineer's due diligence efforts.

All of the elements of a "due diligence program" must be in effect before any accident or injury occurs. If professional engineers have questions about due diligence, they should seek legal advice for their jurisdiction to ensure that all appropriate due diligence requirements are in place.

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Process Safety & Occupational Safety Differences

Occupational Safety vs. Process Safety

Occupation: the work that a person does - a person's job or profession
What is your occupation?
Can you identify some situations that can cause you harm while doing your job?
Can you identify some hazards in your occupation?
Can you identify some hazards related to your profession? (Policeman, Electrician, Firefighter, Operator (process) etc.)

<u>Occupational safety</u> is a multidisciplinary field of healthcare concerned with enabling an individual to undertake their occupation, in the way that causes least harm to their health and safety.

<u>Process safety</u> is "a disciplined framework of activities with the intent to achieve and maintain the integrity of hazardous processes by applying recognized and accepted good design, engineering, and operating practices".

Process safety applies to those processes that are inherently hazardous and need controls in order to achieve the condition of being functionally safe.

Occupational Safety vs. Process Safety

Occupational Health and Safety

- Workplace rules
- Worker training
- Supervision
- Individual behaviors
- Safety equipment, PPE
- Focus on individual well being

Objective: to eliminate injuries and illnesses to personnel, and to protect assets, production, and the environment.

Process Safety

- Collective commitment
- Addresses events over which the individual worker often has little or no control
- Focus on systems
- Broader impact – events that could affect groups of workers or general public

Objective: to eliminate, prevent, avoid process-related incidents.

Process Safety is the use of engineering and management competence focused on preventing catastrophic accidents, in particular explosions, fires, and toxic releases, associated with the use of chemicals and petroleum products.

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Occupational Safety vs. Process Safety

In the case of oil and gas process operations hazards types can be approached in two ways:

- **Process upset hazards** these are the hazards that are inherent to the processes as they are always present but contained within the process boundary.

  (pressures, temperatures, etc.)

- **Personnel Safety hazards** these are safety work practices hazards for which there are stablishes procedures to safely handle or manipulate the hazard. (Occupational hazards – safe work practices – e.g. LOTO, confined space entry, etc.)

Forces Driving PSM into Process Industry

- **Human, Economic, Environmental loss**
- Legislation & regulations
- **Societal risk tolerance**
- Corporate standards
- International standards
- Professional ethics
- Insurance underwriters
- Recognized industry trend

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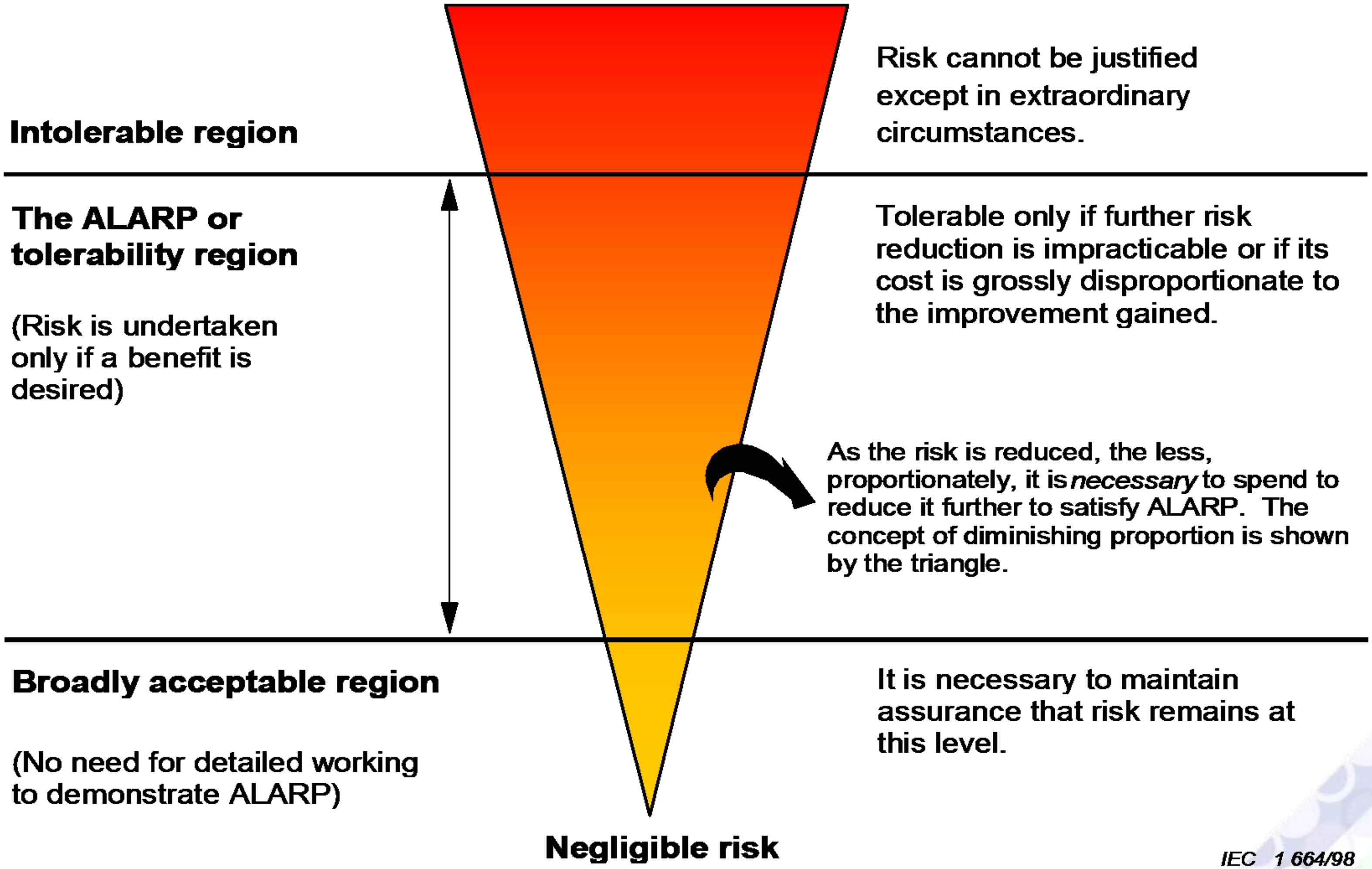
Risk

Combination of the probability of occurrence of harm and the severity of that harm - IEC 61511 - 1, 3.2.64

Risk = Probability x **Consequence (Severity)**

(Assuming exposure)

Tolerability of Risk - TOR



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What is an Acceptable or Tolerable Risk ?

Tolerable Risk

Risk which is accepted in a given context based on the current values of society (IEC 61511 – 3, 3.2.89)

UK HSE has written:
". . . 'tolerable' does not mean 'acceptable.' It refers instead to a willingness by society as a whole to live with a risk so as to secure certain benefits in the confidence that the risk is one that is worth taking and that it is being properly controlled. However, it does not imply that . . . everyone would agree without reservation to take this risk or have it imposed on them." [HSE 20021]

Recognizing that eliminating all risks is impossible, organizations prefer to speak of carefully managed residual risks being tolerable.

What is an Acceptable or Tolerable Risk ?

The ALARP principle: the residual risk shall be as low as reasonably practicable.

The Right to Know	
Part 2, Section 8(2) of Alberta OH&S Code	An employer must ensure that workers affected by the hazards identified in a hazard assessment report **are informed of the hazards and of the methods used to control or eliminate the hazards.**

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Risk Assessment

Hazard Identification and Risk Analysis is an activity performed to estimate the value of risk, and consist in answering the following fundamental questions:

1. What can go wrong that could lead to a hazard exposure and loss event?
2. How likely is the hazardous event to happen?
3. If the hazardous event happens, how likely are the consequences resulting from the hazardous event?

To answer question number one needs to define a list of scenarios with the credible potential to end with the hazard exposure and loss event.

Question number two is the frequency, likelihood or probability of the hazard exposure event to happen.

Question number three is with respect to the magnitude or severity if the expected consequence is realized, (if a loss occurs due to the hazard event exposure).

Decisions under uncertainty of risk analysis

The risk is influenced by several factors:

1. Potential harm inherent in an activity considered beneficial
2. Adverse consequence of an undesirable event, which brings out the harm potential of a situation
3. Uncertainty of whether the undesirable event will happen or not (likelihood)
4. Perception about the combination of the three above

We include in decisions our perception risk.

Accurate understanding of the identified hazards influence the likelihood estimation of undesirable events, and will lead to: more balanced perceptions; and hence to better decisions with less uncertainties "when managing an activity"

(synonymous with "managing the risks of an activity").

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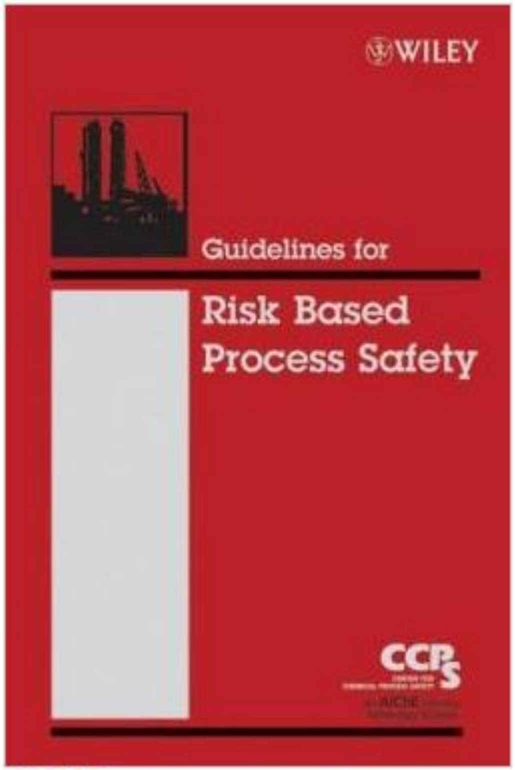
Risk Based Process Safety Guidelines



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Commit to Process Safety

- Process Safety Culture
- Compliance with Standards
- Process Safety Competency
- Workforce Involvement
- Stakeholder Outreach

Understand Hazards and Risk

- Process Knowledge Management
- Hazard Identification and Risk Analysis

Manage Risk

- Operating Procedures
- Safe Work Practices
- Asset Integrity and Reliability
- Contractor Management
- Training and Performance Assurance
- Management of Change
- Operational Readiness
- Conduct of Operations
- Emergency Management

Learn from Experience

- Incident Investigation
- Measurement and Metrics
- Auditing
- Management Review and Continuous Improvement

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RBPS **Elements**	**OSHA PSM Elements**
Commit to Process Safety	**Commit to Process Safety**
• Process Safety Culture • Compliance with Standards • Process Safety Competency • Workforce Involvement • Stakeholder Outreach	Process Safety Information Employee Participation
Understand Hazards and Risk	**Understand Hazards and Risk**
• Process Knowledge Management • Hazard Identification and Risk Analysis	Process Safety Information Process Hazard Analysis
Manage Risk	**Manage Risk**
• Operating Procedures • Safe Work Practices • Asset Integrity and Reliability • Contractor Management • Training and Performance Assurance • Management of Change • Operational Readiness • Conduct of Operations • Emergency Management	Operating Procedures / Safe Work Practices Hot Work Mechanical Integrity Contractor Training Management of Change Pre-startup Safety Review Emergency Planning and Response
Learn from Experience	**Learn from Experience**
• Incident Investigation • Measurement and Metrics • Auditing • Management Review and Continuous Improvement	Incident Investigation Compliance Audits

Process Safety Management

SEVESO II (COMAH)	OSHA 1910.19	SAFETY CASE
Process description	Employee participation	Platform description
Surrounding environment	Training	Reservoir description
Management system	Process hazard analysis	Management system
Policy	Mechanical integrity	Policy
Organisation	Process safety information	Organisation
Processes	Operating procedures	Processes
Risk assessment	Hot work permit	Risk assessment
Permit to work	Management of change	Permit to work
MOC	Pre start-up review	MOC
Performance measurement	Emergency planning & response	Performance measurement
Audit & review	Incident investigation	Audit & review
Major hazard identification	Contractors	Major hazard identification
Systematic	Compliance audits	Systematic
Major hazard risk assessment	Trade secrets	Major hazard risk assessment
Demonstration of:		Demonstration of:
Prevention		Prevention
Control		Control
Mitigation		Mitigation
Emergency Response Plans		Evacuation Rescue & Recovery
Safety Report		Safety Case

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Canadian Society for Chemical Engineering

Process Safety Management Standard 1st Edition

1. Accountability: Objectives and Goals
- Continuity of operations
- Continuity of systems
- Continuity of organization
- Quality process
- Control of exceptions
- Alternative methods
- Management accessibility
- Communications
- Company expectations

2. Process Knowledge and Documentation
- Chemical and occupational health hazards
- Process definition/design criteria
- Process and equipment design
- Protective systems
- Normal and upset conditions
- Process risk management decisions
- Company memory

3. Capital Project Review and Design Procedures
- Appropriation request procedures
- Hazard reviews
- Siting
- Plot plan
- Process design and review procedures
- Project management procedures and controls

4. Process Risk Management
- Hazard identification
- Risk analysis of operations
- Reduction of risk
- Residual risk management
- Process management during emergencies
- Encouraging client and supplier companies to adopt similar risk management practices
- Selection of businesses with acceptable risk

5. Management of Change
- Change of process technology
- Change of facility
- Organizational changes
- Variance procedures
- Permanent changes
- Temporary changes

6. Process and Equipment Integrity
- Reliability engineering
- Materials of construction
- Fabrication and inspection procedures
- Installation procedures
- Preventative maintenance
- Process, hardware and systems inspection and testing
- Maintenance procedures
- Alarm and instrument management
- Decommissioning and demolition procedures

7. Human Factors
- Operator-process/equipment interface
- Administrative control versus engineering control
- Human error assessment

8. Training and Performance
- Definition of skills and knowledge
- Design of operating and maintenance procedures
- Initial qualifications assessment
- Selection and development of training programs
- Measuring performance and effectiveness
- Instructor program
- Records management
- Ongoing performance and refresher training

9. Incident Investigation
- Major incidents
- Third party participation
- Follow-up and resolution
- Communication
- Incident recording, reporting and analysis
- Near-miss reporting

10. Company Standards, Codes and Regulations
- External codes/regulations
- Internal standards

11. Audits and Corrective Actions
- PSM systems audits
- Process safety audits
- Compliance reviews
- Internal/external auditors
- Corrective actions

12. Enhancement of Process Safety Knowledge
- Quality control programs and process safety
- Professional and trade association programs
- Technical association programs
- Research, development, documentation and implementation
- Improved predictive system
- Process safety resource centre and reference library

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API RP 750 Management of Process Hazards

American Petroleum Institute
1220 L Street, Northwest
Washington, D.C. 20005

First Edition, January 1990

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Process Safety Management System

Process Safety Management is a is a set of values, assumptions, concepts, and practices that form a structure for supporting the management and integrity of hazardous operating systems and processes by applying good design principles, engineering and operational practices.

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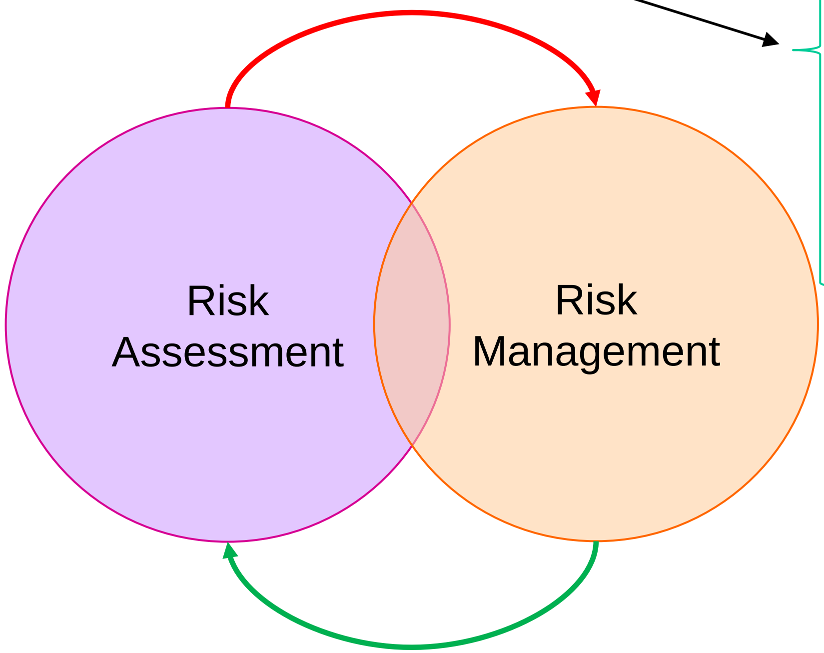
Process Safety System - Open System

Risk Contributors



Affected Risk Contributors

Process System Deviations that contribute to Risk

Not having a system to manage process safety
Annual review / renewal of operating procedures
Percentage of outstanding action items from last PSM audit
Percentage of overdue incident actions.
Risk/Insurance Underwriters Inspection action Items
Percentage of MOCs without updated P&IDs / PFDs in the whole samples reviewed.
Percentage of MOC past the time limit (60days) defined by site
Backlog of hours for preventative and planned maintenance
Overdue inspections of safety critical equipments such as PSV, Vessel, Tank, SIS, etc.
No PHA done (or no PHA review done)
New employees and no training, or refresh training.

Process Safety Management System

Process Safety

1. Employee participation
2. Training
3. Process hazard analysis
4. Mechanical integrity
5. Process safety information
6. Operating procedures
7. Hot work permit
8. Management of change
9. Pre start-up review
10. Emergency planning & response
11. Incident investigation
12. Contractors
13. Compliance audits
14. Trade secrets

Occupational Health and Safety

1. Individual responsibility
2. Joint occupational health and safety committee
3. Health and safety rules
4. Correct work procedures
5. Employee orientation
6. Training
7. Workplace inspections
8. Reporting and investigating accidents
9. Emergency procedures
10. Medical and first aid
11. Health and safety promotion
12. Workplace specific items
    Hazard Management
    Program evaluation, assessment
    Inspections

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Process Safety Management Framework, and elements
Risk Based Process Safety Guidelines, RBPS

Safety Culture Influence on
Application – Implementation of PSM strategy

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Risk Based Process Safety Guidelines

The level of risk inherent in the process or facility must be the primary criterion used to guide , design and implement PSM prioritization and activities

Commit to Process Safety

- Process Safety Culture
- Compliance with Standards
- Process Safety Competency
- Workforce Involvement
- Stakeholder Outreach

Understand Hazards and Risk

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- Hazard Identification and Risk Analysis

Manage Risk

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Commit to Process Safety

- Process Safety Culture
- Compliance with Standards
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- Stakeholder Outreach

Worker Involvement

- Individual Empowerment
- Deference to Expertise
- Open and Effective communication
- Mutual trust
- Responsiveness

Process Safety Culture

1. Maintain Sense of Vulnerability, (continuously look for warning signs)
2. Avoid normalizing deviations from safe operating requirements and specs.
3. Confirm Risk Assessments of process hazards regularly and on time
4. Reverse the Burden of Proof when evaluating the safety of operations (Onus must be to "prove is safe to continue")

1. Ensure open communications (Speaking Freely on safety concerns)
2. Ensure production pressures are not at odds with safety priorities
3. Assess organization's safety culture and improve culture as required

Commit to Process Safety

Commitment and attitudes of an organization have significant impact on the quality of integration and implementation of process safety activities. The quality and commitment of the leadership is also crucial.
Some things to remember:

- Safety culture cannot be manufactured
- It cannot be purchased
- Tough to measure accurately.
- It cannot be contracted out

The state of the safety culture, what level of understanding, and its level of integration within daily operations must be considered before you develop, change, modify or re-develop a process safety management system.

- How deep is the commitment to positive change?
- Are there the resources to make the planned changes?
- Are there pockets of potential resistance and why do they exist?

Process Safety Culture

Lack of Safety Culture can lead to:

- The tolerance of situations in which production pressures take priority over safety concerns
- The gradual acceptance of increasing levels of process equipment deterioration as a normal occurrence even though this is in violation of design and safety specifications and requirements
- A “this will never happen” attitude, based upon past records, that limits an organization’s sense of vulnerability
- Hierarchical structure and attitude that limited both free exchange of information and credibility given to the technical experts and operators who are no part of upper management in the organization.

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Process Safety Culture

How to improve Process Safety Culture

The understanding of different aspects of culture such as attitudes, beliefs, behaviors and values of individuals and/or groups of individual that share the same cultural aspects, is key to the successful achievement of better safety performance levels by an organization.

It is very important to realize that in order to successfully change or influence process safety culture for a group of individuals that may not share the same safety culture, it is best to influence the behavior or *collective practices* of those individuals.

Best safety practices can be affected significantly by management or a management system and bring about the cultural change desired; cultural change that reflect the safety attitudes, beliefs, behaviors and values of a group of people working for an organization.

Best safety practice may be defined as “the way a group of people behaves and reacts to a process or activity with high inherent risk”; which defines the behavioral element in culture.

Understand Hazards and Risk

- Process Knowledge Management
- Hazard Identification and Risk Analysis

Process Knowledge Management

Document and maintain Process Knowledge
(OSHA - PSM, Process Safety Information, PSI)

Process safety information must include information on:

- ✓ Hazards of the highly hazardous chemicals used or produced by process,
- ✓ Technology of the process,
- ✓ Equipment in used the process

Technical standards, RAGAGEP

Engineering drawings and calculations

Specifications for the design , construction and installation of process equipment;

Material compositions, MSDS

Hazard Identification and Risk Analysis

Hazard Identification and Risk Analysis is an activity performed to estimate the value of risk, and consist in answering the following fundamental questions:

1. What can go wrong that could lead to a hazard exposure and loss event?
2. How likely is the hazardous event to happen?
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To answer question number one needs to define a list of scenarios with the credible potential to end with the hazard exposure and loss event.

Question number two is the frequency, likelihood or probability of the hazard exposure event to happen.

Question number three is with respect to the magnitude or severity if the expected consequence is realized, (if a loss occurs due to the hazard event exposure).

Risk is a Combination of the probability of occurrence of harm and the severity of that harm - IEC 61511 - 1, 3.2.64

Risk = Probability x Consequence (Severity)

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Risk Assessment, qualitative

RISK CRITERIA FOR INDIVIDUAL SCENARIOS

SEVERITY				LIKELIHOOD / FREQUENCY				
				Frequent >1/yr	Probable $<10^{-1}$/yr	Remote $<10^{-2}$/yr	Improbable $<10^{-3}$/yr	Highly Improbable $<10^{-4}$/yr
Health and Safety	**Environmental Damage**	**Economic**	**Severity**	**F5**	**F4**	**F3**	**F2**	**F1**
Potential multiple life Loss	Impact on large scale attracting international media attention	>$10M	**S5**	**Severe**	**Severe**	**High**	**Elevated**	**Guarded**
Potential life loss threat In an area and potential to escalate to multiple areas	Impact on large scale attracting national media attention	$1M - <$10M	**S4**	**Severe**	**High**	**Elevated**	**Guarded**	**Low**
Potential severe injury or life threat in a very small area with no possibility of	Impact on large scale attracting local media attention	$50K - <$1M	**S3**	**High**	**Elevated**	**Guarded**	**Low**	**Very Low**
Lost Time Incident	Minimal impact, likely months	$10K - <$50K	**S2**	**Elevated**	**Guarded**	**Medium**	**Very Low**	**Very Low**
First Aid Only	None	<$10K	**S1**	**Guarded**	**Low**	**Very Low**	**Very Low**	**Very Low**

Severe	Unacceptable
High	Typically Unacceptable
Elevated	Acceptable if additional effort disproportional to risk reduction
Guarded	Typically acceptable
Low / Very Low	Acceptable

ACM Facility Safety

Risk Assessment, qualitative

Consequence Severity

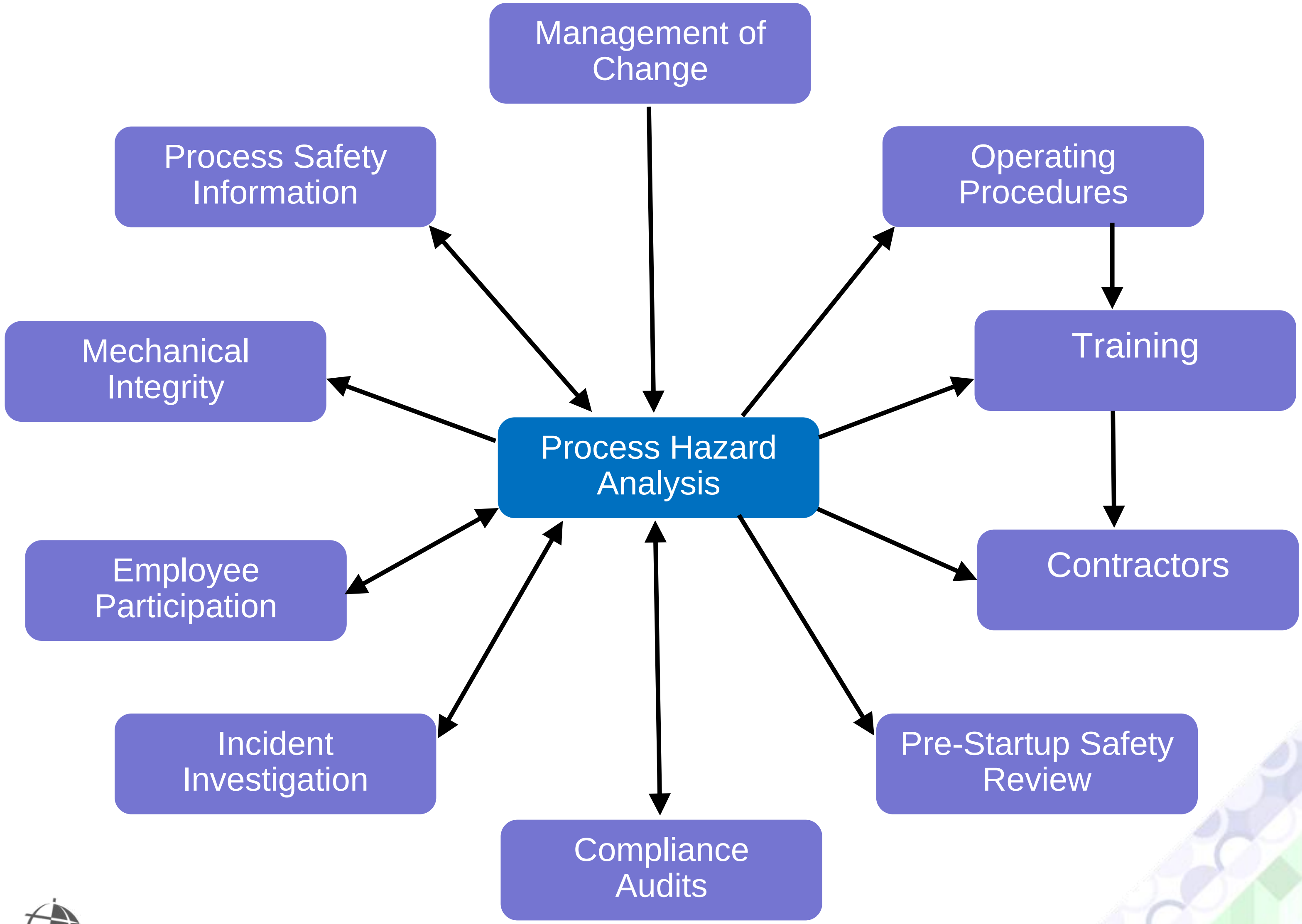
Code	Safety/Health	Environmental	Loss/Disruption	Tolerable Frequency
S5	• Multiple fatalities in one or more areas of facility, or • Off-site fatality.	• Catastrophic and irreversible offsite impact.	≥ 60 M$	10^{-5}
S4	• Single fatality or • Limited off-site health impact.	• Extensive and difficult to reverse offsite impact.	15 M$ to < 60 M$	10^{-4}
S3	• Severe injury resulting in permanent disability, or • Irreversible illness,	• Extensive and difficult to reverse onsite impact.	1 M$ to < 15 M$	10^{-3}
S2	• Long term disability >50 days due to lost time injury accident, or • Long term reversible illness >50 days.	• Serious and widespread but reversible, or • Non-compliance (including non-reporting) resulting in a formal regulatory investigation.	100 k$ to < 1 M$	10^{-2}
S1	• Short term disability <50 days due to lost time injury accident, or • Short term reversible illness <50 days.	• Non-compliance with respect to operating permits but no formal investigation, or • Water or air emissions that does not exceed approval limits but has offsite impact.	Not Applicable	10^{-1}

Likelihood

Code	Description	Frequency
F5	Frequent	>= 1 per year (greater than 1 per year)
F4	Probable	<= 10^{-1} per year (up to 1 in 10 years)
F3	Remote	<= 10^{-2} per year (up to 1 in 100 years)
F2	Improbable	<= 10^{-3} per year (up to 1 in 1000 years)
F1	Highly Improbable	<= 10^{-4} per year (up to 1 in 10,000 years)

ACM Facility Safety

Process Hazard Identification and Risk Analysis



Manage Risk

- Operating Procedures
- Safe Work Practices
- Asset Integrity and Reliability
- Contractor Management
- Training and Performance Assurance
- Management of Change
- Operational Readiness
- Conduct of Operations
- Emergency Management

Operating Procedures

Operating Procedures are written documents that provide clear instructions for safely conducting activities involved in each facility process system, consistent with the process safety information.

Operating Procedures must take into account and be able to clearly point out the Hazards of the Process, as a minimum, in the following phases, transitions, of an operating plant:

- Start Up
- Normal Operating Conditions
- Temporary Operating Condition
- Shut-down
- Emergency Shut-down

Operating Procedures are written documents that must be current, accurate, and useful wit respect to normal operations, non-routine tasks, and identified highly hazardous tasks.

Operating Procedures must provide objective, clear standards of performance for consistently and successfully carrying out effective operations.

Safe Work Practices

Safe work practices are specific procedures needed to address the control of hazards and manage risk associated with non-routine operations.

A non-routine activity is one not described in an operating procedure; and does not makes reference to the frequency the activity is performed.

Non-routine activities are controlled through a system of permits, PTW.

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Safe Work Practices

Safe work practices are specific procedures needed to address the control of hazards during operations and other workplace specific activities. These safe work practice procedures should be studied to identify potential hazards and risk assesses the identified hazards.

Examples of such safe work practices and subordinate procedures are:

- **Opening process equipment or piping** (subordinate procedure)
- **Lock-out/tag-out procedures** (subordinate procedure)
- **Confined space entry** (subordinate procedure)
- Hot-work permits (subordinate procedure)
- **Control over entrance into a facility by maintenance, contractor, etc. (Permit to Work PTW)** (subordinate procedure)
- Material handling rules
- Plant maintenance (e.g. relief systems, temporary isolation of relief devices)
- Fire safeguards (Fire system impairment)
- Vehicle safety rules
- Off-the-job safety
- **Working alone procedures (**subordinate procedure)
- Personal protective equipment requirements (Requirements of a procedure)
- Engineering standards
- purchasing standards
- Preventive maintenance
- Workplace Hazardous Materials Information System (WHMIS)

Asset Integrity and Reliability

The primary objective of an asset integrity management strategy is to help ensure reliable performance of equipment designed and installed in accordance with specifications, such that it remains fit-for-use until it is decommissioned.

Systematic implementation and execution of activities, such as inspections and tests are necessary to ensure that critical equipment and safety systems remain suitable and operational for its intended application throughout its useful life.

Asset Integrity includes designing and maintaining equipment which is fit for its intended purpose, in order to increase the likelihood that the equipment will function when needed. Asset Integrity management is of paramount importance to process industries for ensuring the integrity and reliability of critical equipment.

Contractor Management

Operating companies often relies on Contractors for very specialized skills and, sometimes, to accomplish particularly hazardous tasks, often during activities such as maintenance turnarounds.

Contractor management program must be established for qualifying candidate firms based upon not only their technical capabilities but also their safety programs and safety records.

Contractor management program must establish:

- Responsibilities for training must be defined and assured before the work starts.
- The boundaries of authority and responsibility must be clearly defined
- Periodic monitoring of contractor safety performance and auditing of contractor management systems is required.
- Standards of performance and expectations for contractors and contract workers.
- Appropriate records and documentation to assure appropriate “Due diligence”

Training and Performance Assurance

In order to have confidence that operating procedures and safe work practices are consistently executed, without errors, require an adequate training and performance assurance program.

A consistent high level of human performance is critical in any process safety program.

To achieve consistency and confidence that work activities and tasks will be completed to a minimum acceptable standard of performance requires a well drafted and vetted training program.

Performance assurance is a continuous process implemented to ensure that workers demonstrate they have understood the required training, and can carry the learnings from the received training to actual work practice.

Performance assurance continuous process ensures that workers are initially trained, and thereafter periodically re-trained and re-assessed to demonstrate that they are still qualified to consistently execute with confidence the operating procedures and safe work practices.

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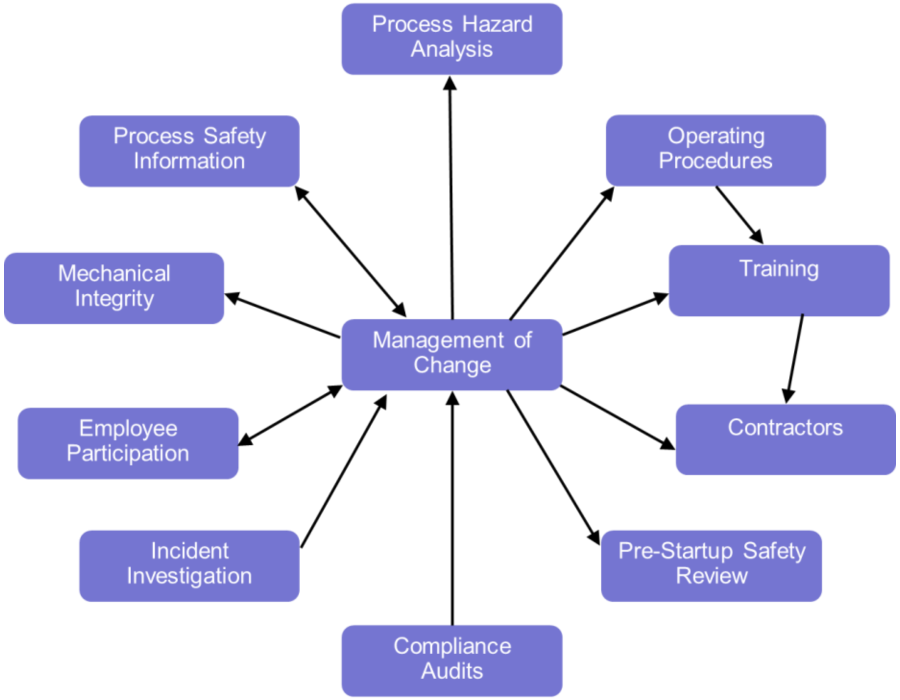
Management of Change (MOC)

Management of Change ensures that changes to a process do not introduce new hazards or that the potential consequences of existing hazards do not become more severe; therefore increasing the risk of the process.

If proposed changes to a process are not carefully reviewed, the probabilities of a hazardous event ending in a severe consequence are increased. That is to say that the risk an existing process hazard poses could increase significantly.

MOC must also includes steps to ensure that affected personnel are notified of the change, and that the required documentation is kept up-to-date.



ACM Facility Safety

Operational Readiness

Before starting up, the status of a process must be verified to be in the intended safe state.

The purpose of a safe start up review is to verify that the physical process conditions are exactly as intended for safe operation.

It is important to understand that “operational readiness” addresses the start up of a process whether it is for the first time, after a process modification, or after any other type of shut down conditions.

Additionally, the pre-start up review considers the length of time the process was in shut down state or safe state conditions.

From OSAH – PSM:
Pre-Startup Safety Review: Perform a pre-startup safety review for new facilities and for modified facilities when the modification is significant enough to require a change in the process safety information. The purpose of the Pre-Startup Review is to confirm that, prior to the introduction of highly hazardous chemicals to a process:

a. Construction and equipment is in accordance with design specifications
b. Safety, operating, maintenance, and emergency procedures are in place and are adequate
c. Modified facilities meet the requirements contained in Management of Change
d. Training of each employee involved in operating a process has been completed.

ACM Facility Safety

Conduct of Operations

The application and execution of management and operational activities must be done in a deliberate and rigorous structured fashion.

Process operations will be negatively affected if an inefficient level of human performance is present.

In order to implement a successful process safety management program, a consistent and effective level of human performance is critical.

The rigor and formality in the manner in which operations are conducted will greatly influence the achievement of safe, reliable, and consistent performance of critical tasks.

Emergency Management

The impact of a hazardous event occurring can be significantly reduced or mitigated with effective emergency planning and response. By reducing, mitigating, or avoiding the impact of a hazardous event when occurs, the severity of the consequences may be also reduced or avoided.
Emergency planning and response may help to avoid, escape the potential harm that ca be caused due to a hazardous event occurring.

The scope of an emergency response and planning goes beyond the reduction or mitigation of a hazardous event such as “quenching a fire”.

The emergency management strategy includes the following:

- Protecting people; on site, off site, and emergency responders.
- Appropriate response to large releases of energy such as explosions, fires, etc. and to release of hazardous, toxic, harmful, chemicals.
- Communicating with stakeholders, including police, fire department, neighbors and the media.

Emergency management does not necessarily address incidents or accidents caused by natural disasters or mal intentional actions such as acts of terrorism, sabotage, public demonstrations, etc.

Learn from Experience

- Incident Investigation
- Measurement and Metrics
- Auditing
- Management Review and Continuous Improvement

Incident Investigation

Risk is a significant driver for the Incident investigation element

The actual potential or consequence usually drive the level of effort expended in the investigation.
Combined with the likelihood of re-occurrence, influence the level of effort.

The greater the potential for an unwanted event occurring and ending in a loss, the greater the importance to prevent he unwanted event from re-occurring.

Incident Investigation strategy must stablish:

- Consistent application (implementation)
- Depth of the extracted learning from the conducted investigation
- Response to positive change from the investigation results.
- Measurement of effective performance
- Effective communication protocols. (Learn to Share , Share to Learn)
- Defined and clear Roles and Responsibilities

Outputs of the incidents element should be used to facilitate the performance improvement of other elements. In most cases, recommendations aimed at the root causes of an incident will involve modifications to other PSM elements.

Measurement and Metrics (Performance Indicators)

How can one show evidence of success?

Relevant process safety metrics are key for understanding the performance and effectiveness of a Process Safety Management system, and for identifying areas of opportunity for continuous improvement.

Process safety accidents have been investigated and the results have shown that the root causes involved a degraded effectiveness, or complete failure of process safety management activities.

PSM systems may degrade and their effectiveness is affected or lost. Therefore, performance of process safety management activities should be monitored in real-time so that management activity problems can be identified and corrected sooner, and more importantly, before serious accidents occurs.

Measurement and Metrics (Performance Indicators)

- Lagging Indicators – Reactive
  - Shows that the desired safety level was not being met.

A lagging indicator is one that follows an event.
Lagging indicator have the ability to confirm that a pattern is occurring or about to occur.
Amber light in traffic light is a lagging indicator for the green light.

- Leading Indicators – Predictive
  - Shows that the desired safety level is not being met.

Leading Indicators signal or anticipate future events.
If no corrective action is taken or contingencies are applied bad events are more likely to happen
Amber traffic light indicates the coming of the red light.

"By definition, catastrophic and major process incidents are rare events, and performance measures need to be preferably focused on leading indicators, or at least lagging indicators of relevant, more frequent incidents" – **Mogford Report on BP Texas City Disaster.**

ACM Facility Safety

Measurement and Metrics (Performance Indicators)

Personnel or occupational Safety Indicators are important, but are not valid indicators of Process Safety!

"It turns out that most injuries and fatalities are a result of personal safety hazards rather than process hazards and, as a result, injury and fatality statistics tend to reflect how well an organisation is managing personal safety hazards rather than process safety hazards.
Any organisation that seeks to assess how well it is managing process safety hazards cannot therefore rely on injury and fatality data; it must develop indicators that relate specifically to process hazards." –
Andrew Hopkins, *Thinking About Process Safety Indicators*

Most Frequent citations stated by NEP PSM

National Emphasis Program, NEP

Element	Description	Percentage of Total Violations
j	Mechanical Integrity (MI))	23.2%
d	Process Safety Information (PSI)	20.9%
e	Process Hazard Analysis (PHA)	15.8%
f	Operating Procedures (OP)	14.0%
l	Management of Change (MOC)	5.5%
o	Compliance Audits (CA)	4.5%
g	Operator Training	3.8%
h	Contractors	3.4%
c	Employee participation	2.8%
m	Incident Investigation (II)	2.6%
n	Emergency Planning & Response (ER)	1.8%
i	Pre-startup Review (PSSR)	1.1%
k	Hot Work	0.6%

Jim Lay, PE
Federal OSHA – Directorate of Enforcement Programs
Office of Chemical Process Safety & Enforcement Initiatives

December 4, 2012

Auditing of PSM system

Audit meant to verify that all PSM system elements are in place and are up to date.

Auditing can be used to establish whether an organization is meeting the requirements of a PSM system.

Key PSM audit points:

- Verify that procedures and practices developed under the PSM system are and were being followed, (e.g. failure to correct MOC issues identified in earlier PSM compliance audits).
- Include at least one member with process knowledge on the audit team
- Develop plan for resolution of compliance audit deficiency findings
- Resolve compliance audit deficiency findings in a timely manner

ACM Facility Safety

Auditing of PSM system

The purpose is to assure that deficiencies of the PSM strategy are identified to improve its performance.

The results of the audit will be considered for continued improvement, sustainability and quality of processes and procedures implemented.

The audit report must reach top management so that they know the results and understand any potential risks when making decisions.

Scheduling, Implementing, Recording, Reviewing must all be coordinated for the audit.

Tracking corrective actions identified by the audit is paramount as this will correct deviations that were preventing from achieving functional process safety.

Management Review and Continuous Improvement

Management Reviews are the routine assessment of whether a management system is performing and producing the desired results to meet the desired expectation such as achieving functional process safety.

Management Review of every element of a PSM system should be conducted according to their own scope and purpose.

1. Is the performance assessment meeting the element objectives and goals?
2. Are the right key performance indicators being monitored?
3. Is re-alignment or focus on key performance indicators required?
4. Are process safety objectives and goals realistic and aligned?
5. How often is the need to re-assess processes or practices?
6. What are priorities for change and improvement? Long and short term

Every level of management should conduct periodic management reviews. Usually the proper functioning of the facility overall process safety management system is the responsibility of the manager or senior manager. “Due diligence”

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Conclusions – Closing arguments

Acronyms

- ABSA Alberta Boiler Safety Association
- ACC American Chemistry Council (Formerly the Chemical Manufacturers Association)
- AER Alberta Energy Regulator (Formerly EUB - Energy Utilities Board and ERCB – Energy Resources Conservation Board)
- AFPN American Fuel & Petrochemical Manufacturers (formerly the National Petrochemical & Refiners Association)
- AIChE American Institute of Chemical Engineers
- ANSI American National Standards Institute
- API American Petroleum Institute
- APEGA Association of Professional Engineers and Geoscientists of Alberta
- BCSA British Columbia Safety Authority
- BSSE Bureau of Safety and Environmental Enforcement
- CAFC Canadian Association of Fire Chiefs
- CAGC Canadian Association of Geophysical Contractors
- CAODC Canadian Association of Oilwell Drilling Contractors
- CAPP Canadian Association of Petroleum Producers
- CDC Center for Disease Control and Prevention
- CCME Canadian Council of the Ministers of the Environment
- CCPA Canadian Chemical Producers Association
- CEPA Canadian Environmental Protection Act
- CEPA Canadian Energy Pipeline Association
- CFR Code of Federal Regulation
- CIAC Chemistry Industry Association of Canada
- CIMAH Control of Industrial Major Accident Hazards Regulations
- COMAH Control of Major Accident Hazards Regulations
- CCPS Center for Chemical Process Safety
- CIAC Chemical Industry Association of Canada
- CSA Canadian Standards Association
- CSB US, Chemical Safety and Hazard Investigation Board
- CSChE Canadian Society for Chemical Engineering (Formerly the Chemical Institute of Canada)
- DACC Drilling and Completion Committee
- DOT US, Department of Transportation

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Acronyms

- EI Energy Institute
- EPA US, Environmental Protection Agency
- EPAC Explorers and Producers Association of Canada (Formerly SEPAC)
- GHS Global Harmonized System of Classification and Labeling of Chemicals
- HSE Health and Safety Executive (United Kingdom)
- IADC International Association of Drilling Contractors
- ICCA International Council of Chemical Associations
- ILO International Labour Organization
- ISO International Organization for Standardization
- LRWS Saskatchewan Labour Relations and Workplace Safety
- MIACC Major Industrial Accident Council of Canada
- NEB National Energy Board
- NIOSH National Institute for Occupational Safety and Health
- NTSB US, National Transportation Safety Board
- OECD Organization for Economic Co-operation and Development
- OGC British Columbia Oil and Gas Commission
- OGP International Association of Oil & Gas Producers
- ORSEC Organisation de la Réponse de SÉcurité Civile (France)
- OSHA US, Occupational Safety and Health Administration
- PSM Process Safety Management
- PSAC Petroleum Services Association of Canada
- PSR Process Safety Regulation
- RAGAGEP Recognized and Generally Accepted Good Engineering Practices
- REACH EU, Registration, Evaluation, Authorisation and Restriction of Chemicals Regulation
- RMP Risk Management Program (US from EPA)
- SCC Standards Council of Canada
- CSA Canadian Standards Association
- ASCC Alberta Safety Codes Council
- SER Saskatchewan Energy and Resources

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Acronyms

- SEMS Safety and Environmental Management System
- TDG Transportation of Dangerous Goods
- TSB Transportation Safety Board of Canada
- TSASK Technical Safety Authority of Saskatchewan
- CCG Canadian Coast Guard
- WHMIS Workplace Hazardous Materials Information System

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