Risk Based PROCESS SAFETY Management

3 Days Training Course

Module 2 – Day 2

Pillars of RBPSM and Pillar 1 & Pillar 2 Elements





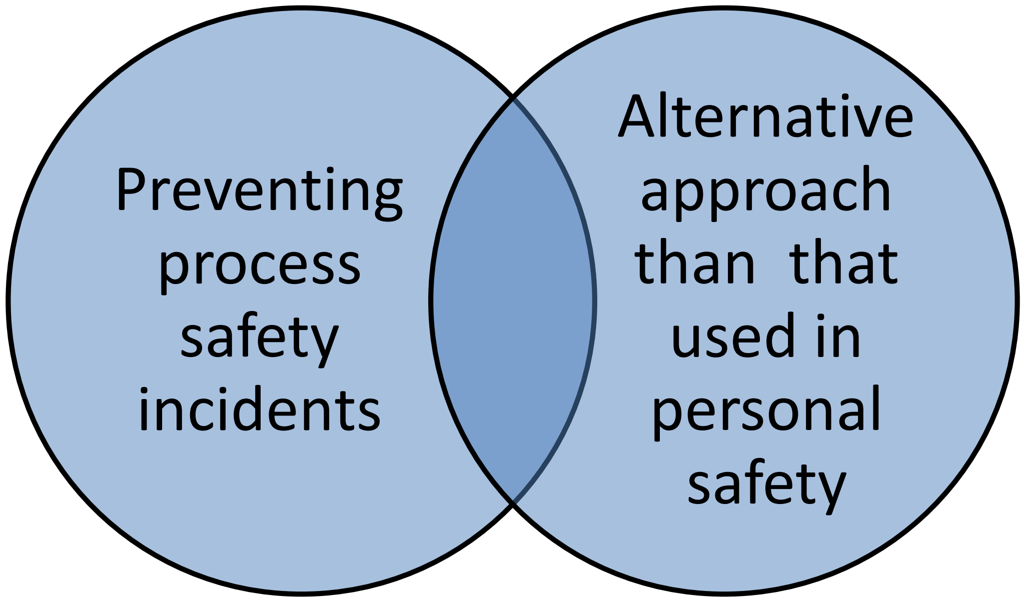

TRAINING PROGRAM

- **Day 1:**
  - **Module 1: PSM Introduction and Overview**
- **Day 2:**
  - **Module 2: 4 Pillars of PSM and Pillar 1 & 2 Elements**
- **Day 3:**
  - **Module 3: Pillar 3 and Module 4: Pillar 4 Elements**
- **Day 4 and 5:**
  - **Module 5: Auditing RBPSM**
- **Day 6:**
  - **Module 6: SIL and LOPA**
- **Day 7: Consolidation and Tests**
- **Day 8: Site visit**

COURSE OBJECTIVES

- Risk Based Process Safety Management
- Risk Management System Model (PDCA)
- Pillars of RBPSM
- Elements of RBPSM
- Pillar 1 Elements

RBPSM


Preventing process safety incidents
Alternative approach than that used in personal safety

Process Safety Management (PSM)

PSM is a management system developed to:

- Prevent;
- Prepare for;
- Mitigate;
- Respond to
- Restore

catastrophic releases of energy and chemicals from a process.

Definition of Process Safety Management

Process: Any onsite activity that involves a highly hazardous chemical, including any use, storage, manufacturing, handling, and/or movement of a highly hazardous chemical.

Safety: The initial driving force for most PSM systems and programs in order to meet H&S regulatory requirements and to prevent or control injuries and illnesses which might be caused by process upsets and hazardous material releases.

Management: Anyone who has control over the process or processes. PSM is not just about equipment, piping, instrumentation, etc., but also about people involvement, training and stakeholder engagement.

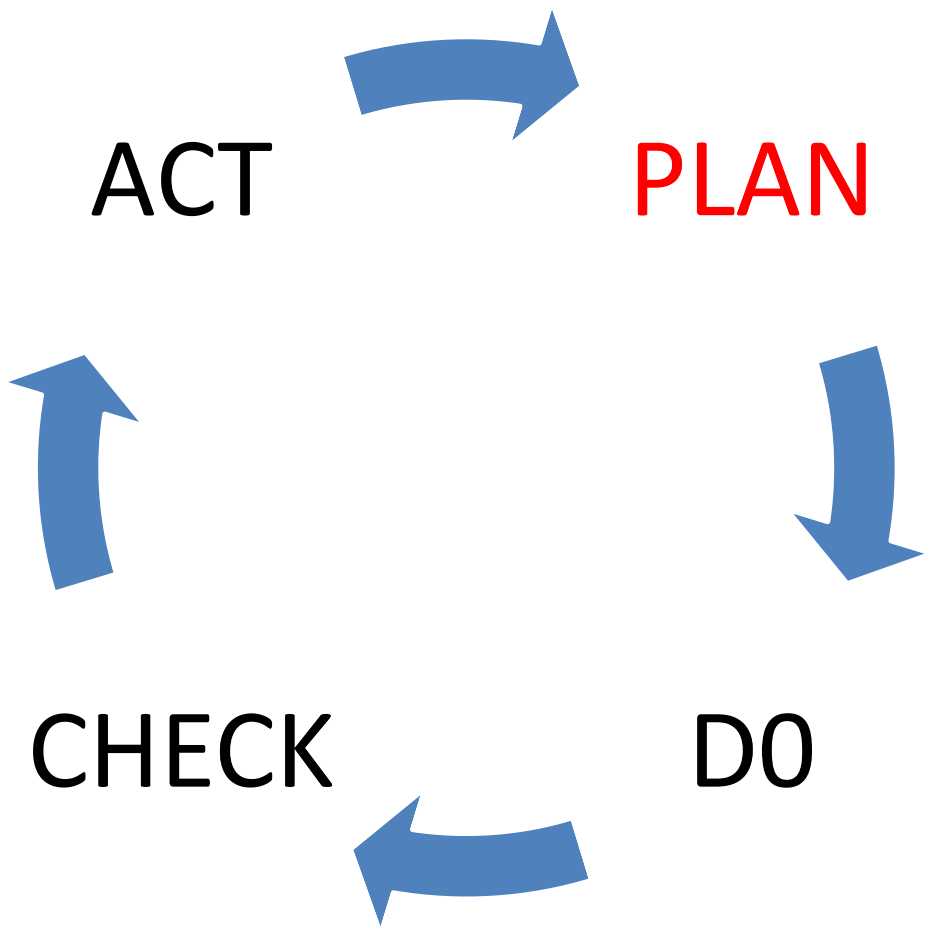
Risk

Definition:

Risk is a combination of three attributes:

- **Hazard (What can go wrong?)**
- **Consequence (How bad could it be?)**
- **Likelihood (How often might it happen?)**

Management System



Step 1: Plan

- Identify what is the problem by using one or more of the following tools:
  - Drill or exercise
  - Root cause analysis “5 Why’s”
  - Process Mapping of the root cause
  - Collection of any other information that might be needed to start identifying possible solutions.

Step 2: Do

- This phase involves numerous activities including:
  - Generating possible solutions
  - Selecting the best of the identified solutions using techniques like ‘Impact Analysis’ to evaluate them.
  - Implementing the decided decision as a pilot project on a small scale basis relating to the nature of the problem, product or initiative.

Step 3: Check

- Monitoring or measurement of the effectiveness of the pilot solution.
- Depending on the success of the pilot or the room for improvement identified and the scope of initiative, it may be decided to redo the Plan and Do phases again until confident and satisfied with the cost / risk benefit analysis of the solution.

Step 4: Act

- This phase is entails the full implementation of the solution identified.
- Continual Improvement is based on repetition of the Plan-Do-Check-Act principle, where shortcomings are identified, controls/solutions are tested, implemented and monitored.

Pillars of RBPSM

There are four pillars of RBPSM, namely:

1. Commit to process safety
2. Understanding risk
3. Manage risk
4. Learn from experience

RBPSM Pillars

Commit to process safety

The Cornerstone of process safety excellence. A workforce that is actively involved and an organization that fully supports process safety as a core value will tend to do the right things in the right ways at the right times-even when no one else is looking.

- Process safety culture
- Process safety competency
- Stakeholder engagement
- Workforce Involvement
- Compliance with Standards

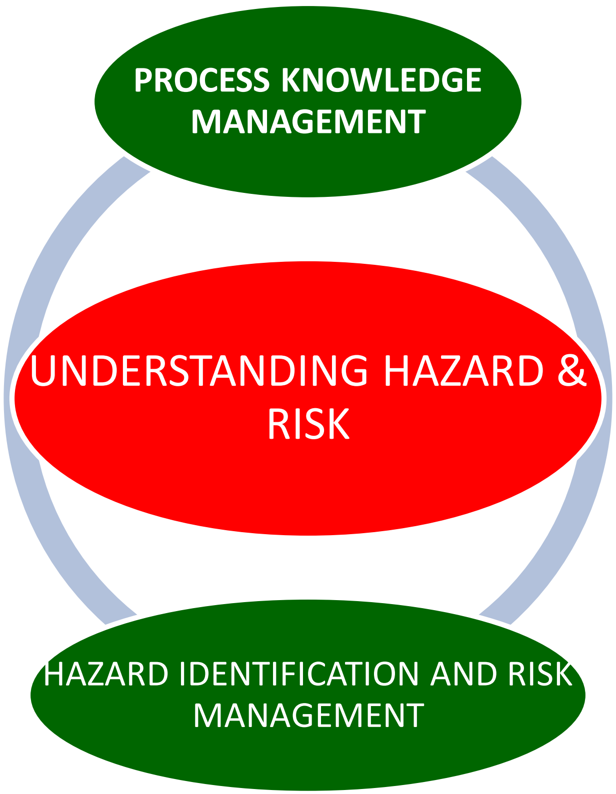
Understanding Hazards & risks

The foundation of a risk-based approach which will allow an organization to use this information to allocate limited resources in the most effective manner

Process knowledge management

Hazard Identification & Risk Analysis

2. Understanding Risk



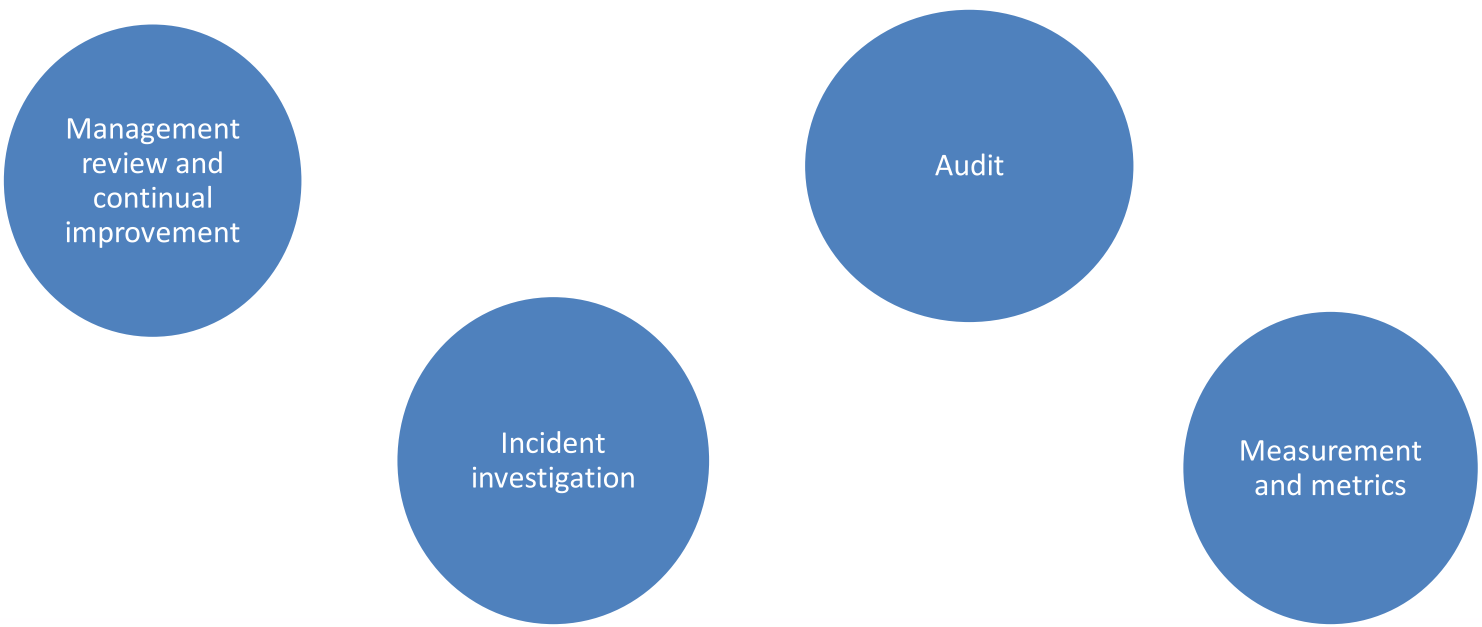
Manage risks

The ongoing execution of risk based process safety tasks. Risk management can help a company to better deal with the resultant risks and sustain long-term accident free and profitable operations.

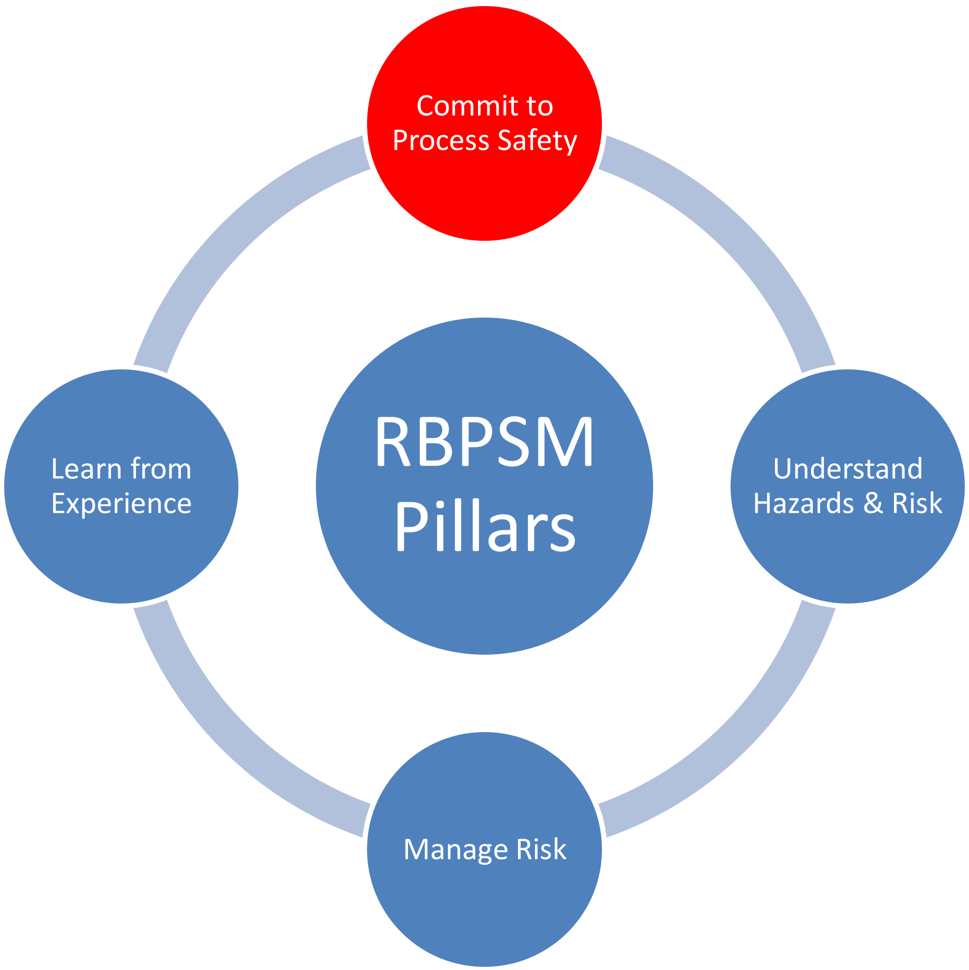
- Operating Procedures
- Management of Change
- Emergency Management
- Operational Readiness
- Safe Work Practices
- Training & Performance assurance
- Contractor Management
- Conduct of operation
- Asset integrity and reliability

Learn from experience

Metrics provide direct feedbacks on the workings of RBPS systems, and leading indicators provide early warning signals of ineffective process safety results. Organizations must use their mistakes and those of others as motivation for action and view as opportunities for improvement



4 RBPSM Pillars



Small Group Discussion

Group Discussion

Questions

- Why do you think RBPSM is important regarding:
  - The design of facilities?
  - The modification of facilities?
  - The operation of facilities?
  - Which RBPSM element is most critical at your company?

RBPSM Elements

Commit to Process Safety

Understand Risk

Manage Risk

Learn from Experience

Process Safety Culture	Process Knowledge Management	MOC	Training and Performance Assurance	Auditing
Process Safety Competency	HIRA	Emergency Management	Contractor Management	Management review & continues improvement
Stakeholder Engagement	Operating Procedures	Operational Readiness	Conduct of Operation	Measurement and metrics
Workforce Involvement	Compliance with Standards	Safe work Practices	Asset Integrity & reliability	Incident Investigation

RBPSM Elements

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1.1- Process Safety Culture (PSC)

What is PSC?

- PSC is the combination of group (company) values and behaviors that determine the manner in which process safety is implemented.
- It is the manner in which a process/procedure is conducted in an organization.
- It is what is expected from the organization.
- It is the manner in which employees behave when no one is watching.

Why is PSC important?

PSC is important to:

- ***Establish and enforce high standards process safety performance.***
- ***Maintain a sense of vulnerability.***
- ***Ensure open and effective communication.***
- ***Provide timely response to process safety issues and concerns.***

Learning from the Columbia Disaster

Columbia Disaster

Space shuttle Columbia, re-entering the Earth's atmosphere at 10 000 miles per hour and disintegrated.

- All 7 astronauts were killed;
- $ 4 Billion spacecraft destroyed;
- Debris scattered over 2000 square miles of Texas;
- NASA ground shuttle fleet for 2.5 years.

Columbia: Physical Cause

- Insulation foam separates from external tank 81 seconds after lift-off;
- Foam strikes the underside of the left wing, breaching thermal protection system tiles;
- Superheated air enters wing during reentry, melting aluminum struts;
- Aerodynamic stresses destroy weakened wing.

Columbia: Key Issues

- Without verification, management was convinced that a foam strike was not a concern.
- No effort was taken to prove shuttle integrity, nor was there a contingency plan prepared.
- Serious concerns about the integrity of the shuttle were raised a day after launch but no actions were taken during the two weeks prior to return.

Key Organizational Findings

- Poor sense of Liability
- Normalization of Deviance
- Inadequate Importance of Safety
- No Open and Direct Communications
- Valid/Timely Hazard/Risk Assessments lacking
- Continual Improvement Process lacking

Poor Sense of Vulnerability

- NASA's historic successes had created a "Can Do" attitude that down-played the consideration of problems.
- Near-misses were considered to be successes of a strong system rather than near-failures.
  - No disasters had previously resulted from prior foam strikes, strikes were no longer a safety issue;
- A weak sense of vulnerability may lead to taking future successes for granted and thus taking greater risks.

Inadequate Importance for Safety

- As a result of project deadline pressures:
  - Critical conditions and checks were ignored;
  - Priorities conflicted as the deadline won over safety issues
- A significant foam strike on a recent mission was not resolved prior to take-off thus ignoring the possibility of an incident occurring as a result of foam strike.

Open and Frank Communication

- Management adopted a uniform mindset that foam strikes were not a concern and was not open to opposing opinions.
- The organizational culture:
  - Did not encourage negative news
  - Did not tolerate challenge to ‘Accepted Wisdom’
  - Allowed rank and status to trump expertise.
- Management pushback can discourage and intimidate people that wish to raise concerns.

What causes a weak culture?

- Lack of process safety leadership;
- Deviance normalization;
- Process safety issues not responded to;
- Lessons learned from previous incidents not effectively communicated and are ignored;
- Process safety metrics and monitoring not effective;
- Technical experts advice not taken into consideration and ignored;
- Lack of trust.

Change of Culture

Successful change of culture requires:

- Expectations and end state (goal) to be communicated;
- Continual positive reinforcement linking changes to the important benefits they bring;
- Gradual change being managed over a long term period
- Clear and certain accountabilities (Roles and responsibilities)
- “No blame” culture

Process Safety Culture

Essential Features

- **Develop and Implement a Sound Culture:**
  - Present and show tough leadership;
  - Establish process safety as a core value;
  - Create high standards of performance.
- **Sustain a Trustworthy Practice:**
  - Maintain a high awareness of process hazards;
  - Empower individuals to fulfill their safety abilities;
  - Defer to expertise;
  - Ensure transparent and efficient communication;
  - Promote mutual trust;
  - Offer timely response to PS issues and concerns.
- **Monitor and guide the culture:**
  - Provide continuous monitoring of performance.

Imperial Sugar Disaster

VIDEO

Imperial Sugar

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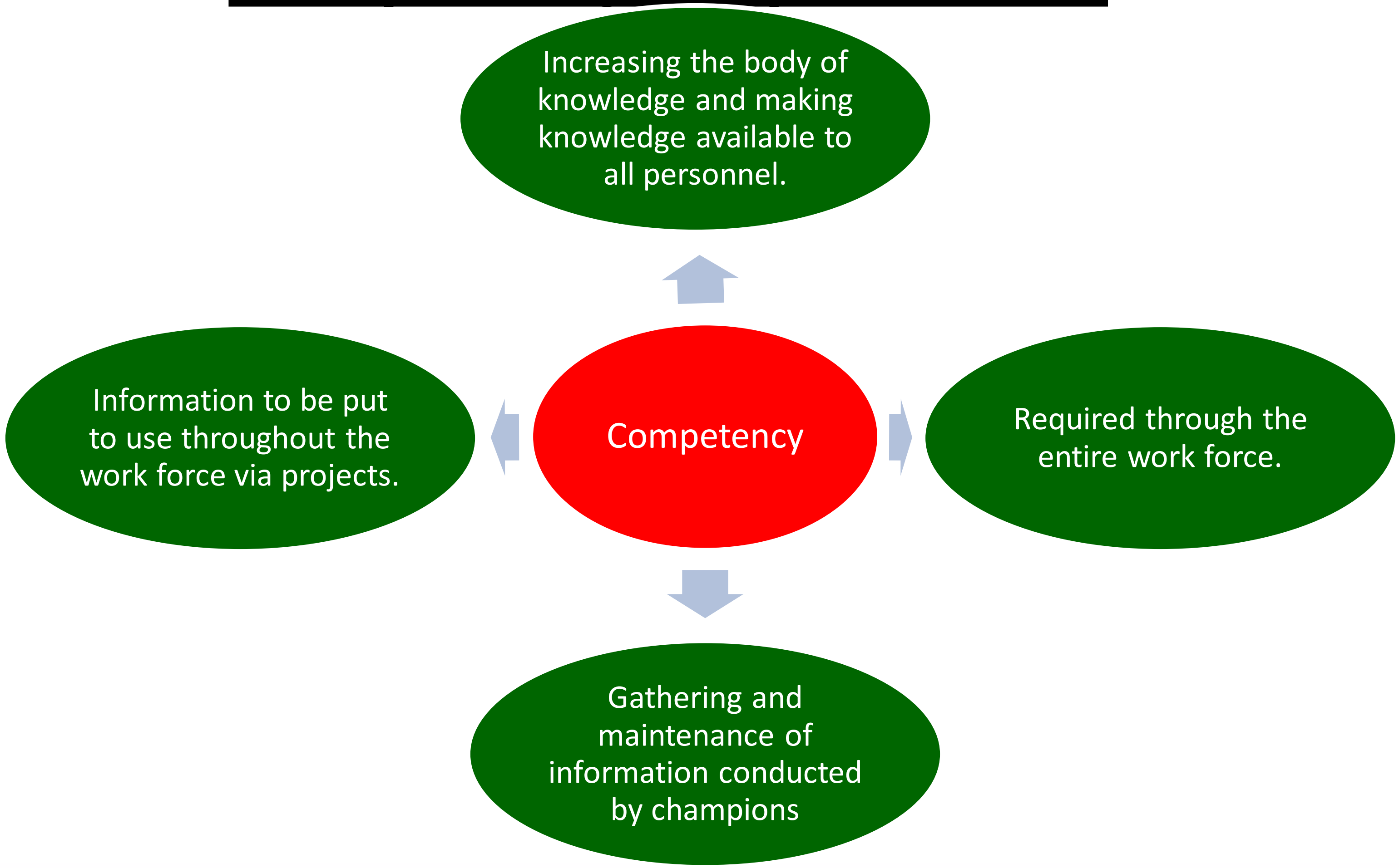
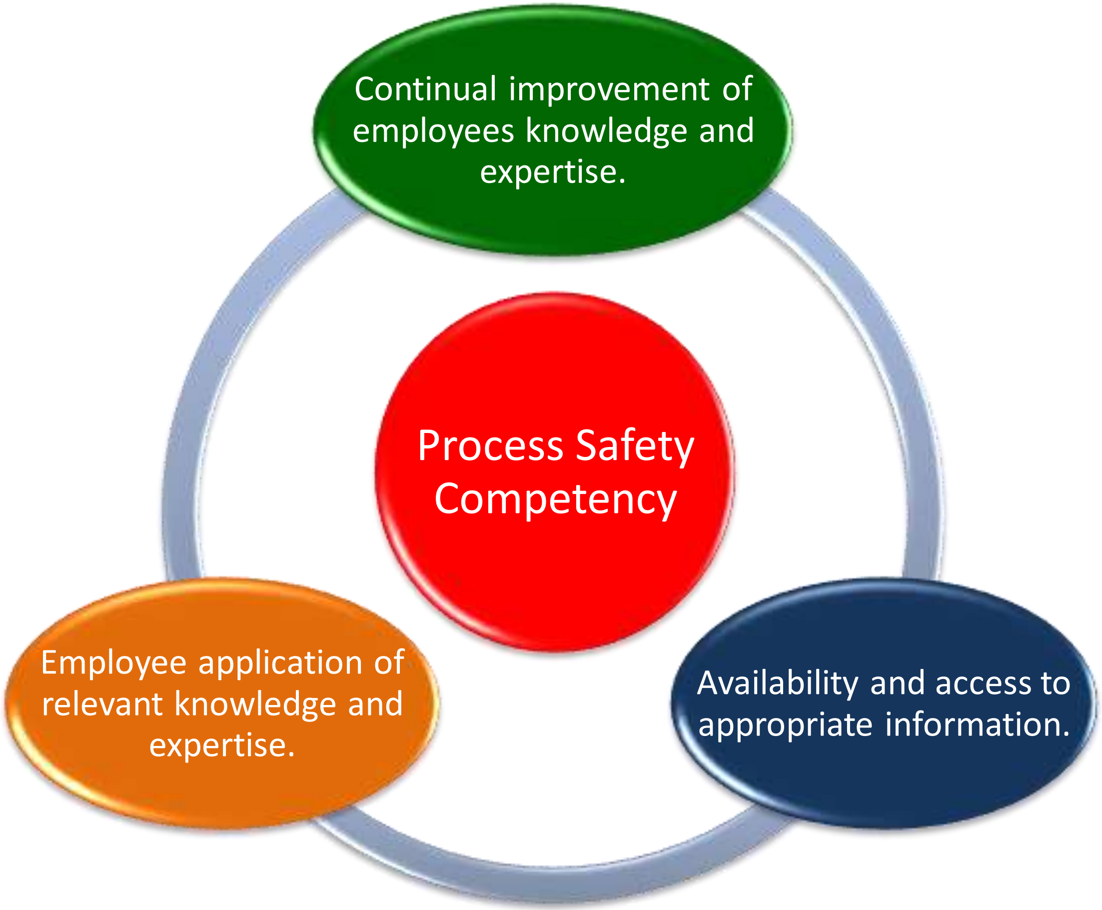
Small Group Discussion

1.2- Process Safety Competency

Competency Requirements



1.2- Process Safety Competency



Examples:

- Training and practicing of operators during normal and abnormal plant operating conditions.
- Conducting of HIRA by competent personnel before start of job.
- Availability of appropriate information for emergency response decisions taken by emergency controller.
- Application of appropriate new installation design codes by the competent engineer.

Core Features

Maintain a dependable practice

- Establish objectives and targets.
- Appoint a champion for each objective.
- Identify all benefits
- Maintain and promote a knowledgeable organization

Maintenance of process safety competence.

- Information and document sharing within the organization.
- Appoint a technology warden.
- Share knowledge to with relevant employees
- Maintain a data base and external sources.

Competence evaluation

- Evaluate the effectiveness and receive input form operators.

Small Group Discussion

Group Discussion

Questions

1. What is process safety competency?
2. What are the three important issues about competency relating to your organization? Why are they important?

Questions

1. What were the main causes that lead to the explosion at Imperial Sugar?
2. What resulted in the poor safety culture?
3. How would you manage this safety culture practiced?
4. Will more stricter rules be effective to improve safety?

1.3- Stakeholder Engagement

Who are the stakeholders?

- Authorities;
- Neighbors and Public;
- Industry Associations;
- NGO's;
- Customers;
- Competitors
- Mutual Aid Associations.
- Professional Bodies.
- Or any other individuals or organizations that can be or believe they can be affected by company operations.

Stakeholder Involvement Process

1. Identify interested and affected parties as a result of your work practices.
2. Develop relationships with the interested and affected parties, including professional groups, authorities, etc.
3. Provide accurate information about your organization’s facilities, products, plans, processes, hazards and risks.

Core Features

- Implementation must be consistent.
- Competent personnel must be involved.

Maintain a dependable practice

Identification of communication and outreach needs

- Relevant stakeholders must be identified.
- An appropriate scope must be defined.

- Communication pathway and tools must be developed.
- Appropriate information must be shared.

Implementation of outreach/ communication activities.

Commitment and actions follow up.

- Commitments and feedback received must be followed up.
- Management and document outreach encounters must be informed.

1.4- Workforce Involvement

- **Workforce involvement allows for active participation throughout the organization, including contractors, in all stages of RBPSM system.**

- **Effectiveness involves a written action plan, consultation and development of each RBPSM element and consistent communication.**

- **Involvement includes consultation by management with employees and contractors at all levels in the business.**

Workforce Involvement

Implementing or Reviewing Safety Operating Procedures (SOP's)

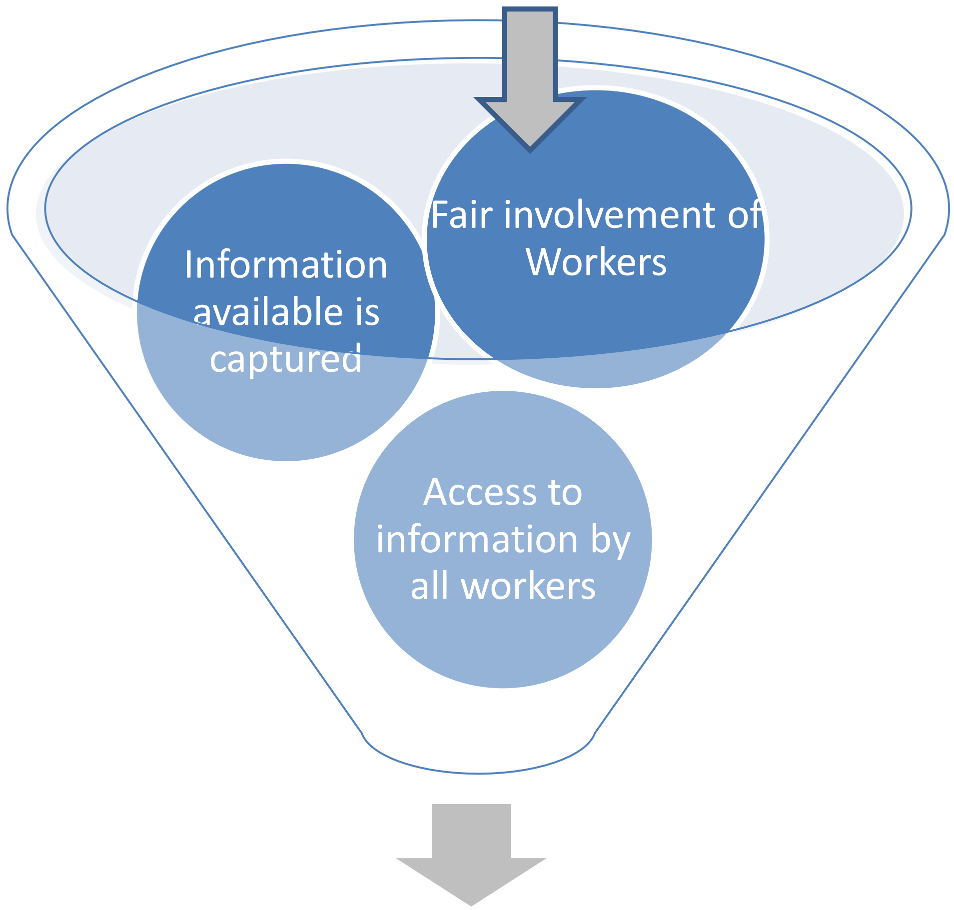
Informal discussions with managers and supervisors.

Incident investigation (including near misses)

Giving feedback on all PSM program aspects

Workforce Involvement Topics

Important Elements



Process Safety Culture Reinforcement

Core Features

Maintain a dependable practice

- Implementation must be consistent.
- Competent personnel must be involved.

Conduct work activities

- Appropriate inputs must be provided.
- Appropriate work processes must be applied.

Monitoring of system effectiveness

- Effectiveness of workforce involvement must be ensured.

Promote workforce involvement

- Workforce participation must be stimulated
- Achievements must be publicized and identify new opportunities

Stakeholder Involvement

Video

Process Safety M4 Video

Small Group Discussion

Group Discussion

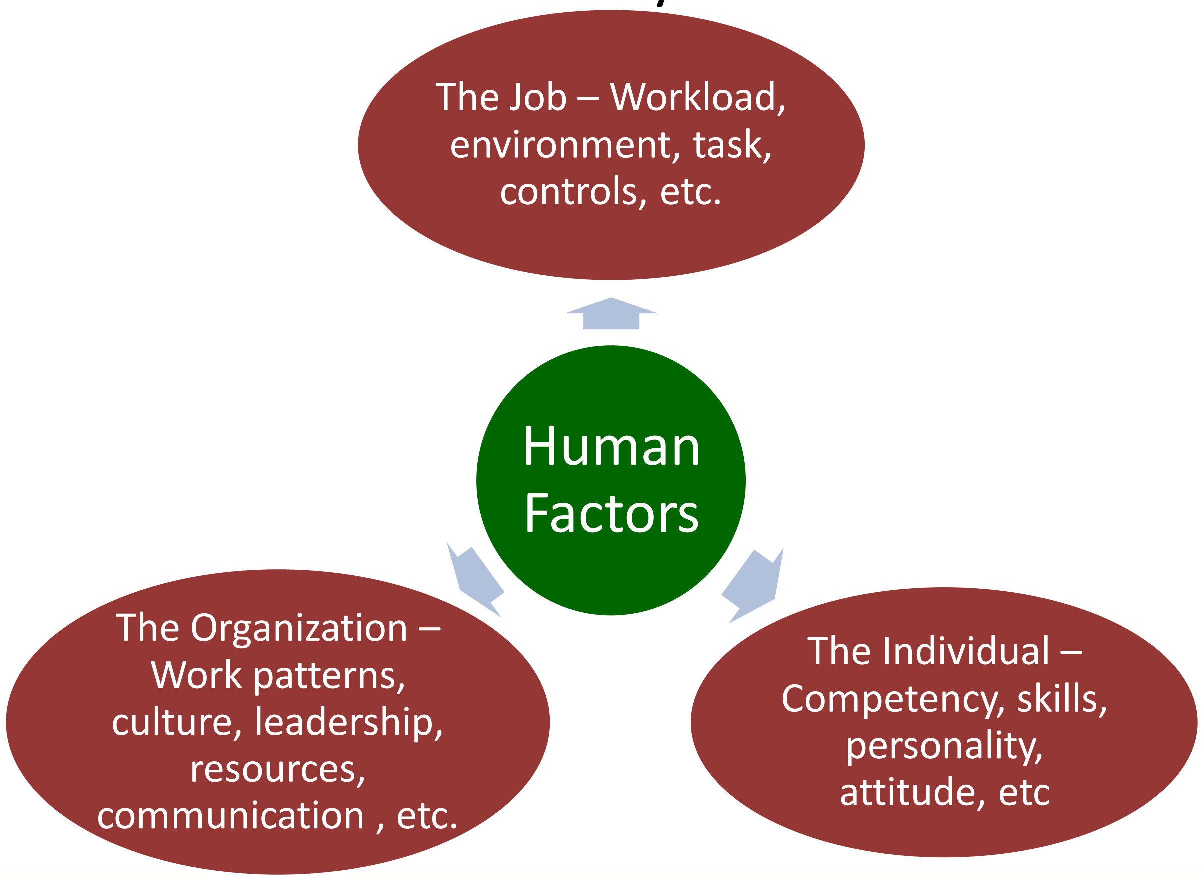
Questions

1. Can you think of any workforce involvement activities that have been conducted at your organization to improve process safety?
2. What other activities may be considered?
3. Who are your important process safety stakeholders at your organization? Why are they important?
4. Do you think a management paradigm shift is required in your company to successfully involve the workforce?

Human Factors

Definition:

Environmental, organizational and job factors, human and individual characteristics, which influence behavior at work in a way that can affect health and safety.



Human Factors

- Human factors include the assessment of:
  - human factors involved in risk assessments and incident investigations
  - Training and competence
  - Procedures
  - Staff availability
  - Human factors in design
  - Culture
  - Maintenance, inspections and testing
  - Fatigue
  - Emergency devices and alarms – responsiveness (drills)
  - Organizational change

Human Functions of Safety Management that influence barrier reliability significantly

- ❖ **Training and Education**
  Provides the competence to respond properly
- ❖ **Procedures**
  Understanding and response
- ❖ **Inspections and Maintenance**
  Necessary to ensure functioning of primary barriers over time
- ❖ **Communications and Instructions**

Human Factors

Video

Piper Alpha

Small Group Discussion

Group Discussion

Questions

1. What does this video tell you about:
   - Procedures?
   - Training?
   - Culture?
   - Risk awareness and management?
   - Communication?
2. What do you recommend should have been done to prevent this incident?

1.5- Compliance with Standards

Standards/standardization

Definition:

A system to identify, develop, obtain, evaluate and provide access to applicable standards, codes, and regulations that govern (control) process safety for both internal and external requirements.

Benefits:

- Operate and maintain a safe working environment;
- Consistent implementation of Process Safety practices
- Lower legal liability

Standards

- NEMA
- OHSAS
- Planning and Zoning Regulations
- Boiler and Pressure Vessel Regulations
- Fire Regulations

- Industry standards
- Industry Association
- National / International standards (SANS, ISO, etc)

- Engineering Codes
- Operation Codes
- Maintenance Activity standards
- Recommended Practices

- General Standards
- Reporting Procedures
- Behavior in Plant
- Specific Process Standards

Core Features

Maintain a dependable practice

- Implement consistent standards system and compliance.
- Involve competent personnel.
- Compliance practices to be effective.

Conduct compliance work activities

- Access to standards, codes and updates must be easily accessible
- Report on compliance activities
- Review applicability of requirements as appropriate

Follow up on action plans and legislation requirements

- Report on compliance documentation and document review.

Compliance with Standards

CSB Video

Laboratory Safety

Compliance with Standards

Small Group Discussion

Group Discussion

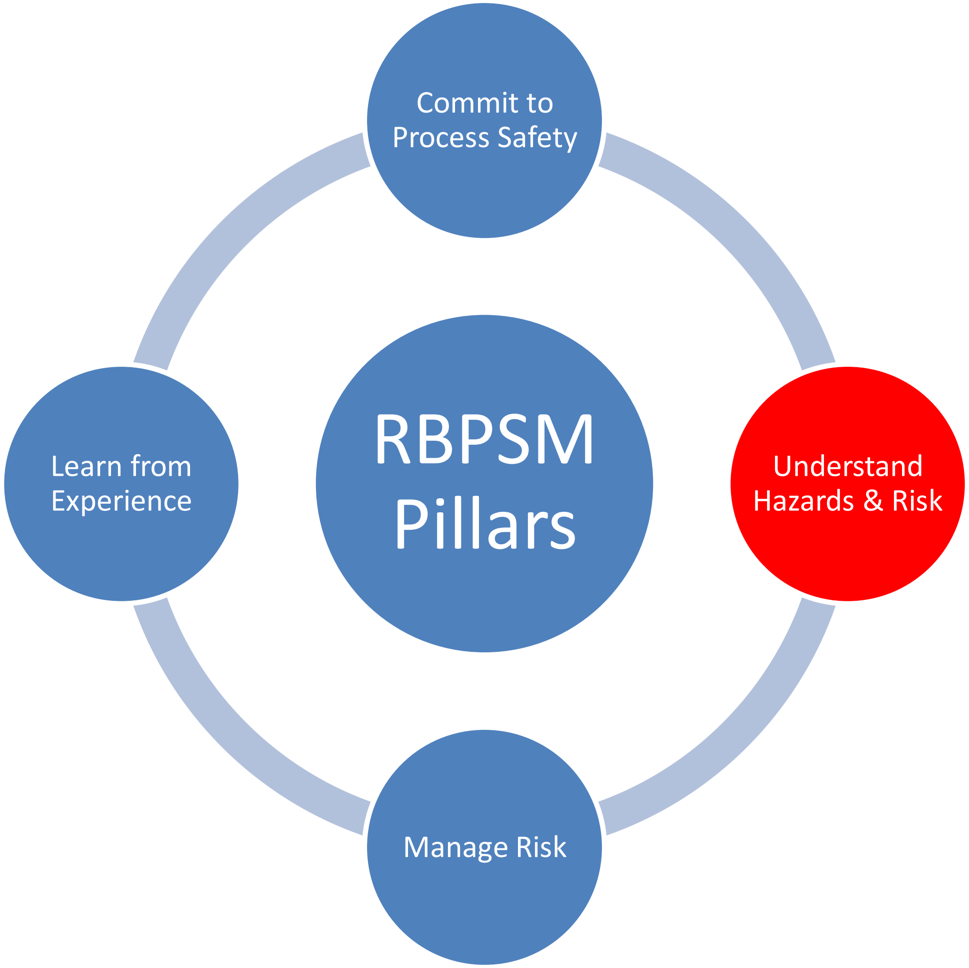
Questions

1. What safety standards were missing regarding the lab explosion?
2. How do you rate the compliance with regards to the standards that existed.
3. What are the causes of this compliance level?
4. What are the process safety standards applicable to your organization?

End of Pillar 1 - Module 2 – Day 2

Thank you

4 RBPSM Pillars



IRCA Global

RBPSM Elements

Commit to Process Safety

Manage Risk

Understand Risk

Learn from Experience

Process Safety Culture	Process Knowledge Management	MOC	Training and Performance Assurance	Auditing
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Course Objectives

Commit to Process Safety

Manage Risk

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Common Problems (based on case studies)

- **Not aware** of the basic facts
- Aware of the facts but **not understanding** them
- Aware of the facts but **not communicating** them to the extent necessary
- Aware of the facts but **forgot** them

2.1-Process Knowledge Management

Process knowledge management focuses on written records as follows:

Process Knowledge Management

DEVIATION	LOSS EVENT	IMPACT
Loss of Containment	Fire	Fatality / Injuries
Low/High temperature	Explosion	Property Damage
High Pressure	Containment ruptures – uncontrolled release of substance/material	Fatalities/Injuries Property Damage Environmental Damage
No/Low Flow	Unscheduled shutdown	Business Interruption
Overfill	Spoiled Batch	Market share loss
Transfer to wrong tank	Equipment damage	Reputation damage
Excess Impurities	Release of energy	Loss of license to operate

SOME TYPICAL FAILURE MODES (DEVIATIONS)

Loss of Containment

the action of keeping something harmful under control or within limits

- ❑ **Opening a pressurised pipe (human error)**
- ❑ **Pipe failure / Corrosion**
- ❑ **Overfilling**
- ❑ **Mechanical failure of vessels/tanks (seams/welds)**
- ❑ **Overpressure / Temperature to high**
- ❑ **Rupture of furnace/heat exchanger tubes**
- ❑ **Mechanical impact (damage)**
- ❑ **Instrumentation malfunctioning**
- ❑ **Poor maintenance on equipments, valves, etc.**
- ❑ **Inadequate blanking of pipe line ends, etc.**
- ❑ **Uncontrolled chemical reaction**

Piping Failures

Pipe failure is the cause of more than 60% of plant incidents.

- Material failure / Corrosion / Erosion
- Joint Pipe failure / Corrosion (under lagging)
- Plugging
- Bending / Stress
- Vibration
- Stress corrosion cracking
- Incorrect closing of valves / figure 8s, etc.
- Freezing and expansion
- Local eddy currents (buried pipes)
- Metallurgical defects.
- Human error

Overfilling

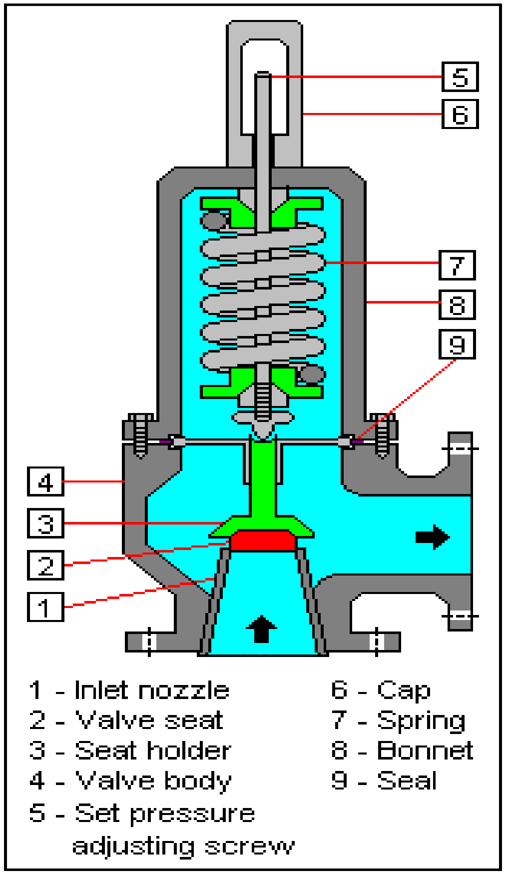
- BP Texas City column overfill
- Buncefield tank overfill

Pressure too high/low

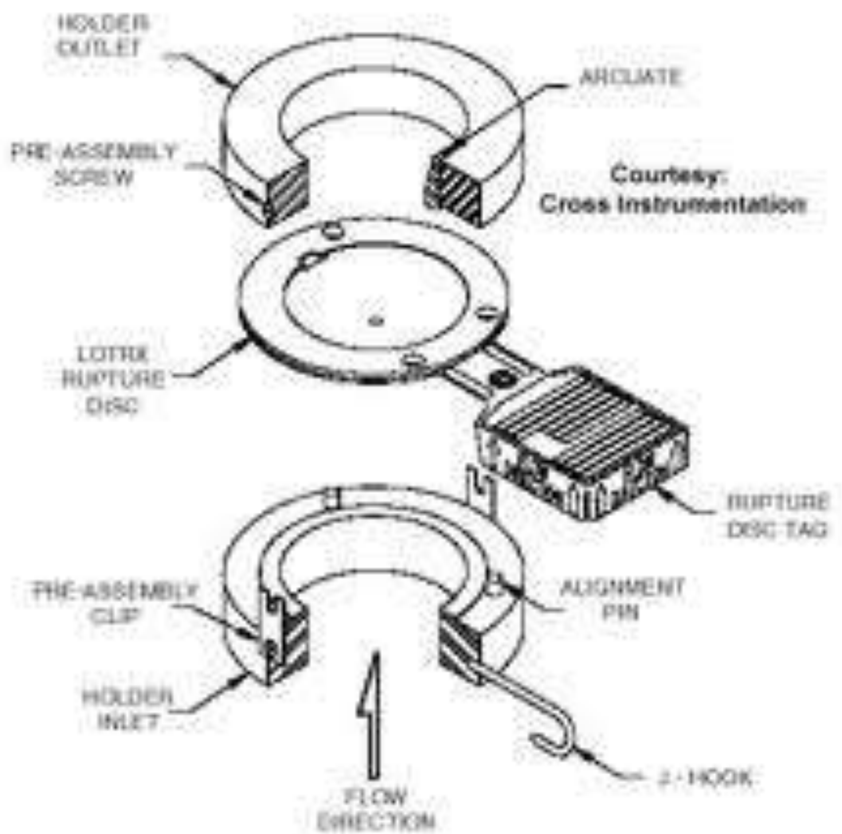
Heating is a common cause of overpressure

Vacuum can cause Collapse

Devices to control pressure



Relief Valve



Rupture Disc

Uncontrolled chemical reaction

BHOPAL AND OTHERS

Gases evolved might be:

- **Hot**
- **Flammable**
- **Toxic / Corrosive**
- **Able to pressurize an enclosure to the point of rupturing**

Solids / Liquids might be:

- **Hot**
- **Thermally sensitive**
- **Shock-sensitive**
- **Corrosive**

Statistics:
167 Incidents in US in 21 year period
108 Fatalities
Extensive damage to property

Reactive Chemicals

Accidental contact of Incompatible chemicals can result in:

- **Generation of heat (acids & bases)**
- **Violent reaction (Acrolein & acids or other catalyst)**
- **Formation of toxic vapors or gases (Cyanide salt & acid)**
- **Formation of a flammable gas (alkali metal & water)**
- **Fire or Explosion (Perchloric acid and Acetic Anhydride)**

Core Features

Maintain a dependable practice

- Implementation must be consistent.
- Scope must be clearly defined.
- Chemical reactivity hazards must be thoroughly documented.
- Roles and responsibilities must be assigned to competent personnel.

Process knowledge must be stored and easily accessible.

- Information to be stored in a central files and backed up.
- Information must be documented in a simple manner.

Process knowledge protection and updating.

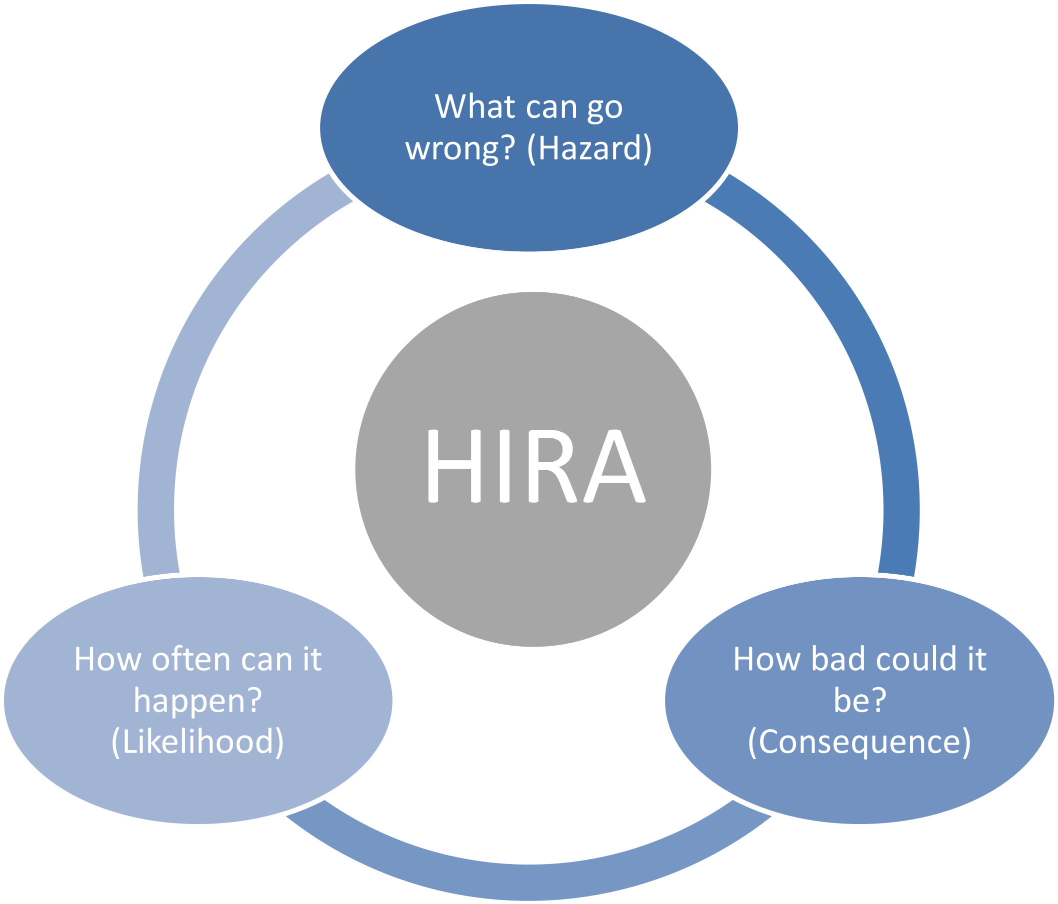
- Accuracy of process knowledge must be ensured and must be protected from change.
- Outdated information must be archived and access must be controlled.
- Management of change must feed into the process knowledge.

Use process knowledge

- Ensure awareness and constantly monitor use of process knowledge.

Small Group Discussion

2.2-Hazard Identification & Risk Analysis



Group Discussion

Questions

1. What are the main categories of process safety knowledge data in your organization?
2. How does your organization ensure that the process safety information is up to date and is complete?

Common Hazards in Chemical Processes

Fires:

Flammability & Combustibility of Materials

Explosions:

Flammability & Explosive Limits (UEL/LEL)

Gas Releases:

Toxicity, Flammability, Explosion

- Fires and explosions can be prevented by either removing:
  - Oxygen (O_2);
  - Heat;
  - Or Fuel.
- The ignition source must also be controlled.
- The flash point(FP), the temperature above which a liquid forms an ignitable gas, must also be closely monitored.

Flammable Limits

TABLE 2-4 Minimum Oxygen for Combustion (MOC)*

	N_2–Air, % v/v O_2†	CO_2–Air, % v/v O_2†
Acetone	13.5	15.5
Benzene	11	14
Butadiene	10	13
Butane	12	14.5
Carbon disulfide	5	8
Carbon monoxide	5.5	6
Diethyl ether	10.5	13
Ethyl alcohol	10.5	13
Ethylene	10	11.5
Hydrogen	5	6
Hydrogen sulfide	7.5	11.5
Isobutane	12	15
Methane	12	14.5
Methyl alcohol	10	13.5
Propane	11.5	14
Propylene	11.5	14

*Safety factors for industrial operations are required.

†% v/v O_2 is in mixtures of the combustible + inert gas + air. Values are for normal room temperature and 101.325 kPa.

Toxicity

TABLE 1. Symptoms from low to high concentrations of H_2S

Exposure level	Concentration, ppmv	Symptom
Low	0–10	Irritation of the eyes, nose, and throat
Moderate	50–200	Coughing Hoarseness Shortness of breath Pneumonia Loss of smell (> 100 ppmv)
High	200–500	Changes in respiratory tissue (200–400 ppmv per laboratory animals) Rapid respiratory distress and failure (acute exposure at > 500 ppmv for 1 to 4 hours)[2]
Very high	> 2,000	Coma and death after single breath[4] Known as "knockdown effect" with immediate immobilization and unconsciousness, possibly from disruption of oxidative metabolism in the brain

HIRA

Identify Hazard

+

Identify who might be harmed

+

Evaluate the risk and decide on precautions — COMPREHENSIVE HIRA

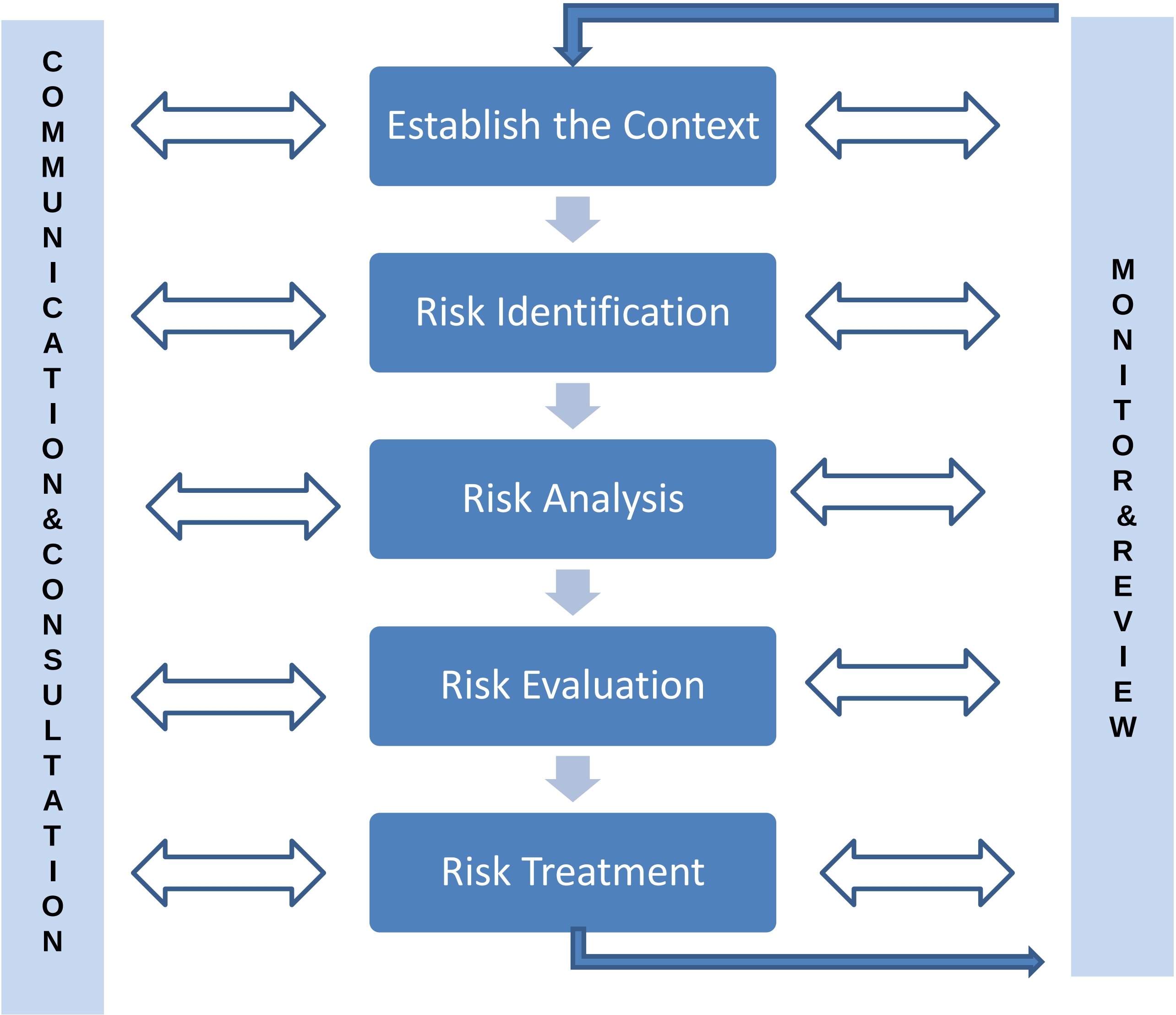
+

Record your findings and implement them.

+

Review your assessment and update when necessary.

Understand Hazard & Risk



HIRA


HANDSOME Consulting's 10 STEPS to HEALTH & SAFETY SUCCESS
STEP 5
RISK ASSESSMENT REPORT WITH RECOMMENDATIONS
STEP 2
RISK ANALYSIS
STEPS 3 & 4
RISK VALUE JUDGEMENT
TOLERATE
NO
YES
STEP 6
RISK REDUCTION
•TERMINATE
•TRANSFER
•TREAT
IDENTIFY HAZARDS IN TARGET AREA
STEP 1
RISK ASSESSMENT PROCESS
STEP 7
•IMPLEMENT RECOMMENDATIONS
•MANAGE CHANGE
STEP 8
STEP 10
NO
YES
ACCEPTABLE
•EVALUATE RESULTS & RECOMMENDATIONS
• MAKE CHANGES
•MEASURE & MONITOR
•INCIDENT INVESTIGATIONS
•COMPLIANCE AUDIT/INSPECTIONS
AUDIT AND/OR INSPECTION REPORT WITH RECOMMENDATIONS
STEP 9

HIRA Categories

- **LEVEL 1: WORKPLACE RISK ASSESSMENT**

  Should be done by plant based people.
  They then have a better understanding of the risks and risk reduction; e.g. 5 Why; Take 5; STOP; etc.

- **LEVEL 2: ENHANCED RISK REVIEW**

  Specialist help from e.g. Process Engineering or Process Safety Function (Internal or Consultants) and should include both Site and Plant personnel, e.g. Formal PHA, HAZOP, FTA, What If, etc.

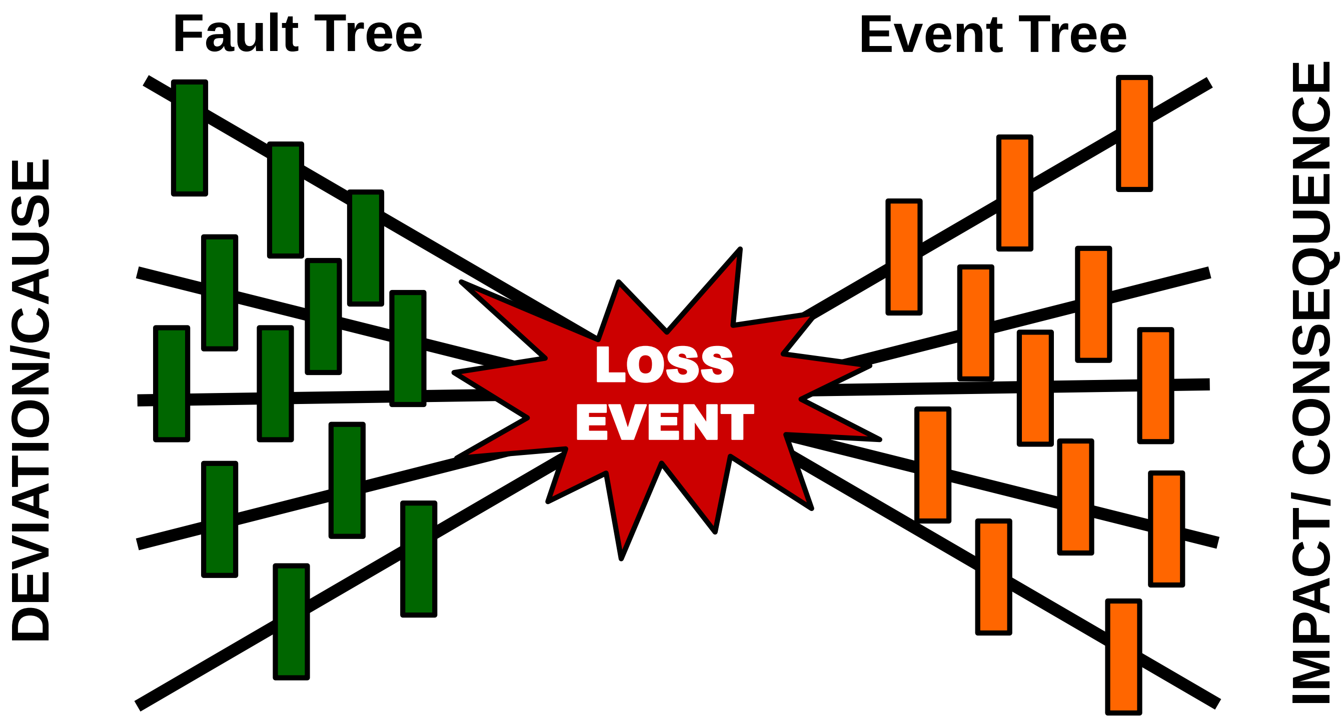
- **LEVEL 3: QAUNTATIVE RISK ASSESSMENT**

  Specialist help from external expertise. Owner needs to define scope and data and critique outcome, e.g. QRA, MHI.

HIRA tools include:

- Checklists
- 5 why
- What if?
- Failure modes and effects analysis, FMEA
- Bow Tie Analysis
- HAZOP, HAZID
- Process Hazard Analysis, PHA
- Dow Fire and explosion index, F&EI
- Dow Chemical Exposure Index, CEI
- Quantitative Risk Assessment

Barriers of Control – Bow Tie Analysis



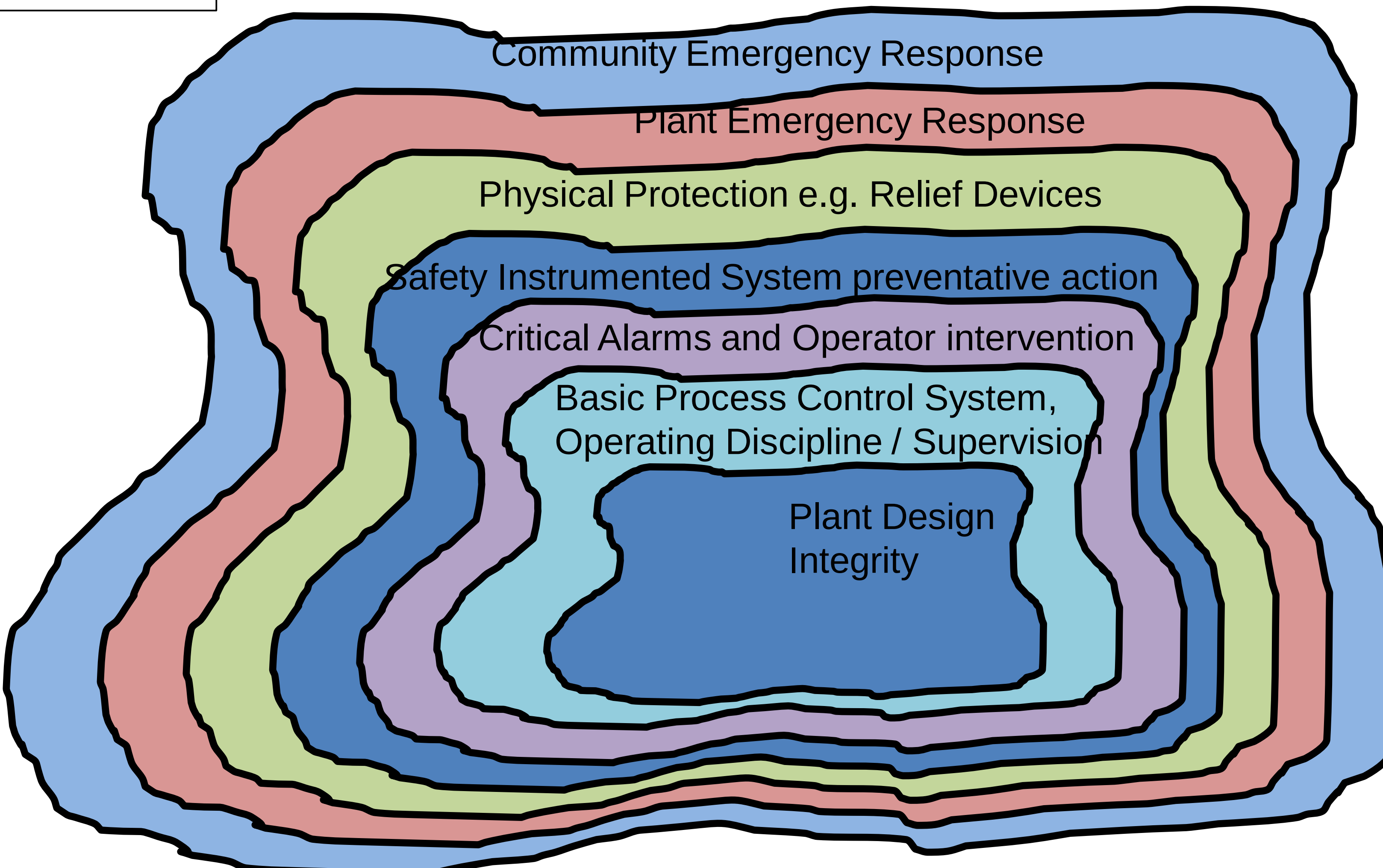
Preventive Barriers / Controls

- Plant layout
- Construction standards
- Inspection
- Instrumentation

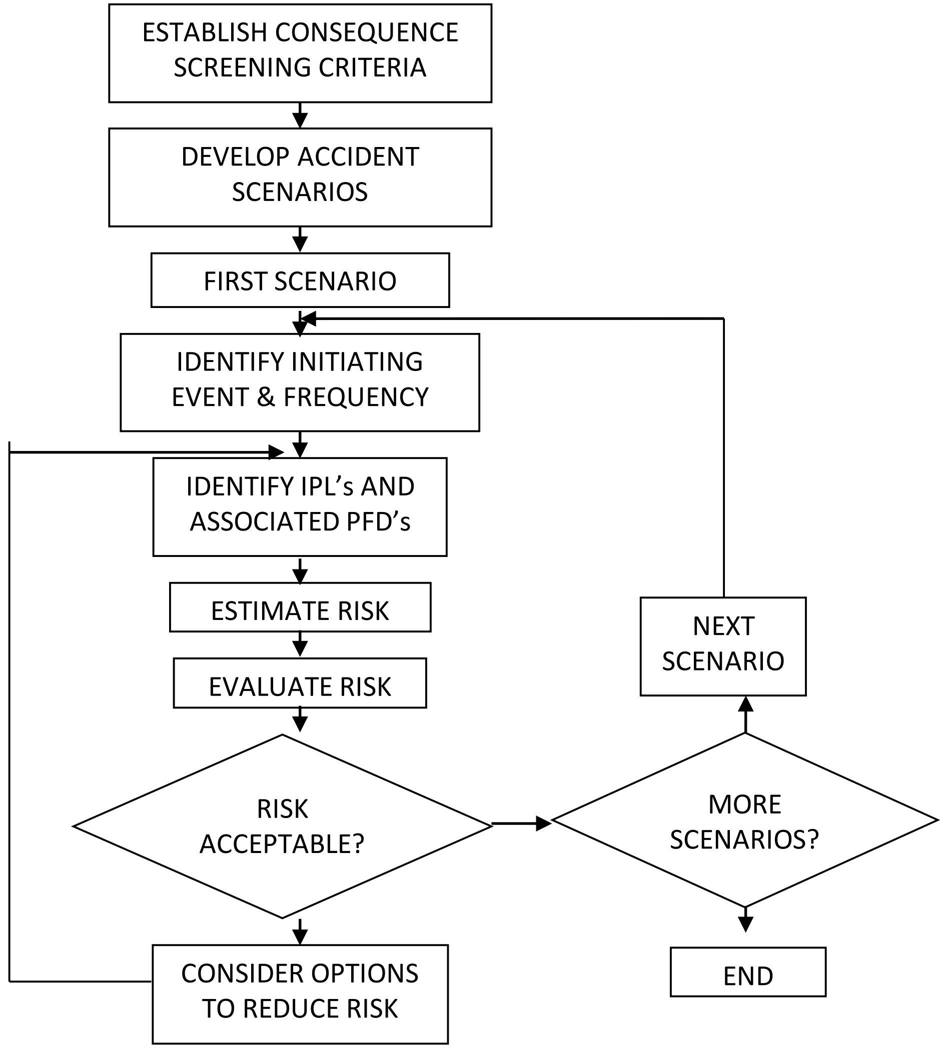
Mitigating Barriers / Controls

- Detection system
- ESD
- Active protection
- Passive protection
- EER

LOPA


Community Emergency Response
Plant Emergency Response
Physical Protection e.g. Relief Devices
Safety Instrumented System preventative action
Critical Alarms and Operator intervention
Basic Process Control System,
Operating Discipline / Supervision
Plant Design
Integrity

LOPA Process



Hazard ID & Risk Analysis

Risk Matrix

	Severity			
Likelihood per year	Limited damage	Reversible damage	Severe (fatalities)	Catastrophe (off-site fatalities)
e-3				
e-4				
e-5				
e-6				
e-7				
e-8				

	Un-Acceptable
	"ALARP" scenarios to be analysed on consequences
	Acceptable

Scenarios for consequence analysis are typically in the yellow zone

But don't forget to manage the scenarios in the green zones!

Applying Risk Matrices

- Develop specific technically relevant categories that define each level of probability and consequence in the risk matrix – *REPEATABILITY*;

- Develop a consistent way to record and document the thought process of how each risk rank is established – *DEPENDABILITY*.

Quantitative Risk Assessment

Benefits

- Rational basis for risk decisions
- Improved communication about risk
- Additional insights into risk

Challenges

- Resources
- Reproducibility
- Management understanding
- Visibility – not shared with all

What risk will we tolerate?

Consultant or in-house?

Tolerability Data (Fatalities) ***(Buncefield LOPA Guidance Dec 2009, final report from U.K. HSE)***

Likelihood of 'n' fatalities from a tank explosion per tank per year	Risk Tolerability		
10^{-4}/yr - 10^{-5}/yr	Tolerate if ALARP	Tolerate if ALARP	Tolerate if ALARP
10^{-5}/yr - 10^{-6}/yr	Broadly acceptable	Tolerate if ALARP	Tolerate if ALARP
10^{-6}/yr - 10^{-7}/yr	Broadly acceptable	Broadly acceptable	Tolerate if ALARP
10^{-7}/yr – $10/^{-8}$	Broadly acceptable	Broadly acceptable	Broadly acceptable
Fatalities (n)	1	2-10	11-50

Hazard ID & Risk Analysis

Maintain a dependable practice
- Integrate and document HIRA system
- Involve competent personnel
- Verify HIRA practices remain effective

Identify hazards and evaluate risks
- Gather and use appropriate data and HIRA methods
- Perform appropriate risk activities and report

Assess risks and make risk-based decisions
- Select appropriate risk control measures

Follow through on assessment results
- Communicate important results to management
- Resolve recommendations and track completion
- Communicate systematically

CSB VIDEO
FORMOSA PLASTICS

RBPSM Small Group discussion

RBPSM Small Group discussion

QUESTIONS

1. What risks were overlooked in the design of the Formosa Plastics unit?
2. What steps could have been taken to mitigate the results of the incident?
3. How could pre-job assessment by the forklift driver have contributed?
4. What are the four most important risk assessments in your operation and why?

End of Pillar 2 - Module 2 – Day 2

Thank you