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How to minimize Audit Findings by achieving a Sustainable and Sound Process Safety Culture

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Introduction: Purpose, Objectives and Motivation



Our main purpose with today's presentation is:

- What?
 - To highlight the key role of a sound process safety culture
- How?
 - By minimizing or avoiding accidental releases of highly hazardous chemicals (HHC)
- Why?
 - To avoid potential catastrophic consequences



April 20, 2010 – Deepwater Horizon (Gulf of Mexico)

Image: Public Domain

What are the specific objectives?

- To **compile and statistically process** audit findings and related data from a sample of Chemical Process Industry (CPI) facilities (ioMosaic's clients)
- To identify the main **common audit findings** and compare them with the results of those analyzed by OSHA (Refinery NEP and Chem NEP)
- To identify **process safety culture benefits** towards minimizing or avoiding these audit findings and therefore, to contributing to an optimized Process Safety management system

The Problem: Catastrophic releases of highly hazardous chemicals



Too many major accidents have taken place in industry over the last 40 years

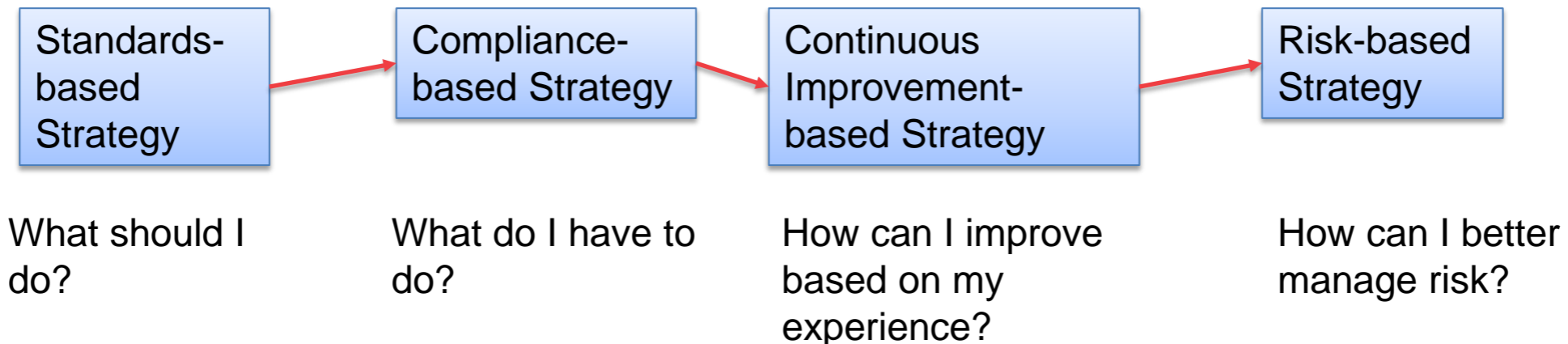
Location	Date	Company	Process	Major Incident	Fatalities (F)/Injuries (I)
Flixborough (UK)	6/1/74	Nypro (UK) Ltd	Production of caprolactam	Explosion in oxidation of cyclohexane process	F: 28 workers I: 36 on-site, 53 off-site
Seveso (Italy)	7/10/76	Industrie Chimiche Meda Societa Azionara (ICMESA)	Batch production of 2,4,5-trichlorophenol (TCP)	Toxic release of TCDD (2,3,7,8-tetrachlorodibenzo-p-dioxin)	F: 0 I: 477 people reported skin injuries (burns & chloracne)
Bhopal (India)	12/3/84	Union Carbide India Ltd	Production of Sevin	Toxic release of methyl isocyanate (MIC)	F: 3,787+ workers and near-by Residents
Piper Alpha (UK)	7/6/88	Occidental Petroleum (Caledonia) Ltd	Offshore oil and gas processing	Oil platform explosion and fire	F: 167 workers
Pasadena (USA)	10/23/89	Phillips 66	Polyethylene production	Polyethylene plant explosion and fire	F: 23 workers I: 130 to 300
Longford (Australia)	9/25/98	Esso Australia Resources Ltd	Gas and crude oil processing	Gas plant explosion and fire	F: 2 workers I: 8
Texas City (USA)	3/23/05	BP	Oil refinery	Isomerisation unit explosion	F: 15 workers I: 180

Process Safety Management is about Accident Prevention

➤ Major accidents have been driving forces for:

- Issuing Regulations (Government)
- Publishing Standards (Industry groups), and
- Developing Policies (Companies)

➤ Evolution of Process Safety & Accident/ Loss Prevention Strategies



The OSHA Process Safety Management Standard was promulgated in 1992 - 29 CFR 1910.119



- It emphasizes the management of hazards through an established comprehensive **performance based program** that integrates technologies, procedures, and management practices
- If a process uses, stores, manufactures, handles, or moves **highly hazardous chemicals** onsite above the TQ, the process is PSM covered
- Focuses on threats to onsite **employees and contractors**
- Prevents or minimizes the consequences of a **catastrophic release** of toxic, reactive, flammable, or explosive chemicals

The current OSHA PSM 1910.119 standard has 14 elements

- 1) Employee Participation (EP)
- 2) **Process Safety Information (PSI)**
- 3) Process Hazard Analysis (PHA)
- 4) **Operating Procedures (OP)**
- 5) Training
- 6) Contractor Safety
- 7) Pre-Startup Safety Review (PSSR)
- 8) **Mechanical Integrity (MI)**
- 9) Hot Work Program
- 10) Management of Change (MOC)
- 11) **Incident Investigation**
- 12) Emergency Planning and Response (ER)
- 13) Compliance Audits
- 14) Trade Secrets

In response to major accidents, OSHA has implemented several National Emphasis Programs (NEPs)

- 2007 – Petroleum Refinery Process Safety Management NEP
 - In depth audit with static question list
 - **Covered all refineries**
- 2009 – PSM Covered Chemical Facilities NEP
 - Pilot program focused on ammonia and chlorine processes
 - **Regions I, VII, and X**
- 2011 – PSM Covered Chemical Facilities NEP
 - **Expanded to all OSHA Regions**
 - Focused on ammonia refrigeration and all other HHC facilities

ioMosaic's PSM Compliance Audits



Case Study: ioMosaic has conducted many audits over the years. Here we present the audit findings analysis of several Chemical facilities

- A sample of **16 facilities audited**
- Timeframe: **2010 - 2016**
- Type of facilities: **chemical, explosives, refineries...**

Our objective was to evaluate how well each facility complied with the requirements of the OSHA PSM Standard (29 CFR 1910.119)

- The scope of the audit included the **14 PSM elements**, plus an assessment of the applicability of the standard based on the chemicals handled on site
- All 14 OSHA PSM Elements were distributed among the several members of the Audit Team

ioMosaic's audit approach consists of a pre-audit questionnaire, opening, daily debriefing and closeout meetings

- Prior to arriving on-site, a **pre-audit questionnaire** was completed and forwarded to the audit team to help prepare for the audit
- An **opening meeting** was held to communicate to plant personnel the scope and approach for the audit
- **Daily debriefing meetings** were held to communicate preliminary findings and observations made by the audit team
- A **closeout meeting** was held to present all of the regulatory, RAGAGEP and local attention findings

What is an audit Finding, Citation or Violation?

- It is the identification of a part of the PSM program that does **NOT meet regulatory requirements** or industry standards
- Here are finding's categories:
 - **Regulatory** – related to the OSHA PSM Standard
 - **RAGAGEP** – related to Recognized and Generally Accepted Good Engineering Practice (or best industry practice)
 - **Local Attention** – a relatively minor nature that does not represent a chronic PSM issue or a finding related to requirements not specifically listed in the PSM regulation
 - **Compliant** – no evidence of non-compliance was identified

ioMosaic's audit protocol: ioAuditor™, is a component of Process Safety Office™

- ioAuditor™ is a **Windows Excel application** for Safety and Environmental Compliance Audits.
- ioAuditor™ allows recording the results of any type of audit including **PSM and Risk Management Program** (RMP) compliance audits.
- ioAuditor™ has **pre-populated audit protocols** (templates) to simplify documentation of findings and communication to the client

ioMosaic's audit protocol: ioAuditor™

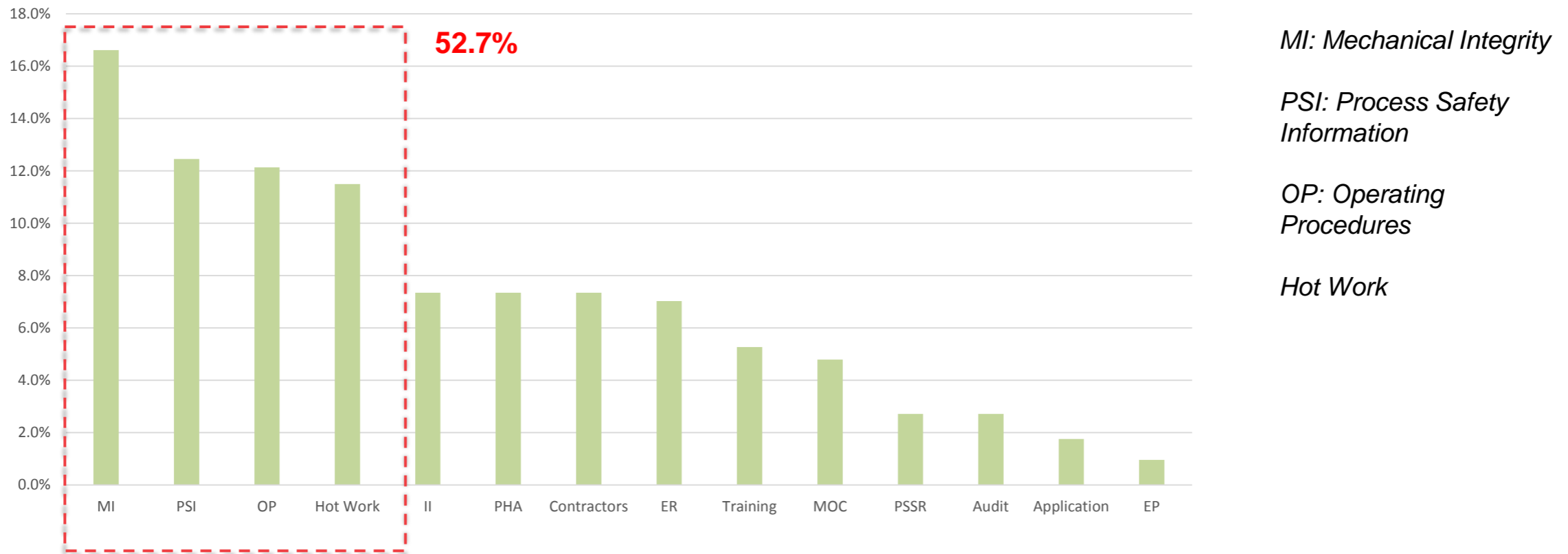
Item No.	Ref	Element	OSHA 1910.119 Requirements (RMP requirements same except as noted in RMP (ref) below.	Auditor guidance	Emphasis	Findings	Category	Action	Responsible	Due Date
1.001	(n)	ER	The employer shall establish and implement an emergency action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38(a). In addition, the emergency action plan shall include procedures for handling small releases. Employers covered under this standard may also be subject to the hazardous waste and emergency response provisions contained in 29 CFR 1910.120(a), (p) and (q).	The only new requirement here is the need for a procedure for handling small releases. Verify there is a written emergency action plan that meets the requirements of 29 CFR 1910.38(a). Verify through employee interviews that all employees understand how to protect themselves in an emergency. Verify that places of safe refuge have been identified and safe distances outlined in the plan. Verify that assembly areas are adequately remote from the process. Observe adequacy of windsocks.	NEP	Picked up five emergency plans at different locations in the main office and they were not controlled documents because they did not have blue headers on each page. The reader cannot be sure that these plans contain the most recent update to the plan.	Regulatory	Ensure the emergency plan in the current binders is the up-to-date version. Issue updated emergency plans in accordance with controlled document printing requirements.		
1.002	(n)	ER	The employer shall establish and implement an emergency action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38(a). In addition, the emergency action plan shall include procedures for handling small releases. Employers covered under this standard may also be subject to the hazardous waste and emergency response provisions contained in 29 CFR 1910.120(a), (p) and (q).	The only new requirement here is the need for a procedure for handling small releases. Verify there is a written emergency action plan that meets the requirements of 29 CFR 1910.38(a). Verify through employee interviews that all employees understand how to protect themselves in an emergency. Verify that places of safe refuge have been identified and safe distances outlined in the plan. Verify that assembly areas are adequately remote from the process. Observe adequacy of windsocks.	NEP	The Emergency Plan binders contain two documents (one with EP-29 pages, and another with 42 pages). There is no table of contents at the front of the binder or quick tabs that show the organization for easy access to a procedure or section during an emergency.	Local Attention	Determine organization for emergency plan for quick reference during an emergency. Update all emergency plan binders.		
1.003	(n)	ER	The employer shall establish and implement an emergency action plan for the entire plant in accordance with the provisions of 29 CFR 1910.38(a). In addition, the emergency action plan shall include procedures for handling small releases.	The only new requirement here is the need for a procedure for handling small releases. Verify there is a written emergency action plan that meets the requirements of 29 CFR 1910.38(a). Verify through employee interviews that all employees understand how to protect themselves in an emergency. Verify that places	NEP	Recommendation and action item from 2010 audit was not adequately addressed: "The current plan should be revised to include or refer to other procedures regarding the actions to be taken to address small releases of covered process hazardous materials."	Regulatory	Update emergency plan to include response to release of anhydrous ammonia.		

Audit Findings: Statistical Analysis



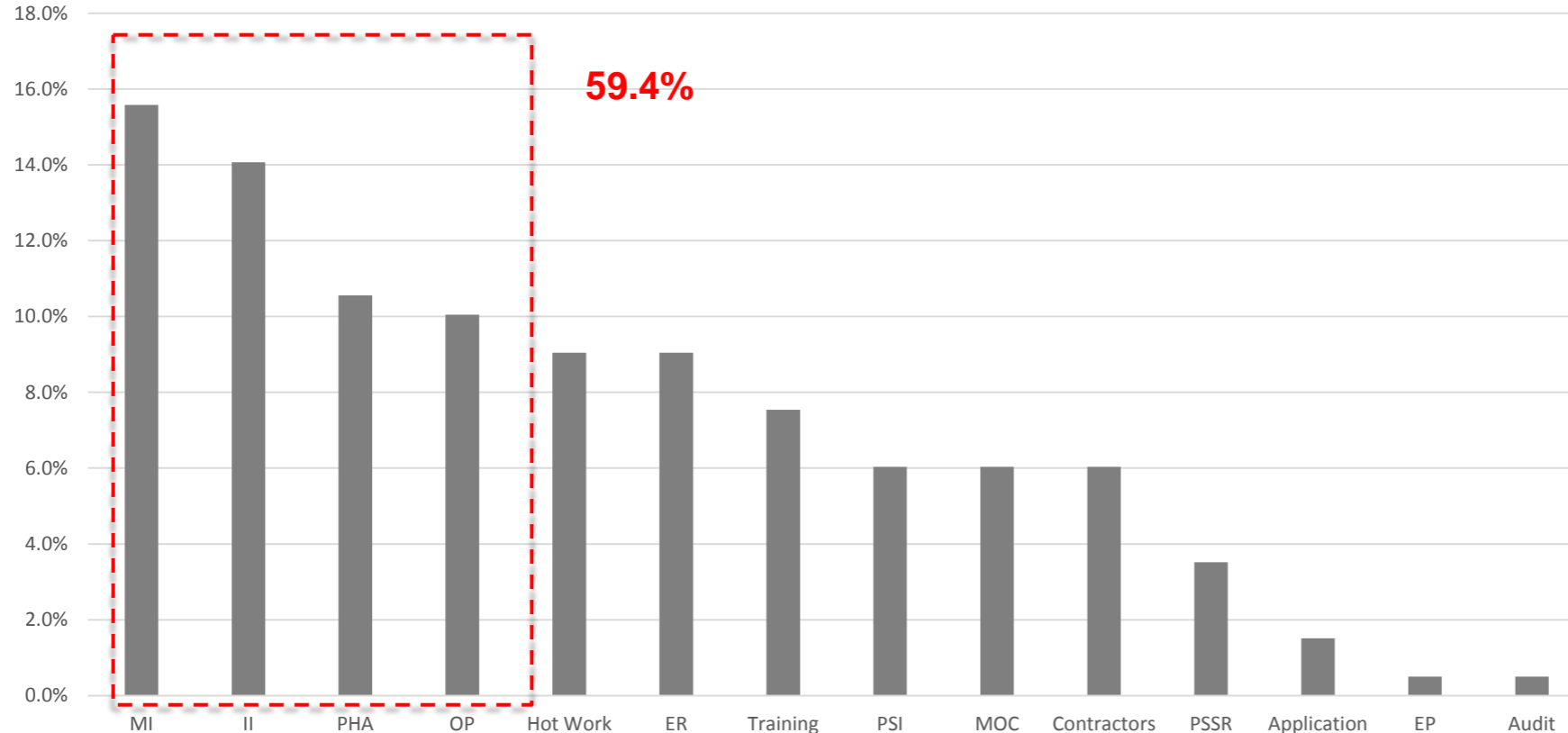
Four PSM elements represent more than the 50% of the Regulatory findings

- This chart shows the total % average of Regulatory findings per each of the 14 OSHA PSM elements



Four PSM elements represent more than the 50% of the RAGAGEP findings

- This chart shows the total % average of RAGAGEP findings per each of the 14 OSHA PSM elements



MI: Mechanical Integrity

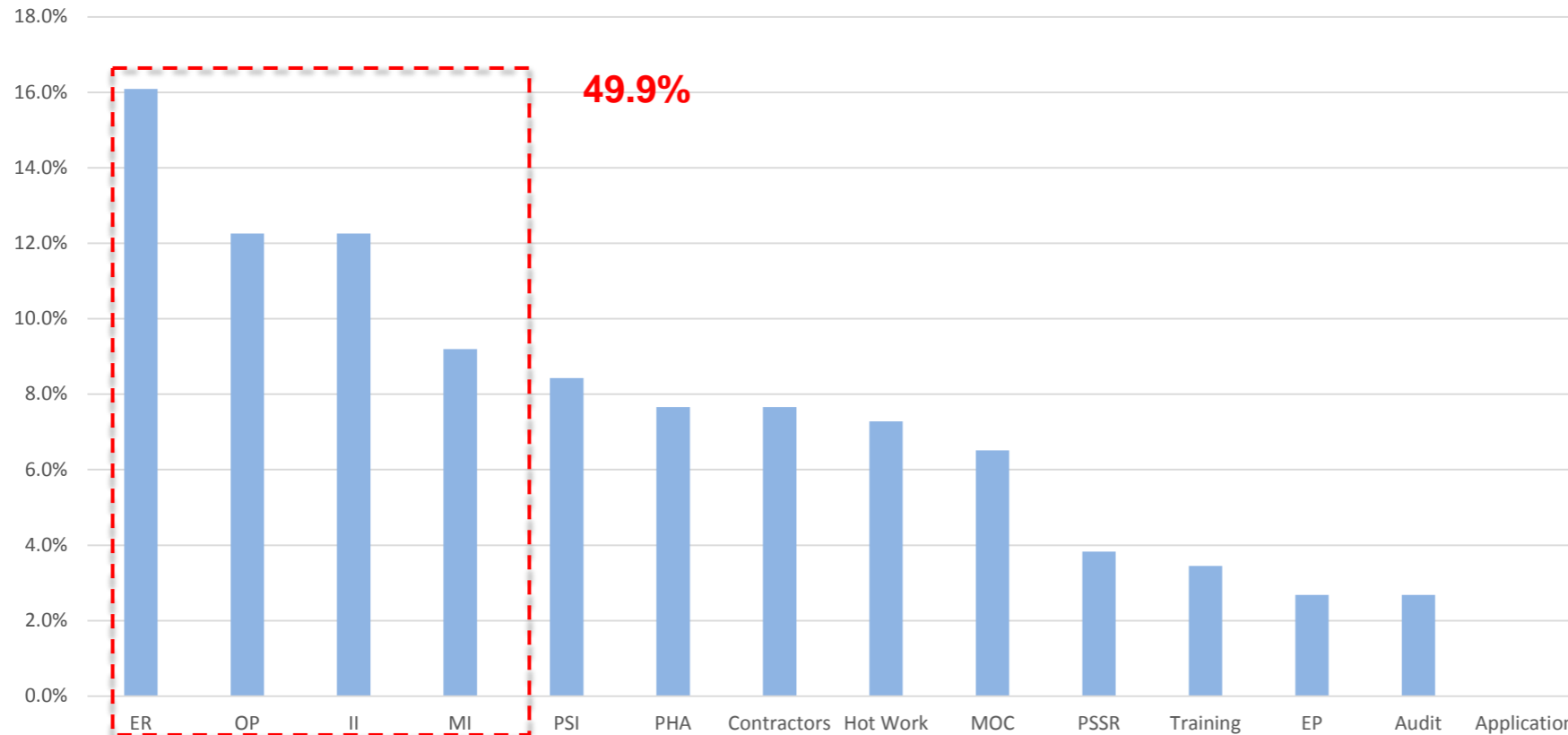
II: Incident Investigation

PHA: Process Hazard Analysis

OP: Operating Procedures

Four PSM elements represent the 50% of the Local Attention findings

- This chart shows the total % average of Local Attention findings per each of the 14 OSHA PSM element



*ER: Emergency
Planning and Response*

*OP: Operating
Procedures*

II: Incident Investigation

MI: Mechanical Integrity

Identification of the main common PSM elements in the 3 categories:

➤ Regulatory:

➤ MI (16.6%)

➤ OP (12.1%)

➤ II (7.3%)

➤ PSI (12.5%)

➤ Hot Work (11.5%)

➤ RAGAGEP:

➤ MI (15.6%)

➤ OP (10.1%)

➤ II (14.1%)

➤ -

➤ Hot Work (9%)

➤ PHA (10.6%)

➤ Local Attention:

➤ MI (9.2%)

➤ OP (12.3%)

➤ II (12.3%)

➤ PSI (8.4%)

➤ -

ER (16.1%)

MI: Mechanical Integrity

OP: Operating Procedures

II: Incident Investigation

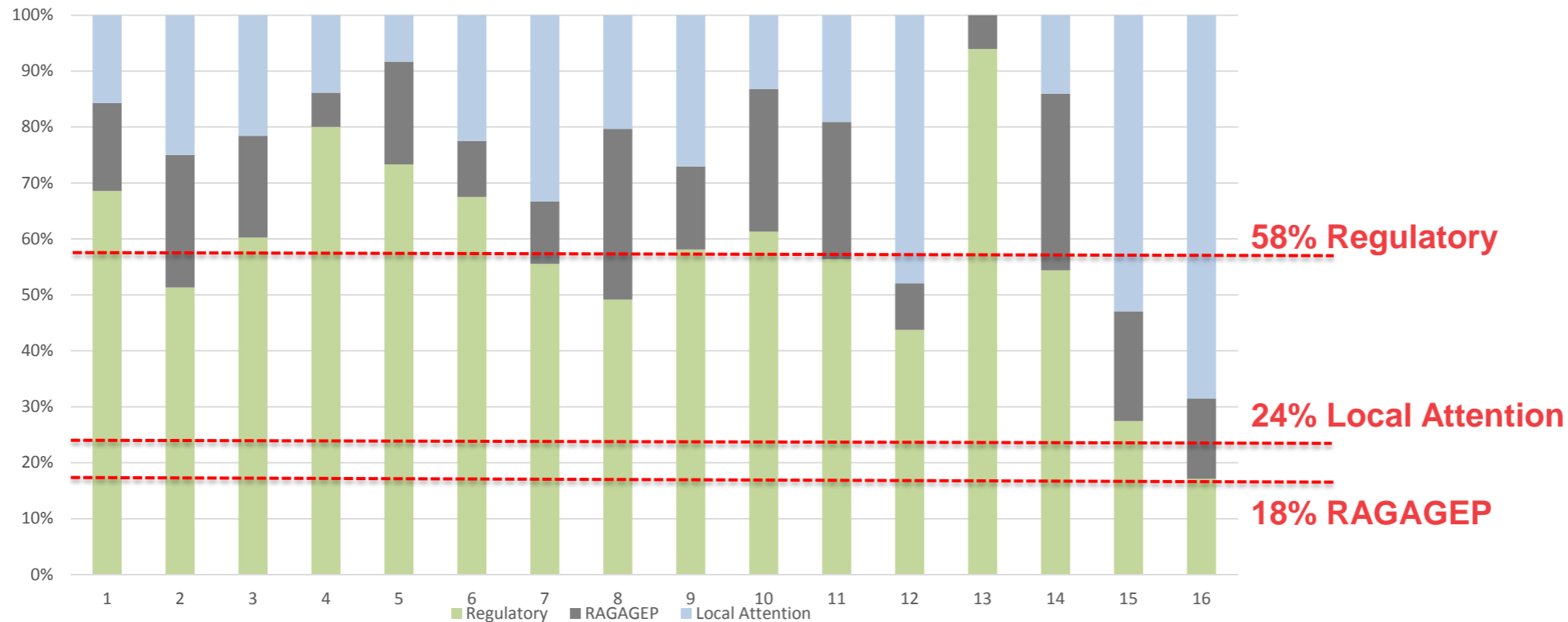
PSI: Process Safety Information

PHA: Process Hazard Analysis

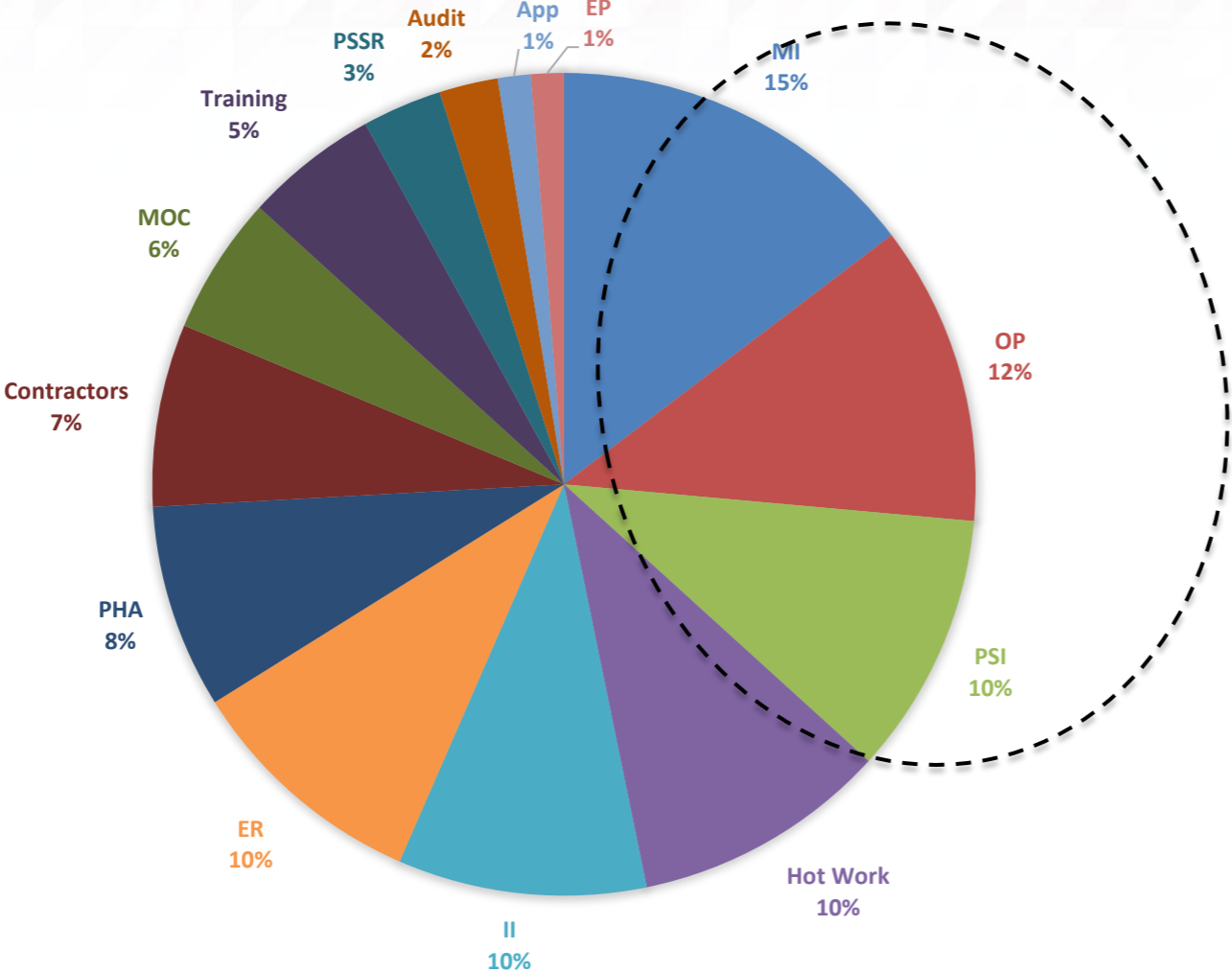
ER: Emergency Preparedness and Response

How are the auditing findings distributed?

- The compilation of findings for all facilities identifies the Regulatory with the main findings, followed by LA and RAGAGEP



Contribution of each PSM element to the total audit findings



MI: Mechanical Integrity

OP: Operating Procedures

PSI: Process Safety Information

II: Incident Investigation

ER: Emergency Preparedness and Response

PHA: Process Hazard Analysis

Comparison of OSHA Refinery and Chem NEP top PSM elements citations with ioMosaic's findings

%	Refinery NEP	Chem NEP	ioMosaic (Regulatory)
MI	19.5	23.2	16.6
PSI	17.4	20.9	12.5
OP	17.1	14	12.1
Total %	54	58.1	41.2

Description	Refinery NEP	Chem NEP	ioMosaic (Regulatory)
Inspections (facilities)	88	173	16
Citations (findings)	962	1487	648
citations/inspections	10.9	8.6	40.5

Source: Presentation by J.Barab (Deputy Assistant Secretary OSHA, 2012): 'OSHA's Refinery & Chemical National Emphasis Programs. [http://www.csb.gov/UserFiles/file/Barab%20\(OSHA\)%20PowerPoint.pdf](http://www.csb.gov/UserFiles/file/Barab%20(OSHA)%20PowerPoint.pdf)

Statistical Analysis Conclusions

- **Key audit findings** is a valued source of information for understanding current weaknesses and lessons learned
- The audit findings are **calls for action**, and should be addressed in a timely manner
- Audits reveal a history of repeat findings indicating chronic problems which can only be effectively achieved addressing the **technical and cultural root causes**
- Mechanical Integrity (MI), Process Safety Information (PSI), Incident Investigation (II) and Operating Procedures (OP), are elements that are highly dependent on the personnel's **attitudes and behaviors**

The importance of a sustainable and sound Process Safety Culture



What do we mean by sound Process Safety Culture?

- *“The combination of group values and behaviors that determine the manner in which process safety is managed. A sound process safety culture refers to **attitudes and behaviors** that support the goal for safer process operations”*

CCPS, Risk Based Process Safety, 2007

- *In other words:*

- *All the people in a company wanting to do the ‘right thing’ the ‘right way’ ‘all the time’ (always, even when no one is watching!)*

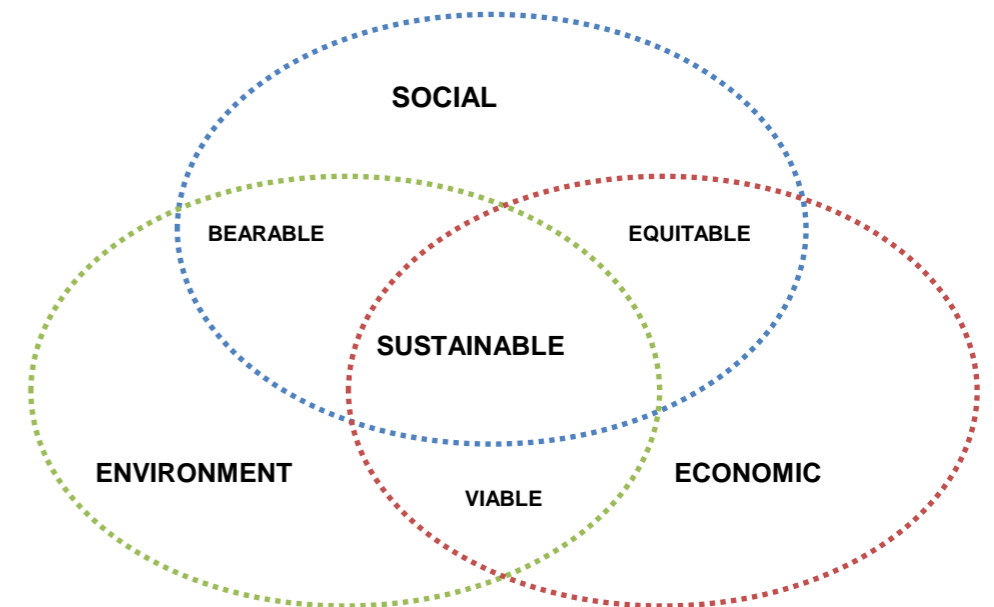


What do we mean by Sustainability?

- *“Sustainable development is development that meets the needs of the present without compromising the ability of future generations to meet their own needs”*

(Brundtland Report, Our Common Future, 1987)

- *Several organizations are promoting sustainable growth via their standards and guidelines*
 - *GRI (Global reporting Initiative Standards)*
 - *ISO 26000 (International Standard for social responsibility)*



How do we achieve a Sustainable and Sound Process Safety Culture?

- Build a strong Process Safety Management system based on the 14 elements of OSHA PSM 1910.119 standard
- Take into consideration the Environmental, Social, Economic aspects in each process
- Have systems in place to ensure that processes run safely
 - Have no negative environmental impact
 - Allow the protection of the social rights
 - Preserve the economic benefits
- All systems need to be auditable, and the audit findings need to be analyzed and actions need to be taken for a continuous improvement

Example: Piping Failure in a Crude Unit



Introduction

- When thinning of a piping occurs, ruptures are possible and can lead to the potential release of large quantities of hydrocarbon streams, which might potentially result in catastrophic incidents



Image: Public Domain

What happened?

- Sequence of events:
 - Leaking pipe: an operator notices a small puddle on the ground
 - Operator informs the Head Operator about the leak
 - An Operating Procedure (OP) should address the problem of a leak, by ensuring that the compromised unit is shut down **immediately**
 - Production should never be prioritized over Safety
 - A sound PS Culture ensures that OP are revised and followed. No short cuts!
 - They tried other solutions, but the leak suddenly worsened, hydrocarbon liquid sprayed out of the pipe (flash fire)
 - They decided to shut down the unit but it was too late as a vapor cloud formed and rapidly expanded and the hydrocarbons ignite
 - To act - being knowledgeable in the process (PSI, OP) and in a timely manner is key
 - A plume of black smoke formed, affecting the surrounding community

Observations based on incident investigation reports

- The old carbon steel pipe had thinned to the point of failure from:
sulfidation corrosion
 - Having accurate Process Safety Information (PSI) is key to Process Safety
 - A sound PS Culture ensures that the operators understand the PSI and act accordingly (e.g. Safety Data Sheets (SDS) give information about corrosion,...)
 - Accurate PSI should be a priority in every company. Companies with a sound PS Culture will establish that P&IDs must be updated every 6 months (Best Practice)
- The same incident had happened at a sister facility a few years earlier
 - Incident Investigation (II) and the resulted lessons learned should help us preventing similar incidents

Observations based on incident investigation reports

- Due to this incident, a Mechanical Integrity (MI) inspection of the piping was performed
 - The result of the MI inspection was severe thinning of the piping
 - The recommendation was replacement. This should have been a priority and never occurred, showing a poor Process Safety Culture
- A few years later, inspectors examined some piping and found significant thinning
 - Each and every segment of a piping should be inspected (MI)
 - If we have identified corrosion, whenever possible the material should be replaced with an inherently safer corrosion-resistant alloy (MI and PSI)
 - If not possible, then piping should be inspected and replaced more often (MI)

General observations

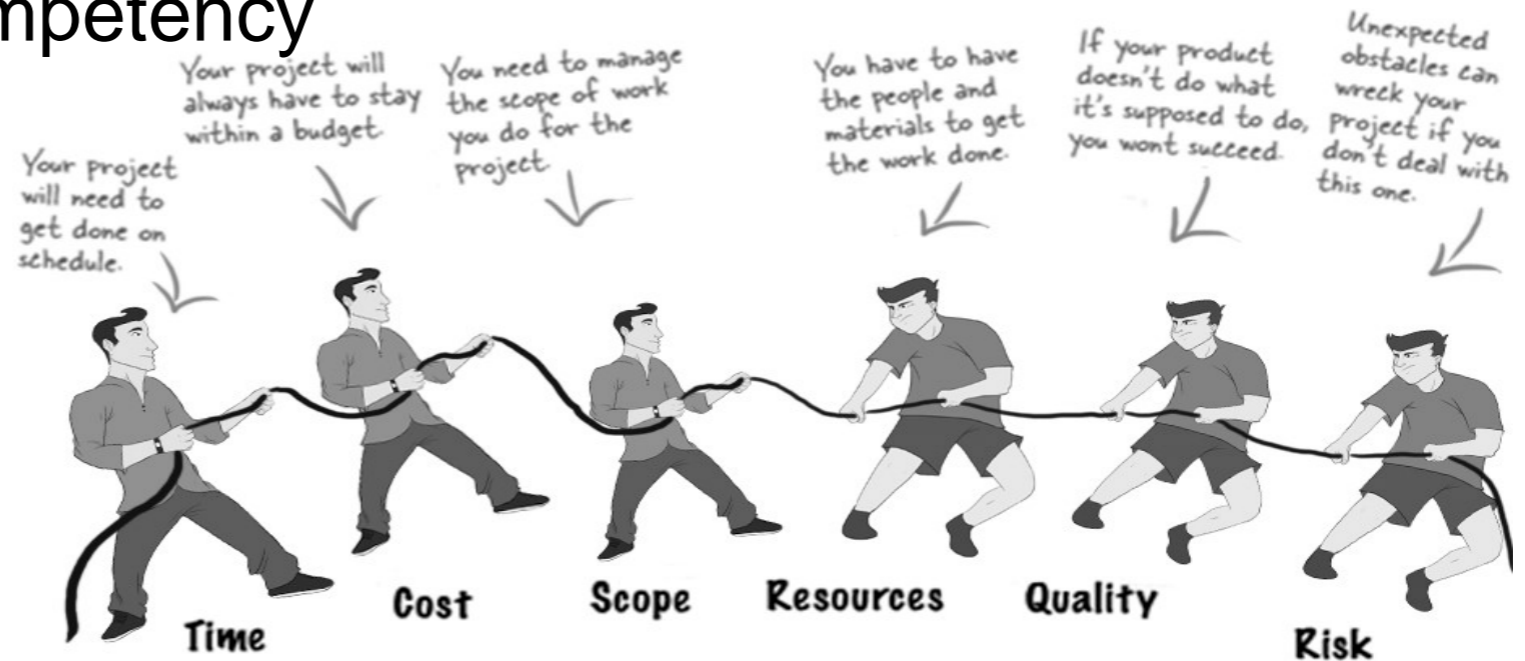
- Overdue inspections should not happen
- Recommendations from inspection should be implemented and in a timely manner
- We should be able to identify the need for inspection and perform it as often as requested (regardless of turnarounds)
- With every Management Of Change (MOC) (e.g. replacement of piping), an update/change of the OP and PSI (e.g. P&IDs, Relief sizing, SDS,...) must be done and communicated accordingly
- Production should never be prioritized over safety

Conclusions

- A safety management program will only be as effective as the underlying safety culture permits
- Change Attitude, safety attitude must be present at all times

- **Build Safety Culture Competency**

- If an organization has a weak safety culture, conflicting priorities many arise
- Priority:
 - SAFETY FIRST
 - ZERO TOLERANCE



Questions?



Thank you!



About ioMosaic Corporation

Through innovation and dedication to continual improvement, ioMosaic has become a leading provider of integrated process safety and risk management solutions. ioMosaic has expertise in a wide variety of areas, including pressure relief systems design, process safety management, expert litigation support, laboratory services, training, and software development.

ioMosaic is an integrated process safety and risk management consulting firm focused on helping you manage and reduce episodic risk. Because when safety, efficiency, and compliance are improved, you can sleep better at night. Our over 300 years of industry expertise allow us the flexibility, resources and capabilities to determine what you need to reduce and manage episodic risk, maintain compliance and prevent injuries and catastrophic incidents.

Our mission is to help you protect your people, plant, stakeholder value, and our planet.

For more information on ioMosaic, please visit: www.ioMosaic.com