Use of Live Barrier Models to Manage Risk

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Presentation Outline

- Basic Barrier Health Concepts
- Steps to creating a live barrier model
- Use of a Barrier model to manage risk
- Lessons Learned
- Conclusion

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A Vision of Good Health

- When last have you had a proper physical or check-up? (Preventative maintenance)
- Do you only seek treatment when health issues arises? (Corrective maintenance)
- Are your critical organs and systems healthy and robust?
- Are you doing what is required to ensure your body (asset) to be reliable and function as per design?

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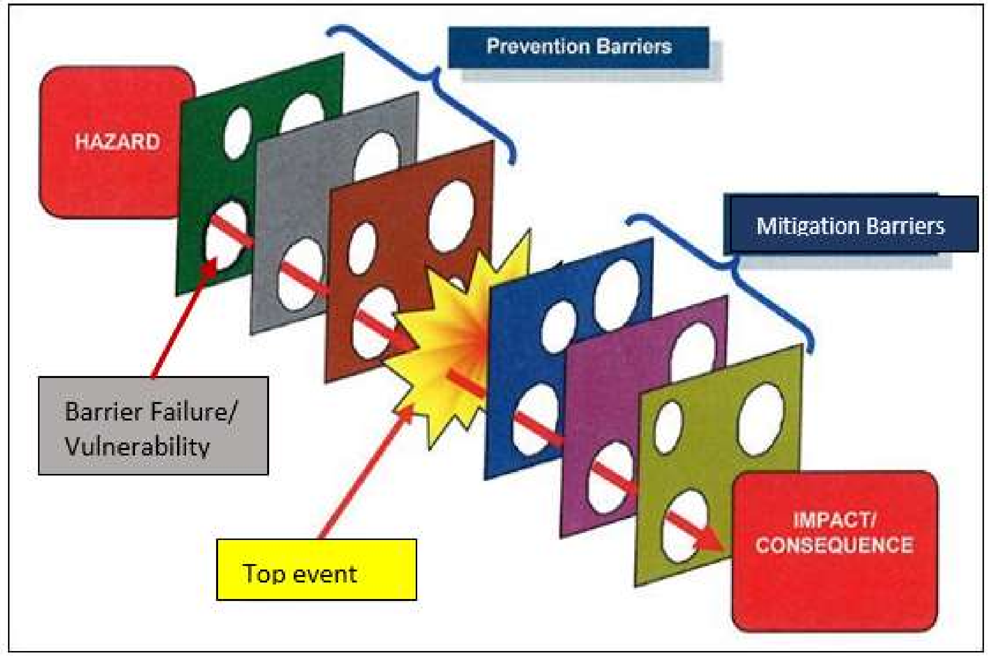
Swiss Cheese Model Illustration

- Swiss cheese model concept - No barrier is 100% effective (each has weaknesses or holes to varying extents).
- 'Holes' form or develop when barriers are
  - Degraded (wear & tear, poor maintenance)
  - Damaged (operated beyond design limits or impacted by nearby activities)
  - Bypassed or removed (Overrides, changes)
- An ineffective barrier leaves one susceptible to the escalation of threats from inherent hazards.
- How does a facility manage that emergent risk?



Introduction

- In order to effectively manage process safety and operational risk, a facility must have a comprehensive understanding of its inherent risks and potential emergent concerns that may rise during its lifecycle.
- Assessing these risks allows for specific, well-designed barriers or controls to be installed and operated to prevent or mitigate against major accidents.
- A Live Barrier Model evaluates the health of a facility's safety critical barriers and provides a visual of the facility's cumulative risk while considering any ineffective barriers.

Develop a Live Barrier Model

1. Identify major accident event (MAE) scenarios from HAZOPs, LOPAs, HAZIDs, bowties etc.
2. Assign SCE to Hardware barrier groups and SCE sub-groups (IOGP 415 Supplement).
3. Identify or tag SCE barriers in the equipment database with the assigned group info.
4. Develop SCE Performance Standards for the applicable SCE groups.
5. Evaluate effectiveness of the facility's SCE barriers (effective, partially effective or ineffective)
6. Use a digital risk visualization tool to illustrate barrier health and a cumulative risk overview.
7. Develop and implement remedial plans to reduce cumulative risk posed by impaired barriers.

Hardware Barrier and SCE Sub-Groups

- Categorize SCE equipment in the 8 hardware barrier groups in IOGP 415 Supplement.
- Develop SCE Performance Standards for each SCE group.

Hardware Barrier Group	Examples of SCE in this Hardware Barrier Group
Structural integrity	Mooring Systems , Heavy Lift Cranes
Process containment	Pressure Vessels, Relief Systems
Ignition control	Hazardous Area Ventilation, Certified Electrical Equipment
Detection systems	Fire and Gas Detection
Protection systems	Firewater pumps and distribution systems, Passive Fire Protection
Shutdown system	Depressurization Systems, High Integrity Protection Systems
Emergency response	Communication Systems, Emergency Power
Lifesaving systems	Personal Survival Equipment, Temporary Refuge

Barrier Effectiveness Criteria

Barrier Effectiveness ratings are determined using qualitative and quantitative rule sets for SCE and Hardware barrier groups.

Effectiveness Rating	**Definition**
Effective	A functional SCE device or barrier with no known defects that can impact functionality of the SCE device. The barrier performs its intended function when required and to the intended standard.
Partially effective	A functional SCE device with known defects that may impact the functionality of the SCE device in the near future (i.e. operating with defects).
Ineffective	A non-functional SCE device that is impaired i.e. not functioning per design and does not meet its performance standard.

Barrier Impairment Risk Evaluation

❖Identify and record known risks for different types of asset integrity related impairments:

❖**Technical and Asset Integrity Risk**

- Deficiency in equipment design based on technical studies e.g. structural reports, flare studies, obsolescence, RCFAs
- Failure to meet Performance Standards criteria due to impairment or failures, inspection reports
- Overdue or deferred preventative maintenance assurance activities e.g., inspection, testing

❖**Operational Integrity**

- Risk due to deviations from repeatedly operating outside the safe design envelope or exceeding safe operating limits over an extended period.

Area Visual for Live Barrier Health Model

Areas with most challenges:

- Area 1
- Area 3
- Area 2
- Area 4

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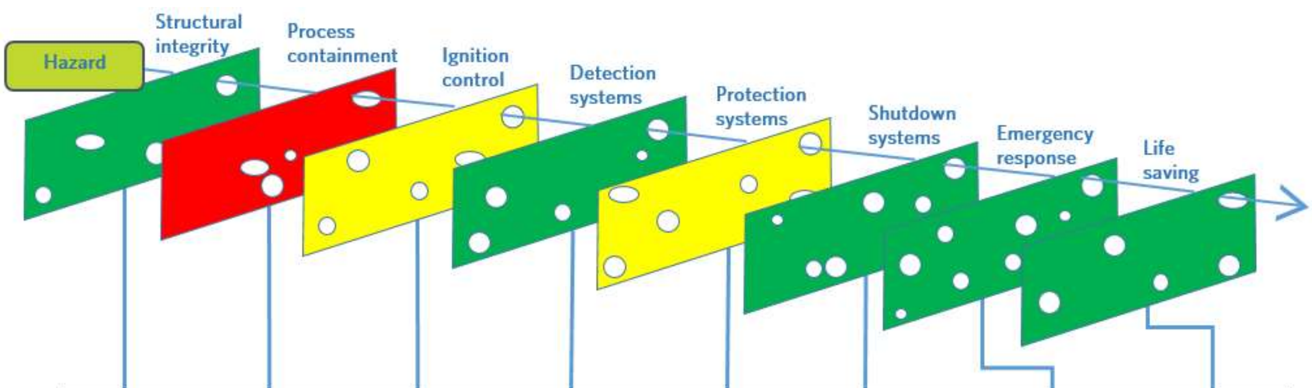
Detailed Barrier Visualization for Area 1



Structural Integrity	Process Containment	Ignition Control	Detection Systems	Protection Systems	Shutdown Systems	Emergency Response	Life Saving
SI001 Foundation Structures	PC001 Pressure Vessels	IC001 Hazardous Area Ventilation	DS001 Fire and Gas Detection	PS002 Fire and Explosion Protection	SD001 Emergency Shutdown System	ER001 Primary Muster Areas	LS001 Personal Survival Equipment
SI003 Heavy Lift Cranes	PC002 Heat Exchangers	IC002 Non-hazardous Area Ventilation	DS002 Security Systems	PS005 Fire Water Ring Main & Other Distribution Systems	SD002 Depressurisation System	ER002 Escape and Evacuation Routes	
SI006 Mooring Systems	PC003 Rotating Equipment	IC003 Certified Electrical Equipment		PS006 Passive Fire Protection	SD003 High Integrity Pressure Protection Systems (HIPPS)	ER003 Emergency/ Escape Lighting	
	PC004 Tanks	IC005 Earth Bonding		PS007 Gaseous Fire Protection Systems	SD006 Process Emergency Shutdown Valves (ESDVs)	ER004 Communication Systems	
	PC005 Piping Systems	IC006 Fuel Gas Purge System		PS010 Power Management	SD009 Instrument Air	ER005 Uninterruptible Power Supply (UPS)	
	PC007 Relief System	IC007 Inert Gas Blanket System		PS018 Instrumented Protective Functions		ER007 Emergency Power	
	PC009 Fired Heaters	IC008 Miscellaneous Ignition Control Components		PS020 Basic Process Control Systems (BPCS) Instrumented SCEs		ER010 Hazardous Drain Systems, Bunds, Secondary Containment	

Impaired Hardware Barriers :

- ❑ Process Containment

Impaired SCE categories

- ➢ Piping Systems: Examples of impairments: moderate valve packing leaks, corrosion below minimal allowable wall thickness
- ➢ Relief Systems: PSVs Overdue for testing and undersized PSVs.

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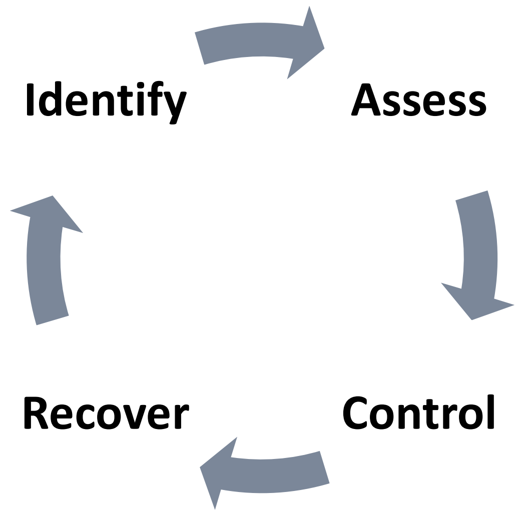
Risk Treatment and Mitigation

- How does one manage risk posed by impaired barriers?
- Repair SCE at the earliest or identify interim mitigating measures until it can be restored to full effectiveness. Examples of interim mitigations
  1. Temporary operating procedures
  2. Increased frequency of surveillance e.g. operator rounds, inspection or testing
  3. Use of a temporary repair or substitute measure e.g., portable fire and gas detectors or mobile fire-fighting equipment
  4. Reduce demand on the system or restriction of activities that may increase risk e.g., reduce inventory, operating parameters, restriction of personnel
  5. Limited work in the vicinity of the impairment e.g. SIMOPs
  6. Total or partial shutdown of the process equipment.



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Lessons Learned

Key lessons from the journey to implement a Live Barrier Model:

- Use an effective change management process and evaluate and plan for all potential challenges.
- Use of a well-defined SCE identification and tagging process at individual, unit and system levels.
- Early stakeholder engagement and buy in for changes to processes owned by other teams.
- Identify key software features and performance criteria from inception e.g., visual layout, ability to summarize data and generate reports of interest.
- Software compatibility between one's CMMS and Risk visualization tool (two-way communication)
- The model inherits systemic issues from the CMMS (e.g. incorrect or missing SCE data and PMs, aged work orders). Output is only as good as the input. Verification of data quality is key.
- Set realistic targets for achieving major project milestones based on workflows and resources needed.
- A detailed interface and handover plan with clear roles and responsibilities for sustained embedding of the changes after the go-live or launch dates.

Benefits of a Live Barrier Health Model

1. Visual, comprehensive overview of cumulative risks posed by ineffective barriers in a central repository.
2. Real-time data to guide risk-based decision making in prioritization of work and allocation of resources for risk reduction efforts
3. Confirms whether the right barriers are in place to manage operational risks.
4. Verifies adequacy of existing barriers and highlights areas of weakness in managing risks.
5. Improved awareness and ownership of barrier management roles (detection, reporting, repair, risk mitigation)
6. Streamlined work management and planning processes for managing barrier health
7. The model revealed various systemic issues in the CMMS and became a catalyst for continuous improvement initiatives to address certain systemic challenges identified.

Conclusion

- A live barrier model provides a visual of a facility's barrier health and the cumulative risk due to ineffective barriers.
- To develop a successful live barrier model, use a clear SCE identification process, well-developed Performance standards with effectiveness criteria and proper risk recovery methods to manage risks.
- Key benefits to implementing this tool include sound risk-based decision making for emergent risks, increased barrier awareness and ownership amongst frontline personnel and assurance that one's assets are safe.

End of Presentation

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Presenter's Bio

Rae-Ann Joseph, MBA

- Team Lead- Process Safety: Seventeen years of experience in the chlorine, chlorinated organics and oil and gas industries.
- Chemical Engineering, BSc – Florida A&M University, MBA – Springhill College (USA)
- Experience: Process Engineer, Production Planner, Process Safety Engineer, Project HSE Lead.
- Led various initiatives in Risk Management and Process Safety (AIM, Barrier health)
- Member of Trinidad & Tobago Board of Engineers and Association of Professional Engineers
- Presenter and Co-chair for AICHE GCPS conferences