



Operational Sustainability, LLC®

Controlling Risk Ranking Variability Using a Progressive Risk Registry

32nd Annual National VPPPA
Safety & Health Conference/Expo

September 1, 2016



BUILDING SUSTAINABLE ORGANIZATIONS

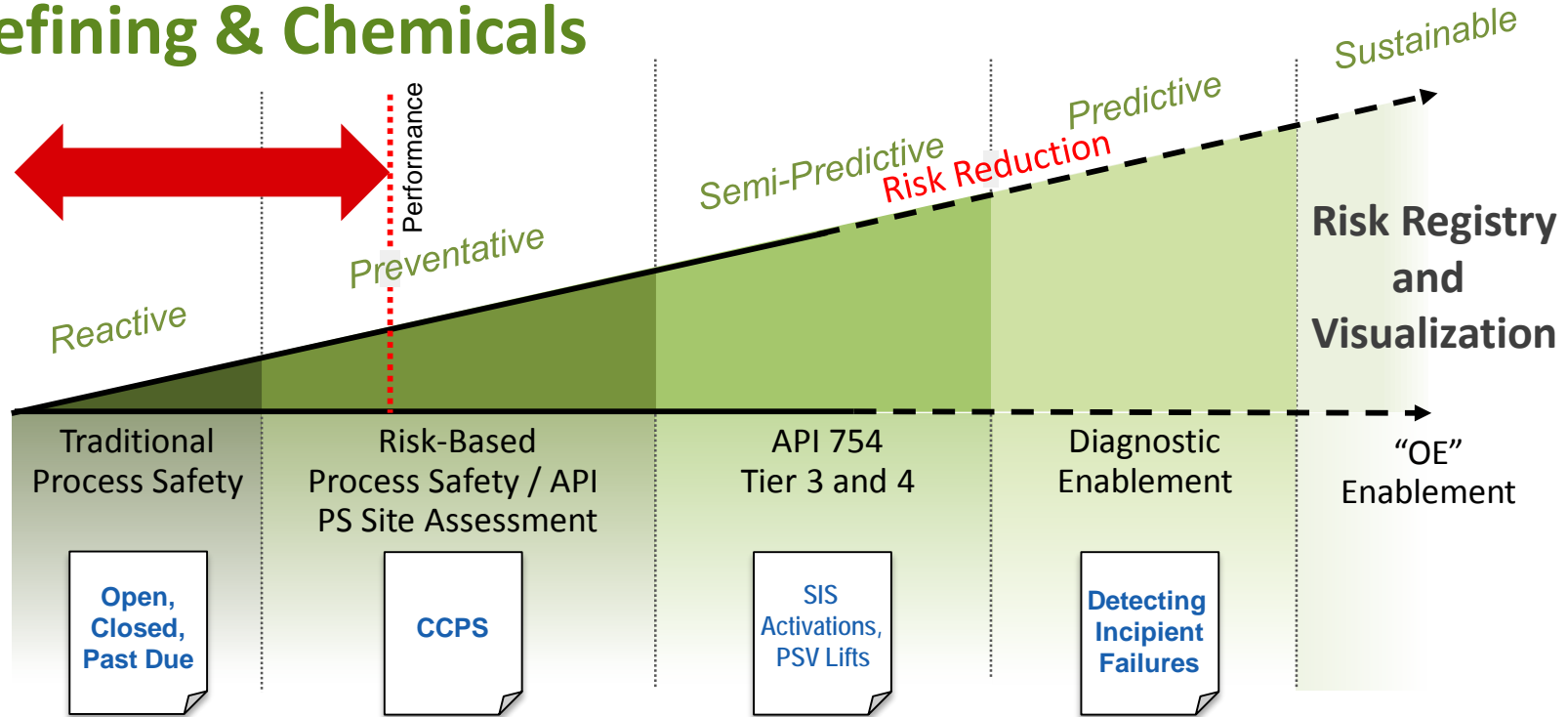
- What is a Progressive Risk Registry?
 - How does it impact PHA?
- PHA Risk Ranking Variability
 - Case study
 - Unintended consequences
 - Management system failures
 - Lessons Learned
- Road to more accurate hazard consequences
 - Worst case credible events
 - Quantify extent of leak, fire, etc.
 - Risk Matrix controls
- Strategies for an Enterprise Level Progressive Risk Registry without the enterprise cost

Risk Continuum & Risk Registry



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Refining & Chemicals

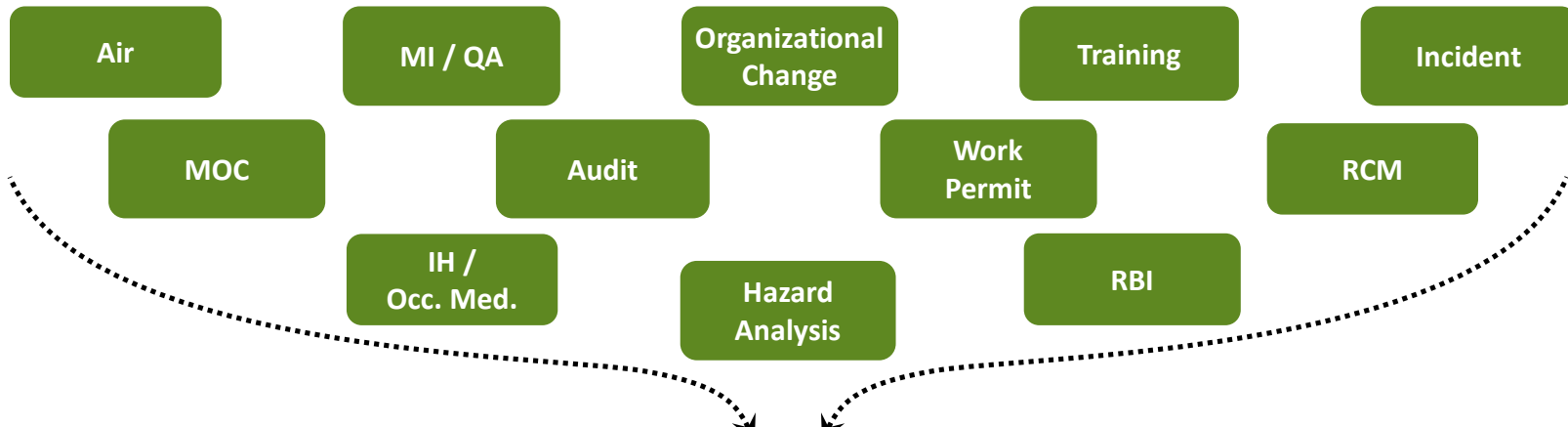


<p>Management of Change</p>	<p>Process Risk Management</p>	<p>Work Permitting/ Control of Work</p>	<p>Task/ Compliance Management</p>	<p>Procedure Management</p>	<p>Competency Management</p>	<p>Inspection Management/ Survey</p>
<p>Pre-Startup Safety Review (PSSR)</p>	<p>CAPA/ Action Item Management</p>	<p>Audit Management</p>	<p>Incident Management</p>	<p>Training Management</p>	<p>Alarm Management/ Integrity Operating Windows</p>	<p>Engineering Content/ Document Management</p>

Assemble Risk Contributors



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Enterprise Risk Management | New Process | Search | Report | Dashboard | Configuration | Administration | John Smith | Log Off

Enterprise Risk List

Entity	Risk Source	Risk #	Risk Scenario	Risk Rank	Barrier/Evidence	Category	Citation/Guidance	RPE	Risk Reduction Recommendation	Responsible Person	Due Date
Field -13142	Inspection	100012	Higher than design pressure - blockage in equipment downstream of choke, failure of choke	3	Equipment checked and pressure tested prior to startup	Operational	API 510	0.032	Well Test ESD	Mike Camphire	3/12/2014
				3	Well test procedures & good practice to avoid blockages	Operational	API 575	1	Implement procedures described in Well Control Manual	David Drerup	7/8/2012
				3	Pressure monitor, controllers and alarms for warning/control of deviation	Compliance	ISA 84.01	0.2	Implement rig emergency procedures	Mike Camphire	12/10/2013
Pazadena Plant	Audit	100015	The maximum design capacity of the product storage including considerations for vapor space listed	3	Reviewed Tank Strapping spreadsheet that has tank volumes and fills, but does not specify the maximum intended fill	Compliance	29 CFR 1910.119(d)(2)(iv)(c); 40 CFR 68.65(c)(1)(iii)	1.6	Consider providing the maximum design capacity of the product storage including considerations for vapor space	John Smith	10/16/2013
Baytown Plant	Process Risk - HAZOP	100016	Add manual override as part of operating procedure	4	Column temp indicators	Operational	40 CFR 65.25 (a)(2)(i); 40 CFR 65.25 (a)(2)(ii)	0.032	Well Test ESD	Dave Drerup	8/9/2013
				4	Flowmeters on pumparound loop	Operational	29 CFR 1910.119(c)(3); 40 CFR 68.83(c)	1.86	Implement procedures described in Well Control Manual	John Smith	11/15/2013
				4	Operator monitoring process will see quality problems with pit and specific gravity.	Operational	29 CFR 1910.119(f)(1)(iii)(D); 40 CFR 68.69(a)(3)(iv)	0.317	Implement rig emergency procedures	Mike Camphire	12/1/2013
Audit	100017	Production loss due to critical equipment shutdown	5	Identify production critical equipment	Operational	30 CFR 1910.119(f)(1)(iii)(D); 40 CFR 68.69(a)(3)(iv)	1.317	Implement rig emergency procedures	Mike Camphire	12/2/2013	
			5	Monitor equipment health	Business (\$5,000,000)		0.492	Backup strategy - spares, backup equipment ready to go	John Smith	12/31/2013	

How do we manage all these risks and prioritize accordingly?

Risk Management via Risk Registry



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Distribution of Risk

Process Risk

Entity: Houston Plant - Unit 1 Methodology: HAZOP/LOPA Status: Performing HAZOP

Title: HAZOP Study for Node 1-5 Study #: 2013-PR-00001 Progress: 1/6 (16%)

Description:

Initiator: Smith, John A Date Initiated: 8/29/2013 Source: Created by User Audit Trail

Navigation: Drawing/Document | Study Information | Related Information | Perform HAZOP | Perform Facility Siting | Perform LOPA | Workflow

Node # 1 Pre-Load all Guidewords/Deviations per Node Add Node Display Filter

Node #	Deviation	#	Cause	#	Consequence	Cat	S	UL	UR	ML	MR	#	Safeguard	#	Recommendation	Responsible Person	Notes
1	Flow, As Well As	1	Power failure, seal failure, manual valve closed	1	Poor product distribution, offspec product, coking of the wash section resulting in potential for overpressure and release/injury	A	Minor		10		8		Column temp indicators Flowmeters on pumparound loop PSV 1009A/B		Add manual override as part of operating procedure	Huynh, Nam	
	Flow, High	1	FV-0101, Bypass open or control valve malfunction open		Offspec product	A					5						
	Flow, Low	2	FV-0100, Bypass open or control valve malfunction open														
	Flow, Low	1	Equipment degradation		Production interruption	A					2						

Verified Completion of HAZOP Verified By: _____

Print HAZOP Worksheet

Likelihood (L)	Description	Severity (S)					
		Incidental	Minor	Moderate	Major	Severe	Catastrophic
Likely	Consequence can reasonably be expected to occur in life of facility	6	5	4	3	2	1
Occasional	Conditions may allow the consequence to occur at the facility during its lifetime, or the event has occurred within the Business Unit	7	6	5	4	3	2
Seldom	Exceptional conditions may allow consequences to occur within the facility lifetime, or has occurred within the OPCO	8	7	6	5	4	3
Unlikely	Reasonable to expect that the consequence will not occur at this facility. Has occurred several times in industry, but not in OPCO	9	8	7	6	5	4
Remote	Has occurred once or twice within industry	10	9	8	7	6	5
Rare	Rare or unheard of	10	10	9	8	7	6

Severity Category	Incidental	Minor	Moderate	Major	Severe	Catastrophic
Safety	Workforce: Minor injury such as a first-aid. AND Public: No impact	Workforce: One or more injuries, not severe. OR Public: One or more minor injuries such as a first-aid.	Workforce: One or more severe injuries including permanently disabling injuries. OR Public: One or more injuries, not severe.	Workforce: (1-4) Fatalities OR Public: One or more severe injuries including permanently disabling injuries.	Workforce: Multiple fatalities (5-50) OR Public: multiple fatalities (1-10)	Workforce: Multiple fatalities (>50) OR Public: multiple fatalities

PHA Ranking Variability – Case Study

- Chemical manufacturing client with multiple North American facilities producing the same products. The hazards are nearly identical for each facility. Client PSM Audit covered **Anhydrous Ammonia** at all facilities.
- The PSM Compliance Audit found that the various PHA teams at these facilities showed a high degree of variability in assessing the hazard consequences for similar scenarios and associated hazards.
 - Often, PSM Compliance Audits are done per site with little or no comparison between sites from an enterprise perspective... Meaning variabilities aren't surfaced until an incident occurs.

Variable Scenarios from PHA Teams



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For near identical equipment in similar service, results from the three PHA Teams were different, and contradictory:

Facility 1

- Risk level 4 (Severity 1, Likelihood 4)
- Severity 1 requires an extra layer of protection over the identical Facility 2 per LOPA
- Facility 1 requires an immediate response from management to either put in temporary measures or shutdown the facilities

Facility 2

- Risk level 7 (Severity 2, Likelihood 4)
- Severity 2 requires one less layer of protection than Facility 1
- This facility has 6 months to address action items

Facility 3

- Risk level 8 (Severity 3, Likelihood 4)
- Severity 3 means no LOPA required
- No recommendations required
- Safeguards “as is” deemed adequate by the team

- PHA and LOPA procedures are not specific enough to accurately and consistently apply company risk criteria. This includes not defining a methodology to:
 - Provide modeling data to help assign consequence severity
 - Compile and compare risk ranking data across similar facilities within a company and within the same facility.
 - Utilize company and industry PSM Incident and near-miss data for use in establishing PHA worst case consequences.
 - Company internal audit doesn't identify the possibility of variable outcomes as a Risk

- PHA Facilitator and Team will not deliver the desired results without appropriate boundaries
 - The Teams in the Case Study based their recommendations on three different outcomes of an identical equipment and operational scenario
 - Team 1 – Total Loss of Ammonia Storage Tank
 - Team 2 – Significant loss with worst case response in 20 minutes
 - Team 3 – Immediate response and control of situation in 10 minutes

Case Study Teams exhibited proper application of written company guidelines, but guidelines were insufficient for integrated, progressive risk management.

What Problems Does This Pose?



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- Underestimating the risk (e.g., not enough safeguards, IPLs)
- Overestimating the risk (e.g., spending money for safeguards, IPLs better spent elsewhere)
- Regulatory questions / fines due to inconsistent protection from one facility to another



Worst Case Credible Events – Overestimating

- Credible worst case events should be controlled by the PHA and LOPA procedure. Why does Overestimating to worst case occur?
 - PHA Teams often feel compelled to “find something” to justify the effort
 - The team escalates a scenario – to show management they are performing or to get a “nice to have” – but after investigation the consequence requires two or more independent failures to occur
- Here are some examples of scenarios that may be deemed not credible by some companies:
 - Simultaneous failure of two separate control loops
 - Reverse flow through two or more check valves
 - Progression by undefined damage mechanisms, with no history
 - PSV failure to relieve
 - External fires in areas where there are no flammables
 - Earthquakes in non-seismic zones

PHA Teams can deem anything credible **that has occurred or in their estimation could occur**. Governance needs to be present to prevent constant coverage of events without adding value.

Worst Case Credible Events – Underestimating

- Credible worst case consequence severity needs to be commensurate with reasonable impacts and guidance should be present in the PHA and LOPA procedure
 - An anhydrous ammonia vapor cloud going off-site can't be a low or moderate severity. However, assessing severe hazards in that way are often found during PSM Compliance Audits.
- Underestimating severity may occur because:
 - Team does not understand that severity must be assessed without taking credit for safeguards
 - Team wants to avoid HAZOP recommendations and or LOPA which is generally triggered by high severity or overall risk
 - Management pressure to reduce/eliminate recommendations without completing any action
 - Team is responsible for closing the items generated, but with few / not enough resources

Missing Assessment Tools – Quantify the Severity

- Severity of a consequence should be a worst-case credible assessment. PHA and LOPA procedure guidelines should address:
 - Nature of chemical (gas, liquid, fire potential, explosion potential)
 - Size of leak
 - Release rate
 - Immediate impacts (normally occupied area, roadways, etc)
 - Delayed / off-site impacts
 - Team should be asked if they feel the scenario is catastrophic or something less than that

Tool: Severity Table



Petro-Chemical Company Table 1 Consequence Categories - Unit

Consequence Category	Consequence Type			Financial/ Business (see note 5)
	Safety	Environment	Reputation	
5	Incident resulting in, <ul style="list-style-type: none"> Multiple Company or contractor fatalities, or Multiple public or offsite injuries or a public fatality. 	Incident resulting in, <ul style="list-style-type: none"> Catastrophic release, or Widespread or permanent ecological system damage, or Public and onsite evacuations, or Shutdown of river traffic or a major interruption of river traffic, or Impact to drinking water supply resulting in closure. 	National and/or International impact with: <ul style="list-style-type: none"> Extensive media coverage, negative public perception, or External stakeholders have made inquiries that will have high impact to competitive positioning, impact on MRO Stock price and market image and on Oil Company Brand dealers, or Possible effect on attraction and retention of top talent. 	>\$30MM
4	Incident resulting in, <ul style="list-style-type: none"> A Company or contractor fatality, or Multiple Company or contractor injuries resulting in, or <ul style="list-style-type: none"> Restricted Duty, or Lost-time, or Hospitalization Public or offsite injury of any nature. 	Incident resulting in, <ul style="list-style-type: none"> Moderate impact to ecological system that can be mitigated, or Release of Toxic or Flammable material resulting in public and onsite Shelter in Place or closure of major public road, or Soil/groundwater offsite impact with long-term cleanup over one year. 	National or broad impact with: <ul style="list-style-type: none"> Widespread media coverage in the nation, potential negative public perception, or External stakeholders have made inquiries that will have some impact to competitive positioning, impact on MRO Stock price and market image and on Oil Company Brand dealers, or Major national effect on attraction and retention of key staff. 	\$30MM - \$7MM
3	Incident resulting in, <ul style="list-style-type: none"> Single Company or contractor injury with, <ul style="list-style-type: none"> Restricted Duty, or Lost-time, or Hospitalization 	<ul style="list-style-type: none"> Uncontained release of Toxic or Flammable material causing on-site environmental impact and emergency response, or Localized environmental impact to soil or groundwater with up to 1 year of cleanup. 	Regional Impact with: <ul style="list-style-type: none"> Event will likely be reported to the public in the region via a news organization, or External stakeholders (customer, partner, lender or other external stakeholders) have made inquiries or raised an issue, or Regional impact with staff/employee performance affected (morale, distractions). 	\$7MM - \$2MM
2	Company or contractor injury or illness up to and including an OSHA recordable incident only.	<ul style="list-style-type: none"> Unpermitted onsite or minor environmental impact, or Reportable release, or Cleanup limited to soil/liquid removal of fully contained release 	Local Impact with: <ul style="list-style-type: none"> The public in local area has interest, or Event may be of interest to external stakeholders, or Local impact with staff/employee performance affected (morale, distractions) locally, or Attracts regular external attention. 	\$2M - \$300K
1	No injuries or illness anticipated	<ul style="list-style-type: none"> No impact anticipated up to unpermitted small contaminated Release that stays onsite with little if any cleanup required 	Internal Impact with: <ul style="list-style-type: none"> The public has little interest, or No customer, partner, lender or other external stakeholder has asked to be relevant to them, or Staff raising concerns 	\$300K - \$0

Quantify the Likelihood

- The likelihood of an event should be a credible assessment. PHA and LOPA Procedure guidelines should address:
 - The component failure initiating the event
 - Allowing double or triple jeopardy
 - Credibility of the component failure
 - Credible cascading failures

Example: Likelihood Table



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Petro-Chemical Company Table 2 Qualitative Frequency Categories

Estimate if a similar initial cause would be expected to occur or has occurred at the site within the following frequencies

Frequency Categories	Qualitative Frequency Definition Guidance
5	Has occurred more than once per year
4	Has occurred at a Company location more than once per year
3	Has occurred in the Petro-Chemical Industry more than once per year
2	Has occurred in the Petro-Chemical Industry
1	Unlikely to occur in the Petro-Chemical Industry
0	Not known to occur in the Petro-Chemical Industry

Tool: Probability of Failure on Demand Table



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Group	List #	Layer	MTBF avg/yr	PFD
Instrument Systems	1	Operational Interlock loop - DCS	10	1.00E-01
Instrument Systems	4	SIL2 dangerous failure	100	1.00E-02
Instrument Systems	6	SIL3 dangerous failure	1000	1.00E-03
Mechanical Barriers	7	Class 1 Check Valve in clean service (reverse flow only)	30	3.33E-02
Mechanical Barriers	11	Diesel Engine	10	1.00E-01
Mechanical Barriers	20	Exhaust Fan	20	5.00E-02
Mechanical Barriers	23	A.C. Generator	15	6.67E-02
Mechanical Barriers	40	Backup Pump (In place spare with auto start)	10	1.00E-01
Pressure Relief Barriers	31	Regulator, Pressure & Flow	52	1.82E-02
Pressure Relief Barriers	34	Relief Valve (general clean service)	200	5.00E-03
Pressure Relief Barriers	35	Relief Valve w/ Rupture Disk	100	1.00E-02

Quantify the Safeguards

- The assurance of a safeguard preventing or mitigating the credible event. PHA and LOPA Procedure guidelines should address:
 - List safeguards that will prevent events, e.g. relief devices, or SISs
 - List safeguards that will mitigate events, e.g. LEL detection, or deluge
 - Credibility of the component failure

Risk Matrix

- The PHA and LOPA procedure must adequately reflect the risk tolerance of the company in order to get the desired result
 - If the intent is preventing a catastrophic event then the consequence severity must clearly state potential multiple fatalities, significant site damage, potential catastrophic damage to adjacent units, etc.



Enterprise Risk Management Benefits



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Reduction of risk profile over time...

Tangible Value

Reduce
consequences
from losses

Reduce
insurance
cost

Fewer
incidents and
accidents

Increased
revenue
through less
downtime

Makes the organization more resilient and enhances their ability to manage change, **reducing overall risk** in multiple interrelated areas.

How often do you redefine your risk profile and revalidate your risk controls?

1. We redefine our risk profile once a year
2. We redefine our risk profile every 3-5 years
3. We re-evaluate our risk profile when a major change occurs
4. We do not have a structured process in place

Does your company have?

- A common risk framework across the company?
- Ability to react to slow and fast changes?
 - MOC is key
 - Identify interdependencies and address them
- An understanding that mitigating one risk may adversely affect another?
- A way to effectively deal with unknown unknowns vs known unknowns (and a way to surface them)?
- The right people making risk decisions?
 - Make sure accountability is clear on who owns the risk
 - Focus on high outcome probability risks



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Questions?

Thank You



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