

The Benefits of Comparing Similar Hazards across 'Sister' Plants

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Overview

- **FMC Corporation**
- **FMC's PSRP Process**
- **Cross Site Comparison Application**
- **Benefits Realized**
- **Lessons Learned**

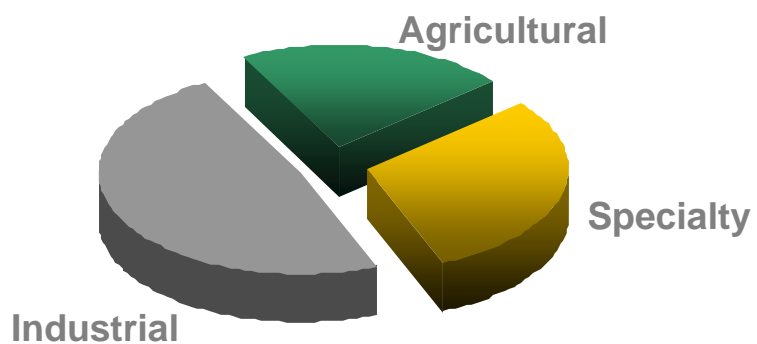
FMC Corporation

FMC Corporation is a global, diversified chemical company serving agricultural, industrial and specialty markets with innovative solutions, applications and products. The company employs 5,000 people throughout the world. Revenue in 2007 was \$2.6 billion.



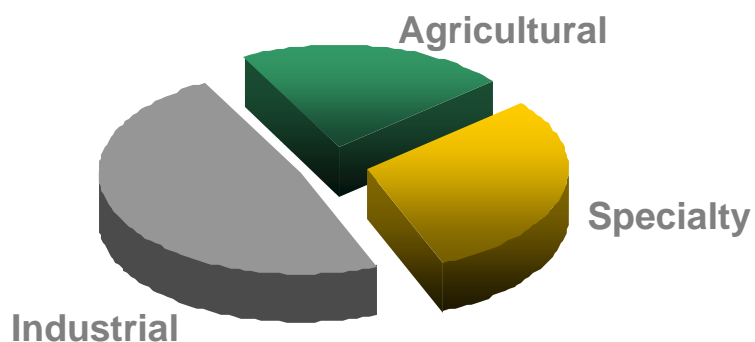
FMC Corporation: A Focused Chemical Company

Business Segments

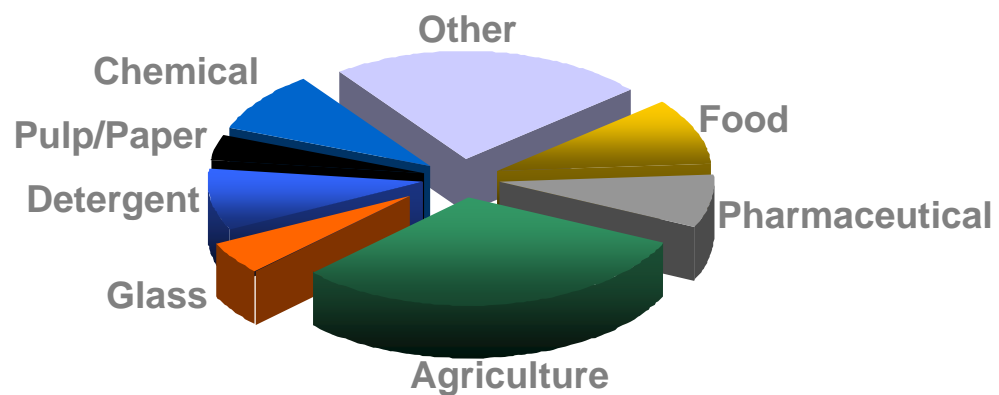


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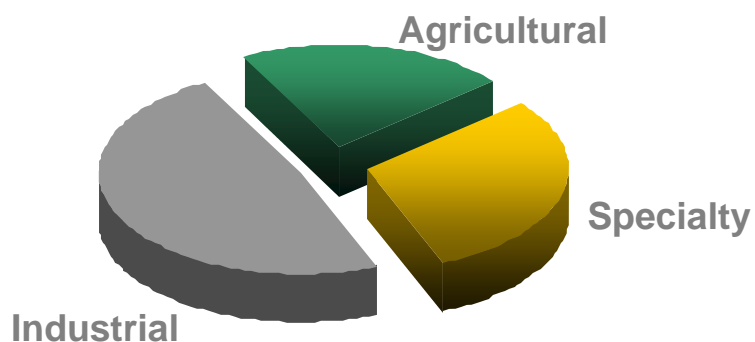


End-Markets Served

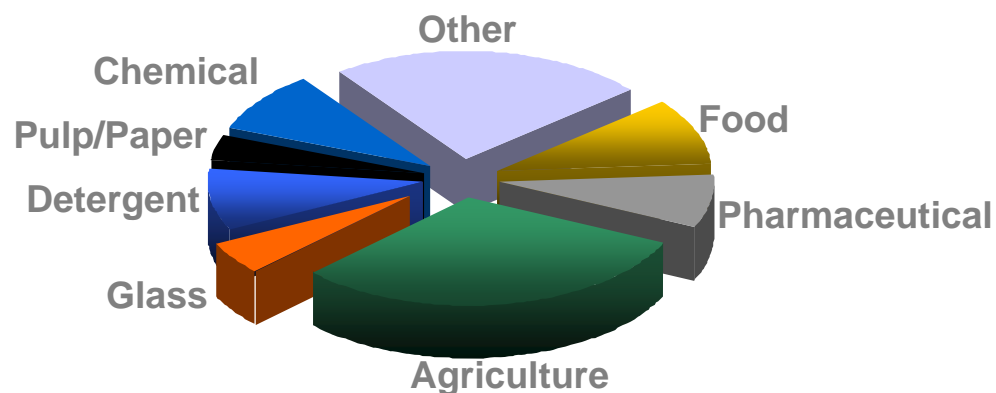


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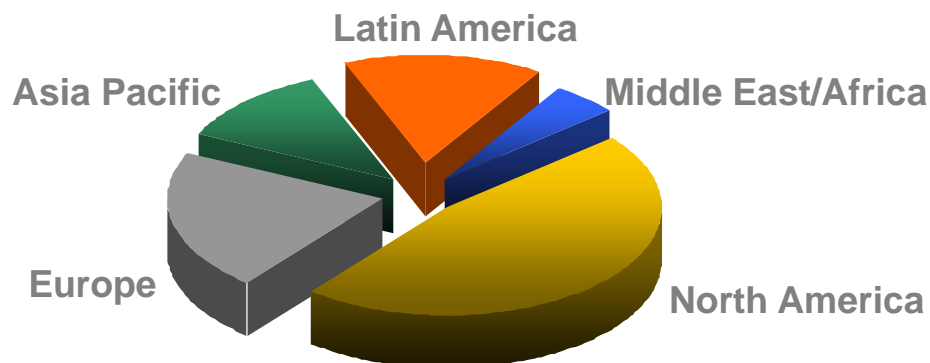
Business Segments



End-Markets Served



Global Diversity



FMC Corporation: A Market Leader

AGRICULTURAL PRODUCTS

2007 Revenue: \$889.7 million

Leading Pyrethroid and Carbofuran Insecticide Positions in Key Crops

- Insecticides
- Herbicides
- Specialty



- Cotton, corn, rice, cereals and fruits & vegetables
- Turf & ornamental

SPECIALTY CHEMICALS

2007 Revenue: \$659.5 million

#1 Market Positions

- BioPolymer
- Lithium



- Pharmaceutical formulation, synthesis
- Food ingredients
- Energy storage (batteries)

INDUSTRIAL CHEMICALS

2007 Revenue: \$1,087.1 million

#1 or #2 Market Positions

- Alkali/Soda Ash
- Hydrogen Peroxide
- Specialty Peroxygens



- Glass, detergents, pulp & paper, food, other chemicals

FMC's PSRP Process

- **An internally developed process hazards management process**
- **Focuses resources on process safety issues, including areas perhaps not considered by regulations**
- **Provides a basis for prioritizing risks and a process for risk-ranked hazard mitigation efforts**
- **Addresses all sites**
- **Based on “30,000 ft” view**
- **Scenarios can “start from scratch” or come from HAZOP study**

PSRP Emphasis is on High Consequence Scenarios

“The first and most important stage in any hazard study is to identify the things that can go wrong and produce accidents or operating problems. It is little use studying small hazards if we have failed to realise that bigger ones are round the corner.”

Trevor Kletz

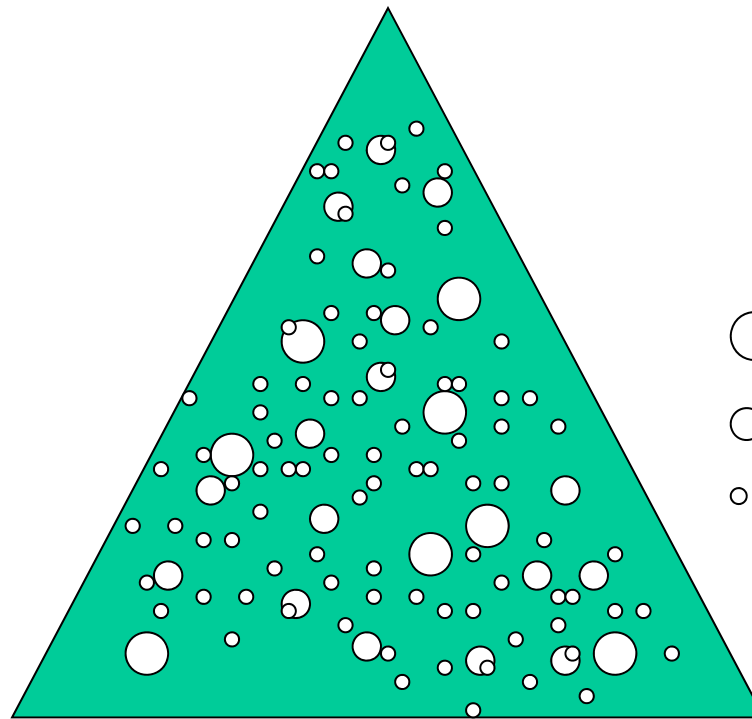
PSRP From Scratch: Risk Analysis Exercise

- **Breakdown process units into sections**
- **Identify consequences in each section**
- **Identify scenarios that lead to the consequences**
- **Scribe scenarios and findings in database forms**

FMC's PSRP Process Uses a Common Database Tool

- Standard format used at all sites
- This enables studies to be filed and maintained in a central database
- Among other benefits, this enables comparisons between sites across FMC.
 - Can be searched for relevant scenarios to support comparison efforts.

PSRP Can Be Derived from a HAZOP



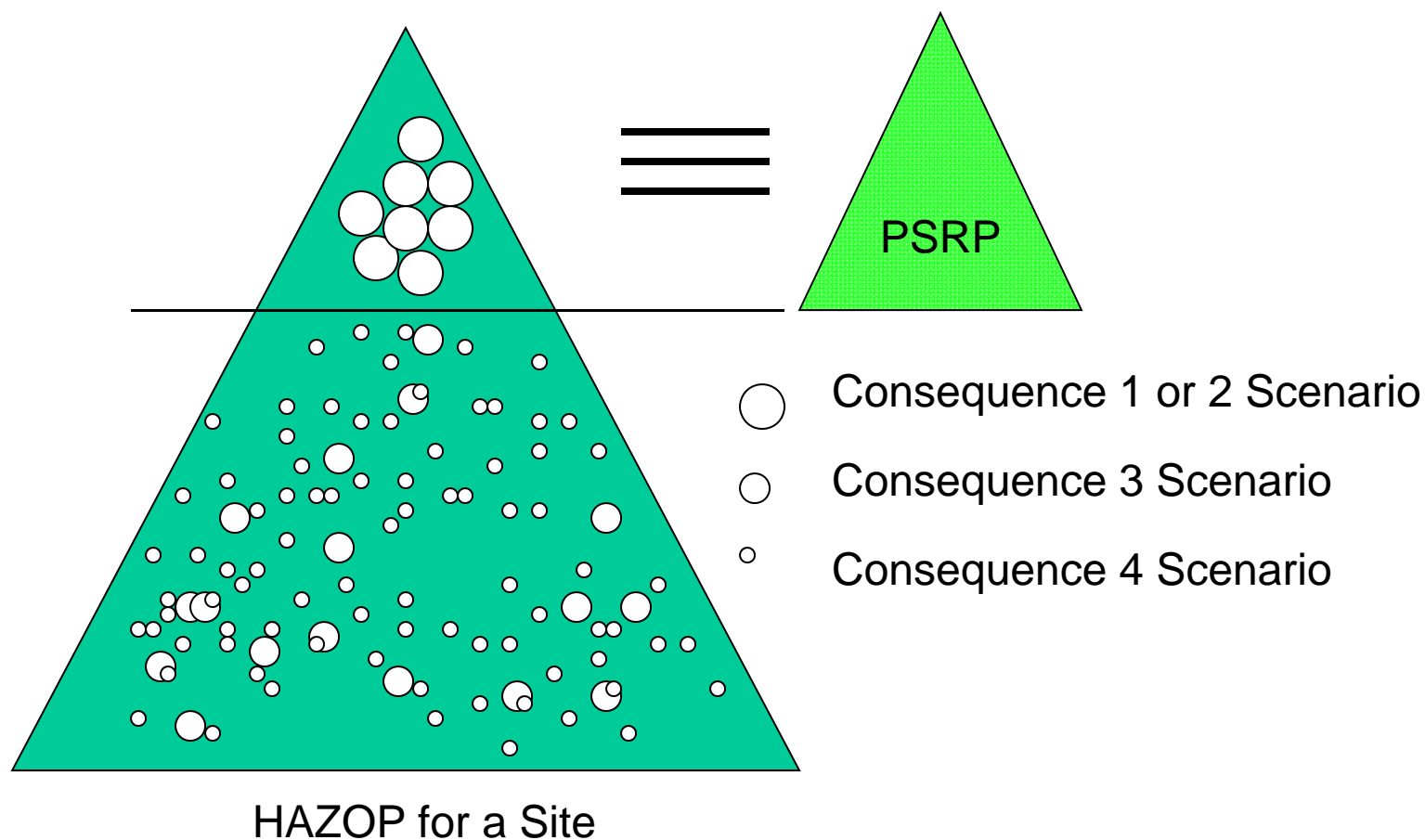
HAZOP for a Site

Typical Set of HAZOP Scenarios

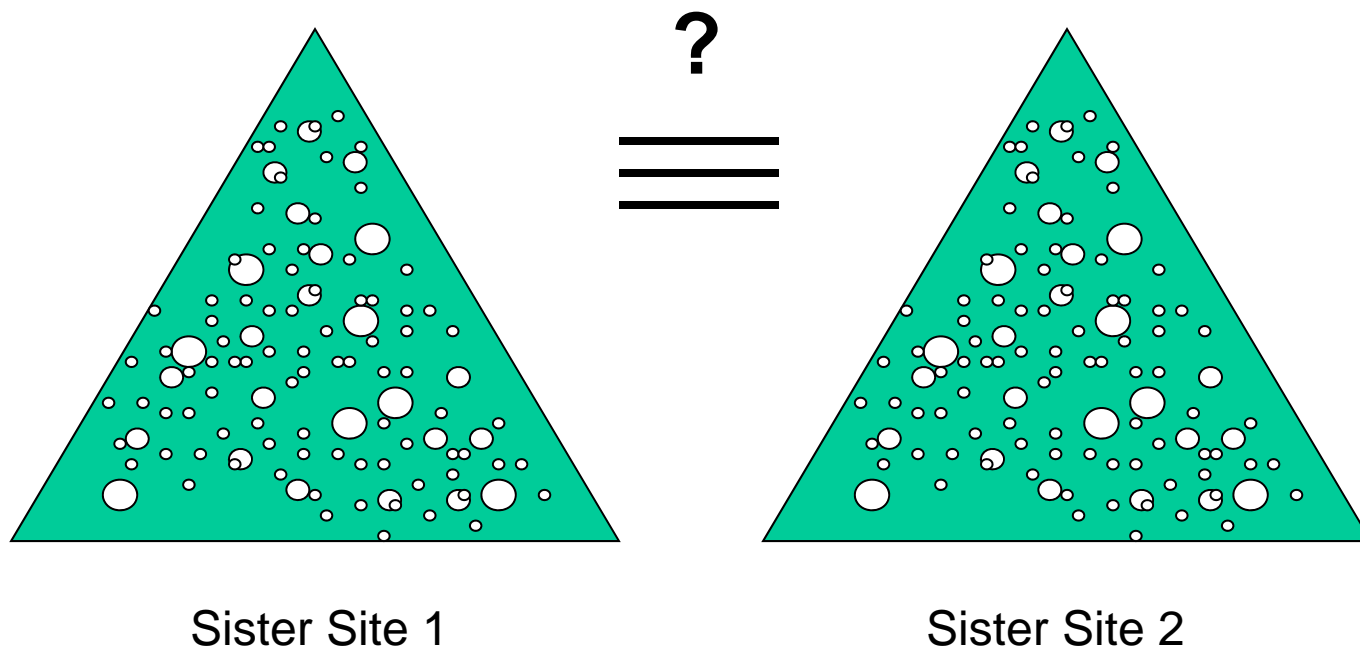
- Consequence 1 or 2 Scenario
- Consequence 3 Scenario
- Consequence 4 Scenario

From an oversight perspective, all the low consequence scenarios (“small bubbles”) are noise that make it hard to ensure PHA quality and consistency.

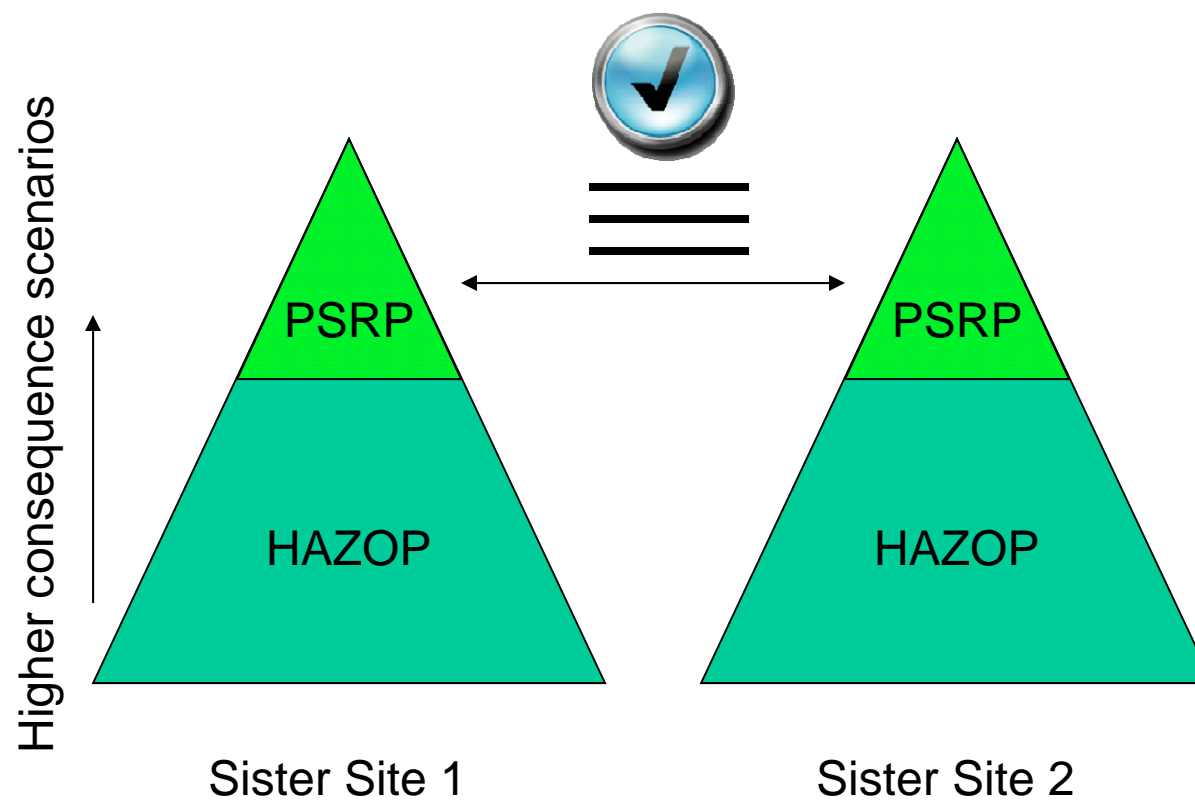
FMC's PSRP Process Focuses on High Consequence Scenarios



***Similar Process at Two Different Sites:
How Do You Know PHA's Were Done Equivalently and Well?***



PSRP's in Central Database Facilitate Sister Plant Comparison



Scenario Comparison Mechanics: Step 1: Create a Master List of Process Safety Scenarios

Two ways to generate this:

1. From one or more of the plants' PSRP's
2. From the distillation of one or more plant's PHA's

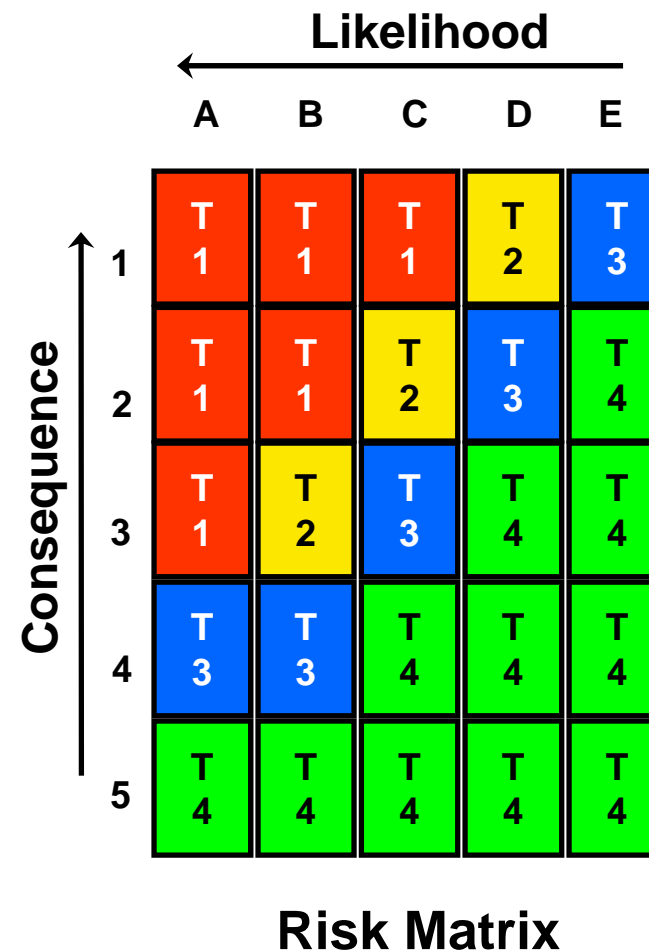
#	System	Subsystem	Scenario Description
14	Separation	Low pressure separator	Rupture LPS due to blowthrough gas from HPS

Scenario Comparison Mechanics: Step 2: Place Plant PSRP Scenarios Alongside Master Scenarios

A	B	C	D	E	F	G	H	I
				Plant A PSRP Results				
#	System	Sub-system	Brief Description (by Corporate Safety)	Scen#	Scenarios	C	L	R
14	Separation	Low Pressure Separator	Rupture LPS due to blow-through of gas from HPS	PlantA-LDP-04.06	Lose liquid level in HiPress Separator. Safeguards are LSSL to LV and RD to atmosphere.	1	D	2
15	Separation	Recycle compr'r	Draw air into the low pressure compressor leading to Decom in the reactor if [O2] exceeds ~10ppm	PlantA-LDP-06.02	Draw air into suction of 1st stage Recycle compressor for any reason, leading to Decom in Reactor. Safeguards are lab sampling, RD's on reactor and reactor blast walls	3	B	2

FMC's QUANTIFIED RISK MATRIX LEVELS

Scale	Consequence Range
1	\$10 - 100 M
2	\$ 1 - 10 M
3	\$100K - 1M
4	\$10 - 100K
5	\$1 - 10K
Scale	Likelihood / Frequency Range
A	1 to 5 years
B	6 to 30 years
C	31 to 100 years
D	101 to 1,000 years
E	1,001 to 10,000 years

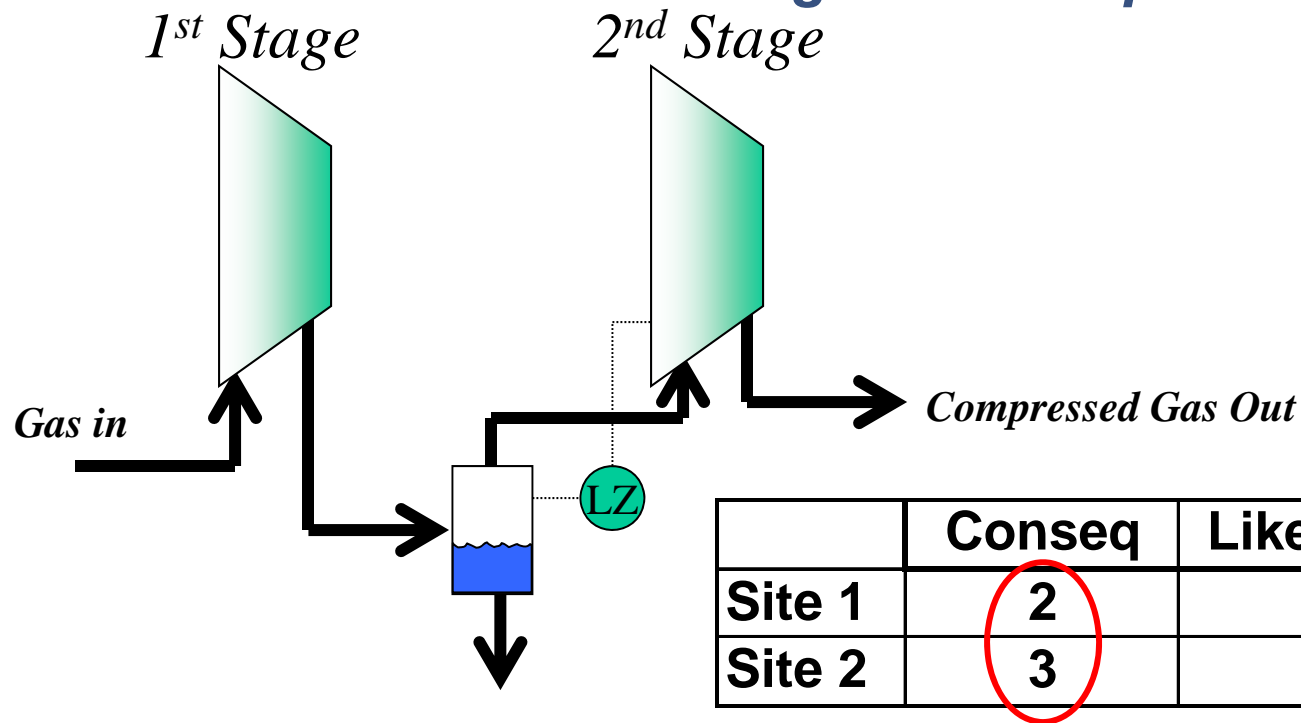


Scenario Comparison Step 3: Repeat for Each Sister Plant

			Plant A PSRP Results				Plant B PSRP Results					
System	Sub-system	Brief Description (by Corporate Safety)	Scen#	Scenarios	C	L	R	Scen#	Scenarios	C	L	R
Separation	Low Pressure Separator	Rupture LPS due to blow-through of gas from HPS	PTA-LDP-04.06	Lose liquid level in HiPress Separator. Safeguards are LSLL to LV and RD to atmosphere.	1	D	2	PTB-LDP-05.01	Overpressure LPS due to failure of LV on bottom of HPS. Safeguards are LSLL hard-wired to XV after the LV, PSV to Flare (but can't take full blow-through)	1	E	3
Separation	Recycle compr'r	Draw air into the low pressure compressor leading to Decom in the reactor if [O2] exceeds ~10ppm	PlantA-LDP-06.02	Draw air into suction of 1st stage Recycle compressor for any reason, leading to Decom in Reactor. Safeguards are lab sampling, RD's on reactor and reactor blast walls	3	B	2	<i>No equivalent scenario identified</i>				

Multi-Stage Compressor

Scenario: Wreck 2nd Stage due to liquid carry-over



Site 2 took safeguard credit before determining the consequences.

>>> Level switch was thus not on critical ITPM program.

Experiences From this Work

- Missed Scenarios

- Understated risk
 - Consequences are understated because safeguards are taken into account
 - Consequences just plain lowballed
 - Probabilities too low

Extending This Application Past “Sister” Plants

- Boiler hazards
 - Hazard: Firebox explosion
 - Is it listed in PSRP?
 - Is it rated high consequence?
 - **AUDIT:** Are burner safeties in place to prevent? On critical ITPM?
 - Hazard: Low water level in boiler followed by boiler BLEVE
 - Is it listed in PSRP?
 - Is it rated high consequence?
 - **AUDIT:** Low water cutoff in place? On critical ITPM?

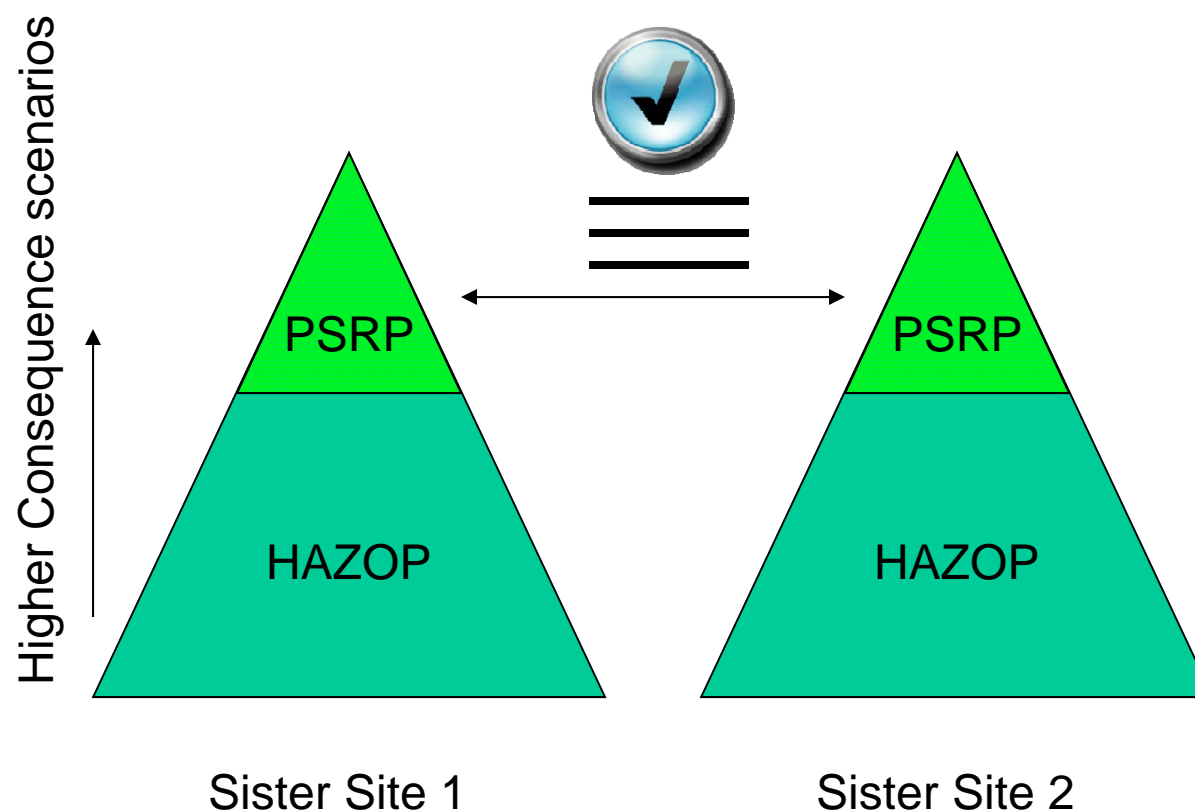
Extending This Application Past “Sister” Plants

- Filling Propane Forklift Tanks from Bulk storage
 - Hazard: Liquid leak >> Vapor cloud flash fire
 - Do sites agree this is a tier 2 scenario?
 - **MANAGEMENT DECISION**: Is it worth it to handle bulk?

Lessons Learned and Critical Success Factors

- Minimize site to site variability, parameter “calibration”
 - Corporate hands on the PSRP process and risk profiles
 - Experience factor needed to ensure this works
- Value of risk profile central database
- Team involvement – understand and buy into the process

PSRP's in Central Database Facilitate Sister Plant Comparison



Thank You

Q & A

