



Process Safety Management

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Decades of Learning, and Relearning . . .

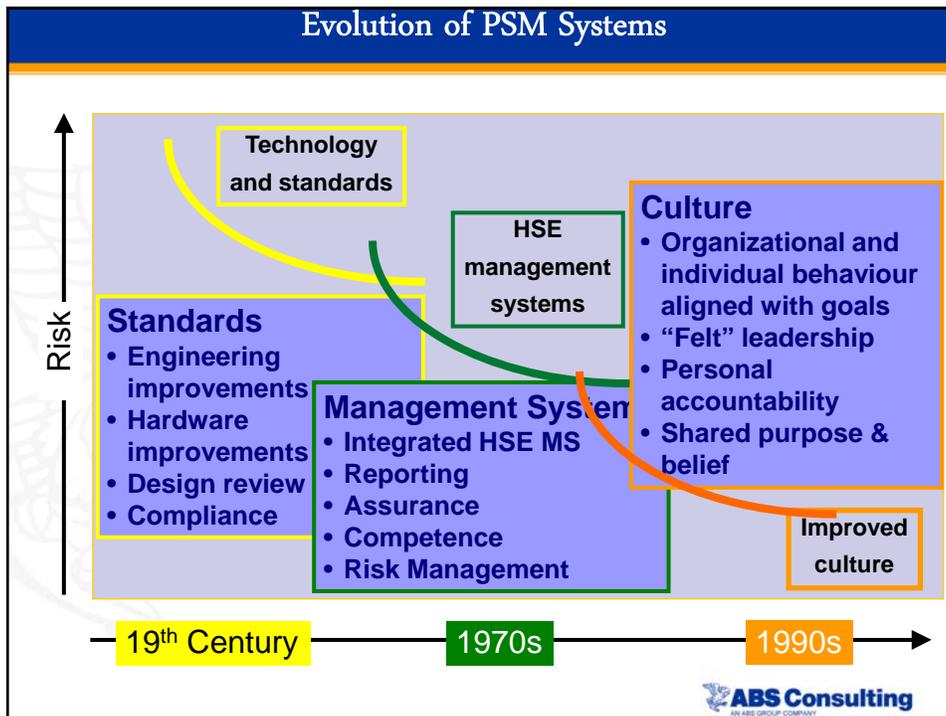
Year	Location/Event	Deaths	Injuries
1974	Flixborough, England / VCE	28	?
1976	Seveso, Italy / Runaway Reaction	?	?
1984	Mexico City, Mexico / LPG release	650	?
1984	Bhopal, India / MIC release	2,000+	?
1985	Institute, WV / MIC event	0	135
1987	Grangemouth, Scotland / VCE	1	0
1988	Henderson, NV / Explosion	2	350
1989	Prince William Sound / Grounding	0	9
1989	Pasadena, TX / VCE	24	132
1990	Channelview, TX / Tank explosion	17	0
1997	Martinez, CA / Runaway reaction	1	46
1998	Longford, Australia / VCE	2	8
2001	Toulouse, France / Explosion	31	2,400+
2005	Texas City, TX / VCE	15	170
2010	Gulf of Mexico / VCE	11	17



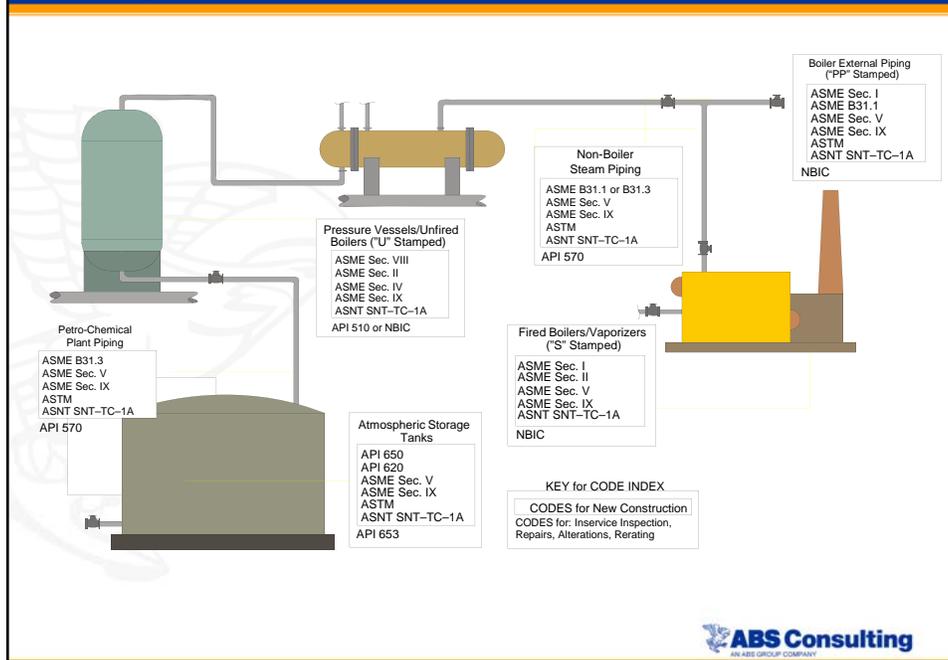
Even More Learning and Relearning . . .

Year	Location/Event	Deaths	Injuries
1979	Three Mile Island / Core damage	0	?
1979	Chicago, IL / Airplane crash	241	0
1981	Kansas City, MO / Walkway collapse	114	216
1986	Kennedy Space Center / Explosion	7	0
1986	Chernobyl, USSR / Meltdown	30+	?
2000	Paris, France / Airplane crash	113	6
2003	Skies over Texas / Reentry failure	7	0
2006	Upshur County, WV / Mine explosion	12	1
2008	Port Wentworth, GA / Dust cloud expl'n	14	?

Evolution of PSM Systems



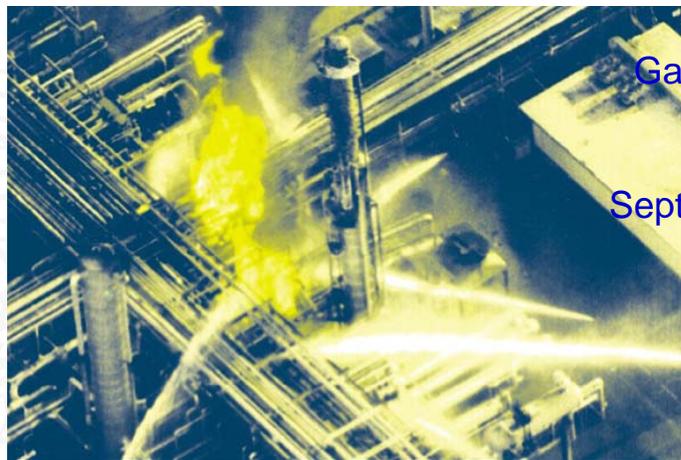
Examples of Some Common Codes and Standards



Management Systems: OSHA's 14 PSM Elements

- | | |
|-------------------------------|------------------------------------|
| c) Employee Participation | j) Mechanical Integrity |
| d) Process Safety Information | k) Hot Work Permits |
| e) Process Hazard Analysis | l) Management of Change |
| f) Operating Procedures | m) Incident Investigation |
| g) Training | n) Emergency Planning and Response |
| h) Contractors | o) Compliance Audits |
| i) Pre-startup Safety Review | p) Trade Secrets |

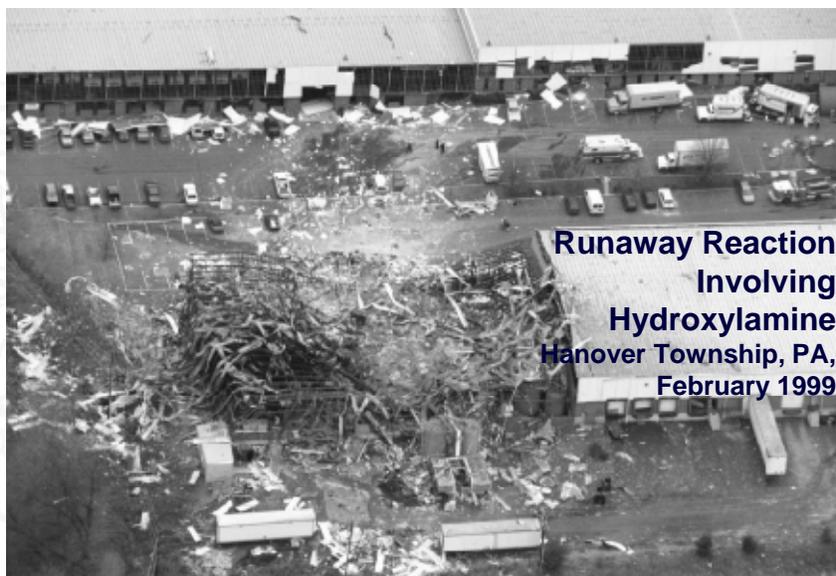
Employee Participation



Gas Explosion,
Longford,
Australia,
September 1998

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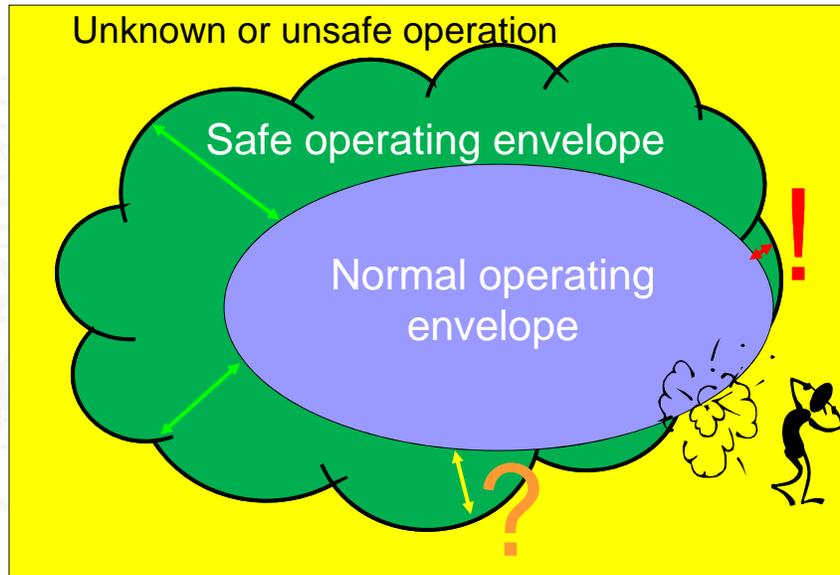
Process Safety Information



Runaway Reaction
Involving
Hydroxylamine
Hanover Township, PA,
February 1999

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Process Hazard Analysis



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Operating Procedures

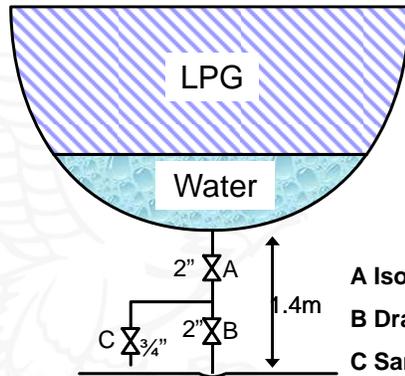


Ammonium Nitrate Explosion
Port Neal, Iowa
December 1994



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Training



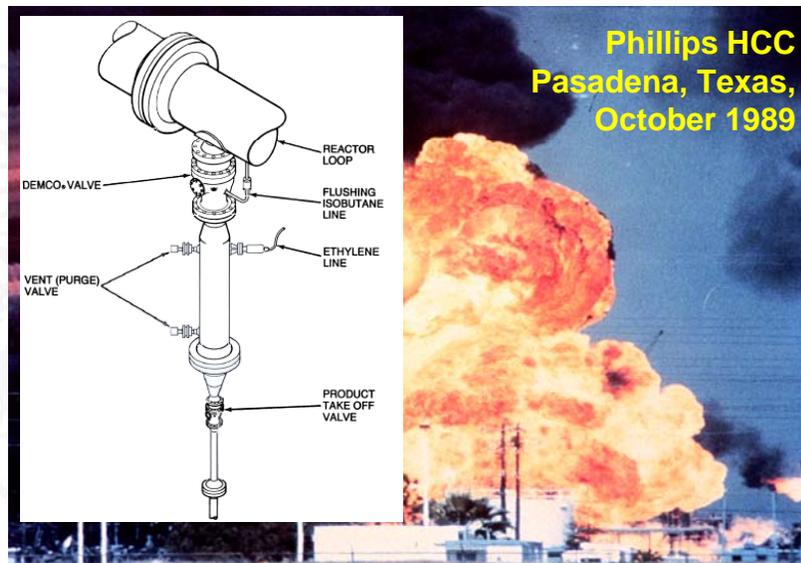
Boiling Liquid Expanding Vapor Explosion

Feyzin, France, 1966

- A Isolation valve
- B Drain valve
- C Sample valve

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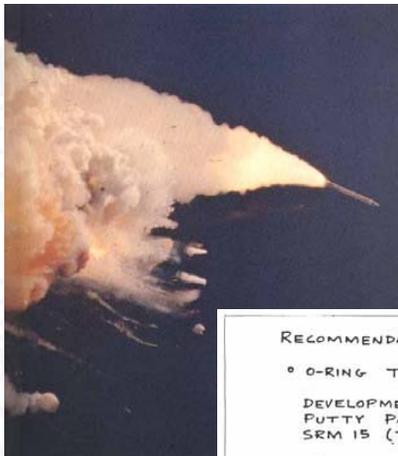
Contractors



Phillips HCC
Pasadena, Texas,
October 1989

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Pre-startup Safety Review



Initial Thiokol recommendation at second teleconference [on the evening before the launch]:

O-ring temp must be $\geq 53^{\circ}\text{F}$ [$\sim 12^{\circ}\text{C}$] at launch

RECOMMENDATIONS :

- O-RING TEMP MUST BE $\geq 53^{\circ}\text{F}$ AT LAUNCH
- DEVELOPMENT MOTORS AT 47° TO 52°F WITH PUTTY PACKING HAD NO BLOW-BY
- SRM 15 (THE BEST SIMULATION) WORKED AT 53°F
- PROJECT AMBIENT CONDITIONS (TEMP & WIND) TO DETERMINE LAUNCH TIME

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Mechanical Integrity



**Repair “Short Cut” Dooms AA Flight 191
Chicago, IL, May 25, 1979**

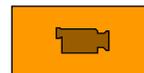
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Pipe Rupture Results in > 600 Offsite Fatalities



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Hot Work Permit (Safe Work Practices)

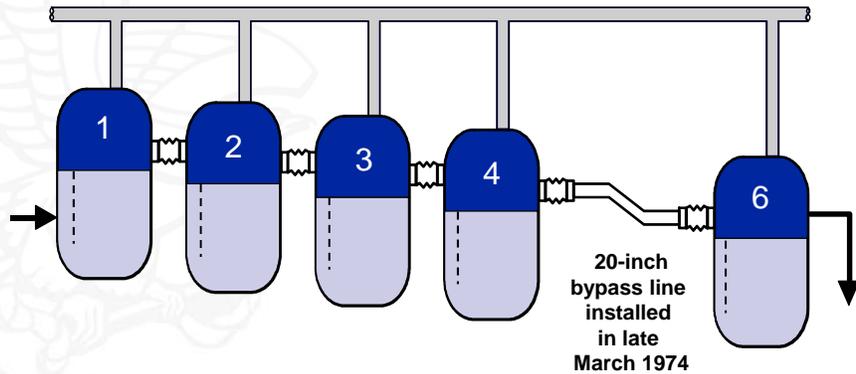


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Management of Change

Piping System Change

Flixborough, UK, June 1, 1974



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Flixborough, UK
June 1, 1974



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Incident Investigation

Space Shuttle Columbia January 2003



- Spec required no foam shedding
- Foam shedding observed on at least 65 previous missions, including six instances of foam shedding from same location that caused the Columbia disaster
- Severe foam shedding reported on STS-112 in October 2002
- Successful return of damaged orbiters seemed to indicate that foam shedding was acceptable

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Emergency Planning and Response



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Compliance Audits



Bhopal, India
December 3, 1984



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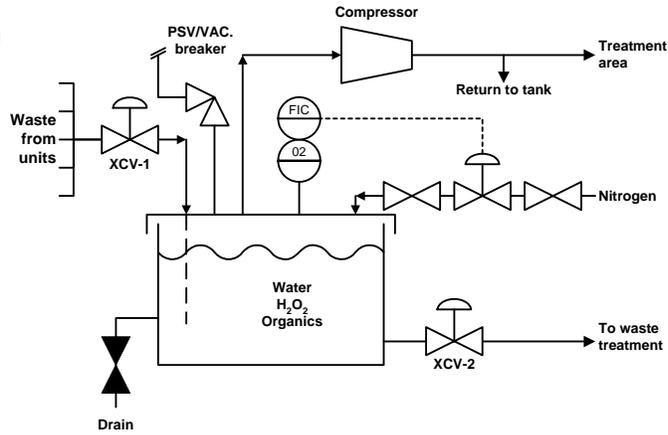
Trade Secrets



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The Problem with PSM Regulations . . .

- Drives “in/o approach based on “coverage”
- Tendency toward minimum compliance strategy
- Tends to discount risk



Wastewater Treatment Process,
ARCO Chemical, Channelview, TX

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AICHe Center for Chemical Process Safety

- Formed in 1985 as a U.S. industry response to the Bhopal tragedy to conduct research and provide objective, technical information on process safety issues
- 100+ member companies
- Managing Board, Technical Steering Committee, and numerous technical project committees
- Has published over 100 guidelines on process safety subjects

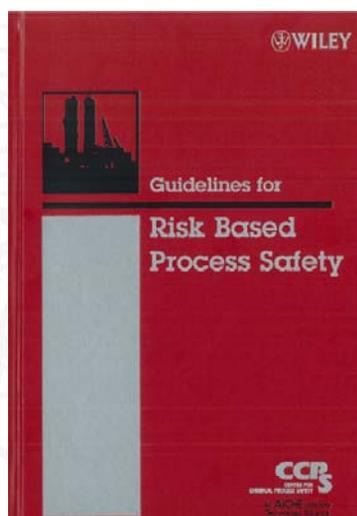
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The Case for the RBPS Approach

- CCPS published its original 12 PSM elements in 1989 and followed it with 3 other management system books thru 1994
- A lot of experience and lessons have been learned since then; CCPS wanted to update its PSM framework to be useful to industry as a thought and action leader for the next 15 years
- RBPS came about for two reasons:
 - Generate better results with fewer resources
 - Provide an approach for companies of all “needs levels” to implement, correct, and improve PSM systems

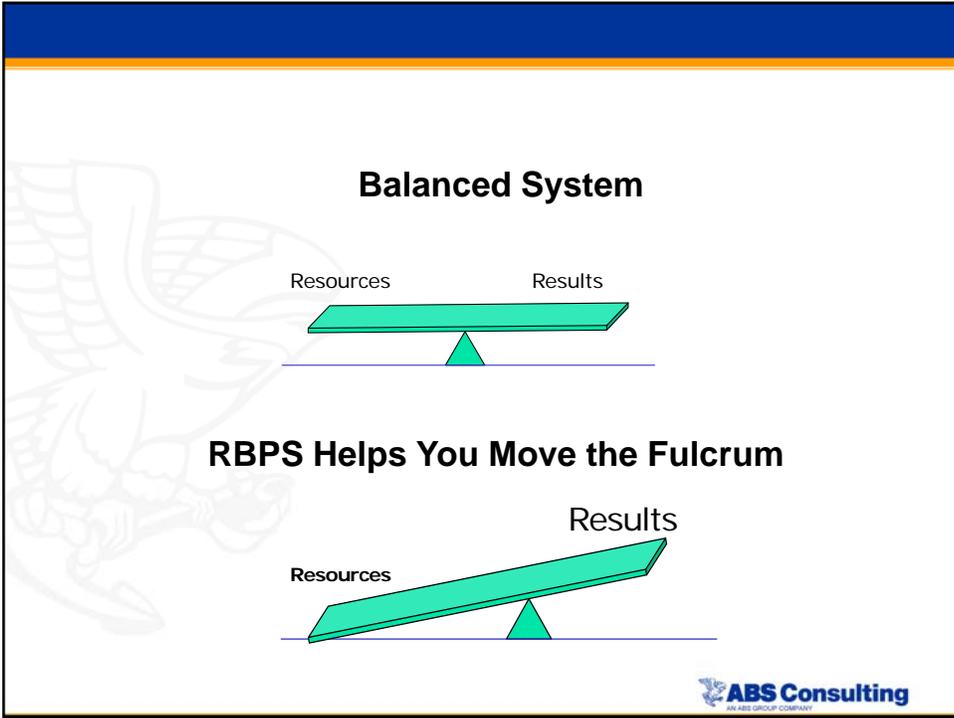


Premise of Risk Based Process Safety



- Management systems should be the simplest that they can be while still being fit-for-purpose
- The following issues determine management system “rigor”
 - complexity, hazard, and risk
 - resource demands/availability
 - culture
- Effective process safety management systems must include continuous improvement





- ## Risk Based Process Safety Elements
- | | |
|---|---|
| <p>Commit to Process Safety</p> <ol style="list-style-type: none"> 1. Process Safety Culture 2. Compliance to Standards 3. Process Safety Competency 4. Workforce Involvement 5. Stakeholder Outreach <p>Understand Hazards and Risk</p> <ol style="list-style-type: none"> 6. Process Knowledge Management 7. Hazard Identification and Risk Analysis <p>Manage Risk</p> <ol style="list-style-type: none"> 8. Operating Procedures 9. Safe Work Practices | <p>Manage Risk (cont.)</p> <ol style="list-style-type: none"> 10. Asset Integrity and Reliability 11. Contractor Management 12. Training and Performance 13. Management of Change 14. Operational Readiness 15. Conduct of Operations 16. Emergency Management <p>Learn from Experience</p> <ol style="list-style-type: none"> 17. Incident Investigation 18. Measurement and Metrics 19. Auditing 20. Management Review and Continuous Improvement |
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Safety Culture Failures

- NASA - Challenger & Columbia
- Piper Alpha
- Longford
- Chernobyl
- Bhopal
- BP Texas City



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Strong Leadership

RECOMMENDATIONS :

- O-RING TEMP MUST BE $\geq 53^{\circ}\text{F}$ AT LAUNCH
DEVELOPMENT MOTORS AT 47° TO 52°F WITH
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SRM 15 (THE BEST SIMULATION) WORKED AT 53°F
- PROJECT AMBIENT CONDITIONS (TEMP & WIND)
TO DETERMINE LAUNCH TIME



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Formalize the Approach



Graphic courtesy of E.I. DuPont and de Nemours and Company

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Enforce High Standards; Avoid Normalization of Deviance



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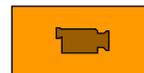
Maintain a Sense of Vulnerability



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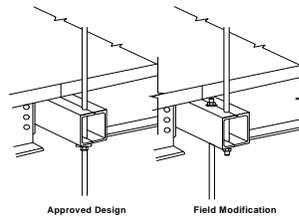
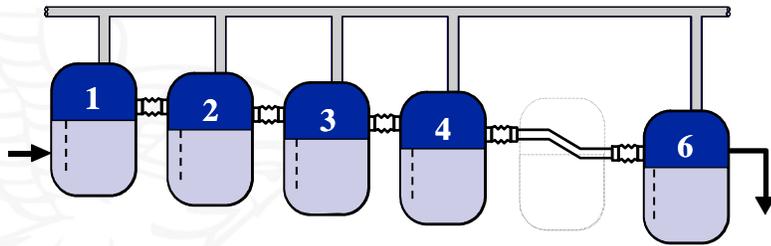
Empower Individuals

- To stop work
- To ask questions/voice concerns
- To do their work



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Defer to Expertise



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Ensure Open Communication



“That [the foam strike to the left wing] is a turnaround issue, right?”

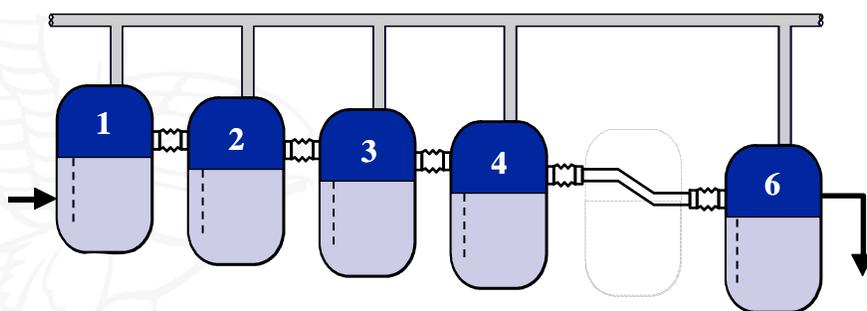
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Establish a Learning Environment



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Respond to Concerns in a Timely Manner



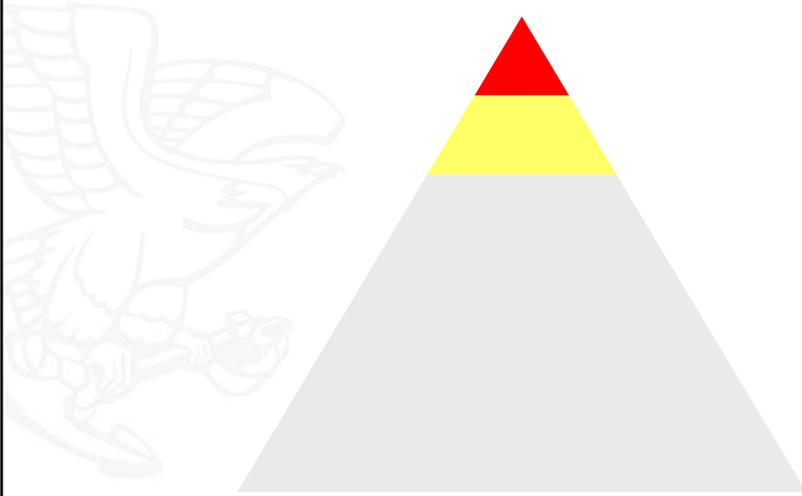
Flixborough, UK

Unsafe modification made late March 1974

Release and explosion occurred over 60 days later

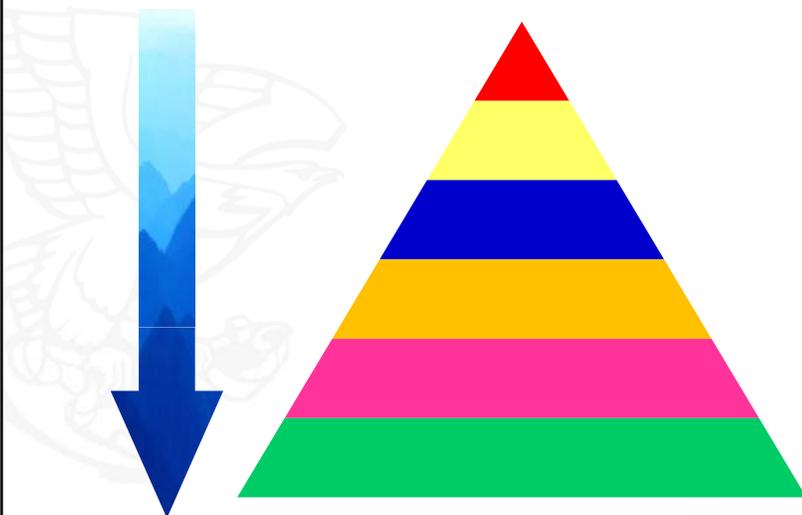
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Foster Mutual Trust



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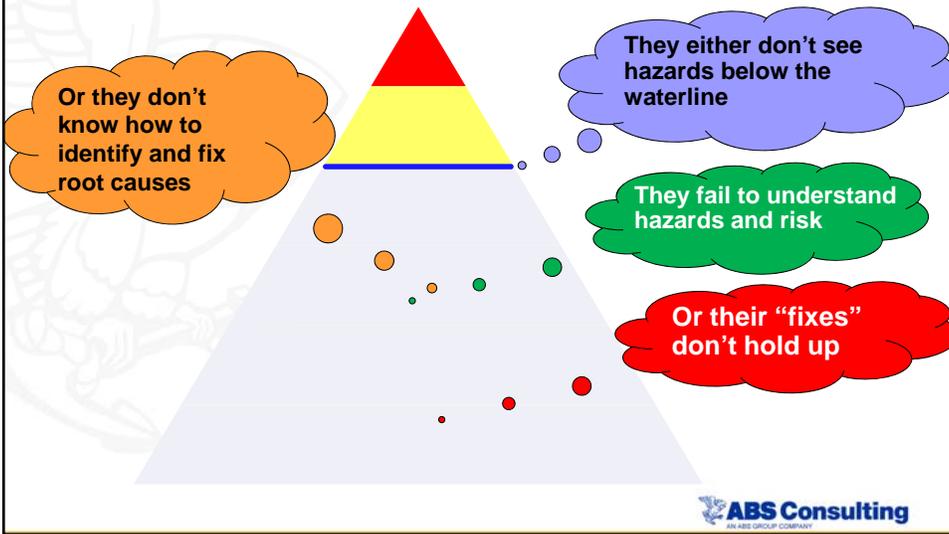
To Learn Lower on the Pyramid



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The Problem with Some Companies...

They Are Taught a Lot of Lessons, But They Never Seem to Sustain Learning



What is Risk?



Layers Can Fail

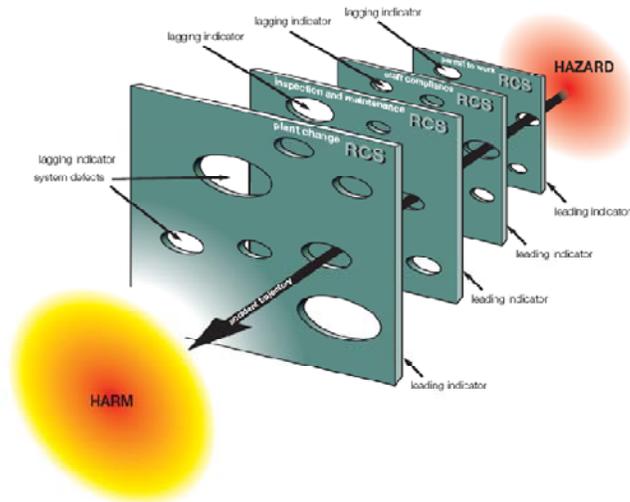


Figure 2. Leading and logging indicators set to detect defects in important risk control systems

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Better Risk Management Means Reducing/Managing:

- Technology failures
- Management system failures
- External factors
- Human failures



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Conduct of Operations



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Metrics and Management Review

- Some activities must be monitored using leading indicators if they want to improve, not just by having accidents happen
- Use a human health care analogy
 - **Lagging indicator = an autopsy after a heart attack**
 - **Leading indicator = blood pressure, cholesterol, EKG**
 - **Culture indicator = proper diet/exercise**
- We must use leading indicators in process safety if we hope to drive continuous improvement; we must address culture for sustainable performance

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Time for Questions

