Learning's from Major Process Safety Incidents

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Objective

To share Learning’s from Major Process Safety Incidents and how the application of a Operations Risk Management Model can significantly reduce the probability of and consequence from such an incident.
My background

• I am a Chemical Engineer by training and an experienced operations leader
• I am currently the Global PSM Practice Leader for DuPont Sustainable Solutions
• I am committed to helping organizations and facilities achieve zero process safety incidents while improving viability and sustainability

“We preach what we practice”
Safety is a DuPont Core Value

• Core values: Safety, ethics and respect for people and the environment
• $32 Billion revenue, 13 business units from electronics to plastics, paints and agricultural chemicals. Sustainable Solutions is the services oriented business unit
• Over 175 facilities around the world
• Worldwide reputation for safety
• DuPont applies a single Operational Risk Management system worldwide
## Major Industrial Incidents

<table>
<thead>
<tr>
<th>Year</th>
<th>Incident Description</th>
<th>Casualties/Injuries</th>
<th>Cost</th>
</tr>
</thead>
<tbody>
<tr>
<td>1988</td>
<td>Piper Alpha (Occidental)</td>
<td>167 killed</td>
<td>US$1.2 billion</td>
</tr>
<tr>
<td>1998</td>
<td>Longford Gas Explosion (Esso)</td>
<td>8 killed, 69 injured</td>
<td>US$1 billion</td>
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<tr>
<td>2005</td>
<td>Texas City Refinery (BP)</td>
<td>15 killed, 170 injured</td>
<td>US$3.5 billion+</td>
</tr>
<tr>
<td>1984</td>
<td>Union Carbide, Bhopal</td>
<td>Reported 3000 killed</td>
<td>Disappearance of Union Carbide</td>
</tr>
<tr>
<td>1991</td>
<td>Sleipner A Platform Collapse (Statoil)</td>
<td></td>
<td>US$1.2 billion</td>
</tr>
<tr>
<td>1995</td>
<td>Nigerian Oil Rig Explosion (Mobil)</td>
<td>13 killed, 25 injured</td>
<td></td>
</tr>
<tr>
<td>1996</td>
<td>Gas Pipeline Explosion (Enron)</td>
<td>33 killed, 69 injured</td>
<td></td>
</tr>
<tr>
<td>2001</td>
<td>P36 Sinking Platform (Petrobras)</td>
<td>10 killed</td>
<td>US$515 million</td>
</tr>
<tr>
<td>2005</td>
<td>Bombay High North Platform (ONGC)</td>
<td>22 killed</td>
<td>US$195 million</td>
</tr>
<tr>
<td>2006</td>
<td>Pipeline Explosion (Nigerian National Petroleum Corp)</td>
<td>200 killed</td>
<td></td>
</tr>
</tbody>
</table>
Defining Risk

• **Risk** is the potential for loss, calculated by combining possible or foreseeable consequences with realistic **probability** (or frequency) of occurrence.

• **Operational risk** is a portion of a business’s total risk profile, specifically the operations or process related aspects—potential losses resulting directly from the business’s operations.
Typical Operational Risks

- Employee / Public Health and Safety
- Environmental Damage
- Physical Assets
- Business Interruption
- Regulatory Compliance
- Reputation, Public Support and Right to Operate
- Employee Retention / Morale
- Product Liability
- Business Value / Market Capitalization
- Community Economic Impact
Top Operational Risk Factors

- Inadequate identification / evaluation of operational risks
- Integrity of facilities
- Competing priorities, i.e., production, quality, costs
- Insufficient resources, both quantity and capabilities
- Inadequate management of change
- Weak compliance-to-procedures culture
- Failure to manage process safety risks differently from workplace safety
- Weak audit function
- Ineffective leadership
What Is Operational Risk Management?

An integrated management system that identifies, evaluates, and controls a manufacturing process’ operational risks in a way that catastrophic incidents are prevented that could impact:

- People – the public, employees and contractors
- The Environment – local community / work sites
- Business – lost assets, business opportunities, loss of customers, loss of shareholders
DuPont Operational Risk Management Model
Why the Model Works for Successful Companies

- Management leadership and commitment is in the center of the wheel. Core Value
- A robust Managing System that identifies, evaluates and mitigates process risks at all stages of a facility's life cycle
- Operational Discipline encircles all the technical elements
- A single governance process
- Integrated into all business processes
- Flexible and adaptable to many industries
Learning’s from Major PSI’s

1. Every element of the Operational Risk Management Model is important
## A Typical Incident RCFA

**PSM Elements Analysis**

<table>
<thead>
<tr>
<th>Category</th>
<th>Performance (vs. system)</th>
<th>System deficient</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Management Leadership and Commitment</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Technology</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Process Technology</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Process Hazards Analysis</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Operating Procedures and Safe Work Practices</td>
<td>✗</td>
<td></td>
</tr>
<tr>
<td>Management of Change – Technology</td>
<td></td>
<td></td>
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<tr>
<td><strong>Facilities</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Quality Assurance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pre-Startup Safety Reviews (PSSRs)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mechanical Integrity</td>
<td>✗</td>
<td>✗</td>
</tr>
<tr>
<td>Management of Change – Facilities</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Personnel</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Training and Performance</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Contractor Safety and Performance</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Incident Investigation and Communication</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Management of Change – Personnel</td>
<td></td>
<td>✗</td>
</tr>
<tr>
<td>Emergency Planning and Response</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Auditing</td>
<td>✗</td>
<td></td>
</tr>
</tbody>
</table>
DuPont 1H2011 PSM Trends – PSM Elements

**PSM Technical Elements**
- Mechanical Integrity: 30%
- Operating Procedures/SWP’s: 18%
- Training and Performance: 17%
- Process Technology: 13%
- Quality Assurance: 5%
- MOC- Technology: 4%

Top 4 for past 5+ years
Most Frequent NEP PSM Citations

1910.119(x)(x)

• (f)(1) Operating procedures......................49
• (d)(3) PSI pertaining to equipment ............47
• (e)(3) PHA specific criteria.........................40
• (j)(4) MI Inspection & Testing .....................32
• (e)(5) PHA recommendation F/U ...............16
• (j)(5) Deficient Equipment.........................16
• (l)(1) MOC implementation .......................15
Learning’s from Major PSI’s

1. Every element of the Operational Risk Management Model is important

2. Every element requires a managing system
   - Ownership and accountability (who)
   - Standard of expectations / subject matter expertise (what, when, where)
   - Metrics, Audits and Continuous Improvement (how and why)
   - Data management (how)
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3. Every element is dependent on other elements, creating the need for a holistic, interdependent and integrated complete managing system
Baker Panel Recommendations

The Panel was charged with making recommendations to improve BP’s corporate safety culture, corporate oversight of process safety, and process safety management systems.

RECOMMENDATION #2 – INTEGRATED AND COMPREHENSIVE PROCESS SAFETY MANAGEMENT SYSTEM

BP should establish and implement an integrated and comprehensive process safety management system that systematically and continuously identifies, reduces, and manages process safety risks at its U.S. refineries.
Baker Panel Recommendation #2

RECOMMENDATION #2 – INTEGRATED AND COMPREHENSIVE PROCESS SAFETY MANAGEMENT SYSTEM

From the Commentary on Recommendations:

(1) “integrated and comprehensive management system”—In order to be effective, a management system for process safety must be comprehensive; a weak or fragmented system will not address all of the numerous process safety risks that exist in BP’s U.S. refineries. Among other things, this comprehensive management system should

(b) utilize an integrated set of leading and lagging performance indicators for process safety as described in Recommendation #7
Example. A minor incident investigation
DuPont Process Safety Management Model

- Incident Investigation
- Contractors
- Training and Performance
- Management of "Subtle Changes"
- Management of Technology Change
- Auditing
- Process Safety Information
- Process Hazards Analysis
- Operating Procedures and Safe Practices
- Quality Assurance
- Management Leadership and Commitment
- Mechanical Integrity
- Prestart-Up Safety Reviews
- Achieving Operating Excellence
- Through Operational Discipline
DuPont Process Safety Management Model

- Management of Personnel Change
- Incident Investigation
- Contractors
- Training and Performance
- Management of "Subtle Changes"
- Auditing
- Process Safety Information
- Process Hazards Analysis
- Operating Procedures and Safe Practices
- Management of Technology Change
- Quality Assurance
- Management Leadership and Commitment
- Mechanical Integrity
- Prestart-Up Safety Reviews
- Through Operational Discipline
DuPont Process Safety Management Model

Achieving Operating Excellence

Management Leadership and Commitment

Through Operational Discipline

Auditing

Emergency Planning and Response

Process Safety Information

Process Hazards Analysis

Operating Procedures and Safe Practices

Management of Technology Change

Quality Assurance

Management of Personnel Change

Incident Investigation

Contractors

Training and Performance

Mechanical Integrity

Prestart-Up Safety Reviews

Management of “Subtle Changes”
DuPont Process Safety Management Model

- Auditing
- Process Safety Information
- Process Hazards Analysis
- Operating Procedures and Safe Practices
- Management of Technology Change
- Quality Assurance
- Through Operational Discipline
- Management Leadership and Commitment
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DuPont Process Safety Management Model

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   - Metrics, Audits and Continuous Improvement (why)

3. Every element is dependent on other elements, creating the need for a holistic, interdependent and integrated overall managing system

4. Process Safety Management must be applied from early conceptual design through mothballing/shutdown if all Major PSI’s are to be prevented
Risk Management from Beginning to End

- PSI & PSM
- Critical Equipment
- Screening PHA
- FEL-1

- PSSR
- MOC-T & F
- Procedure s & Training

- Revalidation PHA’s
- Mechanical Integrity

- Contractors
- Incident Investigation

- Emergency Planning & Response
- Continuous Improvement / Metrics
- PSM Systems Auditing
- MOC-Personnel

- Shutdown / Mothballed
- Final PHA

START-UP
Risk Management Program Benefits

- Avoidance of catastrophic events that injure people, facilities, business and the environment
- Improved sustainability performance
- Improved productivity and reduced costs through reduced downtime; fewer incidents
- Sustained “right to operate,” as granted by the community, governments and other stakeholders
- Improved employee morale
- Improved credibility in the investment community
Conclusion

Successful leaders identify, evaluate and mitigate operational risks by:

- Implementing comprehensive, integrated management systems
- Fostering a positive, trusting and open culture
- Pursuing and achieving the goal of zero significant operational incidents

“It is imperative that leadership set the ‘tone at the top’ of the organization and establish appropriate expectations regarding process safety performance.”

Baker Panel Report (January 2007)