Risk Communications
Barrier Diagrams and Web-sites

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Process Safety is NOT yet a solved problem

Major accident statistics

- US RMP plants no measurable improvement (EPA RMP-Star database – Wharton analysis)
- US Chemical Safety Board incident list (presented at CCPS Meeting 2009)
- EU Safety case no significant improvement (EU MARS database)

but

- North Sea – No recent major disasters (although pre-cursors occur), HSE HCRD leak statistics lower
Authoritative Advice

- Baker panel recommendations well known
  - Reinvigorate PSM and Safety Culture programs

- John Murphy (ex-Dow, CSB, now CCPS)
  - Sharing knowledge is vital
  - Persuade management of value (the business case for Process Safety)
  - PS needs to be deployed globally
  - Complacency is a key challenge

- DNV view
  - Adopting this + similar advice requires some new activities
  - Just “trying harder” is unlikely to succeed
  - (same as with human error – “be more careful” does not work)
Barrier Approach does Work for Major Hazards

- The North Sea suffered two major disasters in 1980’s
  - Alexander Kjelland in 1982 (123f)
    - structural failure, most safety systems failed
  - Piper Alpha in 1988 (167f)
    - Both prevention and mitigation barriers failed after survivable initiating event

- Both UK and Norway adopted solutions with some common elements
  - Both use full risk assessment and barrier analysis
    - UK sector – Safety Case + Safety Critical Elements / Performance Standards / Written Schemes
    - Norway – Z-013 standard + TTS (Technical Safety Condition)
Barrier Based Safety Methods

- Barrier approaches are well established
  - Nuclear industry – Defence in depth – procedural and quantitative
  - SIL approaches & LOPA – quantitative
  - Bow Tie – semi-quantitative

- Bow Tie developed in the Netherlands in 1990’s
  - Alternative to QRA and stronger focus on Operations Phase
  - Prevention and Mitigation aspects
What are Barriers

- Snorre Sklet (BORA method – Norway) suggests:
  - “Safety barriers are physical and/or non-physical means planned to prevent, control, or mitigate undesired events or accidents”.

- A barrier in a Bow Tie:

  A barrier is a slice of swiss cheese in the Reason model and its effectiveness is the size of the holes.

  A barrier is an AND gate with two inputs a demand and control fails. This can be built out further – termed an Escalation factor or Barrier Decay Mechanism.
Real Bow ties can be large

- Prevention example
  - 10 threats
  - 40 controls

- But many duplicates
  - Not as many controls as might be evident

- Real facility
  - 100 – 200 key controls
  - Mixture prevention and mitigation
  - All have owners and are linked to site management system
Comparison Bow Ties to traditional risk tools

■ Positives
  - Bow ties are graphical not numerical
    - Can be displayed on training room or control room walls
    - No hard-to-understand numbers (e.g. $5.3 \times 10^{-7}$) or log-log FN graphs
    - Much easier to understand than 500pg QRA or LOPA reports
  - Bow ties link to known threats
    - Corrosion, mechanical impacts, operational upset, human error
    - Not “generic” leaks
  - Bow ties diagrams can convey extra information relevant to individuals
    - Barriers can be color coded by Dept or job (Operations, Maintenance, Inspection)
    - Barriers can show relative effectiveness (+ or -, or size of barrier = strength)
  - Provides qualitative indication of sufficiency of controls
    - Barriers can be scored and counted on each side (Threat and Outcome)
    - Bow ties integrate straight into a site’s PHA program
    - They re-invigorate tired programs and lead to new thinking on controls sufficiency

■ Negatives
  - Does not provide quantitative results – required separation distances, SIL level, etc
How to Communicate Risk using Bow Ties

- Large format drawings are a powerful tool for training and awareness
  - Good for combining routine controls (used daily) with barriers that mainly serve a role in less frequent process safety events

- But
  - Eventually large drawings must be filed and no longer easy to inspect
  - Bow ties are dynamic – controls effectiveness steadily change with time
    - Remedial action programs enhance or add to existing controls
    - Incidents / near misses show controls that are failed or degraded
    - Audits / MI programs also affect controls status
  - Thus large format drawings become inaccurate over 1-2 years

- Solution
  - Use IT to maintain and share Bow Tie information
  - Microsoft SharePoint is a key tool for corporate knowledge sharing
  - The new versions have enhanced its efficiency
SharePoint – What is it?

- SharePoint was introduced in 2001
  - Various names changes and some early confusion

- Initial focus was document library with search
  - SharePoint 2003 – Explorer style interface
    - User-unfriendly, but good for document sharing

- Newer versions 2007 (and soon 2010)
  - Web Portal interface
    - More graphics, point and click, external feeds, RSS, wiki's, blogs, community of practice support
    - Enhanced Search – with triggers for notifications
  - Full integration with MS Office
    - Databases in Excel, Access and SQL
    - Documents in Word, pdf, ppt
    - Outlook integration – reminders / meetings etc
    - Document protection and access controls
  - Much more powerful
    - Many “out-of-the-box” features that previously needed IT support
    - Can integrate with SAP etc – with IT support
  - Push and Pull functionality for users
    - Personal Dashboards, KPI’s, customized views
Application of SharePoint to Bow Ties

Microsoft SharePoint allows for multiple benefits on communicating bow ties

- Anyone can access the bow ties over organization’s secured intranet/internet network
  - From Management staff at Corporate to Operators at site level to Contractors
  - Not only the person who has the 500pg report and A1 size drawings

- The bow tie Access database is incorporated (SharePoint seamlessly supports)

- Users can access, print or save
  - The overall bow tie drawings – plus any updates
  - Controls owned by them – and their status
  - Controls owned by others – and their status
  - Shortfalls & Remedial action plans to improve controls

- Built-in project management tools can show progress on controls improvements
  - Plug-ins allow sharing & collaboration of MS Project files (normally hard to share)

- Other Process Safety, risk and general safety information can be included
SharePoint – “Pull” Version

- Web interface offers access to all barrier information
- But the user must look for it using tools provided
SharePoint “Push” version - customized

- Home screen shows
  - KPI’s in dashboard format for individual
  - Risk Picture (map) of company facilities to quickly get to Hazard and Risk Registers
  - Project status Gantt charts for control improvements
Barrier Access Database

- In the “Pull version” – users can select the parts of the plants and the types or risk relevant to them
### Hazards & Effects Register

**Hazards:** H-01.08.01 Propane/Loss of Containment - Large Leak

**Hazard Group:** H-01 Hydrocarbons

**Description/Assessment of Hazard:** Storage Tank for propane (Unit 45). Capacity = 70 m³ = 40 tonnes Propane. Surge Drum in Units 42 & 43. Refrigerant supplied from Kuwait by road tanker (Unit 46). Total capacity per train (hold-up capacity) = 90 m³, total capacity = 160 m³.

**Location Areas:** Areas 2 & 3

**Affects:** None

**Top Event:** Loss of Containment - Large Leak

### Risk Assessment

<table>
<thead>
<tr>
<th>SR</th>
<th>Consequence</th>
<th>People</th>
<th>Environment</th>
<th>Assets</th>
<th>Reputation</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Unignited Gas Dispersion</td>
<td>C4</td>
<td>G1</td>
<td>C0</td>
<td>B2</td>
</tr>
<tr>
<td>2</td>
<td>Unignited Liquid</td>
<td>C2</td>
<td>G1</td>
<td>C0</td>
<td>B2</td>
</tr>
<tr>
<td>3</td>
<td>Ignited Liquid - Pool Fire</td>
<td>A4</td>
<td>E3</td>
<td>A5</td>
<td>A4</td>
</tr>
<tr>
<td>4</td>
<td>Ignited Gas - Jet Fire</td>
<td>M4</td>
<td>E3</td>
<td>E2</td>
<td>A4</td>
</tr>
<tr>
<td>5</td>
<td>Ignited Gas - Explosion/Flash Fire</td>
<td>A6</td>
<td>E2</td>
<td>A5</td>
<td>A4</td>
</tr>
<tr>
<td>6</td>
<td>Ignited Vaporising Liquid - BLEVE</td>
<td>A5</td>
<td>E2</td>
<td>A5</td>
<td>A4</td>
</tr>
</tbody>
</table>

### Threats

1) Same as Condensate (H-01.08)

### Consequences

1) Unignited Gas Dispersion

### Recovery Preparedness Measures (RPMs)

<table>
<thead>
<tr>
<th>Recovery Preparedness Measures (RPMs)</th>
<th>Escalation Factors</th>
<th>Controls</th>
</tr>
</thead>
<tbody>
<tr>
<td>Same as Unignited Hydrocarbon Gas Dispersion</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

2) Unignited Liquid

3) Ignited Liquid - Pool Fire

4) Ignited Gas - Jet Fire

5) Ignited Gas - Explosion/Flash Fire

6) Ignited Vaporising Liquid - BLEVE
5 P’s for Communicating Process Safety

People - Process - Plant - Performance - Perspective

My Risks Page

People

Plant

Process

Performance

Perspective

Any Employee or Contractor
Sample SharePoint Video