LOPA Lessons
From Past Process Plant Incidents

October 2009

This document is confidential and is intended solely for the use and information of the client to whom it is addressed.
Given infinite time, a thousand monkeys (tu grads) with computers would eventually write the entire works of Shakespeare

Correlate that philosophy to the following presentation:

- three monkeys, about ten minutes
LOPA Lessons

- Review of selected process plant incidents where sufficient information was available
- Comparison of failed layers of protection or lack thereof
- Commonality or emerging patterns for predicting future incidents
LOPA Lessons
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Photo: Associated Press
LOPA Lessons
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<table>
<thead>
<tr>
<th>Incident</th>
<th>Failed IPLs</th>
<th>Missing IPLs</th>
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<tbody>
<tr>
<td>PVC Manufacturing - VCM Explosion</td>
<td>SIS interlock (manual interlock bypass added allowing safety interlock to be bypassed by operations)</td>
<td>Addition of easily bypassed safety interlock is unacceptable</td>
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<tr>
<td>Runaway Batch Reaction</td>
<td>None available at time of incident</td>
<td>• SIS to automatically activate emergency cooling of Rx jacket&lt;br&gt;• SIS to shutoff initiator feed upon escalation of safe operating limits&lt;br&gt;• Kill system activated by SIS upon escalation of safe operating limits&lt;br&gt;• SIS Rx dump upon escalation of safe operating limits</td>
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<td>Tower Overfill &amp; Subsequent Explosion &amp; Fire</td>
<td>BPCS level transmitter was known to be in a failed state (Tower) LAHH failed (Tower) PCV was known to be inoperable (Tower) BPCS FCV set at 50% level not activated by operations LAH at vent drum failed Vent drum size inadequate</td>
<td>• SIS to control level in Tower bottoms - high level shutdown of Tower feed • Tower overhead routed to adequately sized flare system • SIS to monitor Tower level, feed, &amp; bottoms output to storage</td>
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<td>Dead leg piping failure &amp; Subsequent fire</td>
<td>None available at time of incident (hazard not identified - risk not assessed)</td>
<td>• Installation of slip blind in out-of-service section of piping • Inherently safer alternative - remove out-of-service piping</td>
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<td>Ethylene Oxide Explosion</td>
<td>SIS interlock (Maintenance workers allowed to bypass safety interlock)</td>
<td>EO gas detection system with SIS to prevent opening of vent within flammable/explosive concentration range (LEL – UEL)</td>
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| Chlorine release from Scrubber   | Inadequate operator intervention upon BPCS alarm activation                  | • SIS to shutoff Chlorine upon alarm (low caustic)  
• Standby Scrubber to capture over-chlorination of main Scrubber  
• SIS to automatically inject additional caustic upon alarm (low caustic) |
LOPA Lessons

**Concluding Remarks**

- Commonality does exist – No LOPA
- Repetitive incidents; known risk
- Sites underestimated or did not understand risk
- Workers allowed to easily bypass safety interlocks
- Reliance on operator intervention
- IPLs poorly maintained
- Proper PHA w/LOPA would have identified scenarios
- Additional research of incident causes will likely point to increased importance of LOPA