ExHAZOP: REFRIGERATION SYSTEM

October 2010

This document is confidential and is intended solely for the use and information of the MKO Process Safety Center.
TYPICAL OPERATIONS

Anhydrous Ammonia Facilities
- Frozen Food Preparation, Dairies, Cold Storage Warehouses, etc.
- Over 10K lbs of ammonia
- Covered under 29 CFR 1910.119
- No process engineers; systems operated & maintained by mechanics/technicians
HAZARD IDENTIFICATION:
- Reliance upon “What-If/Checklist” outlining generic ammonia refrigeration issues
- Reactive approach to hazards & incidents
- Other hazards such as, nitrogen, sub-zero temperatures, nitric & sulfuric acid, natural gas, arch flash, etc.
- Large workforce with no knowledge of ammonia hazards, many non-English workers
- Reluctance by management to implement PSM
Refrigeration mechanics/technicians
  - Response to emergencies & incidents
Process Safety Management

- Mgmt Commitment
  - Employee Participation
  - Process Safety Info
  - Op & SW Procedures
  - Mechanical Integrity
  - Incident Data
  - Mgmt of Change

- Process Hazard Analysis
  - Mechanic Training
  - Emergency Preparedness
  - Pre-Startup Safety
  - Contractor Safety

- Compliance Audits
  - Benchmarks
## ExHAZOP Data

<table>
<thead>
<tr>
<th>Guideword</th>
<th>Hazard</th>
<th>Consequence</th>
<th>Safeguard/LOP</th>
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<tbody>
<tr>
<td>Level, Low</td>
<td>Low ammonia level in refrigeration system; HPR, Intercooler, Surge Drum, etc.</td>
<td>Eventual loss of liquid seal on outlet of HPR resulting in high pressure liquid emptying out of system and subsequent hammering of returning liquid – loss of containment issue; piping breaches; personnel exposure; fire; explosion</td>
<td>Automated level control instrumentation of refrigeration vessels; Train operators in the importance of maintaining the proper amount of refrigerant in the system</td>
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<tr>
<td>Control Issue</td>
<td>Simultaneous operation of fans and pumps</td>
<td>Liquid hang up in condensers results in loss of liquid seal</td>
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<tr>
<td>Control Issue</td>
<td>Opening of hot gas solenoid valve at onset of hot gas defrost cycle</td>
<td>Formation of liquid slug and subsequent hammering in evaporator piping – loss of containment issue; piping breaches; personnel exposure; fire; explosion</td>
<td>Automated defrost control with permissives; Consider installing a soft hot gas solenoid to minimize the possibility of liquid slug hammering</td>
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<tr>
<td>Flow, Other than</td>
<td>Hot gas solenoid leak by allowing hot gas to bleed into condensate gas pan and condense</td>
<td>Hot gas solenoid opens and hot gas contacts cold liquid resulting in flashing and rapid expansion – loss of containment (rupture hot gas pan) issue; piping breaches; personnel exposure; fire; explosion</td>
<td></td>
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</tbody>
</table>
Intent of hazard analysis is PROACTIVE IDENTIFICATION of hazards in an effort to prevent losses
- Easy to recognize hazards after an incident

Hazards are often disguised as maintenance issues, operational errors, environmental factors, etc.

Hazards other than ammonia may adversely impact the refrigeration system
- Overhead lifts, Forklift Trucks, & other Motorized Traffic
- Battery Charging Stations
- Utilities (water supply)

Okay to include other refrigeration related hazards
- Natural gas piping & fired boilers
- Use of cryogenic nitrogen at prep lines
- Dust issues (flour explosions)
CONCLUSION – the part everyone has been waiting for!!!!

You’ve lasted through a presentation by Mike Sawyer, & you’ve looked through the program and assured yourself that he is not giving another presentation in a session you want to attend

With basic maintenance the exHAZOP can be kept EVERGREEN
  – 5 year revalidations are not needed – always current
  – Technicians have access to most current refrigeration hazards & control methods
  – Updating exHAZOP is as simple as sending an email or other electronic media
  – May be downloaded onto iPhone & updated as needed