Life after the Thief Hatch

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Vapor Collection System: Design

VCS Design Goals
1. Route tank vapors to combustion device or VRU.
2. Size VCS for adequate capacity to maintain system pressure below relief device setpoints.
Vapor Collection System: Normal Operation

During Normal Operation, tank vapors are routed through the VCS to a combustion device.
The thief hatch can still be a source of fugitive emissions no matter how well designed the rest of the VCS.
Spring-Loaded Thief Hatch

- Pressure spring relieves at setpoint (typically 8-16 osig setting)
- Vacuum spring relieves at setpoint (-0.4 osig setting)
- Two ‘leak points’ per device
Can we replace spring-loaded thief hatch with lock-down hatch and:

- Reduce or eliminate fugitive emissions from tank components
- Reduce frequency of and cost associated with maintaining tank components
- Maintain adequate levels of pressure & vacuum relief for tank systems
- Maintain operability
# Tank Devices: Relief and Access

<table>
<thead>
<tr>
<th>Device</th>
<th>Action</th>
<th>Pressure Relief</th>
<th>Vacuum Relief</th>
<th>Tank Access</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thief Hatch</td>
<td>Spring-loaded</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Lock-Down Hatch</td>
<td>Manually Open/ Close; Screw Tight</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Pressure-Vacuum Relief Valve (PVRV)</td>
<td>Weighted Pallet</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
During Emergency Operation, the standard 4” tank connection is too small to accommodate required relief capacity.
Pilot Project: Tank Modification

Order new tanks with 8” vent connection...

and pre-installed Lock-Down hatch
Modeled the egress of gas during emergency relief scenario to ensure tank pressure stayed within guidelines of API 2000.

Determined:
- PVRV Size
- PVRV Spacing
- Vent Pipe Sizing
Pilot Project: Access & Winterization

- Piping design to allow maintenance access to PVRV from catwalk
- All PVRVs were heat traced and insulated to protect from freezing
- Tank systems have at least two (2) relief devices
Pilot Project: Layout

Pilot Project Q1 2017 – installed 30 lock-down hatches and 6 PVRVs. Eliminated 60 springs.

<table>
<thead>
<tr>
<th>Device</th>
<th>Legacy Configuration</th>
<th>Pilot Lock-Down Configuration</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thief Hatch</td>
<td>30</td>
<td>0</td>
</tr>
<tr>
<td>Lock-Down Hatch</td>
<td>0</td>
<td>30</td>
</tr>
<tr>
<td>PVRV</td>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>
Pilot Project: Results

Upon commissioning the facility, the following results were found:

• Initial inspection – corrected torque on lock-down hatch bolts
• Second inspection – no leaks on lock-down hatches
• Subsequent inspections – no leaks on lock-down hatches
• Winter observation – no freeze-ups on PVRVs

Project was deemed a SUCCESS and rolled out to all new installations.

Existing Locations: Economics do not support retrofit of existing locations due to extensive tank modifications
New batteries with Lock-Down configuration have experienced SIGNIFICANT reduction in work orders written to address fugitive emissions.

Whiting Best Practices for New Tank Installations as of Q3’2017
• 100% Lock-Down Hatch Configuration on new tank installations
• All tanks ordered or installed with 8” vent connections
• All PVRVs heat traced & insulated
• No less than two (2) relief devices will be installed.