



— Refrigerant R-507 – MRU piping release



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Introduction:

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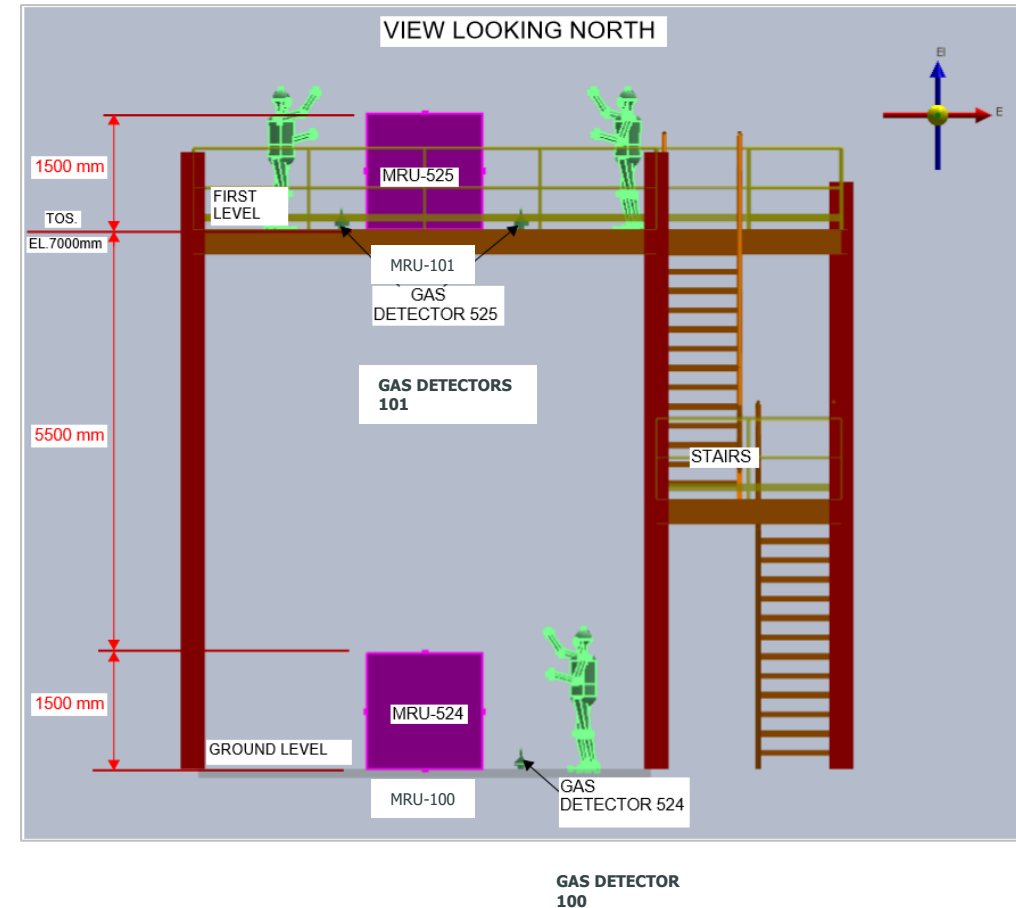


— Refrigerant R-507 – MRU piping release

- Facility: Polyethylene (PE) Operations
- Incident Date: June 3rd, 2020
- Incident Type: Process Safety Incident - Tier-2 (API RP-754)
- Location: Mechanical Refrigeration Unit (MRU) - Indoors
- Impact: None (besides non-hazardous chemical release to atmosphere)

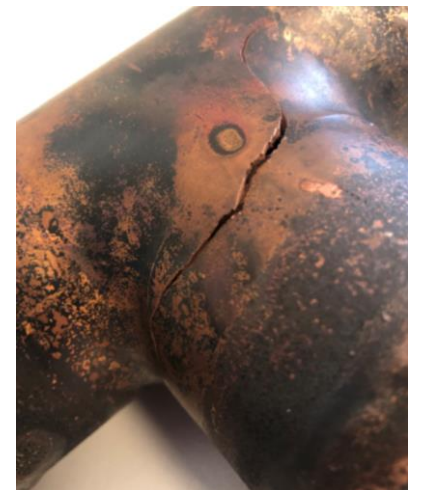
Overview of layout

- Location: Indoor finishing building of a PE manufacturing unit.
- MRU-100: piston compressor on ground level
- MRU-101: screw compressor ~7 m elevated above MRU-100
- Only one is in operation, MRU-100 on June 3rd
- Gas detection:
 - MRU-100; one freon detector at ground level
 - MRU-101; two freon detectors at elevated level
- Freon R507 is used, non-flammable, non-toxic, azeotropic mixture of two other refrigerants (gases heavier than air):
 - R-143a (1,1,1-Trifluoroethane) – flammable gas – 50%w
 - R-125 (Pentafluoroethane) – inert gas - 50%w
- Previous studies showed that no asphyxiation hazard existed for the R-507 worst case release
 - Natural draft by design - confirmed with physical measurement
 - Oxygen will not drop below 19,5% in any scenario



Event Summary

- **Leak** – Indoor release of **346 kg R-507** refrigerant from a crack in the copper discharge line of refrigeration compressor of MRU-100.
- **Duration** – The event lasted **>2 hours** - multiple factors led to the duration:
 - Notification of gas alarm from gas detection in the MRU-area (~15 ppm)
 - No visible plume as the leak was very small at first
 - Natural draft in the building lifted R-507 upwards - only detectors close to another MRU-101 located just above MRU-100 gave a gas reading initially
 - Handheld detectors also seemed to indicate that the leak was coming from the elevated MRU-101
 - After responders tried unsuccessfully to find the leak, they decided to call an expert from the 3rd party Contractor that maintains these MRUs to help troubleshoot
 - While waiting on the expert to reach the site, the responders cleared the room to reduce risk
 - While the building was unoccupied, the leak rate changed and a visible plume formed but not seen (no people in the building)
 - The panel technician did not initially notice the change in the trends.

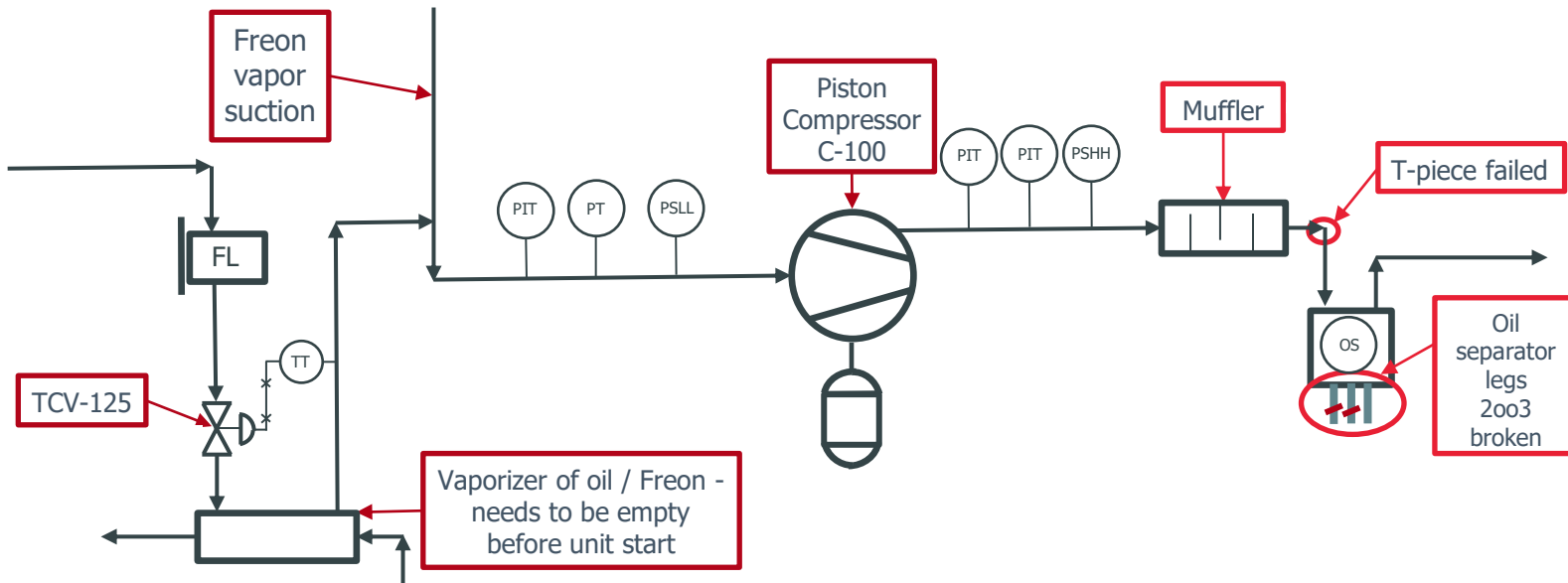


Key Background

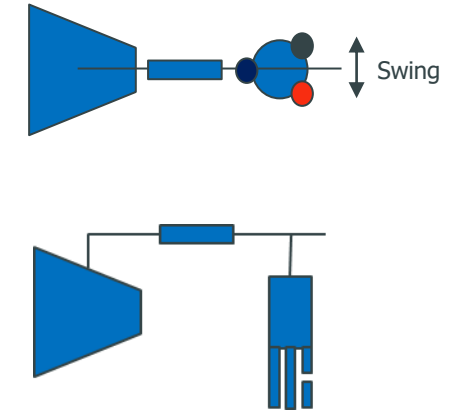
- Maintenance for both units has been completely outsourced to a 3rd party Maintenance Contractor (MC) for many years.
- Communication between Dow/MC is informal – when MC believes maintenance is needed, they contact the Dow maintenance engineer, who starts the internal process for the service
- Historically, there has not been formal Management of Change process used or documented for changes proposed and implemented by MC. When MC recommended a change, they communicated that to their Dow contact, informally gets support from Dow, makes the change and then communicates to Dow contact what they changed.
- No Dow Mechanical Expert designated for MRU at Dow Site for the plant to consult on proposed changes
- Generally, an MC representative returns the system to service and starts the equipment after maintenance for testing
- Generally, Dow Operations starts the unit whenever maintenance has not been done.

EQUIPMENT MRU 100 – RELEVANT COMPONENTS

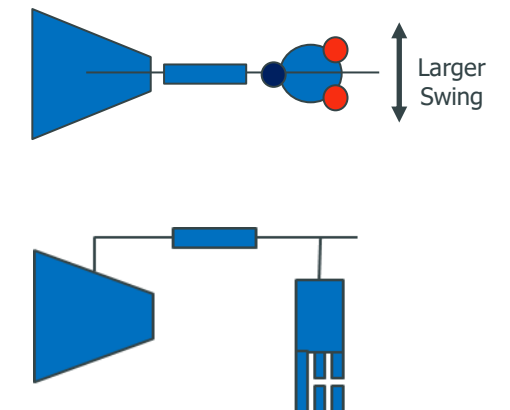
- Good Leg
- Broken Leg



With One Leg Broken



With Two Legs Broken



TCV-125 – This valve failed in July 2019 → liquid carryover to the compressor → high vibrations. This event likely caused the first leg of the oil separator to break. TCV-125 failed because the MC personnel manipulated it during start-up over the years in a way the valve was not designed to.

Oil Separator – The failed pipe section was completely supported by the compressor and the oil separator (no pipe supports). After the June 3rd release, **2 of the 3 legs of the oil separator were found broken**. Probably the two failures occurred at different times (based on failure point inspection), but unknown. **This was not noticed by either MR or Dow.**

T-piece – **The same T-piece cracked 6 weeks before** (36 kg leak, PS Near Miss). The RCI was still on-going, but it was believed to be caused by a significant vibration event (root-causes eliminated). This **T-piece was replaced** when a new muffler was installed in 2018. Its **thickness was inadvertently changed from 3.0 mm to 1.6 mm.**



CAUSES – T-PIECE CRACK

- Delegation of reliability and integrity of MRUs to 3rd party with Less Than Adequate management systems in place and no Dow Mechanical Expert involved for MRU – **wrong Asset Ownership Strategy**
 - The MRU was maintained by MC personnel with no Dow Operations participation (*Operating Discipline*)
- MRU ran with 2 out of 3 legs of the oil separator broken. Compressor vibration + broken legs → material fatigue - **Inadequate Inspection program** (compressor vibration and oil separator supports)
 - ✓ Oil Separator Leg #1
 - probably failed due to high vibration in July 2019 due to TCV-125 failure
 - TCV-025 failed because it was operated manually by MC in a way it was not designed for
 - ✓ Oil Separator Leg #2 –
 - failed sometime between Oil Leg Separator Leg #1 failure and this event, not detected by MC or Dow
 - online vibration monitoring needed?
- No formal Management of Change (MOC) process for MC proposed changes and no Dow MOC documentation processed / maintained – **defective MOC implementation**
 - This section of pipe was
 - ✓ thinner than design (*Quality Assurance*)
- Lack of formal “hold” process to ensure that the plan to put back in service was adequate – **incomplete Return to Operations process**

CAUSES – LONG DURATION

More than 2 hours required to stop the leak

- Area and mobile detection did not indicate the correct leaking point – *excessive reliance on gas detectors*
- No clear troubleshooting guidance for MRU-100/101 (**Operating Discipline**)
- No recognition by operators, ES&S first responders and Emergency Center that the leak rate had significantly increased (freon collection drum D-105 level was not monitored during troubleshooting actions) (**Operating Discipline**)
- MRU was not shutdown (neither automatically by detectors or manually) (**Incident Response**)

LEVERAGEABLE LESSONS LEARNED



- Do not fully delegate accountability and ownership of reliability and integrity of systems with the potential to cause Process Safety Incidents to a 3rd party:
 - Define clearly the scope of service and responsibilities of 3rd party contractor and owner company employees
 - Assign supervision/management of service to an owner company expert
 - Full implementation (definition/approval) of necessary work processes like of the Inspection Program, Operating Discipline, Management of Change
- Define troubleshooting guidelines / procedures appropriate to criticality of equipment/units
- Ensure that your organization has a clear process to establish any desired holds before Return to Operations process can be started.
- Consider automatic (low freon level/level change) or manual shutdown of equipment/units as a layer of protection to avoid Tier-1/Tier-2 PSIs
- Understand which systems have the potential to cause a reportable Tier-1/Tier-2 PSI and make sure all the organization knows that
- Prioritize and investigate “priority” PS Near Misses – they can uncover management system defects that can end up in a reportable incident



— Questions? Comments?

Thank you for your attention!