Overfill Protection Devices and Motor Fuel Tank Safety

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Overfill Protection Devices

- NFPA 58 defines an Overfill Protection Device (OPD) as:
  - A device that is designed to provide an automatic means to prevent the filling of a container beyond a predetermined level

- NFPA 58 does not permit the filling of propane motor fuel tanks to more than 80% of the tank's liquid capacity

Overfill Protection Devices

- OPDs are required by NFPA 58:

> **11.4.1.15** ASME containers fabricated after January 1, 1984, for use as engine fuel containers on vehicles shall be equipped or fitted with an overfilling prevention device.

- OPDs must be listed in accordance with UL 2227:

> **12.4.7.1** All ASME LP-Gas ASME containers manufactured after January 1, 1984 shall be equipped with a listed overfilling prevention device (OPD).
>
> **12.4.7.2** Overfilling prevention devices shall be listed in accordance with UL 2227, *Standard for Overfilling Prevention Devices.*

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Overfill Protection Devices

- OPD function is required to be verified annually:

11.4.1.18 Where the fixed maximum liquid level gauge is not used during filling in accordance with 11.4.1.17, the fixed maximum liquid level gauge or other approved means shall be used annually to verify the operation of the overfilling prevention device.

(A) If the container is found to be overfilled during the test, corrective action shall be taken.

(B) The result shall be documented.

(C) A label shall be affixed to the container near the fill point indicating the expiration date of the successful test.

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Overfill Protection Devices

- OPDs operate inside a propane motor fuel tank and are activated when liquid propane reaches the 80% level

- Rising liquid propane pushes a float upward closing a valve and consequently stopping the flow of fuel into the tank
- OPDs do not shut off the flow gradually. The float rises to a point and then the valve snaps shut

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Overfill Protection Devices

- The 80% threshold allows room for liquid volume changes within the tank due to temperature fluctuations
- The 80% level allows for more than a 100 Degree Fahrenheit rise in temperature before the liquid level within the tank reaches a point where liquid, not vapour would be expelled from the Pressure Relief Valve

Overfill Protection Devices

- OPDs have been in use for over 20 years
  - Proven to be robust and reliable when used appropriately
  - Offer significant reduction in emissions during refueling vs. the Fixed Liquid Level Gauge (“spitter”) alternative
- In rare scenarios, it is possible to damage the OPD during refueling

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Learning from the Unusual

- As a motor fuel tank manufacturer we have the privilege of being engaged in the marketplace with many different players
  - We support each of our customers when they encounter technical difficulties
  - Our interface gives us visibility into unusual circumstances across the industry
  - Our most recent engagement regarding OPDs and the corresponding observations are worthy of sharing with the industry at large

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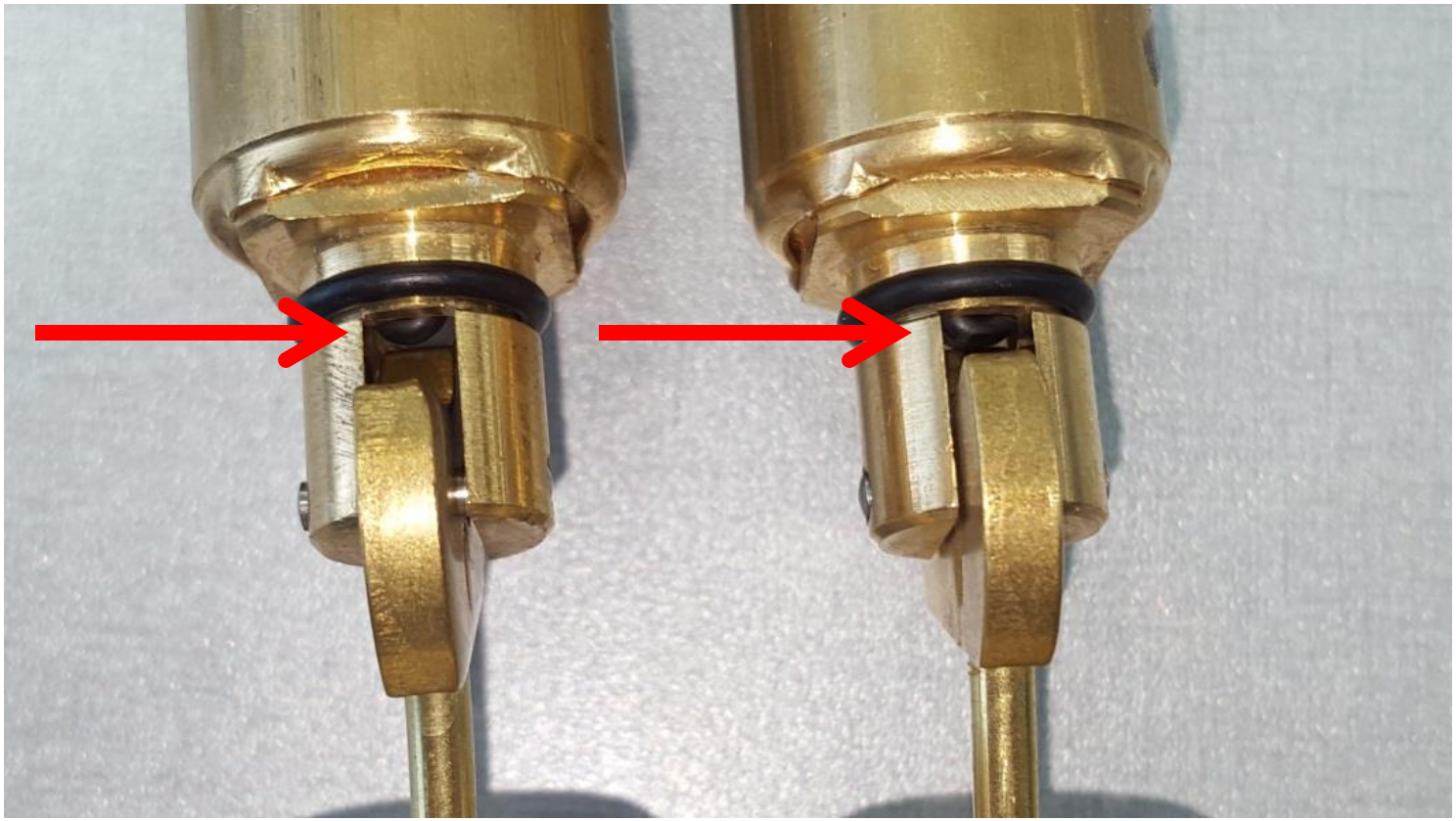
Learning from the Unusual

- We were asked to address a series of very unusual OPD failures
  - The failures were all at one location
  - This was the first group of new vehicles deployed at this location
  - No failures had been recorded at other locations
- The OPD supplier reviewed our samples
  - Dimensional results were all within specification
  - O-rings were within specification
  - This incident report was an anomaly for them

Learning from the Unusual

- Here is what we were seeing:



Learning from the Unusual

- We reviewed the site refuelling process:
  - New vehicle tanks had been purged with Nitrogen at 5 PSI prior to first filling
  - No refuelling dispenser was available, but the installation was planned
  - A bobtail was being used to directly fuel these vehicles
  - The bobtail was new equipment
  - The bobtail pump bypass pressure was configured to maximize pumping speed into bulk tanks (with no OPDs)
  - We suspected that the OPDs were being pushed beyond their capabilities

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Learning from the Unusual

- We wanted to be able to prove the failure mode
  - We tested 10 OPDs at our facility
  - The valves were installed in a 3/4" NPT coupling welded to a steel plate
  - The valves were installed to the manufacturer’s specifications
  - Water was used to simulate the flow of propane
  - We experimented with both hot and cold water but there was no difference in the observations

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Learning from the Unusual

- Water was supplied from a supply pressure vessel though a 1/2" hose
- A nitrogen bulk pack with regulator was used to build and maintain pressure in the supply vessel for the testing
- 1/2" ball valve was installed inline between the supply vessel and the stop fill valve to give us quick on/off control
- In each test, the OPD valve initiated in the open position to simulate a filling scenario

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Learning from the Unusual

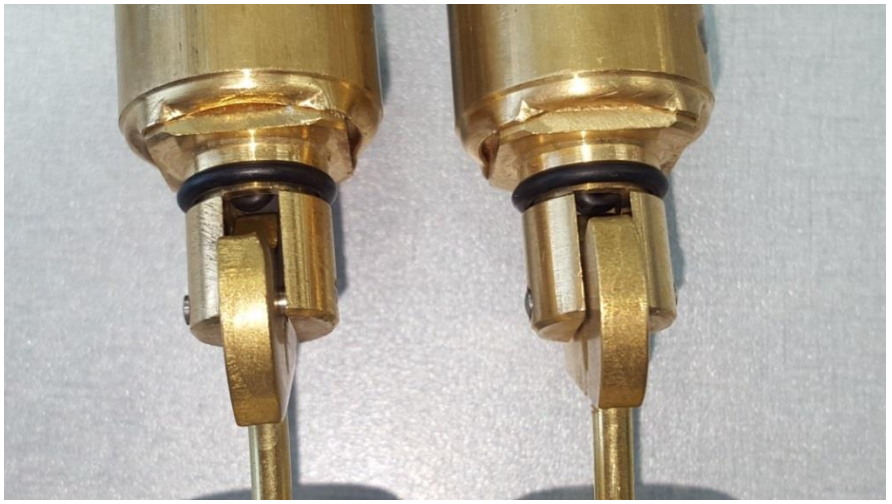
- Normal OPD operation:

Learning from the Unusual

- Failed OPD operation:

Learning from the Unusual

- The Observation:
  - High flow rate through the valve body caused by high differential pressure dislodges and displaces the o-ring seal thus compromising the integrity of the valve



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Learning from the Unusual

- The Learning:
  - There exists a potential for OPD valve damage when fueling a motor fuel tank when the pressure differential is unusually large
  - This could occur in rare circumstances such as:
    - First fill in a tank's service life
    - Refilling a tank after internal service work has been completed
  - To date, we have not observed valve damage from dispensers during these scenarios
  - We have experience that indicates bobtails can cause valve damage in these scenarios

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Fuel Tank Safety

- OPDs are not the only appurtenances in a propane motor fuel tank
  - Common others include:
    - Pressure Relief Valves (PRV's)
    - Electronic Service Valves
    - Fixed Liquid Level Gauges (Spitter Valves)
    - Fuel-Level Gauges (Float Gauges)
    - Flanged Covers and Service Openings
- Fuel tank servicing is also a significant safety matter

Fuel Tank Safety

- The Propane Motor Fuel Tank – The “holder” of the appurtenances
  - Propane tanks are made to ASME pressure vessel standards
  - Propane tanks are made with a malleable steel that favors deformation rather than cracking or splitting
  - With pressure ratings at 312 to 390 PSI, propane tanks are significantly stronger than gasoline or diesel tanks

Fuel Tank Safety

- Pressure Relief Valves (PRVs)
  - All ASME pressure vessels require overpressure protection
    - PRVs must meet the requirements of UL 132 as mandated by NFPA 58
  - PRVs ensure that the pressure within the tank does not exceed the Maximum Allowable Working Pressure (MAWP)
  - PRVs will relieve pressure as required in a safe and controlled manner to protect the integrity of the tank

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Fuel Tank Safety

- Electronic Service Valves
  - Automatically shut off the flow of propane from the tank when the ignition key is off
  - Automatically shut off the flow of propane from the tank following an impact
  - Automatically restrict the flow of propane in the event a line is severed or a similar breech occurs
  - Have an Internal Excess Flow Restrictor so that in the event the external portion of the valve is sheared off, there is not a rapid and substantial release of propane

Fuel Tank Safety

- Fixed Liquid Level Gauges (Spitter Valves)
  - Used annually to validate the operation of the OPD
  - Will shear off leaving only a # 54 drill bit hole as a release opening

Fuel Tank Safety

- Fuel-Level Gauges (Float Gauges)
  - Seal on the tank flange surface but do not present a normal exit for propane from the tank
  - Some models stand proud of the tank surface increasing the risk of sheer damage
  - Could be protected by deflection guarding to enhance sheer protection

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Fuel Tank Safety

- Flanged Service Openings
  - Very sturdy
  - Typically unprotected from sheer
  - Could be protected by deflection guarding to enhance sheer protection

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Fuel Tank Safety

- Servicing of Motor Fuel Tanks
  - Pump replacement and filter maintenance require the opening of the tank for service
  - We have heard of rare incidents relating to servicing internal components of tanks
    - Technicians open up propane tanks containing fuel
    - Technicians open lines, then activate pumps as part of their diagnosis plan
  - All could have been prevented with proper training

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Fuel Tank Safety

- Opening an in-service tank presents challenges:
  - There is always a residual quantity of liquid propane within the tank
  - There is now equipment available from multiple suppliers to assist with tank evacuation
  - Technicians need training to reduce safety risk

Fuel Tank Safety

- Re-initializing a tank following internal service work presents challenges:
  - Air should be purged
  - We have talked about initial refueling challenges
  - Technicians need training to reduce safety risk

OPDs and Fuel Tank Safety

- Summary
  - Tank Appurtenance Performance
    - The current designs of OPDs and other tank appurtenances have proven reliable and safe for many years
    - There is always room for minor improvements
      - Best practices to address rare situations
      - Additional valve protection from accidental impact, etc.
    - Based upon our observations to date, there are no tank safety matters that require immediate response
  - Technician training is an important initiative
    - With growth, there is greater opportunity for mishaps
    - Training is the answer

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Questions?

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