Agenda

- Introduction
- Cushion Unit Basics
- Economics
- What is a Unit Condition Indicator (UCI)
- History of UCI
- Why Cushion Units Leak
- Cushion Unit Performance vs. Pressure / Oil Loss
- AAR Request for Waiver
Cushion Unit vs. Draft Gear Application
The Problem

*When Should a Cushion Unit be Removed?*

- FM Rule 59 requires the use of the Unit Condition Indicator (UCI)

- FRA 49 CFR S215.127 (C)(1) requires that any ‘clearly formed droplets of oil’ is cause for removal.
  - Subjective and difficult to evaluate
  - Does not give a true indication of Cushion Unit health and performance

- In event of conflict – FRA Wins!
The Solution

Use the UCI as the indicator of health in trainyard and/or shop track… Go / No-Go.
AAR Car Repair Billing (CRB) records show 22,940 cushion units have been replaced from January 1, 2007 to January 1, 2012 (5 years) for Why Made Code 15 (Leaking).

If 25% can remain in service, would result in annual savings of $2.2M to the industry.

This is a conservative estimate. A significant number of repairs are made at private car shops that do not utilize the AAR Car Repair Billing system.
Repair Track Cushion Unit Survey

Subsequent repair track inspections (based on 2004 MP&E Memorandum) of 564 units removed from service for evidence of oil leaking:

- **326** – No Defect Found – UCI Indicated OK Condition (unit returned to service) – **58%**.

- **55** – Verified Leaking Units Found -- UCI Indicated OK Condition (Cushion Unit Replaced per Clearly Formed Droplet According to FRA 49 CFR Part 215) – **10%**

- **183** – Verified Leaking Units Found – UCI Confirmed Defective (Cushion Unit Replaced) – **32%**

Use of UCI in the train yard would have allowed **68%** of the units to continue in service.
Clearly Formed Droplets but UCI Indicates OK.
How The UCI Works…

Spring Biased Poppet Design

Unit pressure overcomes spring pressure, poppet extends. Unit pressure drops, spring pressure retracts poppet.
Which one is leaking?

1. Inner cylinder filled with hydraulic fluid

2. Piston forces hydraulic fluid through specially designed valves

3. Nitrogen gas pushes piston back to neutral after impact

4. Rod Seal is always submerged in oil; highly reliable
Which one is leaking?

UCI Indicator

Return Ball Valve In Closed Position On Draft End, Lower Half of Inner Cylinder

Sealing Piston Ring

Bearing Piston Ring

Preload Valves Throughout Travel

Return Ball Valve In Open Position On Buff End, Lower Half Of Inner Cylinder
General Cushion Unit Misconceptions…

- Nitrogen gas does not cushion impacts. Only acts as a return mechanism after an impact. Old designs used mechanical springs.
- Rod seal, seals draft pressures of 12,000 psi vs. 25,000 psi working pressure.
- UCI is a pressure indicator. If nitrogen leaks, oil is also leaking.
- Coupler horn to striker contact is an indication of excessive coupler, yoke, key and stops (lugs) wear, not cushion unit function or loss of oil.
UCI Service History

- 1992: Entered service
- 1996: Required by AAR M-921D (cushioning devices, end-of-car, motor vehicle carrying)
- 1997: Required by AAR M-921B (cushioning devices, end-of-car)
- 1996-97: Required AAR M-921C (reconditioning specification)
- 2001: Operating instructions added to FM Rule 59
- 2004: AAR M-921H issued (UCI Specification)
- Present: ~ 675,000 cushion units with UCI’s produced
  - Highly reliable
  - Proven technology – 20 years of service history
1.0 SCOPE
This standard sets minimum requirements for Unit Condition Indicators (UCIs) to provide uniformity of actuation, verification of operation, corrosion resistance, and safe actuation criteria. UCIs meeting these requirements will provide a reliable indication of whether the preload EOC cushioning units to which they are applied are acceptable for rail service or are in need of maintenance, based on the specified criteria in paragraph 2.0. Clearly formed oil droplets are not an accurate predictor of unit performance. The UCI is the approved method to determine the need for unit maintenance.

2.0 REQUIREMENTS
Unit condition indicators conforming to this standard must meet all of the following conditions.

2.1 The UCI must indicate an acceptable unit by the tactile stem out and an unacceptable unit by the tactile stem in.

2.2 The force required to push the tactile stem must not exceed 10 lb at 70 °F with the unit extended and fully pressurized.

2.3 UCI components exposed to the atmosphere must be made from corrosion-resistant materials.

2.4 The UCI must indicate a bad unit if the unit restoring force falls below 700 lb for an extended unit at −30 °F (−34.4 °C).

2.5 The UCI must indicate a bad unit, whether the unit is extended or compressed, at 70 °F when unit oil loss results in a maximum coupler force that exceeds specification requirements by 50% or more during a 6 mph impact. The impact condition shall be with a loaded car per the impact performance test configuration of the appropriate M-921-series specification.

UCI Specification Requirements:
- Stem in = bad (Note Emerald is Opposite)
- 10 lbs. or less to press stem in (function check)
- Indicate Bad if less than 700 lbs. restoring force (~70 PSI)
Population

- It is estimated that approximately 675,000 cushion units produced are equipped with UCI.
- 2011 UMLER records indicate there are 253,245 cars equipped with End of Car Cushion Units (EOC’s) and 38,236 Cars with Center of Car Cushion Units (COC’s) currently in service.
- Majority of cushion units currently in service have a UCI.
Nitrogen Gas and Hydraulic Fluid are mixed together similar to a carbonated beverage.

The only path for the oil to the outside world is via. the piston rod seal.

If the seal fails, nitrogen gas will escape along with hydraulic fluid (It is impossible to lose one without the other).

A decrease in nitrogen gas pressure is a positive indicator that fluid loss occurred.
UCI Reliability Studies

Per AAR, @ 70 psi, UCI to indicate ‘Bad’. OEM’s indicate ‘Bad’ @ 200 psi (some older designs used 100 psi).

250 UCIs tested – distribution shown above
Cushion Unit Indicator
- Specification and Performance

- New Fully Charged Cushion Units are 700 psi.
- 9 quarts of oil removed…still had 100 psi and passed the AAR Impact Performance Test.
Putting ‘Leaking Fluid’ into Perspective…

One 1 oz shot glass of Hydraulic Fluid equals…

685 “Clearly Formed Droplets”

Oil Volume by Unit type:

10” EOC ~ 4 gals
15” EOC ~ 5 gals
20” COC ~ 15 gals

Oil Volume by Droplets:

10” EOC ~ 351,000
15” EOC ~ 438,000
20” COC ~ 1,315,000
Which one is leaking?

UCI Indicator

Return Ball Valve In Closed Position On Draft End, Lower Half of Inner Cylinder

Sealing Piston Ring

Bearing Piston Ring

Preload Valves Throughout Travel

Cushion Units Draw Oil From The Bottom Of Reservoir As They Restore

Return Ball Valve In Open Position On Buff End, Lower Half Of Inner Cylinder
Normal ‘Wet’ Operation vs. Seal Failure

All Hydraulic cylinders have ‘wet piston rods’

The surface finish of the cylinder rod can have a dramatic effect on the life of the rod seal. If the surface roughness is too low, seal life can be reduced through inadequate lubrication. If the surface roughness is too high, contaminant ingestion is increased and an unacceptable level of leakage can occur.

A lubricated seal is critical to proper performance!
Reasons for Oil Bypass

- **High Loads / Pressures**
  - Seal Hydroplaning
  - May or may not be a failure of seal

- **Piston Rod Damage**
  - Handling
  - Debris / contamination

- **Uncommon Failures**
  - Component wear
  - Catastrophic
    - Incorrect seal
    - Misaplication
    - Component failures
This is a good cushion unit. Indicator is out. Oil loss likely not detrimental to unit performance (needed for seal and shaft lubrication).
This is a good cushion unit. Indicator is out. Oil loss likely not detrimental to unit performance (needed for seal and shaft lubrication).
This is a defective cushion unit. Indicator is in. The UCI indicates loss of pressure (oil loss) requiring attention.
Summary

- Over 675,000 cushion units with UCIs have been produced
- UCIs are widely used in hydraulics industry
- A lubricated seal is critical to proper performance
- UCIs condemn at a safety factor greater than twice what is needed.
- Cushion Units draw oil from the bottom of the cylinder and will operate effectively with significant oil loss.
- UCI is a Go, No-Go Gauge (approximately 70% of set outs for leaking cushion units are unnecessary).
- **AAR recommended to FRA that cushion units should NOT be removed from service for leaking unless the UCI indicates defective.**
  - AAR Established New “Why Made” Code For UCI Indicates Defective
  - We Must Still Remove For Leaking Clearly Formed Droplets Until FRA Grants Waiver
Questions?

http://www.regulations.gov/#!docketDetail;D=FRA-2013-0077