• 1940-1950 Cushioning of paper box cars
  • COC 30 inches travel with draft gear on each end
• Cars increase in tonnage from 50-70-100-110 tons
• Desire to increase capacity drives EOC design
  • Does 30-inch COC equal 15-inch EOC?
• EOC evolution from original design
  • Return Mechanisms (spring / gas)
  • Preload 50K / 100K
  • Active Draft 1,2,3, 4-inches
• Which cars should have cushioning?
• Some cars received them because of design rules

• M-1001 Design standards for bulkheads require a 750,000 pound load for draft versus 400,000 for 15-inch cushion.

4.1.13 Longitudinal Force on Bulkheads of Flatcars and Center Beam Cars

4.1.13.1 The bulkheads on flatcars and center beam cars shall be designed for a longitudinal force induced by the lading under end impact. This force shall be the design coupler force multiplied by 75% of the ratio of load limit to gross weight on rails, and it shall be considered as a uniformly distributed load over the face of the bulkhead with the resultant force at mid height. The induced stresses resulting from this force shall not exceed the allowable unit stresses given in paragraph 4.2.2.6.

4.1.13.2 The bulkheads on flatcars and center beam cars used exclusively in pulpwood service and having permanently canted decks are to be designed for a longitudinal force induced by the lading under end impact. This force shall be the design coupler force multiplied by 50% of the ratio of load limit to gross weight on rails, and it shall be considered as a uniformly distributed load over the face of the bulkhead with the resultant force at mid height. The induced stresses resulting from this force shall not exceed the allowable unit stresses given in paragraph 4.2.2.6.
• Some to improve customer relations (reduce lading damage)
• Which cars should have cushioning?

• What testing is performed to qualify a cushion unit?

• Is online performance better with cushioned cars?

• Does end of car work like center car cushioning?

• What constitutes failure in damage prevention?
What testing is performed to qualify a cushion unit?

4.2.4 Disqualification
4.2.4.1 Examination
The device and the test car structure shall be examined after each impact. There shall be no damage to the device or any test car structural component designed or specified by the applicant, or the device is disqualified. Damage shall be considered as that which requires shopping the car for repairs based on best industry practice.

4.2.2.1 Arrangement
The test cars and consist shall be arranged as shown in Fig. 4.1.

BACK-UP STRING
- Four 70-ton-capacity cars loaded to 220,000 lb
- All hand brakes set and wheel restraints may be used

ANVIL CAR
- 150,000 lb minimum
- Coupled to back-up string

HAMMER CAR
- 220,000 lb

6.0 IMPACT PERFORMANCE DESIGN REQUIREMENTS AND TESTS
6.1 Design Requirements
The allowable coupler force while stroking the device in buff during impacts, from the neutral position up to 8 mph, shall be as follows:

<table>
<thead>
<tr>
<th>Test Car Gross Rail Load (lb)</th>
<th>Maximum Coupler Force at 4 MPH (F4) (lb)</th>
<th>Maximum Coupler Force at 8 MPH (F8) (lb)</th>
</tr>
</thead>
<tbody>
<tr>
<td>150,000</td>
<td>150,000</td>
<td>450,000</td>
</tr>
<tr>
<td>210,000</td>
<td>210,000</td>
<td>630,000</td>
</tr>
<tr>
<td>W</td>
<td>100 W</td>
<td>300 W</td>
</tr>
</tbody>
</table>

where \( W \) = gross rail load for which approval is sought.
6.0 IMPACT PERFORMANCE DESIGN REQUIREMENTS AND TESTS

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</tr>
<tr>
<td>210,000</td>
<td>210,000</td>
<td>630,000</td>
</tr>
<tr>
<td>W</td>
<td>1.00 W</td>
<td>3.00 W</td>
</tr>
</tbody>
</table>

where \( W \) = gross rail load for which approval is sought.
• Is online performance better with cushioned cars?
  • Hose Separations average 5X higher 2006-11
  • Knuckle failures average 1.4X higher 2006-11
  • Some roads limit total length in a consist
Does end of car work like a center car cushion?

- COC has both draft gear AND cushioning
- COC displacement cut in half.
- Draft gear provided in service benefits
- EOC usually dedicates full stroke to impact protection
• What constitutes failure in damage prevention?

• Recall that load configurations are tested with specific car conditions (we don’t always know what other arrangements will produce).

• Does coupler force = load protection?
Two car types each designed with draft gear on one end and a cushion unit on the other.
• Cushioning provided 1/3 more protection
• More stroke does help impact energy absorption
• Moving loads have lower accelerations
• Cushion units dissipate twice the energy
• Cushion unit benefits decrease with speed
• What constitutes failure in damage prevention?
  • Coupler Force / Carbody Accelerations
    (frequency is a major factor in both)
  • Movement
  • Damage
  • DG @ 7.3 mph
  • Csh @ 8.0 mph

Just drive slow and careful!
• Focus the cushion benefit on the cars that really need it.
• Online cushioning performance is much worse than draft gear
• Remember that cushioning is biased to only help in high impact situations.
• The concept of COC and getting similar results when this protection is needed should be the ultimate goal.