Session 6: Maintenance of Systems
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Session 6 Learning Outcomes

At the end of this session, you will be able to:

- Know how damaged barrier MAY BE assessed for maintenance response.
- Understand when a damaged barrier terminal MAY no longer function.
- Effectively delineate damaged hardware prior to repair.

Introduction

- Barriers need routine inspection and maintenance.
- Barrier may need to be repaired after crashes or long term exposure.
Need To Repair

Video Clip

Determine Extent of Damage

NCHRP Report 656 is intended to identify methods to better determine whether minor damage to W-Beam barriers poses a crash safety risk. It is intended to enable maintenance crews to prioritize repairs.

REF: NCHRP 656 – Criteria for Restoration of Longitudinal Barriers
## Modes of Barrier Damage

### BARRIERS
(Based on experimental testing)

- Post and rail deflection
- Rail deflection only
- Rail flattening
- Posts separated from rail
- Missing/broken posts
- Missing blockouts
- Twisted blockouts
- Non-manufactured holes
- Damage at a rail splice
- Vertical tear
- Horizontal tear

### End Treatments
(Based on Engineering Judgment)

- Damaged end post
- Anchor cable missing
- Anchor cable loose
- Anchor cable bracket
- Stub height
- Lag screws
- Bearing plate

**Note:** These evaluations were based on analysis of the “Old” system under 350 and not on MGS system.

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### Low Speed Impact Prior to Damage

**Video Clip**

**REF:** NCHRP 656 – Criteria for Restoration of Longitudinal Barriers

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### Session 6: Maintenance of Systems

#### Test Level 3 After Damage

**Video Clip**

REF: NCHRP 656 – Criteria for Restoration of Longitudinal Barriers

#### Barriers

<table>
<thead>
<tr>
<th>Damage Mode</th>
<th>Repair Threshold</th>
<th>Relative Priority</th>
<th>Measurement</th>
</tr>
</thead>
</table>
| Post and Rail Deflection | One or more of the following thresholds:  
  • More than 9 inches of lateral deflection anywhere over a 25 ft length of rail.  
  • Top of rail height 2 or more inches lower than original top of rail height. | High              | ![Maximum Lateral Rail Deflection](image) |
|                      | 6-9 inches lateral deflection anywhere over a 25 ft length of rail. | Medium            | ![Deflection](image) |
|                      | Less than 6 inches of lateral deflection over 25 ft length of rail. | Low               | ![Deflection](image) |
Damaged Materials: Barrier

Excessive deflection (>9”) – recommended HIGH priority

Bends within compression-based terminal may cause unwanted buckling – little energy absorption – HIGH priority
## Barriers

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| Posts Separated from Rail  | • 2 or more posts with blockout attached with post-rail separation less than 3 inches.  
  • 1 or more post with post-rail separation which exceeds 3 inches.  
  • 1 post with blockout attached with post-rail separation less than 3 inches. | Medium            | ![Detached Posts](image) |
| Missing/Broken Posts       | 1 or more posts  
  • Missing  
  • Cracked across the grain  
  • Broken  
  • Rotten  
  • With metal tears | High               | ![Missing Post](image) |

**Note:**
1. If the blockout is not firmly attached to the post, use the missing blockout guidelines.
2. Damage should also be evaluated against post/rail deflection guidelines.

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### Post separation - Recommended HIGH or MEDIUM priority

![Post separation](image)
### Barriers

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| Non-Manufactured holes (such as crash induced holes, lug-nut damage, or holes rusted-through the rail) | • More than 2 holes less than 1” in height in a 12.5’ length of rail.  
• Any holes greater than 1” height.  
• Any hole which intersects either the top or bottom edge of the rail. | High | ![Image](image1.png) |
| 1-2 holes less than 1” in height in a 12.5’ length of rail. | Medium | ![Image](image2.png) |

Hole > 1” – recommended HIGH priority (indentation probably not significant as long as no tear)
### Barriers

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<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage at a rail splice</td>
<td>More than 1 splice bolt:</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Missing</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Visibly missing any underlying rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>• Torn through rail</td>
<td></td>
<td></td>
</tr>
<tr>
<td>1 splice bolt:</td>
<td>Missing</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Damaged</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
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</tr>
<tr>
<td></td>
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No tension continuity – HIGH priority
# Barriers

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<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vertical Tear</td>
<td>Any length vertical (transverse) tear</td>
<td>High</td>
<td>![Vertical Tear Diagram]</td>
</tr>
<tr>
<td>Horizontal Tear</td>
<td>Horizontal (longitudinal) tears greater than 12 inches long or greater than 0.5 inches wide.</td>
<td>Medium</td>
<td>![Horizontal Tear Diagram]</td>
</tr>
</tbody>
</table>

Note: for horizontal tears less than 12 inches in length or less than 0.5 inches in height, use the non-manufactured holes guidelines.

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**Tension discontinuity (half strength and stress concentrator)** – HIGH priority

![Tension Discontinuity Diagram]
Is it OK to use Weathering Steel (sometimes called Cor-Ten, A-588, or Rusting Steel) in longitudinal barriers?
### Terminals

<table>
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<tr>
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<th>Relative Priority</th>
<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Damage End Post</td>
<td>Not functional (sheared, rotted, cracked across the grain)</td>
<td>High</td>
<td></td>
</tr>
<tr>
<td>Anchor Cable</td>
<td>Missing</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

#### End Terminals

- Check for nuisance hits on terminals to be sure post #1 is not damaged.
- Even with claims of “reusability” – use best judgment and closely examine all salvageable parts.
- Impact Heads may be re-usable based on state policy and manufacturers recommendations (generally say no).
No tension capability – the head may work on head-on hit - HIGH

No tension capability – the head probably will work on head-on hit - HIGH
### End Terminals

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<th>Measurement</th>
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<tbody>
<tr>
<td>Stub Height</td>
<td>Height which exceeds 4&quot;</td>
<td>Medium</td>
<td></td>
</tr>
<tr>
<td>Lag Screws</td>
<td>Missing or failed lag screws</td>
<td>High</td>
<td></td>
</tr>
</tbody>
</table>

**Caution:** Excessive height could have severe consequences

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**Foundation tubes too high – priority depends on how excessive the height is**
FATAL FLAW

Impact head not parallel to rail – don’t know how serious
Just POOR construction
## End Treatments

<table>
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<th>Measurement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bearing Plate</td>
<td>Loose or Misaligned</td>
<td>Medium</td>
<td><img src="image" alt="Correct Bearing Plate" /></td>
</tr>
<tr>
<td>Missing Bearing Plate</td>
<td>High</td>
<td></td>
<td><img src="image" alt="Missing Bearing Plate" /></td>
</tr>
</tbody>
</table>

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No tension capability – the rail MAY go into head (which should be parallel to top of rail), **may** work on head-on hit - **HIGH**
Damaged Terminals

Can’t explain but no tension - HIGH

Damaged Terminals

No tension, impact head damaged – doubtful work - HIGH
Other Problems?

Small tear and Incorrect lap – fairly LOW

Temporary Barrier Delineation

Delineate damaged areas while evaluating damage. Make repairs as soon as practical.
Temporary Barrier Delineation

Spear – worse than no tension
– must be treated (drop beam)
immediately- HIGH
Temporary Cable Repair

Removal of damaged posts will eliminate a spearing hazard for opposing traffic.

Crash Cushion Repair

This is a blunt end until repaired. Good delineation. Have manufacturer’s installation manual available.
How Serious is this???

Crash Cushion Repair

Ensure all mounting hardware is correct, in place & properly secured.
Place proper cartridges in the correct system & in the proper order

Typical QuadGuard Cartridges

Coating needs repair to protect from weathering degradation

ADIEM
Review Learning Outcomes

- Know how damaged barrier MAY BE assessed for maintenance response.
- Understand when a damaged barrier terminal MAY no longer function.
- Effectively delineate damaged hardware prior to repair.