FHWA Pavement Performance Data Process

HiDaC 2019
Saratoga Springs, NY
March 21, 2019
Introduction/Overview

- What we do with the TPM PM2 data
- HERS (Highway Economic Requirements System)
- C&P Report/Other
There are four pavement condition measures.

The four measures for assessing pavement condition are calculated for the Interstate System and for the non-Interstate NHS. The pavement condition measures are percentage of pavement in Good condition on both the Interstate and non-Interstate NHS; and percentage of pavements in Poor condition on the Interstate and non-Interstate NHS.

References: 23 CFR 490.307, 490.407
Data Needed for Calculating the National Pavement Measures

**Inventory Data:**
- Section Length (End_Point-Begin_Point)
- NHS
- Facility Type
- Through Lanes*
- Functional System
- Surface Type
- Structure Type
- Urban Code

*Directional Through Lanes for dual-carriage reporting for Interstates (optional)

References: 23 CFR 490.311, 309, 103, and 101

**Key Message:** The inventory data items required for calculating the national pavement measures. For the most part, these items should remain the same year after year. These items have been a part of HPMS for many years, however, now the data are an essential part of determining pavement performance.

**Background Information:** Additional information on these data items is provided below.

- NHS - HPMS Data Item 64: NHS extent is needed to determine which sections to include in the calculations, as the measures are calculated only for mainline NHS routes.
- Section length - HPMS Section Field Number 7: Value specified for each section to decimal value in thousandths of a mile. Section length and through lanes are used to calculate the conditions and performance of a given roadway section.
- Facility Type – HPMS Data Item 3 – Distinguishes Ramps and Cardinal Direction
- Through lanes - HPMS Data Item 7 – Performance is based on lane-miles
- Functional system - HPMS Data Item 1 – Interstate system or non-Interstate NHS?
- Surface type - HPMS Data Item 49 – Very Important, asphalt, jointed concrete, or CRCP
- Structure type - HPMS Data Item 4 – Also important, is this a bridge?
- Urban code – HPMS Data Item 2 – To allow verification of reported Interstate and NHS length and lane-length.

Pavement performance measures are aggregated based on lane miles.
Changes would occur when roads or removed are added to the NHS, lanes added, new construction, etc. There may be some initial corrections to the NHS mileage.

**Interactivity:** None

**Notes:**
Interstate Pavement Condition Measures

- “Percentage of pavements of the Interstate System in **Good** condition”
  
  \[
  \text{LM of IS Pavement in } \textbf{Good} \\
  \text{LM of IS — LM of Bridges — LM Unpaved Other Surface — LM MIU}
  \]

- “Percentage of pavements of the Interstate System in **Poor** condition”
  
  \[
  \text{LM of IS Pavement in } \textbf{Poor} \\
  \text{LM of IS — LM of Bridges — LM Unpaved Other Surface — LM MIU}
  \]

Note: MIU= Missing, Invalid, Unresolved

References: 23 CFR 490.313(f)
Non-Interstate NHS Pavement Condition Measures

- “Percentage of pavements of the Non-Interstate NHS in Good condition”
  
  \[
  \frac{\text{LM of NIN Pavement in Good}}{\text{LM of NIN} - \text{LM of Bridges} - \text{LM Unpaved Other Surface} - \text{LM MIU}}
  \]

- “Percentage of pavements of the Non-Interstate NHS in Poor condition”
  
  \[
  \frac{\text{LM of NIN Pavement in Poor}}{\text{LM of NIN} - \text{LM of Bridges} - \text{LM Unpaved Other Surface} - \text{LM MIU}}
  \]

Note: MIU= Missing, Invalid, Unresolved

References: 23 CFR 490.313(f)
Note that this example was provided in the preamble of the issued final rule (82 FR 5886) to illustrate the exclusion of bridges in measure calculations.
Note that this example was provided in the preamble of the issued final rule (82 FR 5886) to illustrate the exclusion of bridges in measure calculations.
Key Message: To determine whether a section is classified as good, fair or poor, FHWA will first evaluate each of the metrics collected for the section, then determine the overall condition for each section. For example: An asphalt section is rated good, fair or poor for IRI, then for Rutting, and then for Cracking. These are then combined into the Overall rating. The following slides detail how to classify each metric and determine the overall condition for the section.

Background Information: For all three pavement types—others are jointed concrete pavement and continuously reinforced concrete pavement—the metric data are to be reported to the nearest whole percent for a section as per the HPMS Field Manual even though the measures are reported out to the tenth of a percent.

Interactivity:
Tell: Each of the metrics for the section is evaluated based on the table on the following slide. Note that PSR is not on the slide; we’ll get to that in 4 slides.
Notes:
23 CFR 490.313, 311.
**Key Message:** There are the threshold ranges for each metric for determining good, fair and poor condition.

**Background Information:** Rutting is calculated only for asphalt pavement. Faulting is calculated only for jointed concrete pavement. Thresholds vary by pavement type and reflect the “end-of-life” values in the Mechanistic-Empirical Design Guide. It is important to note that these thresholds are based on the measurement methods outlined in the revised HPMS Field Manual. Also, note that the values for Rutting and Faulting are average for the section, not total rutting or maximum rutting.

**Interactivity:**

Ask: *What is the threshold for poor condition for IRI?*

Answer: 170

Ask: *If the cracking % for a section is 7%, is it in good, fair or poor condition for this measure?*

Answer: Fair.

**Notes:** This figure is adapted from the FHWA webinar introducing the TPM rules. The materials are detailed in 23 CFR 490.313.

* JCP = Jointed Concrete Pavement, CRCP = Continuously Reinforced Concrete Pavement; Pavement Type is determined from the surface layer (asphalt over concrete = asphalt pavement)
What about reporting PSR for highways with speed limit under 40 mph?

**Key Message:** For highways with posted speed limits under 40 miles per hour, it is permitted to report PSR in place of the measured conditions using the overall ratings shown in this slide.

**Background Information:** Note!!! This is not the way that PSR was reported to HPMS in the past because it is not just replacing IRI. For Pavement Performance purposes, the Good/Fair/Poor determination is made directly from the PSR data, not IRI or some other parameter derived from it. Also Note!!! It does not say 40 MPH or less, PSR can be used only on roads with speed limits of 35 mph or less. There is no restriction on the highway classification; for example, if the speed limit is less than 40 on an Interstate route such as at a border crossing or toll booth, you can use PSR.

**Interactivity:**
*Ask:* Can PSR be used to rate a highway with a 45 MPH Speed Limit?
*Answer:* No it is expected that measurements of IRI, cracking Rutting or faulting will be done on those routes.

*Ask:* Can PSR ever be used to rate an Interstate highway?
*Answer:* Usually not, but locations do exist, such as at border crossings or toll facilities, where the posted speed limits are less than 40 MPH. PSR may be used at those locations.

**Notes:** Requirements are detailed in 23 CFR 490.313.
Pavement Sections

- **Spatial Coincidence of Metric Data**
  - 23 CFR 490.309: States DOTs must report condition metrics (CRACKING_PERCENT, FAULTING, IRI, and RUTTING) for each pavement section. HPMS Field Manual: CRACKING_PERCENT (Data Item 52), FAULTING (Data Item 51), and RUTTING (Data Item 50) is to be reported for mile-point limits that are consistent with those reported for IRI (Data Item 47).
    - Asphalt: CRACKING_PERCENT, IRI, and RUTTING
    - Jointed Concrete: CRACKING_PERCENT, FAULTING, and IRI
    - CRCP: CRACKING_PERCENT and IRI
  - **Reference:** 23 CFR 490.311

- **Section Length**
  - 23 CFR 490.309(b) and 23 CFR 490.311(c): State DOTs to collect condition metrics (CRACKING_PERCENT, FAULTING, IRI, PSR, and RUTTING) continuously in a manner that will allow for reporting in nominally uniform pavement section lengths of 0.10 mile with 0.11-mile maximum length of pavement sections. Shorter pavement sections are permitted only at the beginning of a route, the end of a route, at bridges, or other locations where a section length of 0.1 mile is not achievable.

*Reference: HPMS Field Manual: data items 48, 50, 51, and 52*
Pavement Sections

- **Violate Spatial Coincidence (example)**
  2018|###|Route AAA|0.000|0.100|IRI|0.050|60|01/2018|
  2018|###|Route AAA|0.100|0.200|IRI|0.100|65|01/2016|

  2018|###|Route AAA|0.000|0.200|RUTTING|0.150|0.20|01/2018|

- **Violate Section Length (length)**
  2018|###|Route AAA|0.000|0.200|RUTTING|0.200|0.1|01/2018|
### Segment Classification/Rating

<table>
<thead>
<tr>
<th>ROADWAY SEGMENT/TYPE</th>
<th>FUNCTIONAL SYSTEM</th>
<th>PRINCIPAL ARTERIAL - OTHER</th>
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</thead>
<tbody>
<tr>
<td>URBAN CODE</td>
<td>99999 - Rural</td>
<td></td>
</tr>
<tr>
<td>FACILITY TYPE</td>
<td>TWO-WAY ROADWAY</td>
<td></td>
</tr>
<tr>
<td>THROUGH LANES*</td>
<td>6 LANES</td>
<td></td>
</tr>
<tr>
<td>NHS</td>
<td>NHS ROUTE</td>
<td></td>
</tr>
<tr>
<td>STRUCTURE TYPE</td>
<td>BITER</td>
<td></td>
</tr>
<tr>
<td>SURFACE TYPE</td>
<td>ASPHALT (AC)</td>
<td>JOINTED CONCRETE (JCP)</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>PM</th>
<th>60</th>
<th>65</th>
<th>70</th>
<th>75</th>
<th>80</th>
<th>85</th>
<th>90</th>
<th>95</th>
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<tbody>
<tr>
<td>IR</td>
<td>3.2</td>
<td>4.2</td>
<td>4.4</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

0 0.10 0.20 0.30 0.40 0.50 0.60 0.70 0.80 0.90 1.00 1.10 1.20
### Segment Classification/Rating

<table>
<thead>
<tr>
<th>ROADWAY SEGMENT “ABC”</th>
<th>FUNCTIONAL SYSTEM</th>
<th>URBAN CODE</th>
<th>FACILITY TYPE</th>
<th>THROUGH LANES</th>
<th>NHS</th>
<th>STRUCTURE TYPE</th>
<th>SURFACE TYPE</th>
<th>RUTTING</th>
<th>FAULTING</th>
<th>LAKING</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRINCIPAL ARTERIAL-OTHER</td>
<td>99999 - Rural</td>
<td>TWO-WAY ROADWAY</td>
<td>6 LANES</td>
<td>NHS ROUTE</td>
<td>BRIDGE</td>
<td>ASPHALT (AC)</td>
<td>JOINTED CONCRETE (JCP)</td>
<td>775</td>
<td>COMPOSITE (AC / JCP)</td>
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<tr>
<td>IRI</td>
<td>60</td>
<td>63</td>
<td>65</td>
<td>68</td>
<td>70</td>
<td>72</td>
<td>75</td>
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<td>775</td>
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<td>4.2</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
<td>4.3</td>
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<tr>
<td>RUTTING</td>
<td>0.10</td>
<td>0.20</td>
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<td>0.60</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
<td>0.80</td>
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<tr>
<td>FAULTING</td>
<td>0.08</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
<td>0.10</td>
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<tr>
<td>LAKING PERCENT</td>
<td>2</td>
<td>5</td>
<td>7</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>7</td>
<td>77</td>
<td>5</td>
<td>5</td>
</tr>
</tbody>
</table>

Rutting, faulting, and laking are important considerations in evaluating the condition of roadways. The table above provides a classification system based on these factors, with values indicating the severity of each issue. The classification includes considerations for the functional system, urban code, facility type, number of lanes, NHS route, structure type, surface type, rutting, faulting, and laking percentage. Each category is assigned a value, with higher values indicating a greater degree of severity.
## Segment Classification/Rating

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<tr>
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<td>TWO-WAY ROADWAY</td>
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<tr>
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<td>6 LANES</td>
</tr>
<tr>
<td>NHS</td>
<td>NHS ROUTE</td>
</tr>
<tr>
<td>STRUCTURE TYPE</td>
<td>BRIDGE</td>
</tr>
<tr>
<td>SURFACE TYPE</td>
<td>ASPHALT (AC)</td>
</tr>
<tr>
<td></td>
<td>JOINTED CONCRETE (ICP)</td>
</tr>
<tr>
<td></td>
<td>COMPOSITE (AC / ICP)</td>
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<tr>
<td>MW</td>
<td>0.00, 0.05, 0.10</td>
</tr>
<tr>
<td></td>
<td>0.10, 0.20, 0.40</td>
</tr>
<tr>
<td></td>
<td>0.65, 0.95, 1.70</td>
</tr>
<tr>
<td></td>
<td>3.00, 4.00, 6.00</td>
</tr>
<tr>
<td></td>
<td>MIU, MIU, FAIR, FAIR, BRIDGE</td>
</tr>
<tr>
<td></td>
<td>FAIR, FAIR, MIU, FAIR, GOOD</td>
</tr>
<tr>
<td></td>
<td>GOOD, GOOD</td>
</tr>
</tbody>
</table>

Federal Highway Administration (Office of Highway Policy Information)
HERS/Other uses

- HERS: Highway Economic Requirements System
  - Uses both the HPMS pavement distress and structural data items.
- HPMS feeds FHWA pavement deterioration and other models and reports on condition in biennial C&P Report to Congress. (see next slide)
- Agency dashboards, analysis/visualization tools, reports, etc. ITIP (Integrated Transportation Information Platform) and HIPAT (Highway Infrastructure Performance Analysis Tool)
# HERS Model HPMS Inputs

<table>
<thead>
<tr>
<th>HPMS Data Input Categories</th>
<th>Deficiency Criteria/ Improvement Triggers</th>
<th>Improvement Options</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pavement</td>
<td>Surface type</td>
<td>Reconstruction (w/ option for surface type upgrade)</td>
</tr>
<tr>
<td></td>
<td>Roughness</td>
<td>Resurfacing (w/ option for shoulder improvements)</td>
</tr>
<tr>
<td>Traffic/Capacity</td>
<td>Congestion level (V/ C)</td>
<td>Adding lanes</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Major widening</td>
</tr>
<tr>
<td>Road Geometry</td>
<td>Lane width</td>
<td>Reduce curves</td>
</tr>
<tr>
<td></td>
<td>Right shoulder width</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Shoulder type</td>
<td></td>
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<tr>
<td></td>
<td>Grades</td>
<td></td>
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<tr>
<td></td>
<td>Traffic control devices</td>
<td></td>
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<tr>
<td></td>
<td>Intersections</td>
<td></td>
</tr>
<tr>
<td>Other</td>
<td>Speed limit</td>
<td></td>
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<tr>
<td></td>
<td>Highway work history</td>
<td></td>
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<tr>
<td></td>
<td>Widening potential, etc.</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Miscellaneous</td>
<td></td>
</tr>
</tbody>
</table>

* Improvement option only in combination with pavement preservation (resurfacing or reconstruction).
Examples...

2015 C&P Report:

- Exhibit 7-4 (Impact of Future Investment on Pavement Indicators)
  - Exhibit 7-11 (same for NHS)
  - Exhibit 7-14 (same for Interstate)

- Exhibit 8-4 (Backlog: Highway System Rehabilitation – Federal-aid highways)

- Exhibit 8-5 (Annual Capital Investment Scenarios – Highway System Rehabilitation portion)
  - Exhibit 8-7 (same for Federal-aid highways)
  - Exhibit 8-9 (same by functional class)
  - Exhibit 8-10 (same for NHS)
  - Exhibit 8-11 (same for Interstate)
Examples...

- Exhibit 7-4 Projected 2032 Pavement Ride Quality Indicators on Federal-Aid Highways Compared with 2012 for Different Possible Funding Levels

![Graph showing Pavement Ride Quality Indicators](image)

- Roads with Good Ride Quality
- Roads with Acceptable Ride Quality

Average Annual Investment Modeled in HERS (Billions of Dollars) vs. Percent of VMT
Examples...

- Exhibit 8-5 Systemwide Highway Capital Investment Scenarios for 2013 Through 2032: Distribution by Capital Improvement Type Compared with Actual 2012 Spending

<table>
<thead>
<tr>
<th>Scenario</th>
<th>System Rehabilitation—Highway</th>
<th>System Rehabilitation—Bridge</th>
<th>System Expansion</th>
<th>System Enhancement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Actual 2012 ($105.2 Billion)</td>
<td>43.5%</td>
<td>15.9%</td>
<td>25.9%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Maintain Conditions and Performance ($69.9 Billion)</td>
<td>45.1%</td>
<td>13.2%</td>
<td>20.2%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Sustain 2012 Spending ($105.2 Billion)</td>
<td>44.0%</td>
<td>15.9%</td>
<td>25.9%</td>
<td>15.1%</td>
</tr>
<tr>
<td>Improve Conditions and Performance ($142.5 Billion)</td>
<td>42.6%</td>
<td>17.3%</td>
<td>25.1%</td>
<td>15.1%</td>
</tr>
</tbody>
</table>
Conclusion

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