Automated Pavement Data Collection – QC/QA Practices

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Presentation Topics

- Importance of Quality Data
- Overview of QC/QA Activities
- Field Activities
- Data Processing Activities
- Data Acceptance Activities
- QA Tools in Oklahoma
Importance of Quality Data

- Calculation of Condition Indexes
- Development of Deterioration Models
- Prediction of Future Conditions
- Development of Treatment Recommendations

Pavement Condition Data
Recognizing Variability

- Variability in pavement conditions
- Procedures used to collect pavement condition information
  - Subjectivity
  - Automated versus manual
  - Sampling rate
- Rater consistency
- Other factors
What Level of Variability is Acceptable?

- How will the data be used?
  - Network level versus project level
- What level of variability is reasonable?
Overview of QC/QA Activities

Field Activities
- Equipment Monitoring
- Systems Monitoring & Calibration
- Calibration Setup
- Verification

Data Processing Activities
- Distress Data Processing
- Sensor Data Processing
- QC Checks

Data Delivery Activities
- Timely Delivery of Data
- Data Acceptance or Rejection
- Payment

Problem Resolution
- QA Checks on Data
Field Activities – Before Surveys

- Calibration of vendor to agency definitions
  - Calibration sites
- Test field procedures
  - Safety
  - Proper equipment operation
- Vendor must pass to proceed
### Establish Acceptability Requirements

<table>
<thead>
<tr>
<th>DATA ELEMENT</th>
<th>REQUIRED MINIMUM ACCURACY</th>
<th>REQUIRED RESOLUTION (Measure to the Nearest)</th>
<th>REQUIRED MINIMUM REPEATABILITY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rut Depth</td>
<td>+/- 0.08 inches compared to manual survey</td>
<td>0.01 inch</td>
<td>+/- 0.08 inches run to run for three repeat runs</td>
</tr>
<tr>
<td>International Roughness Index</td>
<td>+/- 5% compared to Rod &amp; Level, Dipstick, or Class I profiler</td>
<td>1 in/mi</td>
<td>+/- 5% run to run for three repeat runs</td>
</tr>
<tr>
<td>Faulting</td>
<td>+/- 0.04 inches compared to manual survey</td>
<td>0.01 inch</td>
<td>+/- 0.04 inches run to run for three repeat runs</td>
</tr>
</tbody>
</table>

From Oklahoma DOT
Field Activities – During Surveys

- On-board verification and validation checks
  - Flag incorrect values
- Data continuity checks
  - Check for breaks in the data
  - Check for correct location references
- Periodic calibration checks
Data Processing Activities - Vendor

- Training on distress ID
- Distress identification
- Sensor processing
- QC checks
Data Processing Activities - Agency

- QA checks by agency
  - Sample size
- Resolution of differences with vendor
Agency QA Checks

- Consistency
- Completeness
- Uniqueness of key fields
- Data reasonableness
- Acceptable data ranges
Data Delivery Activities

- Vendor is responsible for timely delivery of data in the proper format.
- Agency is responsible for accepting or rejecting the data.
Oklahoma DOT Pavement Data QA Tool

Database Setup
- Establish Table Links

Prior to conducting QA checks, the database (DE) manager must format the condition DB on the server. Once complete, each user must first link to the database using the "Establish Table Links" button.

Database Link: \{C:\mrc\projects\2001\01-074-RM06 Development of QC Procedures\QA Tool Development\NEW Development Files 05-05-05\MainDatabaseSample.mdb

QA Checks
- Preliminary Checks
  - Conduct Preliminary Checks

- Sensor Data Checks
  - Conduct Sensor Data Checks

Distress Checks
- Division Selector
  - Select the division on which to run distress checks.
  - Division: 1

- Distress Check Type
  - AC or COMP Distress Data
  - JCP Distress Data
  - CRCP Distress Data
  - Special Checks

AC/Composite Pavement Distress Category
- ALL AC/COMP DISTRESS GROUPS
  - Transverse Cracking
  - Alligator Cracking
  - Miscellaneous Cracking
  - Raveling
  - Patching

Hide Ignored Values

View Summary Report

Set Valid Variable Data Ranges

Generate Category Report
**ODOT QA Tool: Establishing the Database Links**

**Establishing the Database Links**

Establishing links to the main database is critical to ensure that data is properly retrieved from, and stored in, the main database. To setup the tool on your computer, please follow the steps below to link all needed tables. After establishing the links, click the 'Return to Main Page' button to return to the main page and begin the QA checks.

**Step 1:** Click the 'Establish Table Links' button to bring up the 'Access' interface that allows you to link to the master database on the server.

**Step 2:** Use the interface to navigate to the master database location and select "Link" on the dialog box. This will populate a list of tables within the database to which you can link.

**Step 3:** Link to the following tables by in the main database:
- 'All Sections'
- 'QC Documentation Data'
- 'Structures'
- 'Track Count'
- 'Condition'
- 'Ignored Values'
- 'Corrected NLF_ID GPS'

Click the "Ok" box to establish the links between the QA tool and the main database.

**Step 4:** Select the specific table names from the provided lists of linked tables to ensure that the correct tables will be used in the analysis. Note: that during the linking process, 'Access' will add an integer to the end of a linked table name if your current database contains an existing table with the same name.

- Database name: `\Cmler\projects\2001\01-074-RM06 Development of QC Procedures\QA Tool Development\NEW Development Files 05-05-05\MainDatabaseSample.mdb`

  - 'All Sections' table: tblAll_Sections1
  - 'QC Documentation' table: tblAPTech_QC_Documentation_Data1
  - 'Structures' table: tblStructures1
  - 'Track Count' table: tblTrack_Count1
  - 'Condition' table: CONDITION Sample
  - 'Ignored Values' table: IgnoredValues
  - 'Corrected NLF_ID GPS' table: tblBegSectionGPS

**To access the Database Manager utilities, click on the button to the left.**

**Note:** a password is required to gain access to these utilities.
## Setting Data Ranges

### Oklahoma Department of Transportation

#### PMS Data Quality Assurance (QA) Investigator

### Valid Variable Value Ranges

<table>
<thead>
<tr>
<th>Data Element</th>
<th>Low Value</th>
<th>High Value</th>
<th>Data Element</th>
<th>Low Value</th>
<th>High Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>SURVEY DATE</td>
<td>3/1/2002</td>
<td>1/2/2005</td>
<td>FAULT_AVG</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>SENSORS</td>
<td>31</td>
<td>31</td>
<td>FAULT_MAX</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>IRI_RT</td>
<td>30</td>
<td>600</td>
<td>FAULT_DEV</td>
<td>0</td>
<td>0.4</td>
</tr>
<tr>
<td>IRI_LT</td>
<td>30</td>
<td>600</td>
<td>FAULT_CNT</td>
<td>0</td>
<td>31</td>
</tr>
<tr>
<td>IRI_AVG</td>
<td>30</td>
<td>600</td>
<td>TEXTURE</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>RUT_AVG</td>
<td>0</td>
<td>1.25</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUT_MAX</td>
<td>0</td>
<td>2</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUT_1</td>
<td>0</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>RUT_2</td>
<td>0</td>
<td>100</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Checks for Duplicate Data

The following table contains groups of duplicate latitude or longitude values. The FKEY value is included as a reference to make these duplicate values more visible.

<table>
<thead>
<tr>
<th>Fkey</th>
<th>CtlSect</th>
<th>Direction</th>
<th>Chainage</th>
<th>Latitude</th>
<th>Longitude</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 03-02</td>
<td>5</td>
<td></td>
<td>0.04</td>
<td>34.15775</td>
<td>1800</td>
</tr>
<tr>
<td>6 03-02</td>
<td>5</td>
<td></td>
<td>0.05</td>
<td>34.15788</td>
<td>1800</td>
</tr>
</tbody>
</table>
# Checks of Supplied Data

## Category Check - ODOT Supplied Fields

Preliminary Checks of ODOT Supplied Fields

Click on each of the buttons below to run preliminary checks on the different ODOT supplied fields. Note that these checks are specific to only one district.

**Current DISTRICT:** Current DISTRICT

<table>
<thead>
<tr>
<th>Check Type</th>
<th>Status</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Data Types Check</td>
<td>PASSED</td>
<td>Checks the data types of the fields in the condition table.</td>
</tr>
<tr>
<td>NLF_ID Check</td>
<td>ERRORS</td>
<td>Checks the 'NLF_ID' values in the current distress table against the acceptable list of 'NLF_ID' values contained in the 'tblAll_Sections' table.</td>
</tr>
<tr>
<td>CtlSect Check</td>
<td>Unchecked</td>
<td>Checks the 'CtlSect' values in the current distress table against the acceptable list of 'CtlSect' values contained in the 'tblAll_Sections' table.</td>
</tr>
<tr>
<td>Direction Check</td>
<td>Unchecked</td>
<td>Checks that the 'Direction' value is either a '5' or a '6'.</td>
</tr>
<tr>
<td>Chainage Check</td>
<td>Unchecked</td>
<td>Checks that the 'Chainage' value is greater than zero and less than the maximum 'LENGTH_3D_MI' value for the 'CtlSect'.</td>
</tr>
<tr>
<td>GRP Check</td>
<td>Unchecked</td>
<td>Checks that the 'GRP' value is equal to 'I', 'N', 'O', 'TI', or 'TN'.</td>
</tr>
</tbody>
</table>
Oklahoma Department of Transportation

PMS Data Quality Assurance Investigator

Detailed Report Generator for Data Categories

Use the controls below to 1) select the type of checks you wish to run, and 2) select the data items on which you wish to run. The combination of the two will determine the report that will be created.

Quality Check Types:
- Data format
- Data acceptability
- Data completeness
- Data duplication
- Data range
- Data relationship

Data Element Categories:
- General Elements
  - Pavement Type
  - Geometrics
  - Section/Sample ID
  - Number of Slabs Joints
  - Section Lengths
- Sensor Data
  - IRI
  - Rutting
  - Faulting
  - Macrotexture
- Distress Data Elements
  - Transverse Cracking (AC, COMP, CRCP)
  - Alligator Cracking (AC or COMP)
  - Miscellaneous Cracking (AC or COMP)
  - Patching
  - Raveling (AC or COMP)
  - Transverse Slab Cracking (JCP)
  - Longitudinal Slab Cracking (JCP)
  - Slabs w/ Multiple Cracks (JCP)
  - Shattered Slabs (JCP)
  - Corner Breaks (JCP)
  - Spalling (JCP)
  - D-Cracking (JCP)
  - Longitudinal Cracking (CRCP)
  - Punchouts (CRCP)
Sensor Data Range Checks

Sensor Data - Range Checks

Section ID Information
CtlSect: 03-02
Direction: 5
Chainage: 0.01

Date
Var: DATE
Value: 12/31/2003
Valid Range: 3/1/2002 to 1/2/2005
Status: Passed
Ignore?: 

Number of Sensors
Variable: SENSORS
Value: 31
Valid Range: 31 to 31
Status: Passed
Ignore?: 

IRI Data

Variable: IRI_RT
Value: 30 to 600
Valid Range: Blank
Status: Passed
Ignore?: 

Variable: IRI_LT
Value: 600
Valid Range: 30 to 600
Status: Passed
Ignore?: 

Variable: IRI_AVG
Value: 128
Valid Range: 30 to 600
Status: Passed
Ignore?: 

Faulting Data

Variable: FAULT_AVG
Value: 0
Valid Range: 0 to 1
Status: Passed
Ignore?: 

Variable: FAULT_MAX
Value: 0
Valid Range: 0 to 1
Status: Passed
Ignore?: 

Variable: FAULT_DEV
Value: 0
Valid Range: 0 to 0.4
Status: Passed
Ignore?: 

Variable: FAULT_CNT
Value: 0
Valid Range: 0 to 31
Status: Passed
Ignore?: 

Rutting Data

Variable: RUT_AVG
Value: 0.21
Valid Range: 0 to 1.25
Status: Passed
Ignore?: 

Variable: RUT_MAX
Value: 0.29
Valid Range: 0 to 2
Status: Passed
Ignore?: 

Variable: RUT_1
Value: 100
Valid Range: 0 to 100
Status: Passed
Ignore?: 

Variable: RUT_2
Value: 0
Valid Range: 0 to 100
Status: Passed
Ignore?: 

Macrotexture Data

Variable: TEXTURE
Value: 0.843
Valid Range: 0 to 2
Status: Passed
Ignore?: 

Record: 1 of 1
Distress Data Range Checks

### Category Check - AC and Composite Pavement Distress

#### Transverse Cracking

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRANSV_1</td>
<td>0 to 10</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSV_2</td>
<td>0 to 10</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSV_3</td>
<td>0 to 8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>TRANSV_4</td>
<td>0 to 5</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Alligator Cracking

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ALLIG_1</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALLIG_2</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>ALLIG_3</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total ALLIG</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### Miscellaneous Cracking

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>MISC_1</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MISC_2</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
<tr>
<td>MISC_3</td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Total MISC</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0 to 52.8</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

#### AC Patching

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACPATCH</td>
<td>6000</td>
<td>100 to 636</td>
<td>Out of Range</td>
<td></td>
</tr>
</tbody>
</table>

#### Raveling

<table>
<thead>
<tr>
<th>Variable</th>
<th>Value</th>
<th>Valid Range</th>
<th>Status</th>
<th>Ignore?</th>
</tr>
</thead>
<tbody>
<tr>
<td>RAVEL</td>
<td>0 to 0</td>
<td>Blank</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Note: The 'Total ALLIG' will be blank if one of the corresponding individual values [e.g., ALLIG_1] is blank. This is also the case for the 'Total MISC' value.

When 'TEXTURE' < 0.75, valid value for 'RAVEL' = 0
When 'TEXTURE' ≥ 0.75, valid range for 'RAVEL' = 0 to 53

TEXTURE 0.895 (for the current section)
**Sensor Summary Report**

**Oklahoma Department of Transportation**  
**PMS Data Quality Assurance Investigator**

**General Summary Output Report**  
This summary table identifies the number of records in the database that are identified as "potential errors" after comparing the field values to the chosen criteria. For more information on the specific records with problems, return to the main page and run detailed output reports on selected data elements or data element categories.

**Sensor Data Elements**

<table>
<thead>
<tr>
<th>Field Name</th>
<th>Data Format</th>
<th>Acceptability</th>
<th>Completeness</th>
<th>Duplication</th>
<th>Data Range</th>
<th>Relationships</th>
</tr>
</thead>
<tbody>
<tr>
<td>IRI_RT</td>
<td>Pass</td>
<td>Pass</td>
<td>1</td>
<td>Pass</td>
<td>20</td>
<td>n/a</td>
</tr>
<tr>
<td>IRI_LT</td>
<td>Pass</td>
<td>Pass</td>
<td>2</td>
<td>Pass</td>
<td>20</td>
<td>n/a</td>
</tr>
<tr>
<td>IRI_AVG</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>15</td>
<td>n/a</td>
</tr>
<tr>
<td>RUT_AVG</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>5</td>
<td>n/a</td>
</tr>
<tr>
<td>RUT_MAX</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>Pass</td>
<td>4</td>
<td>n/a</td>
</tr>
</tbody>
</table>
**Detailed Outputs**

**Oklahoma Department of Transportation**

**PMS Data Quality Assurance Investigator**

**Detailed Category Output Report**

<table>
<thead>
<tr>
<th>CtgSect</th>
<th>Chainage</th>
<th>Direction</th>
<th>Field Name</th>
<th>Problem ID</th>
<th>IRL_Rt</th>
<th>Valid Criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>13-02</td>
<td>3.65</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - HIGH</td>
<td>5668</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>4.68</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - HIGH</td>
<td>567</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.78</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.79</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.85</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.81</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.65</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.83</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>10.64</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>6.21</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
<tr>
<td>03-02</td>
<td>6.22</td>
<td>5</td>
<td>IRI_RT</td>
<td>Out of Range - LOW</td>
<td>-1</td>
<td>Range = 50 to 400</td>
</tr>
</tbody>
</table>
Automated Data Collection

QC/QA Recommendations

- Provide data quality requirements in the RFP
  - make vendor responsible for quality of data
- Verify that the vendor is following its QC plan
- Get distress data in batches
- Require an early submittal of the data
- Check any data delivered by vendor
- Avoid second party relationships to vendor