Detector Quality Monitoring (DQM)
User Guide

RAILINC

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Learning about DQM in EHMS

Overview

Railinc's Equipment Health Management System (EHMS) is a web-based application that communicates the condition of railroad equipment and alerts the responsible parties when repairs are needed. See the *EHMS User Guide* for more information about logging in and access to EHMS.

Within EHMS is DQM, the detector quality monitoring tool, which can be available to detector owners. Wayside detectors are complex instruments that monitor the health of freight cars. However, the accuracy of their measurements are affected by calibration, track geometry and condition, weather and the environment.

DQM analyzes detector data as it is received by Railinc and compiles the results into key performance indicators (KPI). The KPI and supporting data analysis are published daily in a series of Tableau reports, available through EHMS.

DQM provides detector quality monitor reporting for the following detector types:

- ABD – Acoustic Bearing Detector
- HBD – Hot Box Detector
- HWD – Hot Wheel Detector
- THD – Truck Hunting Detector
- WILD – Wheel Impact Loading Detector
- WPD – Wheel Profile Detector

For additional Tableau© resources, see Tableau's free online training.

DQM Prerequisites

Each EHMS user must register to use Railinc Single Sign-On. If you are not already registered, refer to the *Railinc Single Sign-On User Guide* for more information. Once you have completed SSO registration, request access to EHMS within SSO.

DQM operates as part of EHMS. Each user must have an SSO Id and password, be authorized to use EHMS with access to DQM with the role, EHMS Detector Quality Viewer, and be granted a license for access to Tableau reporting. Tableau licenses are available to each Class I owner on a limited basis.

DQM User Roles

To use DQM, you must be assigned to the **EHMS Detector Quality Viewer** role for your company by Railinc or your company administrator.

System Requirements

For information about the system requirements of Railinc web applications and for information about downloading compatible web browsers and file viewers, refer to the *Railinc UI Dictionary*.

Accessing the Railinc Customer Success Center

The Railinc Customer Success Center provides reliable and timely high-level support for Railinc customers. Representatives are available to answer calls and respond to emails from 7:00 a.m. to 7:00 p.m. Eastern time, Monday through Friday, and provide on-call support via pager for all other hours to ensure support 24 hours a day, 7 days a week. Contact us toll-free by phone at 877- RAILINC (1-877-724-5462) or send an email directly to csc@railinc.com.

DQM Reporting

Daily Emails – Quality Scorecard

In addition to the Tableau© reports in EHMS, DQM provides summary email reports, which are sent to detector owners each morning. The summary email shows the number of detectors that are performing below par (red), questionably (yellow), and at par (green).

Detector Quality Status

ABD	0	1	47
THD	0	3	110
WILD	14	6	174
WPD	1	13	25

Below the summary are tables indicating specific detectors with their summarized KPI scores. The summarized scores are normalized to 100. Scores between 86 and 100 are shown as green, between 71 and 85, yellow and 70 or below are shown in red.

It is recommended that detectors owners review their emails first. For any detectors shown as green it can be assumed they are operating optimally. Detectors shown in yellow may be starting to trend to a non-optimal performance range and should be tracked. Detectors in red are operating below par so it is advisable to investigate them further.

The summarized KPI scores in the daily email reports indicate problem areas for detectors in red. This is a good starting point for diagnosing detector issues. To further any investigation, the user is advised to log into EHMS to view details of the KPI scores and supporting data analysis.

## DQM Tableau© Reports

Use the following procedure to view DQM reports:

1. From the EHMS main menu, select **Detector** > **Detector Quality Monitoring**.

2. Choose the type of detector to view.

In general, DQM includes the following reports:

- **Detectors at a Glance** is the first report shown when the user selects a detector type. The report visually shows how all the owner's detectors are related to each other by KPI score. This type of graph is known as a tree map. Each detector is represented by a colored rectrange whose size indicates the detector's KPI score. The higher the KPI score, the larger the rectangle. The highest rated detectors are in the upper left corner, the lowest are in the lower right corner. After verifying that the detectors shown in red in the daily email are in the lower right corner of **Detectors at a Glance**, the user can continue to the **KPI Scorecard.**
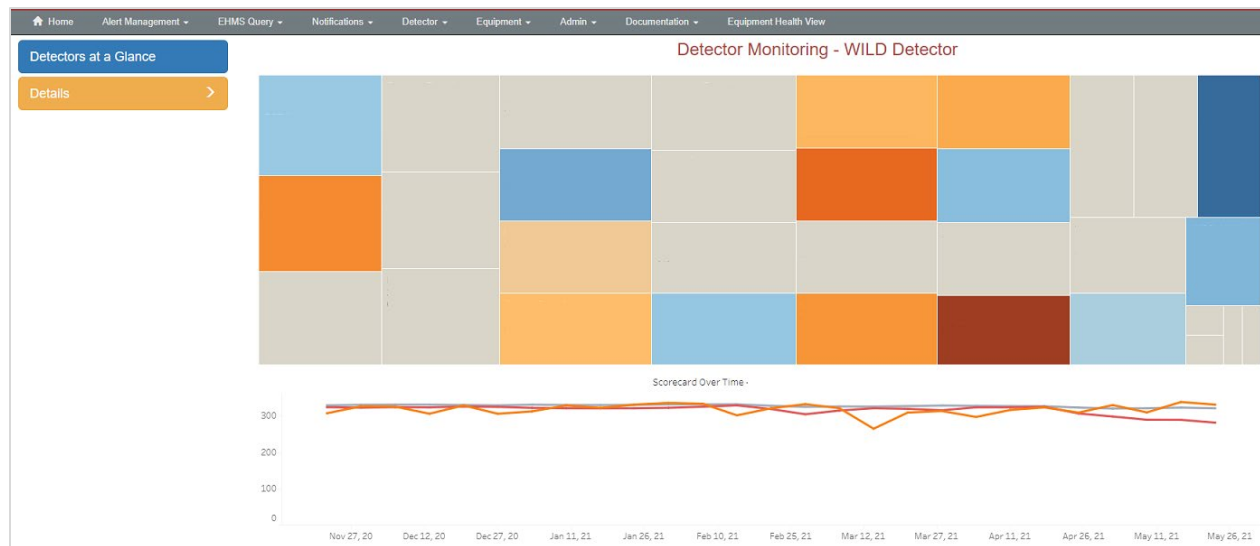
Clicking the **Details** button to the left of **Detectors at a Glance** shows the other available reports.

- **KPI Scorecard** is a more detailed KPI report than available in the email. Here is where the user can find the specific KPI that have negatively affected the KPI score. The chart is a matrix with all the detectors in rows, from lowest to highest ranked and individual KPI in columns. The detectors in red will be listed at the top. Each individual KPI score is represented by a colored square, red, yellow or green. Problematic individual KPI are shown in red squares.

The remaining **Details** reports are specific to each detector type. There are two types of reports, **KPI Analysis** and **Supporting Analysis**.

- **KPI Analysis Reports** show graphically how the data analysis resulted in an individual KPI score moving into yellow or red.

- **Supporting Analysis Reports** show non-KPI data analysis that can be viewed to further investigation. It should be noted that any investigation should be approached holitstically since detector performance are affected by many variables. KPI data analysis may show a downward trend in performance but may not point to a root cause. **Supporting Analysis Reports**, seen in conjunction with **KPI Analysis Reports**, can pinpoint specific problems that need to be correct.

Key Performance Indicators

KPI are specific to each detector type. Analyzing data within the view of a particular KPI means the data analysis must yield a single quantative value that can be compared against thresholds. The analysis aggregates detector data over the previous 7 days so data one day can affect the KPI for up to 7 days.

Typically, two thresholds categorize the resulting value as red, yellow or green. Note that a few KPI only support yellow and green so only a single threshold is required.

In addition to defining thresholds, each KPI is weighted as follows

- High importantance – 9
- Medium importance – 5
- Low importance – 1

Scoring takes into account weighting and thresholds. Green rankings are 7 points, yellow are 3 points and red are 0 points. Weighting is applied to these points such that a high importance KPI ranked as green receives 9x7 or 63 points.

Finally, there are KPI that depend on characteristics such as train direction. In these cases, KPI is separate, for example one for each train direction. However, many detectors see trains in a single direction only. To account for missing data, the scores are averaged so the missing data yields no penalty.

Because of the weighting of the KPI, if a detector's KPI score is in red, it is most likely due to failing scores of one or more high importance KPI.

The following sections provide KPI details, including a brief description, thresholds and importance.

Statistic Process Control

Statistical Process Control (SPC) is a statistical method for verifying measurements do not deviate from their expected normal range. For DQM, the measurements are a time series. They are plotted against the industry average and standard deviation. The majority of the measurements are expected to be within 1 sigma (average ± standard deviation).

Anomalies will occur and are considered inconsequential. SPC rules define when a train passing measurement is out of control. The rules are:

- Two measurements in a row are above 2 sigma.
- Three measurements in a row are above 1 sigma.
- Four out of five measurements are above 1 sigma.

Out of control measurements are considered a failure, but most KPIs require a percentage of train passes to be out of control before the score is affected.

Acoustic Bearing Detectors

The primary KPI reviews the perceived bearing defects known as fault descriptors. The analysis looks at the count of first time fault descriptors reported for each train pass. First time means the fault descriptor for a specific bearing was not reported by any ABD. The count is normalized as a percent of bearings read. The percentage is then compared to an industry datum for each type of fault descriptor.

KPI	Description	Thresholds and Scoring				Max Score
		Green		Yellow		
Active Microphones	The number of microphones for each rail and train pass is at or above the minimum requirement	All train passes meet requirement	7	No more than 2 train passes failed to meet requirement	3	14
Axle Side Mismatch	The right side train count matches the left side count	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15	35
Odd Axle Count	The number of axles is odd	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15	35
Avg. Cup Defects	Percent of first time defects > (TADS 11.3%, RailBAM 0.57%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. Cone Defects	Percent of first time defects > (TADS 11.3%, RailBAM 0.57%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. Roller Defects	Percent of first time defects > (TADS 0.71%, RailBAM 0.3%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. Multiple Defects	Percent of first time defects > (TADS 0.69%, RailBAM 0.13%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. LAS (Growler) Defects	Percent of first time defects > (TADS 0.83%, RailBAM 0.36%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. Unclear / Unknown Defects	Percent of first time defects > (TADS 0.63%, RailBAM 0.06%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Avg. All Defects	Percent of first time defects > (TADS 1.69%, RailBAM 0.57%) for each rail	All train passes meet requirement	63	No more than 2 train passes failed to meet requirement	27	126
Train Speed	Average train speed for previous 7 days	Average speed > 30 mph	7	Average speed > 20 mph	3	7
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27	63
						1036

Hot Bearing Detectors

The primary KPI is an SPC method analyzing the reported bearing temperatures for a train pass. Both the average and standard deviation of the train pass bearing temperatures are calculated. But it is the standard deviation that is analyzed against the industry averages and standard deviation.

Two other KPI review the differences between the right and left rail train averages and the maximum train bearing temperatures.

KPI	Description	Thresholds and Scoring					Max Score
		Green		Yellow			
Bearing Stdev	SPC: Train pass bearing temperature standard deviation. Left and right rails are analyzed.	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27		126
Bearing Maximum	Train pass bearing temperature < 260. Left and right rails are analyzed.	Less than 0.1% of trains passes with maximum bearing temps	63	Less than 1.0% of trains passes with maximum bearing temps	27		126
Bearing Differentail	Train pass bearing average temperature difference between right and left rails < 12	Less than 0.1% of trains passes with maximum wheel differences	63	Less than 1.0% of trains passes with maximum wheel differences	27		63
Missed First Axles	Verifies that the first axle of a train was measured by the detector	All train passes meet requirement	63	Less than 0.1% of train passes failed to meet requirement	27		63
Axle Side Mismatch	The right side train count matches the left side count	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15		35
Odd Axle Count	The number of axles is odd	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15		35
Train Speed	Average train speed for previous 7 days	Average speed > 30 mph	7	Average speed > 20 mph	3		7
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27		63
							518

Hot Wheel Detectors

The primary KPI is a statistical process control (SPC) method analyzing the reported wheel temperatures for a train pass. Both the average and standard deviation of the train pass wheel temperatures are calculated. But like Hot Bearing Detector, it is the standard deviation that is analyzed against the industry averages and standard deviation.

Another KPI reviews the maximum train bearing temperatures.

KPI	Description	Thresholds and Scoring				Max Score
		Green		**Yellow**		
Wheel Stdev – Non-Braking	SPC: Non-braking train pass wheel temperature standard deviation. Left and right rails are analyzed.	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27	126
Wheel Stdev – Braking	SPC: Braking train pass wheel temperature standard deviation. Left and right rails are analyzed.	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27	126
Wheel Maximum	Train pass wheel temperature < 900. Left and right rails are analyzed.	Less than 0.1% of trains passes with maximum wheel temps	63	Less than 1.0% of trains passes with maximum wheel temps	27	126
Missed First Axles	Verifies that the first axle of a train was measured by the detector	All train passes meet requirement	63	Less than 0.1% of train passes failed to meet requirement	27	63
Axle Side Mismatch	The right side train count matches the left side count	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15	35
Odd Axle Count	The number of axles is odd	All train passes meet requirement	35	No more than 2 train passes failed to meet requirement	15	35
Train Speed	Average train speed for previous 7 days	Average speed > 30 mph	7	Average speed > 20 mph	3	7
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27	63
						518

Truck Hunting Detectors

The primary KPI are SPC methods analyzing the truck hunting index (THI) for a train pass. The first KPI analyzes the train pass average THI relative to the industry average and standard deviation. The second KPI analyzes the percent of trucks with a THI>= 0.35 relative to the industry average and standard deviation.

KPI	Description	Scoring					Max Score
		Green		**Yellow**			
Train Avg THI	SPC: train average THI, each train direction and light and heavy trucks	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27		63
Truck Hunting Index >= 0.35	SPC: Percent of train average THI >= 0.35, each train direction and light and heavy trucks	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27		63
Elevated Truck Hunting Index	Percent of 40 ton trucks with THI >= 0.35 for trains going slower than 35 mph	All train passes meet requirement	63	Less than 0.5% of train passes failed to meet requirement	27		63
Train Speed	Average train speed for previous 7 days	Average speed > 30 mph	7	Average speed > 20 mph	3		7
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27		63
							259

Wheel Impact Load Detectors

The primary KPI analyze the crib sensor averages for the train pass. Two of the KPI, Crib Active Percent and Crib Range, are related to the WABL qualifications for WILD. Data that fails to meet WABL qualifications is quarantined and not used for creating industry alerts.

KPI	Description	Scoring				Max Score
		Green		Yellow		
Crib Active Percent	Percent of crib sensors active for each rail and train direction	At least 90% of sensors active	63	At least 70% of sensors active	27	63
Crib Inactive Count	Absolute count of inactive crib sensors, taking into account 10 or 16 sensor devices	Not more than 0.15 * total number of crib sensors can be inactive	63	Not more than 0.3 * total number of crib sensors can be inactive	27	63
Crib Range	Differential between maximim crib average and minimum crib average for each rail and train direction.	Not more than 8 KIPs	63	Not more than 15 KIPs	27	63
Crib Range / Average	Normalized version of crib range.	Not more than 1.09	7	Not more than 1.25	3	7
Crib Max Avg Distribution	Percent of crib sensors that have reported a maximum crib average per train pass for each rail and train direction.	At least 60%	35	At least 40%	15	35
Crib Max Avg Percent	Percent of train passes that each crib reported a maximum crib average for each rail and train direction.	Less than 20%	35	Less than 40%	15	35
Count 90 KIPS	Count of 90 KIPs wheels reported for each train pass.	Less than 20	7	All other train passes (no red)	3	7
Percent 90 KIPS	Percent of 90 KIPs wheels relative to total wheels reported for each train pass.	Less than 0.3%	7	All other train passes (no red)	3	7
90 KIPS Cross Correlation	Percent of 90 KIPs wheels reported that were also seen by other detectors and those detectors reported at least 80 KIPs.	At least 20%	35	At least 10%	15	35
Train Speed	Average train speed for previous 7 days	Average speed > 30 mph	7	Average speed > 20 mph	3	7
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27	63
						385

Wheel Profile Detectors

The primary KPI are SPC methods analyzing each of the six WPD measurements for a train pass. It is the train pass average measurements that are analyzed relative to the industry average and standard deviation. The six measurements include rim thickness, flange thickness, flange height, tread hollow, wheel width and back to back gauge.

KPI	Description	Scoring				Max Score
		Green		**Yellow**		
The following 7 KPI applies to Rim Thickness, Flange Thickness, Flange Height, Tread Hollow, Wheel Width and Back to Back measurements						
Rim Thickness Quality	SPC: Percent of rim thickness measurements for each rail.	Less than 0.1% of trains passes out of control	63	Less than 1.0% of trains passes out of control	27	126
Rim Thickness Variability	Percent of rim thickness measurements above 1, 2 and 3 sigma for each rail.	1 sigma: <=10% 2 sigma: <= 5% 3 sigma: <= 1%	63	1 sigma: >10% <=20% 2 sigma: > 5% <= 10% 3 sigma: > 1% <= 5%	27	126
Rim Thickness Repeatability	Percent of rim thickness measurements that are repeated for the same wheel and same detector.	At least 60% repeated	35	At least 40% repeasted	15	35
Rim Thickness Reproducibility	Percent of rim thickness measurements that are repeated for the same wheel and a different detector.	At least 60% repeated	35	At least 40% repeated	15	35
Rim Thickness Yield	Percent of rim thickness measurements relative to total wheels.	At least 90% repeated	63	At least 80% repeated	27	35
The above 7 maximum scores * 5						1785
AEI Matching	Percent of non-ZZZZ cars is above UCL for train pass	> 90 %	63	> 75%	27	63
						2373