A report by the

Public Utilities Commission of Ohio

Railroad Technology Report

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Ohio | Public Utilities Commission

Introduction

The Public Utilities Commission of Ohio (PUCO) has compiled this report as required in §749.20 of Amended Substitute House Bill 23 (the Transportation Budget Bill). This Railroad Technology Report will summarize types of wayside detection, current use and general best practices. It will cover more specifically hot box and hot bearing detectors, acoustic bearing detectors, and cameras installed on or alongside railroad tracks or wayside detection systems.

Types of Wayside Detection Systems

Wayside detection systems are designed to detect various defects and irregularities in rail equipment. They monitor items such as wheel temperature, wheel profile changes, wheel load impacts, wheel cracks or internal defects, load imbalances, suspension performance for car axles and wheel suspensions, wheel bearings, and dragging equipment. Overall, wayside detection systems can be grouped into six main categories. The table below identifies these categories and expands on the subtypes for each category.

Detector Types	Detector Sub-Types	Functional Use
Hot Bearing	Trackside Acoustic Detection System (TADS)	Detects the internal defects of wheel bearings using acoustic technology
	Railway Bearing Acoustic Monitor (RailBAM)	
	Acoustic Bearing Detector (ABD)	
	Hot Box Detector (HBD)	Detects wheel bearing defects using infrared thermal detection
	Hot Wheel Detector (HWD)	Detects hot wheels due to locked or sticking brake shoes using infrared thermal detection
Dragging Equipment	Dragging Equipment Detector (DED)	Detects components of rolling stock that are loose under moving trains
Suspension Axle Wheel Force	Truck Bogie Geometry Inspection (TBOGI)	Measures the performance of car axles and wheel suspension using laser-based technology combined with a high-speed camera
	Truck Hunting Detector (THD)	Evaluates a truck's deviation from the centerline of the rail

		using strain-gages or laser-based technologies
	Truck Performance Detector (TPD)	Evaluates the suspension performance of trucks along an S curve section of track using strain-gages and laser-based technologies
Load Detector	Weigh-In-Motion (WIM)	Measures the overload, side to side imbalance, or end-to-end imbalance condition of the cars
Wheel Defect	Wheel Impact Load Detector (WILD)	Detects the wheel defects (flat, shell, thermal cracks, etc.) by analyzing wheel impact loads
	Wheel Profile Measurement System (WPMS)	Measures wheel profile defects (flange height, flange thickness, rim thickness, etc.) using laser and high-speed cameras
	Wheel Temperature Detector (WTD)	Detects hot wheels (due to locked or sticking brake shoes) and cold wheels (inoperative brake system) using infrared scanning technology
	Automated Cracked Wheel Detector (ACWD)	Identifies wheel flange cracks and internal defects by submerging the wheel tread through water
Other	Other	Other systems that might not be outlined above.

Below is more detailed information on the types of railroad technology named in §749.20 of Amended Substitute House Bill 23 (the Transportation Budget Bill).

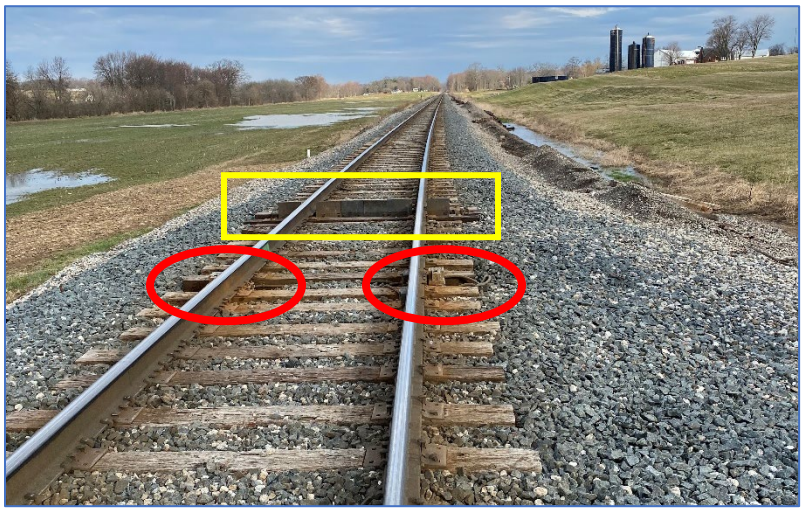
Hot Bearing Detectors

The term "Hot Bearing Detectors" can include hot box detectors (HBD's), trackside acoustic detection systems (TADS), railway bearing acoustic monitors (RailBAM), acoustic bearing detectors (ABD's) and hot wheel detectors (HWD's).

TADS, RailBAM, and ABD's utilize acoustic technology while the HBD's and HWD's utilize infrared technology. Their function is to detect defects in the internal wheel bearings and wheels prior to their failure due to excessive heat.

Hot Box Detectors (HBD's)

HBD's are common wayside detection systems used to monitor and identify hot journal bearings. It uses infrared thermal detection as the wheelsets pass over the detector.



LEFT: Hot Box detector (red oval) that is operating in Ohio. Dragging Equipment Detector (yellow rectangle)

BELOW: Close up of Hot Box Detector

HBD's can frequently be found installed in conjunction with dragging equipment detectors as shown above. PUCO has found that this is a common installation combination for wayside detection in Ohio.

According to an American Association of Railroads (AAR) report in 2015, North American railroads had installed more than 6,000 HBD detectors throughout their network to reduce the risk of bearing failures due to overheating.[1] As result, there is an HBD system every 25 miles, approximately, along Class I freight rail networks.[2] Train accident rates caused by axle and bearing-related factors have dropped 81 percent since 1980 and 59 percent since 1990 due to the use of HBD detectors.[3]

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[1] United States, Department of Transportation, Federal Railroad Administration, *An Implementation Guide of Wayside Detector Systems*, Office of Research, Development and Technology, May 2019 citing American Association of Railroads, "Nationwide Wayside Detector System," 2015.

[2] United States, Department of Transportation, Federal Railroad Administration, *An Implementation Guide of Wayside Detector Systems*, Office of Research, Development and Technology, May 2019 citing H. Braren, "Wayside Detection - Component Interactions and Composite Rules," *Rail Transportation Division Fall Conference (RTDF)*, Fort Worth, TX, 2009.

[3] United States, Department of Transportation, Federal Railroad Administration, *An Implementation Guide of Wayside Detector Systems*, Office of Research, Development and Technology, May 2019 citing T. Sultana and S. Belport, "Evaluation of Improved Hot Bearing Detectors," *22nd Annual AAR Research Review*, Pueblo, CO, 2017.

When hot journal bearings are detected, the train should be inspected and will be operated at a reduced speed, if necessary, until it reaches a set-out location where the car can be removed from the train.[4]

HBD's are best installed in systems where passing trains are traveling at least 10 mph, outside of areas where heavy braking occurs, away from track joints and switches, and at least 300 feet from grade crossings.[5] Additionally, they must be carefully installed so that they are scanning the bottom of the bearing housing.

Acoustic Bearing Detectors

There are two types of acoustic bearing detectors known to be installed nationwide and they are TADS and RailBAM. These systems use acoustic technology through a series of microphones to locate defects of wheel bearings.

LEFT: "RailBAM" Acoustic Bearing Detector.

The TADS system requires trains to operate at a minimum speed of 40 mph while the RailBAM system is limited to a minimum of 15 mph. These systems must be installed in

[4] United States, Department of Transportation, Federal Railroad Administration, *An Implementation Guide of Wayside Detector Systems*, Office of Research, Development and Technology, May 2019 citing H. Braren, "Wayside Detection - Component Interactions and Composite Rules," *Rail Transportation Division Fall Conference (RTDF)*, Fort Worth, TX, 2009.

[5] United States, Department of Transportation, Federal Railroad Administration, *An Implementation Guide of Wayside Detector Systems*, Office of Research, Development and Technology, May 2019 citing P. Bladon, et al., "The Challenges of Integrating Novel Wayside Rolling Stock Monitoring Technologies, A Case Study," *IHHA 2015 Conference*, Perth, Australia, 2015.

an area where there is no train braking so that the noise associated with that action will not cause interference or false positives.

PUCO has identified one RailBAM, acoustic bearing detector in Ohio.

Cameras Installed on or Alongside Railroad Tracks or Wayside Detection Systems

While cameras can be used along wayside detection systems, the PUCO is not aware of their use in Ohio. The wheel profile measurement system (WPMS) does specifically utilize high speed cameras to help detect wheel profile defects, but there are no installations of this detection system in Ohio.

Current Use of Wayside Detector Systems in Ohio

The PUCO sent data requests to all railroads asking for wayside detector system information to include location, type, subtype and manufacturer, and received responses from over 50 railroads. Only seven railroads reported having any wayside detection installed as of July 28, 2023. Based on this initial data, PUCO estimates that 33 railroads having over 10 miles of track will have to install wayside detection to comply with the new Ohio regulations. The table on pages 6 and 7 list the results of the PUCO data request received from railroads which own track in Ohio:

Railroad	Track Miles Operated	Railroad Class[6]	Hot Box, Hot Bearing Detectors	Acoustic Bearing Detectors	Cameras	Other Detectors	Total
Akron Barberton Cluster Railway Co	37	Class III					**0**
Ann Arbor Acquisition Corp	17.09	Class III					**0**
Ashland Railway, Inc.	57	Class III					**0**
Ashtabula, Carson & Jefferson Railroad Inc.	6	Class III					**0**
Belpre Industrial Railroad	44	Class III					**0**
Bessemer and Lake Erie Railroad Co	4.92	Class III					**0**
Camp Chase Rail LLC	15.1	Class III					**0**
Central Railroad of Indiana	20.2	Class III					**0**
Chicago Ft Wayne & Eastern	127	Class III	**6**			**6**	**12**
Cincinnati East Terminal Railway DBA Cincinnati Eastern Railroad	69.5	Class III					**0**
Cleveland & Cuyahoga Railway	12	Class III					**0**
Cleveland Harbor Belt Railroad LLC	1.25	Class III Industrial					**0**
Cleveland Works Railway Co	76	Class III					**0**
Columbus & Ohio River Railroad Co	117.58	Class III	**4**			**4**	**8**
CSX Transportation, Inc.	1404	Class I	**115**			**125**	**240**
Cuyahoga Valley Scenic Railroad (Scenic)	28	Class III Scenic Passenger					**0**
Grand River Railway	2.56	Class III					**0**
Grand Trunk Western Railroad Company	4.84	Class III Industrial					**0**
Hocking Valley Scenic Railroad (Scenic)	12	Class III Scenic Passenger					**0**
Independence Rail Works Ltd.	13.1	Class III					**0**
Indiana & Ohio Railway Co	496.66	Class III	**8**			**7**	**15**
Indiana Eastern Railroad	14	Class III					**0**
Indiana Northeastern Railroad Co	8.55	Class III					**0**
Kanawha River Railroad	109.5	Class III				**2**	**2**
Lake Shore Railway Association, Inc.	21	Class III					**0**

[6] Railroad class definitions and money limitations are set by the Surface Transportation Board using deflator factors to the values found in 49 CFR Section 1201.
Class I: A carrier earning revenue greater than $1.032 billion
Class II: A carrier earning revenue between $46.3 million and $1.032 billion
Class III: A carrier earning revenue less than $46.3 million
Class III- Scenic Passenger- railroads that are operating solely as a scenic passenger railroad.
Class III- Industrial- railroads that are operating for a specific industrial end user.

Lake Terminal Railroad Co	*	Class III					**0**
Lebanon Mason Monroe Railroad (Scenic)	*	Class III Scenic Passenger					**0**
Mahoning Valley Railway Company	53	Class III					**0**
Michigan Southern Railway Company DBA Napoleon, Defiance & Western Railway	43	Class III					**0**
Newburgh & South Shore Railroad Ltd.	5	Class III					**0**
Norfolk Southern Corp	3777.46	Class I	**156**	**1**		**160**	**316**
Northern Ohio & Western Railway	25	Class III					**0**
Ohio Central Railroad, Inc.	70.65	Class III					**0**
Ohio South Central Railroad	64.5	Class III					**0**
Ohio Southern Railroad, Inc.	21.4	Class III					**0**
Ohio Terminal Railroad Company	*	Class III					**0**
Pittsburgh & Conneaut Dock Company	*	Class III					**0**
R.J. Corman Railroad (Cleveland)	50.32	Class III					**0**
R.J. Corman Railroad (Western Ohio)	64.3	Class III					**0**
Republic Short Line	6	Class III					**0**
River Terminal Railway Company	*	Class III Industrial					**0**
The Great Lake Port Corporation	2.56	Class III Industrial					**0**
Warren & Trumbull Railroad Co.	4	Class III					**0**
Wheeling & Lake Erie Railway Company	549.43	Class II	**11**			**19**	**29**
Wyandot Dolomite, Inc. / The Shelly Company	3.95	Class III Industrial					**0**
Wye Transportation Corporations	0.49	Class III Industrial					**0**
Youngstown & Austintown Railroad, Inc.	5	Class III					**0**
Youngstown & Southeastern Railroad Co Inc	37.5	Class III					**0**
Youngstown Belt Railroad	14	Class III					**0**
Zanesville & Western Scenic Railroad	12	Class III-Scenic Passenger					**0**

* Non jurisdictional under ten track miles operated

General Best Practices:

The best practices for use of hot box and hot bearing detectors, acoustic bearing detectors, cameras and other wayside detectors vary greatly depending on the specific technology. The Federal Railroad Administration (FRA)'s publication "An Implementation Guide for Wayside Detector Systems" has identified requirements for use of these systems which reflect best practices. Those requirements include:

1) **Site Selection**

   Railroads must carefully evaluate the location of a wayside detector system and select a location based on the following criteria:

   a. Track Characteristics
      i. Some detectors require concrete crossties or specific types of rail and fastening systems.
      ii. Some detectors require installation with no curvature or steep grades.
      iii. Some detectors may not be installed within the boundaries of grade crossings or switches.
      iv. Vibration or noise levels can also affect wayside detector sensors.
   b. Traffic and Speed Coverage
      i. Detectors need to be located so that they have as much traffic flow as possible so they can maximize their benefit.
      ii. If a detector system is only operative in one direction, then two systems would have to installed on rail lines with traffic in both directions.
      iii. Some systems have minimum and maximum speed thresholds.
   c. Location Access and Maintenance requirements
      i. Some detection systems require immediate remedial action in the event of malfunctions. It is recommended they be located near a rail facility to allow crews to respond quickly.
      ii. The railroad network and layout are very important in determining system location as the train crew might need to inspect or set aside a car that has been flagged.
      iii. Consideration must be given to the location of power along the right of way and also location must be considered to prevent easy access by the public to prevent vandalism.
      iv. Some systems cannot be in areas where there is a high variability in operating speeds as this can result in unreliable detection.

v. Limitations on maintenance that might interrupt general freight operations should also be considered.

d. Other Issues
    i. Consideration should be given to existing facilities and signal interference that might be present at a proposed location.
    ii. Railroads must ensure that the spacing of detectors complies O.R.C. 4955.51 and any other applicable legal authority.

2) **Operating Parameters**

Operating parameters must be considered when choosing a wayside detection system. These include but are not limited to the nature of the railroad (e.g., freight, scenic, industrial), train frequency, carload volumes, and track specifications. Some wayside detectors may not function as designed when used under certain operating parameters.

3) **Data Communication, Storage and Sharing**

Since wayside detector systems can collect large amounts of data, consideration should be given to how the data will be collected, reviewed, and reported. Additionally, how will information be shared for rail lines which have multiple railroads operating on the same rail lines. Agreements between the track owners and the operators should be put in place to document how data will be shared.

4) **Installation and Testing a New System**

A wayside detection system should be fully tested according to manufacturer specifications before being put into service. Test results should be recorded and maintained. Any fault discovered should be diagnosed and resolved as recommended by the system vendor. A passing result must be obtained before operating the system. Some initial testing of systems is highly complex and can be disruptive to the rail operations. Care should be given to conduct such testing during a time when disrupted rail traffic would pose the least chance of blocking public crossings for long lengths of time.

5) **Performance Monitoring**

Data should be analyzed according to manufacturer's recommendations. Detector operating thresholds should meet American Association of Railroads requirements and system performance should be closely monitored to evaluate its potential impact on other parts of the railroad operation.

6) **Response Action Plan**
When a wayside detection system flags rail equipment as being outside of acceptable values, there should be an action plan in place to address the defect indication. Railroad operators and car owners should work together to determine action plans that to the greatest extent possible, minimize the chance of a catastrophic incident.

7) **Calibration and maintenance requirements**
When a wayside detection system is installed, it must be calibrated and then maintained periodically according to manufacturer recommendations. Calibration cycles can be dependent on conditions such as environmental changes, new car types, track conditions, and the age of the components of the system to name a few. These factors and similar considerations should inform the development of maintenance plans.

8) **Training**
Training is an integral part of the wayside detection system. All railroad employees who interact with and maintain the system equipment should be thoroughly trained on that system to ensure the full benefit is realized.

Summary

Prior to July 1, 2023, existing state and federal railroad regulations did not require wayside detection systems. Historically, these devices have been installed voluntarily by railroads to improve their operational oversight.

The PUCO would like to thank the members of the General Assembly for their continued guidance in directing the agency to take this first of its kind opportunity to wholistically review the types of rail technology currently in use throughout the state as well as review industry best practices. Through these efforts, state leaders, policy makers and industry alike will have a better understanding of necessary steps to ensure that Ohio's rail industry is operating safely.