

National Transportation Safety Board

Office of Railroad, Pipeline and Hazardous Materials

Washington, DC 20594



RRD23FR011 - NEW CASTLE, PA

COMMUNICATIONS, SIGNALS & TRAIN CONTROL

Group Factual Report

November 6, 2023

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A. ACCIDENT

Location: New Castle, Pennsylvania
Date: May 10, 2023
Time: 10:57:39 pm (eastern daylight time)
Train: Norfolk Southern Railway (NS), manifest train 14M

B. COMMUNICATIONS, SIGNALS & TRAIN CONTROL GROUP

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Federal Railroad Administration	T. Henry Signal & Train Control Safety Inspector Pittsburgh, PA
NS Railway	G. Bedell C&S Director of Operations Keystone Division Conway, PA
Brotherhood of Railway Signalmen	J. Pier Grand Lodge Representative Front Royal, VA
NS Railway	G.S. Craker Director - Mechanical Operations Dearborn Division: ATC - Mechanical Chicago, IL

C. ACCIDENT SYNOPSIS

For a synopsis of the accident, refer to the Accident Synopsis in the docket for this investigation.

D. DETAILS OF THE INVESTIGATION

1.0 Description of NS Radio Communication System

The NS used several assigned railroad radio channels for their communication system. Trains communicated with the NS dispatch center, wayside defect detectors and other NS trains.

NS traincrews departing Conway yard northbound on the Youngstown Line transmitted and received on AAR radio channel 43 (160.755 MHz). Traincrews used AAR radio channel 89 (161.445 MHz) between milepost YG 94.9 (control point Bright) and milepost YG 74.5 (near New Castle, PA). Between New Castle, PA and Youngstown, PA, train crews used AAR radio channel 65 (161.085 MHz).

NS traincrews operating on the Ft. Wayne line transmitted and received on AAR radio channel 89 (161.445 MHz) from milepost PC 0.0 (control point West Pitt) to milepost PC 45.3 (control point Enon). At milepost PC 45.3, traincrews used AAR radio channel 46 (160.800 MHz).

1.1 NS Radio Base Stations

The NS located radio base stations along the railroad right-of-way to extend radio channel coverage. Following the accident, a review of data logs from radio base stations in the vicinity of the derailment identified four radio base stations that recorded the critical alarm message transmitted by the Vale defect detector regarding northbound Train 14M (See Table 1).

The Conway base station was located near milepost PC 22.4 on the Ft. Wayne Line and about 10 miles south of the derailment site. The Highland Cut base station was located near milepost PC 38.4 on the Ft. Wayne Line and about 5 miles northwest of the derailment site. The Rochester base station was located near milepost RD 0.05 on the Cleveland Line and about 7 miles south of the derailment site. The Wood base station was located near milepost PC 34.8 on the Ft. Wayne Line and about 4 miles north of the derailment site.

Table 1. NS Base Radio Station Transmission Log

Broadcasted Radio Message	Radio Base Station			
	Conway	Highland Cut	Rochester	Wood
Critical alarm, Critical alarm, Critical alarm. Norfolk Southern milepost 9 1 point 9; hot box, axle 6 7 1; east rail.	10:18 pm	10:18 pm	10:18 pm Partial Message	10:17 pm
Rebroadcast. Norfolk Southern milepost 3 0 point 5, track 2, no defects.	10:18 pm 10:19 pm	-----	10:18 pm 10:19 pm	10:18 pm 10:18 pm
Norfolk Southern milepost 9 1 point 9. Critical alarm, hot box axle 6 7 1; east rail.	10:19 pm 10:20 pm	10:19 pm 10:20 pm	10:19 pm 10:20 pm	10:19 pm 10:19 pm

1.2 Locomotive NS 4342 Radio

Train 14M had locomotive NS 4342 at the head-end of the train. Locomotive NS 4342 was equipped with a JEM radio, model G17012-112 (serial number QCM0511044). The JEM radio was a two-piece radio. The radio deck was mounted in the electronics cabinet located in the nose of the locomotive. The control head was located on the locomotive engineer control stand. An auxiliary control head was located on the conductor desk console of the locomotive.

The JEM radio panel functions included:¹

Channel entry button- Depressing the CHAN button and entering six digits (first 3 digits for TX and 3 digits for RX) selected the radio channel.

Volume rocker switch - Volume level could be adjusted between 1 and 20 on the front panel speaker of the radio control head. Depressing the rocker switch increased or decreased the volume. As the volume was changed, a tone would sound to indicate the volume level.

Squelch button - Depressing the SQUELCH button adjusted the radio receive sensitivity between a setting of 0 to 9. A setting of 0 would allow any signal on that channel to be heard. A setting of 9 would require a stronger signal to be received for it to be broadcasted. Squelch could be adjusted to receive necessary communications without having to listen to unnecessary radio traffic.

1.2.1 Postaccident Locomotive Radio Examination

A postaccident examination of the locomotive radio deck and radio control heads did not identify any notable physical damage. Radio connectors were found secured except for a UHF-style termination connector that was found loose where the coaxial cable terminated into the radio feed end of the 160 VHF filter. The coaxial connector could be manipulated by hand with no tools.

The radio was found set to transmit and receive on AAR channel 65. Both the engineer and conductor radio transceiver control heads were examined, and the radio was determined to be operational and able to communicate with the NS dispatcher with clear and audible transmit and receive messages. Onboard integrity and signal reflectivity measurements determined the locomotive VHF radio antenna was functional. Testing also determined the reflective radio signal tolerance was outside the acceptable range (1.5 - 2.0 range with a 2.2 reading).

¹ Radio panel functions also included DMTF Tones, Single Tones, Home Numbers, Revert to Last TX-RX Channel Pair, Brightness Control, TX BSY Indication and PTT.

1.2.2 Locomotive Radio Bench Testing

The locomotive radio deck and radio control head were removed from locomotive NS 4342 and taken to the NS radio shop in Roanoke, Virginia for additional testing. The NS radio shop test report listed the following results:²

- No physical damage was noted.
- No water damage nor corrosion on any connectors.
- Radio powered up and passed self-test.
- Volume level was set at 10 out of 20.
- Testing verified the receiver could not be completely muted by lowering the volume control to 1 of 20.
- Testing could not verify the Squelch level setting since the squelch reverted to a setting of 2 of 10.
- Radio deck was left powered up throughout a weekend and no intermittent faults were identified.
- Testing determined the radio deck and radio control head operated within manufacturer and FCC specifications.

2.0 Description of the NS, Vale Defect Detector Location

NS wayside defect detectors were located along the Youngstown Line. In the vicinity of the accident, an automatic equipment identifier reader (AEI), and a combination hot wheel bearing defect detector (HBD) and dragging equipment detector (DED) was installed at Vale, milepost YG 91.9.

Another combination HBD/DED in the vicinity of the accident was located at milepost YG 74.5 near control point Castle. NS Train 14M derailed prior to reaching the defect detector location at milepost YG 74.5.

Wheel bearing related alarms could be in the form of a warm bearing talker alert or a critical bearing talker alert. All alarms were received by radio directly to the traincrew operating over the HBD.

When a train crew received a warm bearing talker alarm, it indicated the HBD had detected wheel bearings which were between the temperatures of 170°F to 200°. After a train crew received the alarm, they were required to reduce train speed until the rear of the train cleared the HBD location, then stop and inspect the alarmed axle location in accordance with NS Operating Rules.

When a train crew received a critical bearing talker alarm it indicated the HBD had detected wheel bearings which were above a temperature of 200°F. After the traincrew received the alarm, they were required to bring the train to a controlled

² The complete NS Communications Repair Facility Radio Shop report can be found in the docket for this investigation.

stop immediately and inspect the alarmed axle location in accordance with the NS Operating Rules.³

2.1 NS, Vale Defect Detector Components

The major components of a standard combination HBD/DED configuration were composed of five main sub-groups:

- Wayside Defect Detector Controller
- Wheel Bearing Scanners
- Dragging Equipment Detector
- Wheel Detectors
- Transceiver

2.1.1 Wayside Defect Detector Controller

The Vale wayside defect detector model was a Micro Talker Controller manufactured by Progress Rail Services. The controller was a microprocessor-based controller used in conjunction with field apparatus to detect defective equipment. This was a single main track application, which had both dragging equipment detection and hot wheel bearing detection features and utilized track-mounted equipment to detect defects.

2.1.2 Wheel Bearing Scanner

Detection of wheel bearing temperatures was achieved using rail mounted thermal scanners. The scanners were mounted, optically focused, and thermally calibrated to search for thermal signatures of passing wheels bearings. The information was then converted to electrical signals for the controller unit to determine if any wheel bearing temperatures exceeded the configured alarm settings.

2.1.3 Dragging Equipment Detector

Detection of dragging equipment under a moving train that could damage the track structure, was achieved by using paddle draggers mounted between and outside the rails. The paddles rotated or deflected when struck by dragging equipment. Deflected paddles would open an internal electrical contact that would provide an indication to the controller.

³ Exception: The ATC analyst may relieve a crew from inspecting their train for defect alarms when information is available confirming it is safe to proceed. Trains relieved of inspection may proceed, in accordance with existing authority, at a speed not to exceed 30 MPH to the next detector or to the location where the car is to be set out, if applicable.

2.1.4 Wheel Detectors

Establishment of train direction and train axle counting was performed by transducers (rail mounted magnetic sensors). Accurate and precise train direction and axle information was coupled with the scanner and dragger data and analyzed by the controller. Data that met an alarm threshold included axle data to the controller. Transducers detected when a wheel flange passed over the transducers magnetic field, which then generated an electrical signal that corresponded to each axle that passed over the wayside detector.

2.1.5 Transceiver

Abnormal data from the defect detector would be classified into two categories, alarms, and alerts. HBD readings that exceed certain absolute bearing, "audible alarm" temperature thresholds automatically transmitted an audible announcement to the train crew, informing the crew of the presence of a temperature reading that required inspection. The Vale detector location utilized a Kenwood VHF transceiver radio (model NX700). The postaccident examination of the Vale detector transceiver radio determined the radio was set to transmit on AAR channel 89 using a roof mounted antenna.

HBD readings that did not meet the alarm thresholds but met the criteria for various NS informational alerts only transmitted the data to the ATC analyst for their evaluation and action. The HBD only transmitted train data to the ATC desk after the rear of a train cleared the HBD field equipment. Train log data was sent to the ATC desk via network IP connections for off-site data analyses.

2.2 Vale Defect Detector Data Logs & Parameter Settings

A postaccident review of the parameter settings for the Vale defect detector indicated the following configuration settings:

Track Configuration

- Milepost Number : 91.90
- Site Name : Vale, PA
- Track Direction (A-B) : North
- Alarm Side For Ch 1 : East
- Track Name : Single Track - Do not broadcast name
- Train Scan Direction : A<->B

Calibration

- Calibrate Scanner 1 : Calibration Complete
- Last Changed On : 13:58:15 (05-08-2023)
- Calibrate Scanner 2 : Calibration Complete

- Last Changed On : 14:03:12 (05-08-2023)

Alarm Limits

- Hot Bearing High Limit : 200 F
- Warm Bearing High Limit : 170 F
- Differential Alarms : Disabled
- Differential Bearing High Limit : 115 F
- Differential Bearing Low Limit : 0 F
- Low Battery Threshold : 9.000 Volts

Train Reporting Options

- Report All Trains : Yes
- Report Test Trains : Yes

Equipment Setup

- Dragger : Enabled
- Radio : Enabled
- System Function : Function As a HBD Only
- Bearing Scanner : Enabled
- AC Monitor : Enabled

A review of the postaccident data log from the Vale defect detector indicated a Critical Hot Wheel Bearing alarm message was detected. The detector data logs indicated Train 14M was recorded arriving at Vale at 10:13 and the rear of the train departing at 10:19:54.⁴ The critical alarm indicated axle 671 on the east rail was recorded measuring a temperature of 253°F.

The Vale detector, train summary log displayed key information regarding Train 14M:

- Direction: 14M was recorded as a southbound train move.
- Alarms: One alarm was logged
- Radio: The radio broadcast feature was set to ON
- HBD Scanners: Wheel scanners were set to ON
- Announce ABS: the detector setting was set to ON, to immediately broadcast alarm/notification by radio
- Announce DED: dragging equipment was set to ON, to immediately broadcast an alarm/notification by radio
- Integ Ch1: 253°F was measured by the scanner during its post-train internal self check procedure, which verifies the integrity of the scanner's ability to scan for wheel bearing heat

⁴ Clock times are local microprocessor and have not been synced

- Integ Ch2: 253°F was measured by the scanner during its post-train internal self check procedure, to verify the integrity to be able to scan for wheel bearing heat
- 1 - ABS Hot Journal. Axle 671 East Ch1 = 253 Ch2 = 10 The alarm log entry at the bottom of the train log summary, logged axle 671 triggering an alarm.

2.3 Defect Detector Standards & Maintenance Requirements

Railroad signal and train control systems fell under the requirements listed in Title 49, Code of Federal Regulations Part 236 - Rules, Standards, and Instructions Governing the Installation, Inspection, Maintenance, and Repair of Signal and Train Control Systems, Devices and Appliances. Wayside defect detectors did not fall under the Federal regulations governing railroad signal and train control systems.

There were no Federal regulations that required the use of HBDs for freight trains, or any regulation related to the inspection, calibration, and maintenance of wayside defect detectors. Industry standards and manufacturer recommended guidance were available for railroads to incorporate as part of their inspection and maintenance practices.

NS followed HBD temperature thresholds as specified in the Association of American Railroads field manual, rule 36, except for differential alerts. AAR recommended an alert for a temperature differential of 95°F, while NS used a 115°F temperature differential threshold.

The NS maintenance requirements for HBD systems were outlined in the NS procedure MS-404.⁵ The MS-404 procedures listed the requirements for detectors to be maintained, calibrated, aligned and to ensure all sensors were working as intended. The procedures included the requirements for 30, 90, 180 and 365-day testing intervals.

The configuration settings log for the Vale defect detector indicated the most recent scanner calibration was completed on May 8, 2023, at 14:03:12.

3.0 Description of NS Automatic Train Control Wayside Help Desk

The Norfolk Southern Advance Train Control (ATC) Wayside Help Desk was monitored twenty-four hours a day, seven days a week by an analyst working a twelve-hour shift.

The Vale wayside defect detector was the first detector encountered by Train 14M after departing northbound out of Conway Yard. According to the ATC desk guidance, if a train crew did not receive a radio response from a wayside defect

⁵ Hot Bearing/Wheel Temperature Detector Systems (Issued 5/25/19 93. Revised 3/11/2023).

detector and it is the first detector out of a yard, the traincrew was required to have a visual inspection (either a roll by or stop and inspect).

If a train crew did not receive a response from a wayside defect detector and it was not the first detector out of a yard, the train crew could proceed until passing the next wayside defect detector at a speed not to exceed 30 mph.

After a train traversed past an NS defect detector, the train data from the detector was transmitted to the Advance Train Control desk (ATC) desk at the Dispatch Center in Atlanta, Georgia where it was processed to provide trending information to the ATC desk personnel. The ATC algorithm used the train axle count and the train direction data from the defect detector to identify the train and compare the data to previous defect detector data. This data comparison provided trending capabilities to the ATC desk. The ATC algorithm could then generate critical and non-critical alerts to identify possible developing issues, as a train moved along its route, to the ATC desk personnel.

Following notification of the train derailment, investigators contacted the NS ATC help desk and requested all wheel bearing trending data for Train 14M. The ATC desk informed investigators the critical alarm had not been received at the ATC desk.

The investigation determined that previous track work earlier in the week required wayside detector appurtenances at the Vale detector to be removed. Upon reinstallation, the A & B transducers were transposed. With the A & B transducers reversed, train direction was reported to ATC desk as opposite of true train direction. The ATC algorithm could not associate the detector data with the accident train due to the reported incorrect train direction. ATC desk did not receive a notification regarding the hot bearing alarm on the accident train.

During postaccident testing, the Vale wayside detector transducer positions were transposed, and the wayside HBD was tested.

4.0 Description of NS Youngstown Line, S&TC System

The NS Youngstown Line extended from milepost YG 0.0 (Ashtabula Drawbridge) to milepost YG 97.2 (control point Rochester) in a north-south timetable direction. The NS Youngstown Line consisted of mostly single and two main track territory with passing sidings. Milepost numbering increased in the timetable south direction. Maximum authorized timetable speed between control point Castle (milepost 75.8) and control point Rochester (milepost 97.2) was 40 mph.

In the vicinity of the derailment area, NS authorized train movements with a Traffic Control System (TCS). Train movements were coordinated by the Youngstown Line train dispatcher located at the NS dispatch center in Atlanta, Georgia. Train movements on the Youngstown Line were governed by operating rules, special instruction, timetable instructions, and the signal indications of the TCS and supplemented with an overlaid positive train control system (Interoperable - Electronic Train Management System).

The signal system used coded track circuits for train occupancy detection. Wayside signals were colorlight signals with upper and lower signal heads capable of displaying green, yellow, and red aspects for train movements in either direction.

4.1 TCS and I-ETMS Data Logs

Wayside TCS data logs for control point Castle (milepost YG 75.8), intermediate signal 781N and control point Wampum (milepost YG 81.2) were downloaded for the investigation. Data logs were examined to develop a timeline of signal events for the movement of train 14M (see Table 1).

Table 2: Wayside Signal Data Log

Time ⁶	Location	Event
1:51:04:	CP Castle	2N Signal indicates Clear
1:51:03	CP Wampum	2N Signal indicates Clear
1:51:10	Signal 781N	Intermediate signal indicates Clear
2:38:08	CP Wampum	2N Signal indicates at Stop
2:45:25	Signal 781N	Intermediate signal indicates at Stop
2:51:42	CP Castle	2N Signal indicates at Stop

Wayside PTC data logs for control point Castle (milepost YG 75.8), intermediate signal 781N and control point Wampum (milepost YG 81.2) were downloaded for the investigation. Data logs were examined to develop a timeline of signal events for the movement of train 14M (see Table 2).

Table 3: Wayside PTC, Device State Data Log

Time ⁷	Location	Event
1:51:10:	Signal 781	Signal indicates Clear
2:45:25	Signal 781	Intermediate signal indicates Restricting
2:51:04	CP Wampum	2NA Signal indicates Medium Clear
2:51:05	CP Castle	2NA Signal indicates Clear
2:51:43	CP Castle	2NA Signal indicates at Stop
3:38:09	CP Wampum	2NA Signal indicates at Stop

4.2 Postaccident Signal System Examination

The postaccident investigation found all wayside signal equipment and appurtenances between control point Wampum and control point Castle, locked and

⁶ Clock times are local microprocessor GMT times.

⁷ Clock times are local microprocessor GMT times, CP Wampum and CP Castle had Daylight Savings Enabled/Active, Signal 781 had Daylight Savings Disabled/Inactive.

secured with no indications of tampering or vandalism. Following the accident, NS railroad signal personnel sealed all signal bungalows as requested by FRA and NTSB.

Postaccident review of signal indications were in accordance with the physical location of the accident wreckage. No terrain or physical structures were identified during the examination of the alignment of the signal heads that could obstruct the signal aspect preview at the control points.

5.0 Postaccident Interviews

Postaccident interviews of two signal maintainers were conducted on May 15, 2023, in New Castle, Pennsylvania. Both signal maintainers were trained and qualified by the NS. One signal maintainer was working on his territory between control point Bright and control point Lowell. The second signal maintainer was helping the other maintainer and was from an adjacent territory that extended from control point Valley to signal 65.

The signal maintainer was notified on the Friday before the accident, that a track surfacing gang would be working at spots along the Youngstown Line beginning on Monday morning (May 8th). The surfacing gang would be surfacing the track over the location where the Vale detector was located. On Monday morning, the signal maintainer started his day by talking to the surfacing gang and verified they would be working at the Vale detector location. He then went over to the Vale detector location and disassembled the defect detector. He stated he took everything off the rail except the dragging equipment portion, only removing the panels and leaving the cam shaft. The signal maintainer also removed the scanner heads, the transducers, disconnected the cables and moved them out of the track and away so they wouldn't be damaged by the surfacing gang. The signal maintainer described how the east rail scanner was not disconnected, but the west rail scanner was disconnected to remove it from the track. The transducers were not disconnected, the signal maintainer stated he just moved them under the rail.

The second signal maintainer arrived after the track surfacing gang had already departed and began to assist the first signal maintainer to reassemble the defect detector location.

After the detector was reassembled, the signal maintainer stated they performed the checks from the MS-404 procedures. An alignment, calibrations on both scanners, ran test trains, kicked the dragger and made sure it was functioning properly and applied heat to both scanners to make sure the detectors were functioning properly.

The signal maintainers completed their work around 2:30 that afternoon. ⁸

End of Communication, Signals & Train Control Factual Report

⁸ Complete transcripts of both interviews can be found in the docket for this investigation.