DCA-11-FR-002
BNSF Coal Train – Work Train Collision
Red Oak, IA
April 17, 2011

ATTACHMENT 28

Red Oak Signal Factual

NATIONAL TRANSPORTATION SAFETY BOARD

OFFICE OF RAILROAD, PIPELINE &

HAZARDOUS MATERIAL INVESTIGATIONS

WASHINGTON, D. C. 20594

DCA-11-FR-002

REAR END COLLISION/DERAILMENT OF BNSF RAILWAY CBTMCNM0-26A STRIKING BNSF RAILWAY WORK TRAIN UBRGCRI5-15G

On BNSF RAILWAY Creston Subdivision, Line Segment No.1, Nebraska Division

Red Oak, Iowa

April 17, 2011

SIGNAL GROUP FACTUAL REPORT

Prepared by: Timothy J. DePaepe, Signal Group Chairman

Accident:

NTSB Accident Number:	DCA-11-FR-002
Date of Accident:	April 17, 2011
Time of Accident:	6:55 a.m. (CDT)[1]
Type of Trains:	CBTMCNM0-26A, BNSF RAILWAY 9159 East (Coal Train) UBRGCRI5-15G, BNSF RAILWAY 9470 East (Maintenance of Way Equipment Train)
Railroad Owner:	BNSF Railway
Train Operator:	BNSF Railway
Fatalities:	2
Location of Accident:	Red Oak, Iowa

Signal Group:

Mr. Timothy J. DePaepe – Signal Group Chairman – NTSB
Mr. Russel E. Sweet – Manager Signals – BNSF Railway
Mr. James G. Levere – Assistant Vice President Signals – BNSF Railway
Mr. Gabe Neal – Signal & Train Control Specialist – FRA Region 6

Synopsis:

On April 17, 2011 at about 6:55 a.m. central daylight time, eastbound BNSF Railway coal train C-BTMCNM0 26A, BNSF Railway 9159 East, collided with the rear end of standing BNSF Railway maintenance of way equipment train U-BRGCRI5 15G, BNSF Railway 9470 East, near Red Oak, Iowa. The accident occurred at milepost 448.3 on the number two track on the Creston subdivision of the BNSF Railway Nebraska Division[2]. The coal train was travelling about 23 mph when it struck the standing train.

The coal train consisted of 130 loaded coal cars, weighed 18,529 tons, and was 7,122 feet long with two locomotives on the head end and one locomotive on the rear end. The maintenance of way equipment train was consisted of 21 loaded cars, 13 empty cars, weighed 2,635 tons and was 3,170 feet long with one locomotive on the head end.

As a result of the collision, the two head end coal train locomotives derailed along with the head two coal cars. The locomotive crew cab of the striking train was damaged and involved in a subsequent diesel fuel fire. Seven additional coal cars were also damaged but not derailed. Nine cars of the standing maintenance of way train were derailed. Both the engineer and conductor on the coal train were fatally injured. The two crew members on the locomotive of the maintenance of way equipment train were not injured. Damages are estimated at $8 million. The weather at the time of the accident was reported as five miles visibility with mist at Red Oak airport which is about two and one half miles east of the accident location.

[1] All times in this report are Central Daylight Time unless noted otherwise.
[2] See Figure 1.

Locomotive event recorder data indicate that just before the collision, train speed increased and the throttle was decreased as the coal train crested a hill just west of the accident site. The coal train emergency brakes were not applied before impact.

Parties to this investigation are the Federal Railroad Administration (FRA), the BNSF Railway, Electro Motive Diesel (the manufacturer of the leading locomotive on the coal train), the Brotherhood of Locomotive Engineers and Trainmen, the United Transportation Union, and the Iowa Department of Transportation.

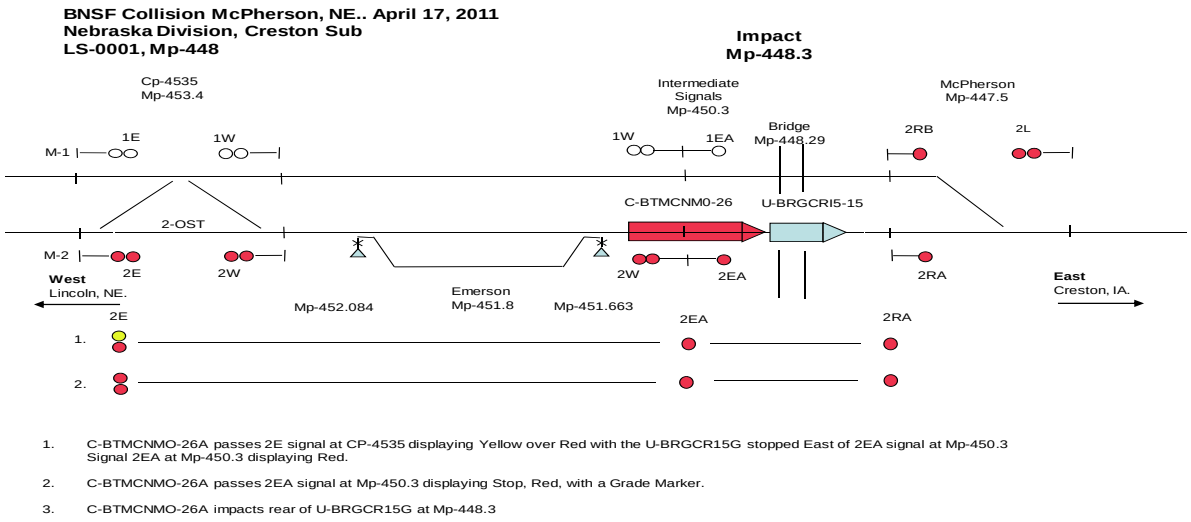


Figure 1. Signal System Layout with Derailment Location. ***(Not to Scale)***

Description of Railroad Signal System:

The BNSF Railway Creston Subdivision runs in a timetable east/west direction. The Creston Subdivision which is located on the Nebraska, Division begins at Creston, Iowa, MP 392.9 and continues westward to Pacific Junction, Iowa MP 475.1 and MP 0.0 then continues westward to Lincoln, Nebraska, MP 59.6. The BNSF Railway track structure in the vicinity of the accident consists of two main track territory eastward from Control Point (CP) 4535 at MP 453.4 then converging to a single main track at CP McPherson at MP 447.49. The maximum timetable speed on the Creston Subdivision is 60 mph for freight trains and 79 mph for passenger trains and 55 mph for eastward trains over 100 Tons per Operative Brake (TOB).

Train movements throughout the Creston Subdivision are governed by a mixture of: operating rules, Train Orders, Special Instructions, General Orders, Track Warrant Control (TWC),

timetable instructions, Automatic Block Signal (ABS) indication and the signal indications of a Traffic Control System (TCS) utilizing a combination of three or four aspect signaling.

In the area of the accident the method of operation over the two main tracks is by signal indications of a TCS, supplemented by timetable and special instructions. CP McPherson is equipped with Union Switch & Signal (US&S) plug-in relays, US&S H-type searchlight signal mechanisms, US&S M23 power operated switch machines, a General Electric Transportation Services (GETS) Harmon Logic Controller for TCS controls and GETS Electro-code 4H coded track system. The intermediate signals are equipped with GETS Electro-code IV processors. The TCS protocol Advanced Railroad Electronic System (ARES) are via lease line and microware base station to control point communications path from the Network Operations Center (NOC) located in Fort Worth, Texas, to field control point locations.

In 1998, the CP McPherson signal system was updated from relay logic and pole line circuits to coded track circuits by Harmon Electro Code IV and Harmon Logic Controller (HLC). The signal equipment at CP McPherson consists of US&S M-23 dual-control power-operated switch machines, and US&S H2 searchlight type signals. The BNSF Railway utilizes a three aspect signal system at this location.

After a derailment which occurred in 1997, CP 4535 was renewed by BNSF Railway. The signal equipment at CP 4535 consists of US&S M-23 dual control power operated switch machines, and three position color-light type signals. The BNSF Railway utilizes a three aspect signal system; however, a fourth aspect (Flashing-Yellow) is used as a light out down-grade function in the event the light bulb fails to light in the green aspect.

Back-to-back intermediate signals are located on both main tracks at MP 450.3 between the two control points. The signal equipment at these intermediate signal consists of three position color-light type signals. The eastbound intermediate signals have a grade marker attached to the signal mast below the color-light signal heads. These grade markers are displayed at this location because the track grade is too severe for trains to stop and proceed. With this marker displayed a train is allowed to proceed at restricted speed by the intermediate signal without stopping when a red aspect is displayed. The indication for this signal is "Proceed at Restricted Speed.[3]" (See Figure 2.)

[3] See Appendix A, BNSF Railway Signal Aspects and Indications, 9.1.13.

Figure 2. Intermediate Signal 24504 with Grade Marker.

Railroad Signal Event Recorders:

Information from the signal data event recorders was collected from four locations relevant to this accident: CP McPherson; Intermediate Signal 24504 at MP 450.3; CP 4535; and the train dispatching office located at the NOC in Fort Worth, Texas. Members of the Signal Group performed an examination of the signal data with no exceptions noted.

The incident occurred on Main Track No. 2 as the Coal Train was being operated in an eastward direction from controlled signal 2E at CP 4535 to the eastbound controlled signal 2RA at CP McPherson. The progression of signal aspects, intended to be displayed to the Coal Train, leading up to the accident was; a Yellow-Over-Red aspect at the 2E signal at CP 4535, leading up to a Red aspect at Intermediate Signal 24504. This intended progression of signal aspects was confirmed by the signal data captured by the aforementioned event recorders.

Post Accident Inspection/Testing Of Signal System:

Representatives from the BNSF Railway, NTSB and the FRA participated in the field inspection and testing of the signal system. The post accident inspection found all signal units, and signal cases with no indications of tampering or vandalism that would interfere with the designed and intended operation of the signal system. Relay positions were found to be in accordance with the physical location of the accident trains and the signal aspects expected to be displayed. No exceptions were identified with either the design or operation of the signal system. No signal

damage was incurred as a result of the collision. However, after the damaged continuous welded rails were replaced with track panels, signal personnel bonded all electrical connections.

Post accident testing began with the verification of track circuits utilizing a 0.06 ohm shunt. The Signal Group then requested and lined the route on Main One from 2L signal at CP McPherson to 1W signal CP 4535, which was lined at the time of the incident for a westbound train. The Signal Group then requested and lined the route on Main Two from 2E signal at CP 4535 to 2RA signal at CP McPherson. The signal team used a shunt wire to simulate the location of the standing MOW train stopped at the 2RA signal at CP McPherson on Main Track No. 2. The Signal Group also simulated the movements of the Coal Train by utilizing rolling shunts[4]. During the simulation, signal personnel were stationed at the following locations: CP McPherson, Intermediate Signal 24504 and CP 4535. Signal aspects were observed. The signal system functioned as designed and intended.

Applicable tests were performed at CP McPherson, Intermediate Signal 24504 and CP 4535. These tests included: route locking; time locking; signal indication locking; loss of shunt timers; track circuit verification; insulation resistance of signal cables; ground tests; operating characteristics of relays, and signal lamp voltages were recorded. The red signal aspect lamp voltage at Intermediate Signal 24504 was 9.8 volts. At CP 4535, the yellow signal aspect lamp voltage was 9.0 volts and the red signal lamp voltage was 9.0 volts. The lamps were industry standard 10-volt, 25-watt lamps. At these voltages the lamp illumination and signal preview is within the BNSF Railway standards.

The Signal group also participated in the sight distance test. The Signal Group had the NOC request and line the route on Main One from 2L signal at CP McPherson to 1W signal CP 4535. This was an opposing route on Main Track No. 1 which was lined at the time of the incident for a westbound train. The Signal Group then requested and lined the route on Main Two from 2E signal at CP 4535 to 2RA signal at CP McPherson.

Representatives were stationed at various signal locations and observed signal aspect displays while the test train traversed the accident area eastbound on Main Track No. 2 simulating the Coal Train movement on the day of the accident.

The BNSF Railway maintenance test and inspection records were collected and reviewed. The signal test records reviewed consisted of the results from testing performed in accordance with: Title 49 Code of Federal Regulations (CFR) Part 236 Rules, Standards, Instructions Governing the Installation, Inspection, Maintenance and Repair of Signal and Train Control Devices and Appliances, §236.102, Searchlight Signal Mechanisms; §236.103, Switch Circuit Controller; §236.104, Switch Fouling Circuit; §236.106, Relays; §236.107, Ground Tests; §236.108, Insulation Resistance, Wires in Trunking and Cables; §236.109, Time Releases, Timing Relays and Timing Devices; and §236.382, Switch Obstruction Tests.

[4] Signal personnel place shunts on the track thereby deenergizing track circuits simulating the movement of a train from one location to another.

The Grade Crossing Signal System test records which were also reviewed consisted of the results from testing performed in accordance with: Title 49 CFR Part 234 Grade Crossing Signal Systems, §234.249, Ground Tests; §234.251, Standby Power; §234.257, Warning System Operation; §234.263, Relays; and §234.267, Insulation Resistance, Wires in Trunking and Cables.

The Signal Group reviewed the last six months of records of tests associated with the following locations: CP McPherson, MP 447.49; Intermediate 450, MP 450.3; East Emerson House Track (HT) Switch Circuit Controller (SWCC) on Main Track No. 2, MP 451.70; Harrison Street, MP 451.95; Cabinet West HT Emerson, MP 452.10; County Road, MP 452.88; and Double Crossover (DBLXO) 453.5, MP 453.50. The maintenance records indicate all applicable signal tests and inspections were conducted in accordance with BNSF Railway and Federal requirements.

Signal trouble reports for the previous three months for the area from MP 460 to MP 445 were reviewed and no exceptions were noted.

Signal Damages

Signal damages were nominal. The BNSF Railway engineering personnel estimated the total signal damage at under $1,000.00. After the damaged track was repaired signal personnel replaced all bonded electrical connections.

Positive Train Control (PTC) – BNSF Railway Electronic Train Management System (ETMS)

PTC refers to technology that is capable of preventing train-to-train collisions, overspeed derailments, movement through a switch improperly lined, and casualties or injuries to roadway workers (e.g., maintenance-of-way workers, bridge workers, signal maintainers) operating within their limits of authority as a result of unauthorized incursion by a train. The PTC systems vary widely in complexity and sophistication based on the level of automation and functionality they implement, the system architecture utilized, the wayside system upon which they are based (i.e., non-signaled, block signal, cab signal, etc.), and the degree of train control they are capable of assuming.

Prior to October 2008, PTC systems were being voluntarily installed by various railroads. However, the Rail Safety Improvement Act of 2008 (RSIA)[5] has mandated the widespread installation of PTC systems by December 31, 2015.

Currently, all of the affected railroads are aggressively pursuing the development and implementation of PTC in accordance with their PTC Implementation Plans required by the RSIA and approved by the FRA, and are adapting their individual PTC systems to maximize interoperability. The BNSF Railway, Union Pacific Railroad (UP), Norfolk Southern Railway (NS), and CSX Transportation (CSXT) are leading the interoperability effort for technologies based on

[5] Signed by the President on October 16, 2008, as Public Law 110-432.

the Electronic Train Management System (ETMS) for rail traffic outside of the Northeast Corridor (NEC). The National Passenger Rail Corporation (Amtrak) is undertaking similar action for rail traffic in the NEC using the Advanced Civil Speed Enforcement System (ACSES).

The FRA is supporting all rail carriers that have statutory PTC reporting and installation requirements, as well as rail carriers that are continuing to voluntarily implement PTC, through a combination of regulatory reform, project safety oversight, technology development, and financial assistance.

The BNSF Railway has received FRA approval for full revenue deployment of their ETMS Version 1 on 35 separate BNSF Railway subdivisions and has received Type Approval and System Certification for the use of ETMS Version 6. The BNSF Railway and FRA are working together on testing a further enhanced version of ETMS on additional subdivisions taking an increment development step towards interoperability. ETMS is an overlay-type communication-based system that enforces movement authority and speed restrictions for ETMS-equipped trains. This system works in conjunction with the existing methods of operation, including using input from the currently installed signal system components, to protect against the consequences of human error.

At the time of this accident ETMS was not installed at the accident site. However due to the fact that this line has both passenger and freight trains, BNSF Railway is currently working on implementing ETMS on the Creston Subdivision by the mandated dates contained in the RSIA.

When installed on the Creston Subdivision, ETMS will establish signals as targets. As currently designed, the rear of a standing train is not a target. In this accident scenario, ETMS would have established Intermediate Signal 24504 with a G plate as a target and upon the signal displaying a Restricted Proceed, the system would enforce the upper limit of restricted speed, meaning 20 MPH. The ETMS onboard display unit would show a “restricted speed fence” (i.e., diagonal lines on the display) with the reminder of restricted speed being required. Upon a train reaching 3 MPH over the 20 MPH restriction, a visual alarm would be displayed and an audible alarm sounded. Upon a train reaching 3 additional MPH over the 20 MPH restriction, a full service penalty brake application would be applied bringing the train to a stop. ETMS may or may not have prevented this accident but it would have conveyed a visual and audible warning before the train reached the collision point.

In this accident scenario, after entering the block for Intermediate Signal 24504 with a G plate, ETMS would have established the next target as signal 2RA at CP McPherson.

APPENDIX A

SIGNAL ASPECTS AND INDICATIONS—April 7, 2010

BNSF Railway - SIGNAL ASPECTS AND INDICATIONS

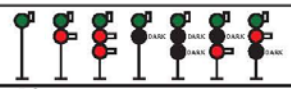
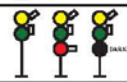
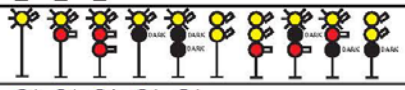
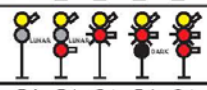
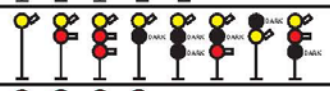
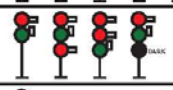
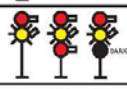
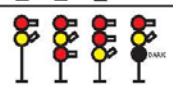
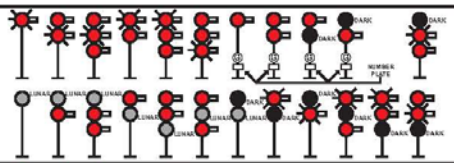
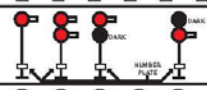
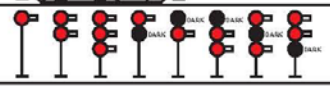
All signals are subject to modification indicated under individual subdivision special instructions.

DISTANT SIGNALS

Aspects shown in Rules 9.1.3 through 9.1.8 may be displayed with a "D" sign on the signal mast to identify the signal as a distant signal. When a "D" sign is displayed, if train is delayed per Rule 9.9 or Rule 9.9.1 between a distant signal and the next signal, proceed prepared to stop short of the next signal. Absolute signals at automatic switches, outside of block system limits, convey main track distant signal information for the other end of the siding.

BLOCK AND INTERLOCKING SIGNALS

Aspects shown in Rules 9.1.3 through 9.1.8 and 9.1.13 may be displayed on signals with or without a number plate on signal mast.

Rule	Aspects of Color Light and Semaphore Signals	Cab Signal Aspects	Name	Indication
9.1.3			CLEAR	Proceed.
9.1.4			APPROACH LIMITED	Proceed prepared to pass next signal not exceeding 60 MPH and be prepared to enter diverging route at prescribed speed.
9.1.5			ADVANCE APPROACH	Proceed prepared to pass next signal not exceeding 50 MPH and be prepared to enter diverging route at prescribed speed.
9.1.6			APPROACH MEDIUM	Proceed prepared to pass next signal not exceeding 40 MPH and be prepared to enter diverging route at prescribed speed.
9.1.7			APPROACH RESTRICTING	Proceed prepared to pass next signal at restricted speed.
9.1.8			APPROACH	Proceed prepared to stop at next signal, trains exceeding 30 MPH immediately reduce to that speed. (Note: *Speed is 40 MPH for Amtrak and Commuter trains.)*
9.1.9			DIVERGING CLEAR	Proceed on diverging route not exceeding prescribed speed through turnout.
9.1.10			DIVERGING APPROACH DIVERGING	Proceed on diverging route not exceeding prescribed speed through turnout prepared to advance on diverging route at the next signal not exceeding prescribed speed through turnout.
9.1.11			DIVERGING APPROACH MEDIUM	Proceed on diverging route not exceeding prescribed speed through turnout prepared to pass next signal not exceeding 35 MPH.
9.1.12			DIVERGING APPROACH	Proceed on diverging route not exceeding prescribed speed through turnout; approach next signal preparing to stop, if exceeding 30 MPH immediately reduce to that speed. (Note: *Speed is 40 MPH for Amtrak and Commuter trains.)*
9.1.13			RESTRICTING	Proceed at restricted speed.
9.1.14			STOP AND PROCEED	Stop, then proceed at restricted speed.
9.1.15			STOP	Stop.