Federal Railroad Administration
Office of Safety
Headquarters Assigned
Accident Investigation Report
HQ-2008-82

Burlington Northern Santa Fe (BNSF)
Baring, MO
October 24, 2008

Note that 49 U.S.C. §20903 provides that no part of an accident or incident report made by the Secretary of Transportation/Federal Railroad Administration under 49 U.S.C. §20902 may be used in a civil action for damages resulting from a matter mentioned in the report.

DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION

FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File # HQ-2008-82

1.Name of Railroad Operating Train #1: BNSF Rwy Co. [BNSF]	1a. Alphabetic Code: BNSF	1b. Railroad Accident/Incident No.: CH1008109
2.Name of Railroad Operating Train #2: N/A	2a. Alphabetic Code: N/A	2b. Railroad Accident/Incident No.: N/A
3.Name of Railroad Operating Train #3: N/A	3a. Alphabetic Code: N/A	3b. Railroad Accident/Incident No.: N/A
4.Name of Railroad Responsible for Track Maintenance: BNSF Rwy Co. [BNSF]	4a. Alphabetic Code: BNSF	4b. Railroad Accident/Incident No.: CH1008109
5. U.S. DOT_AAR Grade Crossing Identification Number:	6. Date of Accident/Incident: Month 10 | Day 24 | Year 2008	7. Time of Accident/Incident: 06:40: ☑ AM ☐ PM

8. Type of Accident/Indicent *(single entry in code box)*: 1. Derailment; 2. Head on collision; 3. Rear end collision; 4. Side collision; 5. Raking collision; 6. Broken Train collision; 7. Hwy-rail crossing; 8. RR grade crossing; 9. Obstruction; 10. Explosion-detonation; 11. Fire/violent rupture; 12. Other impacts; 13. Other *(describe in narrative)* — Code: 01

9. Cars Carrying HAZMAT	10. HAZMAT Cars Damaged/Derailed	11. Cars Releasing HAZMAT	12. People Evacuated	13. Division
0	N/A	N/A	0	Chicago

14. Nearest City/Town	15. Milepost *(to nearest tenth)*	16. State Abbr	16. State Code	17. County
Baring	294.4	N/A	MO	KNOX

18. Temperature (F) *(specify if minus)*	19. Visibility *(single entry)* 1. Dawn 2. Day 3.Dusk 4.Dark — Code	20. Weather (single entry) 1. Clear 2. Cloudy 3. Rain 4. Fog 5.Sleet 6.Snow — Code	21. Type of Track 1. Main 2. Yard 3. Siding 4. Industry — Code
44 F	1	2	1

22. Track Name/Number	23. FRA Track Class (1-9, X) — Code	24. Annual Track Density *(gross tons in millions)*	25. Time Table Direction 1. North 2. South 3. East 4. West — Code
Main Track No 1	5	60.26	4

OPERATING TRAIN #1

26. Type of Equipment Consist *(single entry)* 1. Freight train 2. Passenger train 3. Commuter train 4. Work train 5. Single car 6. Cut of cars 7. Yard/switching 8. Light loco(s). 9. Maint./inspect.car A. Spec. MoW Equip. — Code	27. Was Equipment Attended? 1. Yes 2. No — Code	28. Train Number/Symbol
1	1	GLOWELP922

29. Speed *(recorded speed, if available)* R - Recorded E - Estimated — Code	30. Trailing Tons *(gross tonnage, excluding power units)*	31. Method(s) of Operation *(enter code(s) that apply)*	31a. Remotely Controlled Locomotive?
49 MPH — R	14388	a. ATCS; b. Auto train control; c. Auto train stop; d. Cab; e. Traffic; f. Interlocking; g. Automatic block; h. Current of traffic; i. Time table/train orders; j.Track warrant control; k. Direct traffic control; l.Yard limits; m.Special instructions; n. Other than main track; o. Positive train control; p. Other *(Specify in narrative)* — Code(s): e | N/A | N/A | N/A | N/A	0 = Not a remotely controlled; 1 = Remote control portable; 2 = Remote control tower; 3 = Remote control transmitter - more than one remote control transmitter — 0

32. Principal Car/Unit	a. Initial and Number	b. Position in Train	c. Loaded *(yes/no)*
(1) First involved *(derailed, struck, etc)*	BNSF486481	30	yes
(2) Causing *(if mechanical cause reported)*	0	0	N/A

33. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box.

Alcohol	Drugs
0	0

34. Was this consist transporting passengers? (Y/N): N

35. Locomotive Units	a. Head End	Mid Train b. Manual	Mid Train c. Remote	Rear End d. Manual	Rear End c. Remote
(1) Total in Train	3	0	0	0	0
(2) Total Derailed	0	0	0	0	0

36. Cars	Loaded a. Freight	Loaded b. Pass.	Empty c. Freight	Empty d. Pass.	e. Caboose
(1) Total in Equipment Consist	109	0	0	0	0
(2) Total Derailed	36	0	0	0	0

37. Equipment Damage This Consist	38. Track, Signal, Way, & Structure Damage	39. Primary Cause Code	40. Contributing Cause Code
$2,309,527.00	$190,000.00	T213	N/A

Number of Crew Members

41. Engineer/ Operators	42. Firemen	43. Conductors	44. Brakemen
1	0	1	0

Length of Time on Duty

45. Engineer/Operator	46. Conductor
Hrs 4 Mi 50	Hrs 4 Mi 50

Casualties to:	47. Railroad Employees	48. Train Passengers	49. Other
Fatal	0	0	0
Nonfatal	0	0	0

50. EOT Device? 1. Yes 2. No	51. Was EOT Device Properly Armed? 1. Yes 2. No
1	1

52. Caboose Occupied by Crew? 1. Yes 2. No: N/A

OPERATING TRAIN #2

53. Type of Equipment Consist *(single entry)* 1. Freight train 2. Passenger train 3. Commuter train 4. Work train 5. Single car 6. Cut of cars 7. Yard/switching 8. Light loco(s). 9. Maint./inspect.car A. Spec. MoW Equip. — Code	54. Was Equipment Attended? 1. Yes 2. No — Code	55. Train Number/Symbol
N/A	N/A	N/A

56. Speed *(recorded speed, if available)* R - Recorded E - Estimated — Code	58. Method(s) of Operation *(enter code(s) that apply)*	58a. Remotely Controlled Locomotive?
N/A MPH — N/A	a. ATCS; b. Auto train control; g. Automatic block; h. Current of traffic; m.Special instructions; n. Other than main track	0 = Not a remotely controlled; 1 = Remote control portable

57. Trailing Tons *(gross tonnage, excluding power units)* N/A

c. Auto train stop
d. Cab
e. Traffic
f. Interlocking
i. Time table/train orders
j.Track warrant control
k. Direct traffic control
l.Yard limits
o. Positive train control
p. Other *(Specify in narrative)*
Code(s) N/A N/A N/A N/A N/A

2 = Remote control tower
3 = Remote control transmitter - more than one remote control transmitter N/A

59. Principal Car/Unit	a. Initial and Number	b. Position in Train	c. Loaded *(yes/no)*
(1) First involved *(derailed, struck, etc)*	N/A	N/A	N/A
(2) Causing *(if mechanical cause reported)*	N/A	N/A	N/A

60. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box.

Alcohol	Drugs
N/A	N/A

61. Was this consist transporting passengers? (Y/N) N/A

62. Locomotive Units	a. Head End	Mid Train b. Manual	Mid Train c. Remote	Rear End d. Manual	Rear End c. Remote
(1) Total in Train	N/A	N/A	N/A	N/A	N/A
(2) Total Derailed	N/A	N/A	N/A	N/A	N/A

63. Cars	Loaded a. Freight	Loaded b. Pass.	Empty c. Freight	Empty d. Pass.	e. Caboose
(1) Total in Equipment Consist	N/A	N/A	N/A	N/A	N/A
(2) Total Derailed	N/A	N/A	N/A	N/A	N/A

64. Equipment Damage This Consist N/A

65. Track, Signal, Way, & Structure Damage N/A

66. Primary Cause Code N/A

67. Contributing Cause Code N/A

Number of Crew Members

68. Engineer/ Operators	69. Firemen	70. Conductors	71. Brakemen
N/A	N/A	N/A	N/A

Length of Time on Duty

72. Engineer/Operator Hrs N/A Mi N/A

73. Conductor Hrs N/A Mi N/A

Casualties to:	74. Railroad Employees	75. Train Passengers	76. Other
Fatal	N/A	N/A	N/A
Nonfatal	N/A	N/A	N/A

77. EOT Device? 1. Yes 2. No N/A

78. Was EOT Device Properly Armed? 1. Yes 2. No N/A

79. Caboose Occupied by Crew? 1. Yes 2. No N/A

OPERATING TRAIN #3

80. Type of Equipment Consist *(single entry)*
1. Freight train
2. Passenger train
3. Commuter train
4. Work train
5. Single car
6. Cut of cars
7. Yard/switching
8. Light loco(s).
9. Maint./inspect.car
A. Spec. MoW Equip.
Code N/A

81. Was Equipment Attended? 1. Yes 2. No Code N/A

82. Train Number/Symbol N/A

83. Speed *(recorded speed, if available)* Code
R - Recorded
E - Estimated N/A MPH N/A

84. Trailing Tons *(gross tonnage, excluding power units)* N/A

85. Method(s) of Operation *(enter code(s) that apply)*
a. ATCS
b. Auto train control
c. Auto train stop
d. Cab
e. Traffic
f. Interlocking
g. Automatic block
h. Current of traffic
i. Time table/train orders
j.Track warrant control
k. Direct traffic control
l.Yard limits
m.Special instructions
n. Other than main track
o. Positive train control
p. Other *(Specify in narrative)*
Code(s) N/A N/A N/A N/A N/A

85a. Remotely Controlled Locomotive?
0 = Not a remotely controlled
1 = Remote control portable
2 = Remote control tower
3 = Remote control transmitter - more than one remote control transmitter N/A

86. Principal Car/Unit	a. Initial and Number	b. Position in Train	c. Loaded *(yes/no)*
(1) First involved *(derailed, struck, etc)*	N/A	N/A	N/A
(2) Causing *(if mechanical cause reported)*	N/A	N/A	N/A

87. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box.

Alcohol	Drugs
N/A	N/A

88. Was this consist transporting passengers? (Y/N) N/A

89. Locomotive Units	a. Head End	Mid Train b. Manual	Mid Train c. Remote	Rear End d. Manual	Rear End c. Remote
(1) Total in Train	N/A	N/A	N/A	N/A	N/A
(2) Total Derailed	N/A	N/A	N/A	N/A	N/A

90. Cars	Loaded a. Freight	Loaded b. Pass.	Empty c. Freight	Empty d. Pass.	e. Caboose
(1) Total in Equipment Consist	N/A	N/A	N/A	N/A	N/A
(2) Total Derailed	N/A	N/A	N/A	N/A	N/A

91. Equipment Damage This Consist N/A

92. Track, Signal, Way, & Structure Damage N/A

93. Primary Cause Code N/A

94. Contributing Cause Code N/A

Number of Crew Members

95. Engineer/ Operators	96. Firemen	97. Conductors	98. Brakemen
N/A	N/A	N/A	N/A

Length of Time on Duty

99. Engineer/Operator Hrs N/A Mi N/A

100. Conductor Hrs N/A Mi N/A

Casualties to:	101. Railroad Employees	102. Train	103. Other
Fatal	N/A	N/A	N/A
Nonfatal	N/A	N/A	N/A

104. EOT 1. Yes 2. No N/A

105. Was EOT Device Properly 1. Yes 2. No N/A

106. Caboose Occupied by Crew? 1. Yes 2. No N/A

Highway User Involved

107. Code N/A
A. Auto
B. Truck
C. Truck-Trailer.
D. Pick-Up Truck
E. Van
F. Bus
G. School Bus
H. Motorcycle
J. Other Motor Vehicle
K. Pedestrian
M. Other *(spec. in narrative)*

108. Vehicle Speed *(est. MPH at impact)* N/A

109. *geographical)* Code N/A
1.North 2.South 3.East 4.West

Rail Equipment Involved

111. Equipment Code N/A
1.Train *(units pulling)*
2.Train *(units pushing)*
3.Train *(standing)*
4.Car(s) *(moving)*
5.Car(s) *(standing)*
6.Light Loco(s) *(moving)*
7.Light(s) *(standing)*
8.Other *(specify in narrative)*

112. Position of Car Unit in N/A

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110. Position	Code	113. Circumstance	Code
1.Stalled on Crossing 2.Stopped on Crossing 3.Moving Over Crossing 4. Trapped	N/A	1. Rail Equipment Struck Highway User 2. Rail Equipment Struck by Highway User	N/A
114a. Was the highway user and/or rail equipment involved in the impact transporting hazardous materials? 1. Highway User 2. Rail Equipment 3. Both 4. Neither	N/A	114b. Was there a hazardous materials release 1. Highway User 2. Rail Equipment 3. Both 4. Neither	N/A

114c. State here the name and quantity of the hazardous materials released, if any.
N/A

115. Type Crossing Warning	1.Gates	4.Wig Wags	7.Crossbucks	10.Flagged by crew	116. Signaled Crossing *(See instructions for codes)*	Code	117. Whistle Ban 1. Yes 2. No 3. Unknown	Code
	2.Cantilever FLS	5.Hwy. traffic signals	8.Stop signs	11.Other *(spec. in narr.)*				
	3.Standard FLS	6.Audible	9.Watchman	12.None				
Code(s)	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A

118. Location of Warning 1. Both Sides 2. Side of Vehicle Approach 3. Opposite Side of Vehicle Approach	Code	119. Crossing Warning with Highway Signals 1. Yes 2. No 3. Unknown	Code	120. Crossing Illuminated by Street Lights or Special Lights 1. Yes 2. No 3. Unknown	Code
	N/A		N/A		N/A

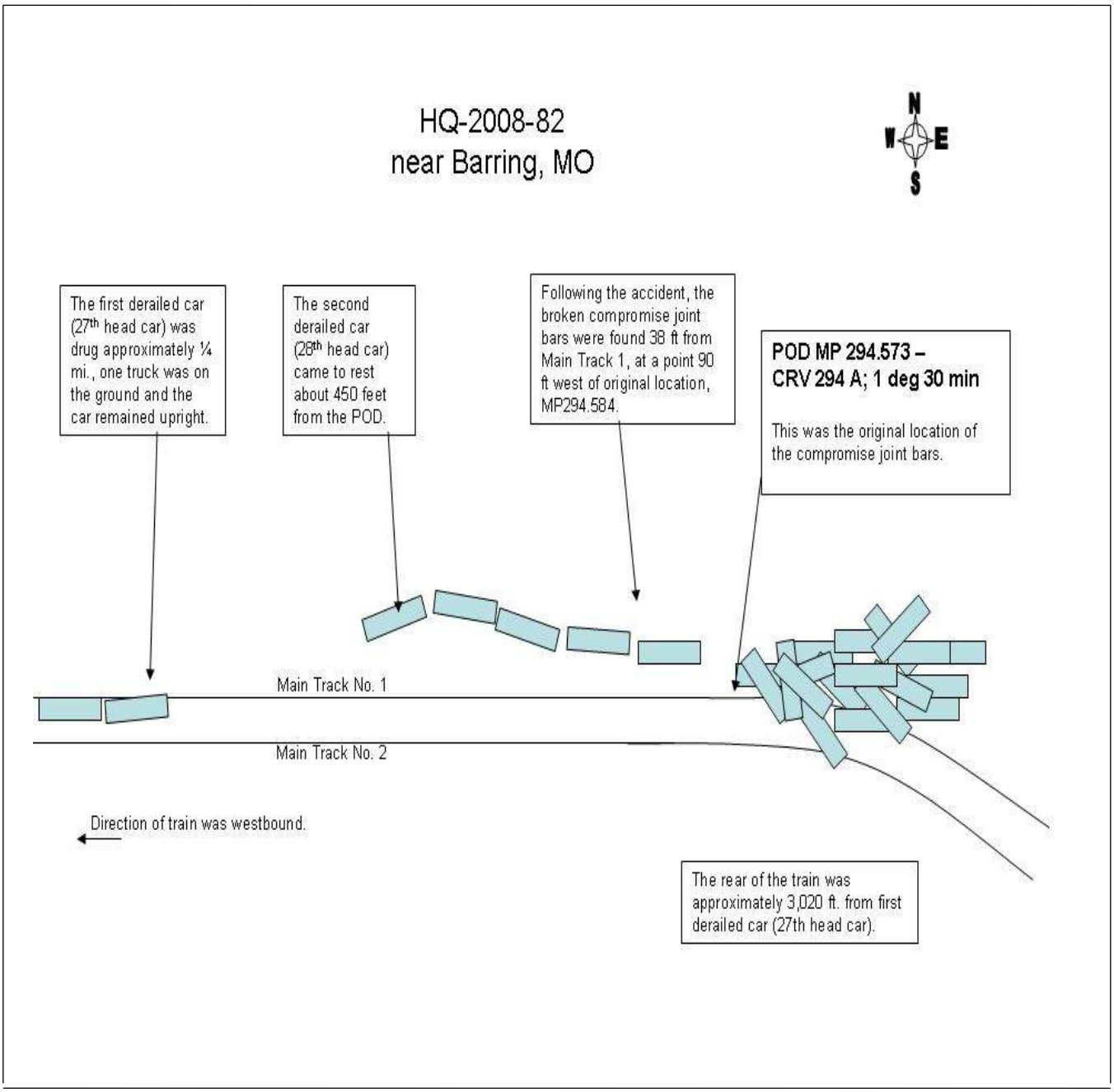
121. Age	122. Driver's Gender 1. Male 2. Female	Code	123. Driver Drove Behind or in Front of and Struck or was Struck by Second Train 1. Yes 2. No 3. Unknown	Code	124. Driver 1. Drove around or thru the Gate 2. Stopped and then Proceeded 3. Did not Stop 4. Stopped on Crossing 5. Other *(specify in narrative)*	Code
N/A		N/A		N/A		N/A

125. Driver Passed Highway Vehicle 1. Yes 2. No 3. Unknown	Code	126. View of Track Obscured by *(primary obstruction)* 1. Permanent Structure 2. Standing Railroad Equipment 3. Passing Train 4. Topography 5. Vegetation 6. Highway Vehicle 7. Other *(specify in narrative)* 8. Not obstructed	Code
	N/A		N/A

Casualties to:	Killed	Injured	127. Driver 1. Killed 2.Injured 3. Uninjured	Code	128. Was Driver in the Vehicle? 1. Yes 2. No	Code
				N/A		N/A
129. Highway-Rail Crossing Users	N/A	N/A	130. Highway Vehicle Property Damage *(est. dollar damage)*	N/A	131. Total Number of Highway-Rail Crossing Users *(include driver)*	N/A

132. Locomotive Auxiliary Lights? 1. Yes 2. No	Code	133. Locomotive Auxiliary Lights Operational? 1. Yes 2. No	Code
	N/A		N/A
134. Locomotive Headlight Illuminated? 1. Yes 2. No	Code	135. Locomotive Audible Warning Sounded? 1. Yes 2. No	Code
	N/A		N/A

136. DRAW A SKETCH OF ACCIDENT AREA INCLUDING ALL TRACKS, SIGNALS, SWITCHES, STRUCTURES, OBJECTS, ETC., INVOLVED.



137. SYNOPSIS OF THE ACCIDENT

On October 24, 2008 at approximately 6:40 a.m. CDT westbound Burlington Northern Santa Fe Railway Company (BNSF) Train G-LOWELP9-22A, a loaded grain train traveling at a recorded speed of 49 mph, derailed 36 cars on Main Track # 1 (double main track) at milepost (MP) 294.45. The accident occurred about 2.4 miles west of Baring, Missouri. The 27th through the 62nd head cars were derailed. There were no hazardous materials (HM) involved, no evacuation, and no injuries reported. The weather was cloudy with a temperature of 44 °F. The wind was from the south, southwest at 8 mph.

Equipment damage was estimated at $ 2,309,527. About 500 feet of Main Track # 1 and about 600 feet of Main Track # 2 were damaged. Track damages were estimated at $ 190,000, making the total estimated damages $2,499,527.

The Federal Railroad Administration (FRA) investigation determined that the probable cause of the train accident was FRA Cause Code T-213, Joint bar broken (compromise).

138. NARRATIVE

CIRCUMSTANCES PRIOR TO THE ACCIDEN

The crew of BNSF Train G-LOWELP9-22A included a locomotive engineer and a conductor. They went on duty at Fort Madison, Iowa at 1:45 a.m. CDT October 24, 2008. They had in excess of the required statutory off-duty rest period prior to reporting for duty.

BNSF Train G-LOWELP9-22A consisted of three diesel electric locomotives and 109 loaded grain hopper cars. The train was 6,720 feet long and weighed 14,388 tons. It had departed Lowder, Illinois about 5:00 p.m. CDT October 23, 2008 after the conductor had performed a Class I train air brake test and an initial terminal inspection.

Prior to the accident the locomotive engineer was seated at the controls on the right (north) side of the cab. The conductor was seated on the left (south) side of the cab in the forward seat. The railroad timetable direction of the train was west. The geographic direction was west.

In the accident area the grade descends for westward movement from 0.6 to 0.85 percent. Near the point-of-derailment (POD) there is a 1-degree, 30-minute left-hand curve. The track consists of continuous-welded rail (CWR). Main Track # 2 is 141-lb. CWR. In the high side of the curve, Main Track # 1 is 141-lb. CWR (installed in 2006) and in the low side of the curve, 136-lb. CWR (installed in 1993).

Prior to the accident the engineer had been operating the train in throttle position 8 (maximum power) for about 9 minutes. Approaching the accident area from the east the train crew observed a plug rail which felt “rough” as they passed over the POD.

THE ACCIDENT

Shortly after passing over the plug rail there was a train line separation which initiated an emergency application of the train air brakes. The engineer placed the automatic brake valve handle in the emergency

position. However, he did not activate the switch for the rear end-of-train device (EOTD). The conductor disembarked the locomotive and made a walking inspection of the train and discovered rail car # BNSF 486481, the 27th head car, to be the first rail car derailed. The remaining 35 derailed cars (28th through 62nd head cars) were discovered mostly in a pile fouling both main tracks. Prior to and at the time of the accident the train was traveling at a recorded speed of 49 mph as recorded by the event recorder on lead Locomotive # BNSF 4984. The maximum authorized speed for the train was 55 mph as designated in the current BNSF Timetable # 6 dated June 20, 2007.

ANALYSIS AND CONCLUSIONS

ANALYSIS - END-OF-TRAIN DEVICE:

An evaluation of the event recorder from lead Locomotive # BNSF 4984 revealed that there was approximately an 11-second delay from the emergency brake application at the front of the train to the emergency brake application at the rear of the train. This delay was abnormal. With the automatic brake valve handle in emergency position the rear end-of-train unit should have activated. An FRA representative requested and observed testing of both the front end-of-train unit (hereafter, front unit) and the rear end-of-train unit (hereafter, rear unit).

The front unit was tested onboard lead Locomotive No. BNSF 4984 at the BNSF Locomotive Maintenance and Inspection Terminal (LMIT) in Kansas City, Kansas, on November 5, 2008. BNSF placed a rear unit on the front coupler of the locomotive. The rear unit was armed with the front unit and tested for functionality. The FRA took no exception to the operation of either the front unit or the rear unit. It should be noted the rear unit was not the rear unit from the rear car of Train Symbol G-LOWELP9-22A.

During testing, the front unit was mounted in the equipment locker in the locomotive cab. Following testing, the front unit was removed for ease of inspection and additional testing. Inspection revealed that the front unit, No. BNQ 192446, calibration sticker was incomplete. The last calibration was performed November 11, 2007, at location “KGBG” by person “BDW.” BNSF could not provide information regarding location “KGBG” or person “BDW.” FRA exception was taken to the incomplete calibration sticker.

The front unit was forwarded to the Central Repair Facility (CRF) at Kansas City. The rear unit from the rear car of Train Symbol G-LOWELP9-22A was also forwarded to the CRF. The last calibration of the rear unit was performed on July 30, 2008, at location “CRFKC” (Central Repair Facility Kansas City) by person “Castagno.”

BNSF tested the front and rear units on November 6, 2008. By attenuation of the front unit antenna line, BNSF simulated a distance of about 6,000 feet of train length. Both the front and rear units performed as intended. Following testing, BNSF tested the antenna system on lead Locomotive No. BNSF 4984. The test revealed a nearly flawless antenna and coax system on the locomotive. BNSF concluded the head and rear units should have performed as intended on the day of the accident with no delay between the emergency brake application at the front of the train and the rear unit activation. BNSF speculated the cause may have been (1) an impeded communication path between the front and rear units, or (2) rear unit power loss possibly due to a loose battery caused by dynamic forces at the rear-of-train or other cause. Both events would have delayed the emergency request from reaching the rear unit.

Conclusion: Post-accident testing of the front and rear units revealed the 11-second delay between the locomotive emergency brake application at the front of the train and the rear unit emergency activation, could not be replicated. Their operation on the day of the accident was abnormal because of this delay. While the operation of the end-of-train units was abnormal, the 11-second delay was not a probable cause of the accident.

Analysis - Locomotive, Car, and Train Brake System Inspection: Following the accident, the front portion of Train Symbol G-LOWELP9-22A (3 locomotives and 26 cars) was moved to West Ethel, Missouri. This front portion of the train was not derailed. On October 25, 2008, an FRA representative inspected the locomotives and cars including the train brake system. The inspection did not reveal any physical defects.

Conclusion: The train brake system on the front portion of Train Symbol G-LOWELP9-22A operated as intended. The BNSF failed to properly prepare and retain daily inspection reports. This failure was not a

probable cause of the accident.

Analysis - BNSF Track Inspection: On October 24, 2008, an FRA representative and a Missouri Department of Transportation representative (hereafter FRA representatives) inspected records of a BNSF track inspection performed on October 23, 2008. The FRA representatives took exception to BNSF failure to properly prepare and retain inspection records. A BNSF track inspector failed to complete the inspection report for the hi-rail vehicle inspection. Neither the BNSF track inspector nor the BNSF roadmaster could recall the electronic record from the system when requested. The electronic storage had not been initiated within 24 hours. The electronic system did not maintain the integrity of each record. The BNSF track inspector and roadmaster both stated the electronic system sometimes fails to input inspection records. Following this inspection, the representatives observed BNSF enter the data into an electronic record.

Conclusion: BNSF failed to properly prepare and retain hi-rail vehicle inspection records for an inspection on October 23, 2008. This failure was not a probable cause of the accident.

Analysis - FRA Post Accident Track Inspection: The FRA representatives conducted extensive inspection of the accident area on October 25, 2008, and took exception to the following. At MP 294.32, 294.38, and 294.4, the crossties were not effectively distributed to support a 39-foot segment of track. At MP 294.32 and 294.38, there were eight (8) ties in a row which were crushed, cut-in, or would not hold fasteners because they were split. At MP 294.4, there were five (5) defective ties in a row which were crushed, cut-in, or would not hold fasteners because they were split. At MP 294.35, there were fewer than the minimum allowable number of non-defective ties per 39 feet for turnouts and curved track over 2-degrees. There were 7 effective ties out of 24 ties in a 39-foot section; a minimum of 14 effective ties were required. The defective ties were crushed, split, cut-in, or would not hold fasteners.

Conclusion: FRA post-accident track inspection revealed that due to the catastrophic damage caused by the derailment, the number of cars derailed and the derailment debris, geometry measurements and crosstie conditions at the POD could not be assessed. The inspection did reveal numerous locations with defective crosstie conditions in areas undisturbed by the derailment. No physical evidence was found that could attribute crosstie or geometry conditions as a causal or contributing factor of the derailment.

Analysis - Laboratory Investigation of Rail and Truck Components: On December 18, 2008, the BNSF Technical Research and Development laboratory (hereafter laboratory) located at Topeka, Kansas, reported investigative findings. BNSF had removed rail components and truck components from the accident area and forwarded them to the laboratory for analysis. Some rail components requested by the laboratory were destroyed by a scrap dealer precluding possible analysis.

The laboratory analyzed the following data to determine the probable cause of the accident:
(1) train make up, (2) train dynamics including truck performance (hunting and bounce), (3) failed wheels (broken wheel plates), (4) track geometry, and (5) track component failure (broken joint bars).

(1) Train Make-up: The train make up met BNSF train make up standards and was ruled out as a probable cause of the accident.

(2) Train Dynamics (Truck Performance): Train G-LOWELP9-22A passed a truck performance detector (TPD) at Argyle, Iowa, approximately 2 hours 30 minutes prior to the accident. The laboratory reviewed this data and other truck performance data for the 2nd and 3rd derailed cars (Car Nos. BNSF 484324 and CIFX 71117, the 28th and 29th head cars). Additionally, the laboratory considered the truck component condition for both cars. The truck bolster bowl liners of both cars exhibited a cold flow condition indicating possible bolster rotational stiffness. The TPD history for the 3rd derailed car indicated occasional elevated lateral forces in curving. However, the increases in forces were within an acceptable range. The laboratory did not consider the elevated lateral forces to be either unusual nor unique. Evaluation of the other truck components did not indicate any physical evidence of truck hunting.

(3) Failed Wheels: BNSF evaluated 3 wheel sets at the laboratory. There were 2 failed wheels from the 2nd derailed car and 1 failed wheel found underneath the 17th derailed car. BNSF determined the wheels failed as a result of impact to the wheel plates during the derailment, and were ruled out as a probable cause of the accident.

(4) Ultrasonic Rail Testing: The last ultrasonic rail test was performed on September 11, 2008. There were no defects noted at MP 294.5. However, there was a previous ultrasonic rail test performed on August 1, 2008. At that time, there was a vertical split head found within the rail head of the 136-lb low rail on Main Track No. 1. This rail was replaced with a 136-lb plug rail. The plug rail was installed with 132/136 compromise joint bars at each end because they provided a better fit at the heads between the adjoining rails.

(4) Geometry Car Testing: The last geometry car test was performed on August 18, 2008. There were five geometry conditions noted during this inspection in the curve in which the derailment occurred. Three of these conditions were for excess super elevation; one was for wide gauge and one was for poor surface condition on the right or low rail of the curve. None of these conditions had reached the defective limits of the FRA's Track Safety Standards for geometry.

(5) Track Component Failure (Broken Joint Bars): BNSF discovered a 16-foot section of rail with broken compromise joint bars (132- lb, 136-lb, 141-lb.) in the approximate location of the point-of-derailment. The rail was believed to have come from the plug rail which was installed on August 1. BNSF determined that the compromise joint bars were at the west end of the plug rail. Using a metal rule, BNSF determined there was 7/16 inch of rail batter at the rail head. The compromise joint bars were used instead of standard joint bars, although both rails were 136-lb. It was reported that the compromise joint bars were used because they provided a better fit at the heads between the adjoining rails. The adjoining rails were not salvaged from the derailment site so the fit could not be substantiated. The current BNSF Engineering Instruction No. 6.5.3(d) states that compromise joint bars are not to be used in curves (the actual instruction states: "Do not use compromise joints on turnouts, open-deck bridges, switch ties or curves").

BNSF determined the Brinell hardness of the broken compromise joint bars with the use of a Brinell Optical Scanning System (BOSS). The AREMA standard requires a minimum tensile strength of 100,000 psi. Both the gage side and field side compromise joint bars had a tensile strength well above the minimum required.

Conclusion: The laboratory ruled out train make up, train dynamics including truck performance (hunting and bounce), failed wheels (broken wheel plates), and track geometry as probable causes of the accident. The laboratory determined track component failure (broken joint bars) was the probable cause of the derailment.

Analysis - Computer Modeling: BNSF performed detailed computer modeling to determine truck and rail performance relative to the probable cause of the accident. The modeling included New and Untried Car Analytical Regime (NUCARS) analysis.

Conclusion: Computer modeling indicated the highest lateral/vertical force ratio (L/V) was 0.6. Generally an L/V of 0.7 or greater is required to cause wheel climb. BNSF concluded neither wheel climb, bounce, nor any other car dynamics were the probable cause of the accident.

Analysis - Fatigue: FRA uses an overall effectiveness rate of 77.5 percent as the baseline for fatigue analysis, which is equivalent to a blood alcohol contact (BAC) of 0.05. At or above this baseline, we do not consider fatigue as probable for any employee. Software sleep settings vary according to information obtained from each employee. If an employee does not provide sleep information, FRA uses the default software settings.

FRA obtained fatigue related information, including a 10-day work history, on two employees involved in this accident including the locomotive engineer and the conductor assigned to Train Symbol G-LOWELP9-22A.

Conclusion: FRA concluded fatigue was probable for the crewmembers involved; however, it was not a causal factor in the accident. Information for these two employees follows:

The engineer's effectiveness level at the time of the derailment was 64.23 percent.
Lapse index of 6.6
Reaction Time 153
Chronic Sleep Debt 10.15
Hours of continuous Wakefulness 7.10 Hours
Time of day 6:50 a.m.
Blood Alcohol Equivalency of approximately >0.08

The conductor's effectiveness level at the time of the derailment was 68.85 percent.
Lapse index of 5.6
Reaction Time 151
Chronic Sleep Debt 8.00
Hours of continuous Wakefulness 7.10 Hours
Time of day 6:50 a.m.
Blood Alcohol Equivalency of approximately >0.08

Overall Conclusions: Train make up, train dynamics including truck performance (hunting and bounce), failed wheels (broken wheel plates), and track geometry were not a factor in this accident. The train make up met BNSF train make up standards. There was no physical evidence of poor truck performance; this was confirmed with computer modeling. All failed wheels failed as a result of impact to the wheel plates during the derailment.

The discovery of failed track components (broken joint bars) at or near the point-of-derailment provides the most conclusive evidence that the broken joint bars were the probable cause of the derailment. The joint bars were 132-lb, 136-lb, and 141-lb compromise joint bars. These bars were used instead of standard joint bars although both rails were 136-lb. It was reported that the compromise joint bars were used because they provided a better fit at the heads between the adjoining rails with the plug rail. These 132-lb, 136-lb, and 141-lb compromise joint bars are compatible with all three sizes of rail and FRA takes no regulatory exception to their use. However, BNSF Engineering Instruction No. 6.5.3(d) prohibits the use of compromise joint bars in curves.

Probable Cause and Contributing Factors

The Federal Railroad Administration's investigation determined that the probable cause of the train accident was Train Accident Cause Code T-213, Joint bar broken (compromise).