SYNOPSIS

On Sunday February 6, 2011, at 2:20 AM (EST), Norfolk Southern (NS) freight Train No. 68KL305, Fort Wayne, IN, to Bellevue, OH, derailed at milepost B287.8, on single main track, while proceeding east at a recorded speed of 46 miles per hour. The derailment occurred on the Fostoria Line Subdivision of the Lake Division in Arcadia, OH, Hancock County, approximately 100 yards northeast of the intersection of Hancock 216 and Cass Township 247. The annual volume of rail traffic is approximately 21 million gross tons (MGT). At the time of derailment, the weather condition was cloudy, light snow, with a temperature of 25 degrees Fahrenheit.

Train No. 68KL305 was powered by two locomotives (NS9978 and NS7571) pulling 61 loads and 1 empty, 7,779 trailing tons, and 7,836 feet in length. Train No. 68KL305 was operating on a clear signal in traffic control territory at a recorded speed of 46 miles per hour at time of derailment. The authorized timetable speed for subject train was 50 miles per hour. The engineer was operating in No.8 throttle notch pulling 504 amps with no reduction in brake pipe pressure, no independent brake application, and no dynamic brake.

As a result of the derailment, all wheels on the both trucks of the 2nd head buffer car (UELX 30218-covered hopper/grain products) derailed including the derailment and general pileup of 33 loaded tank cars containing hazardous materials (Ethyl Alcohol), Class 111, UN 1987. Train No. 68KL305 was a unit Ethanol train. Local citizens residing in the rural farming area of Arcadia, OH, reported hearing five or more explosions and seeing mushroom clouds of flame rising from the derailment site, which could be seen for miles. Subsequent onground investigation revealed there was a BLEVE (boiling liquid expanding vapor explosion) of several tank cars. Each tank car contained 30,000 gallons of Ethyl Alcohol and it is estimated that 900,000 gallons of this product was lost.

There were no injuries to the two-man train crew or to the public as a result of the derailment. However, evacuations were ordered for 60 residents residing in approximately 30 households that were within a mile and a half of the derailment.

The following damage costs were reported by NS investigating personnel: 1) equipment, $1,700,000; 2) track $194,000; and 3) signal $1,500. Total damages, $1,895,500.

Initial investigation revealed the probable cause of the derailment was a head and web separation measuring 8-1/2 inches in length broken out at the end of a turnout closure rail. The rail break out was located within the confines of a bolted joint within a turnout connecting the toe of a spring frog to the closure rail.

On March 18,2011, NS Research and Tests personnel submitted the following derailment cause: "Rail head broke out under previous train account head web separation (within joint bar limits)." FRA Cause Code T211.

U.S. Department of Transportation
Federal Railroad Administration

FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File #HQ-2011-4

TRAIN SUMMARY

1. Name of Railroad Operating Train #1	1a. Alphabetic Code	1b. Railroad Accident/Incident No.
Norfolk Southern Railway Company	NS	D041313

GENERAL INFORMATION

1. Name of Railroad or Other Entity Responsible for Track Maintenance	1a. Alphabetic Code	1b. Railroad Accident/Incident No.
Norfolk Southern Railway Company	NS	D041313

2. U.S. DOT Grade Crossing Identification Number	3. Date of Accident/Incident	4. Time of Accident/Incident
	2/6/2011	12:00 AM

5. Type of Accident/Incident
Derailment

6. Cars Carrying HAZMAT	7. HAZMAT Cars Damaged/Derailed	8. Cars Releasing HAZMAT	9. People Evacuated	10. Subdivision
59	33	33	60	Lake

11. Nearest City/Town	12. Milepost *(to nearest tenth)*	13. State Abbr.	14. County
Arcadia		OH	HANCOCK

15. Temperature (F)	16. Visibility	17. Weather	18. Type of Track
25 ˚F	Dark	Snow	Main

19. Track Name/Number	20. FRA Track Class	21. Annual Track Density *(gross tons in millions)*	22. Time Table Direction
Single Main	Freight Trains-80, Passenger Trains-90	21	East

23. PTC Preventable
N/A

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FRA FACTUAL RAILROAD ACCIDENT REPORT

FRA File #HQ-2011-4

OPERATING TRAIN #1

1. Type of Equipment Consist:	2. Was Equipment Attended?	3. Train Number/Symbol
Freight Train	Yes	68KL305

4. Speed (recorded speed, if available) R - Recorded E - Estimated	Code	5. Trailing Tons (gross excluding power units)	6a. Remotely Controlled Locomotive? 0 = Not a remotely controlled operation 1 = Remote control portable transmitter 2 = Remote control tower operation 3 = Remote control portable transmitter - more than one remote control transmitter	Code
46.0 MPH	R	7779		0

6. Type of Territory

Signalization:
N/A

Method of Operation/Authority for Movement:
N/A

Supplemental/Adjunct Codes:
Q, N/A

7. Principal Car/Unit	a. Initial and Number	b. Position in Train	c. Loaded (yes/no)	8. If railroad employee(s) tested for drug/alcohol use, enter the number that were positive in the appropriate box	Alcohol	Drugs
(1) First Involved *(derailed, struck, etc.)*	UELX 30218	2	yes			
(2) Causing *(if mechanical, cause reported)*	0	0		9. Was this consist transporting passengers?		No

10. Locomotive Units (Exclude EMU, DMU, and Cab Car Locomotives.)	a. Head End	Mid Train b. Manual	Mid Train c. Remote	Rear End d. Manual	Rear End e. Remote	11. Cars (Include EMU, DMU, and Cab Car Locomotives.)	Loaded a. Freight	Loaded b. Pass.	Empty c. Freight	Empty d. Pass.	e. Caboose
(1) Total in Train	2	0	0	0	0	(1) Total in Equipment Consist	61	0	1	0	0
(2) Total Derailed	0	0	0	0	0	(2) Total Derailed	34	0	0	0	0

12. Equipment Damage This Consist	13. Track, Signal, Way & Structure Damage
1700000	195500

14. Primary Cause Code
T211 - Broken Rail - Head and web separation (within joint bar limits)

15. Contributing Cause Code

Number of Crew Members

16. Engineers/Operators	17. Firemen	18. Conductors	19. Brakemen
1	0	1	0

Length of Time on Duty

20. Engineer/Operator	21. Conductor
Hrs: 4 Mins: 50	Hrs: 4 Mins: 50

Casualties to:	22. Railroad Employees	23. Train Passengers	24. Others
Fatal	0	0	0
Nonfatal	0	0	0

25. EOT Device?	26. Was EOT Device Properly Armed?
Yes	Yes

27. Caboose Occupied by Crew? N/A

28. Latitude	29. Longitude

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CROSSING INFORMATION

Highway User Involved		Rail Equipment Involved
1. Type		5. Equipment
2. Vehicle Speed *(est. mph at impact)*	3. Direction *(geographical)*	6. Position of Car Unit in Train
4. Position of Involved Highway User		7. Circumstance
8a. Was the highway user and/or rail equipment involved in the impact transporting hazardous materials? N/A		8b. Was there a hazardous materials release by N/A

8c. State here the name and quantity of the hazardous material released, if any.

9. Type of Crossing	10. Signaled Crossing Warning	11. Roadway Conditions
1. Gates 4. Wig wags 7. Crossbucks 10. Flagged by crew 2. Cantilever FLS 5. Hwy. traffic signals 8. Stop signs 11. Other *(spec. in narr.)* 3. Standard FLS 6. Audible 9. Watchman 12. None N/A		N/A

12. Location of Warning	13. Crossing Warning Interconnected with Highway Signals	14. Crossing Illuminated by Street Lights or Special Lights
N/A	N/A	N/A

15. Highway User's Age	16. Highway User's Gender	17. Highway User Went Behind or in Front of Train and Struck or was Struck by Second Train	18. Highway User

19. Driver Passed Standing Highway Vehicle	20. View of Track Obscured by *(primary obstruction)*

Casualties to:	Killed	Injured	21. Driver was	22. Was Driver in the Vehicle?
23. Highway-Rail Crossing Users			24. Highway Vehicle Property Damage *(est. dollar damage)*	25. Total Number of Vehicle Occupants *(including driver)*

26. Locomotive Auxiliary Lights?	27. Locomotive Auxiliary Lights Operational?
N/A	N/A
28. Locomotive Headlight Illuminated?	29. Locomotive Audible Warning Sounded?
N/A	N/A

10. Signaled Crossing Warning

1 - Provided minimum 20-second warning
2 - Alleged warning time greater than 60 seconds
3 - Alleged warning time less than 20 seconds
4 - Alleged no warning
5 - Confirmed warning time greater than 60 seconds
6 - Confirmed warning time less than 20 seconds
7 - Confirmed no warning
N/A - N/A

Explanation Code

A - Insulated rail vehicle
B - Storm/lightning damage
C - Vandalism
D - No power/batteries dead
E - Devices down for repair
F - Devices out of service
G - Warning time greater than 60 seconds attributed to accident-involved train stopping short of the crossing, but within track circuit limits, while warning devices remain continuously active with no other in-motion train present
H - Warning time greater than 60 seconds attributed to track circuit failure (e.g., insulated rail joint or rail bonding failure, track or ballast fouled)
J - Warning time greater than 60 seconds attributed to other train/equipment within track circuit limits
K - Warning time less than 20 seconds attributed to signals timing out before train's arrival at the crossing/island circuit
L - Warning time less than 20 seconds attributed to train operating counter to track circuit design direction
M - Warning time less than 20 seconds attributed to train speed in excess of track circuit's design speed
N - Warning time less than 20 seconds attributed to signal system's failure to detect train approach
O - Warning time less than 20 seconds attributed to violation of special train operating instructions
P - No warning attributed to signal systems failure to detect the train
R - Other cause(s). Explain in Narrative Description

NARRATIVE

Circumstances Prior to the Accident:

Train No. 68KL305

Train No. 68KL3.05 originated at Iowa City, lA, and was interchanged to NS at Chicago, IL. Upon arrival at Fort Wayne, IN, a train crew reported for duty at 9:30 PM on February 5, 2011 to operate the train eastward to Bellevue, OH. The final destination for this run-through train was Selma, NC. Train No. 68KL305 departed Fort Wayne, IN, at 11:05 PM on February 5, 2011, powered by two locomotives (NS9978 and NS7571) pulling 61 loads and 1 empty, 7,779 trailing tons, and 7,836 feet in length. Prior to the derailment, the weather conditions in the immediate vicinity of Arcadia, OH, were snowing and approximately 25 degrees Fahrenheit.

The method of operation is traffic control with wayside automatic block signals. The Fostoria Line track consists of continuous welded rail attached to standard wood crossties with conventional fixation (double shoulder tie plates, cut spikes, and anchors).

The railroad timetable direction for Train No. 68KL305 was east. The single main track is tangent. The track milepost numbering decreases in the eastbound direction, and is geographically aligned east and west. Timetable direction will be used throughout this report. Subject track is not an Amtrak route.

Approaching the site, in the direction of Train No. 68KL305, the main track grade ascends 0.27% between B289.5 and B288. In the immediate vicinity of the derailment (MP287.75) the grade is level then it begins a 0.17% descent.

The Accident

At approximately 2:20 AM on February 6, 2011, Train No. 68KL305 derailed while traversing (trailing point movement) over a No. 10 right-hand spring frog located at Milepost B287.8. The derailment resulted in the derailment of a loaded covered hopper car and a general pile up of 33 loaded tank cars immediately east of the point of frog. The bulk of the derailed cars came to rest on the north side of the main track. There were a total of 32 derailed tank cars on fire.

The authorized timetable speed for subject train was 50 mph. As the crew approached the accident site, they were operating on a clear signal. During the derailment, the two locomotives and two head end buffer cars (NW 868539-empty hi-cube box and UELX 30218-covered hopper/grain) remained coupled after separating from the derailed tank cars. It was later determined that all wheels on rail car UELX 30218, which was the second head car, were derailed. The recorded speed of the train at time of derailment was 46 mph. The engineer was operating in No.8 throttle notch consuming 504 amps with no reduction in brake pipe pressure, no independent brake application, and no dynamic brake.

As a result of the derailment, the main track required the installation of 19 track panels (741 feet) and the replacement of the frog. NS Maintenance of Way (MofW) personnel also replaced welded rail (2,450 ft) to replace damaged north rail east of the track panels. This segment of rail was damaged by the derailed wheels on UELX30218, which was pulled by the train crew approximately 1/2-mile east of the derailed and burning tank cars. NS MofW also reported replacing a damaged culvert.

Two divisions of Hulcher and R. J. Corman Rerailing Services were dispatched to the derailment site arriving at approximately 9:15 AM and 9:30 AM, respectively, on February 6, 2011. All derailed equipment was cleared from the main track at 11:00 PM on February 7, 2011. NS Train No. 53N passed eastbound over the derailment site at 11:30 PM on February 7, 2011. All evacuated residents were allowed to return to their respective homes on the morning of February 7, 2011.

Responding to the accident scene were the following groups:
Hancock County Sheriffs' Department
Ohio Environmental Protection Agency - Air & Water
Public Utilities Commission of Ohio
Washington Township Fire Department
R. J. Corman Rerailing Services
Hulcher Rerailing Services

Preliminary Analysis and Conclusion:

During an interview with FRA personnel, the conductor advised having no problems with the operation of Train No. 68KL305 east until the train passed over the switch at MP B287.8. The conductor stated, "... the track felt rough, the roughest I have ever experienced, it felt like we hit a pothole." The conductor stated the train went into an undesired emergency brake application. Next, the two locomotives and two coupled rail cars came to a stop about twenty car lengths east of the derailed cars. The conductor stated he dismounted the lead locomotive and walked back to the rear buffer car (UELX 30218) and found the tank cars on fire.

During an interview with FRA personnel, the engineer stated he did not experience any problems until the train reached the switch at MP B287.8. The engineer stated "... it felt like we hit a pothole." According to the engineer, he stated the train "... hit the switch hard enough to rock the locomotive to the side."

Analysis and Conclusion

Analysis - Toxicology Testing
Toxicology testing was conducted because the initial damage estimates exceeded one million dollars. The crew on Train No. 68KL305 submitted to drug and alcohol testing under 49 CFR 219, Subpart C, at Believue, OH.

Conclusion:
Test results were negative for the engineer and conductor.

Analysis - Fatigue
FRA obtained fatigue related information for the 10-day period preceding the incident including the 10-day work history (on duty/off/duty cycles for the engineer and conductor).

Conclusion:
FRA concluded the sleep setting and analysis information indicated fatigue was evident for the engineer and conductor. However, it was determined that fatigue related data obtained on the train crew was not a contributing factor in the derailment.

Analysis-Locomotive Engineer Operating Performance
The locomotive was equipped with a speed indicator and an event recorder as required by Federal Regulations. The relevant event recorder data was downloaded by the NS Road Foreman of Engines and analyzed by NS Officials.

Conclusion:
The locomotive engineer was in compliance with all applicable FRA Regulations, railroad operating and train handling rules and requirements.

Analysis Signals
The signal system on the Fostoria Subdivision from the control point (CP) E, North Findlay through CP Arcadia uses Safetran model CLS 20 color-light type signals, Union Switch and Signal (US&S) model M23 power Switch machines, and are operated via data radio by a train dispatcher in Fort Wayne, Indiana. The signal are controlled by General Electric Harmon Logic Controller (HLC) technology and US&S shelf type relays. Track continuity is checked and trains are detected using Safetran GEO Code, coded dc track circuits between signal locations and DC track circuits within the limits of the control points. There is an elevator industry track with a hand throw switch at 8287.75 and it uses a Hayes hand throw switch with a US&S ModelS circuit controller. The last signal Train No. 68KL305 passed prior to derailing was the No. 2888 intermediate signal located at 8288.7. This signal location has back-to-back Safetran CLS 20 color-light signals controlled by Safetran Geo unit.

A FRA Signal Inspector reviewed the signal test records and conducted on-site signal testing. The US&S circuit controller that was used to indicate switch pOint closure for the elevator switch, along with much of the

underground cable that connected it to the signal system were destroyed.

Conclusion:

There was some signal damage as a result of the derailment; however, signals were not determined as a contributing factor in the derailment. Hot box detector records at all prior detectors were analyzed and no exceptions were taken on the operation of the signal system and all required FRA signal testing was in compliance. The signal system operated as intended.

Analysis - Mechanical

A FRA Mechanical Inspector inspected both locomotives and did not find any mechanical defects or conditions that could have caused the derailment. Also, the first two rail (buffer) cars were inspected and no defects were found. The first rail car, a high-cube box car, did not derail. However, both trucks on the second rail car, a covered hopper, had derailed.

Conclusion:

None of the car bodies or truck components removed from the wreckage were found to have mechanical defects or conditions that could have caused the derailment.

Analysis - Track Inspection Records

An audit of NS Track Inspection Reports dated November 1, 2010, through February 3, 2011, revealed that the main track in the accident location had been inspected in accordance with the Federal Track Safety Standards (TSS). There were no exceptions noted on NS's Daily Track Inspection Report (Form 11349). A majority of the defects noted related to loose, missing or broken frog bolts, loose, missing or broken guard rail bolts and loose, missing or broken frog bolts in track crossings, which all showed being repaired.

An audit of NS Semi Annual Turnout Inspection Report (Form 11403) dated October 6, 2010, revealed no exceptions taken by the NS Track Supervisor, who conducted a walking inspection of subject turnout located at MP 8287.8. No exceptions were noted in the supervisor's inspection report concerning the spring frog turnout located at MP 8287.8.

Conclusion:

All required track inspections of the NS Lake Division, Fostoria Line Subdivision were inspected in accordance with the Federal Track Safety Standards (TSS) for Class 4 track, in compliance with FRA CFR 213.233. Proper remedial action was taken on all defects noted on NS track inspection reports.

Analysis - Track

The main track is tangent from North Findlay (MP B293) eastward through point of derailment (POD) at MP b287.75 to Arcadia, OH (MP B286.5) leading to a 1.2 degree right hand curve. The track profile ascends 0.27% between MP B289.5 and MP B288. In the immediate vicinity of the derailment (MPB287.75) the grade is level, and then it begins a 0.17% descent, the same direction as eastbound Train No. 68KL305.

On February 8, 2011, a FRA walking track inspection was conducted between MP B288 to MP B287. Track speed for freight trains is 50 mph, Class 4, and no speed restrictions were in effect. Train No. 68KL305 was a key train restricted to 50 mph. The segment of track between MP B288 and MP B287 was part of a NS T&S (timbering & surfacing) scheduled maintenance program, which was performed September through October 2010.

NS reported that the spring frog was installed during the year 1992. The spiking pattern in the turnout was double rail spike inside and outside rail, as well as anchor spiked. Rail located immediately east of the POD had the following pedigree; 132 lb. RE section, USS Illinois, 1974, Heat Number 91352B. The 132 RE joint bars had 6

holes and were secured by 4 bolts, which were not broken or cracked. The joint bars in the toe joint were secured with two 14 inch x 1-1/8 inch diameter bolts nearest the frog point and two 6 inch x 1-1/8 diameter inch bolts, for a total of 4 bolts. The bolts were in good condition.

The anchors were 132 lb. RE snap on type and ties were box anchored 24 ties per 39 foot all box anchored 200 feet from nearest joint. The double shoulder tie plates measured 14-3/4 inches x 6 inches. It is noted that Padrol clips secured the frog and lag screws were used in the turnout.

Hardwood crossties were in good shape as there was no evidence of splitting, plate cutting, or spike kill. The track was not swinging or pumping.

The ballast consists of granite stone with adequate cross-section. There were no gauge rods used in the turnout.

An analysis of track geometry car testing conducted on September 22, 2010, revealed no defects detected neither within the immediate area nor within the confines of the No. 10 right hand spring frog turnout. An analysis of Sperry Car testing conducted on December 3, 2010, revealed no defects in the turnout. It is noted that the Sperry Car operator performed a manual hand test on a joint located at the toe end of the spring frog in an effort to determine the cause of abnormal equipment response's to web drilling conditions within the joint confines, and annotated the data with the negative hand test result.

Conclusion:

Preliminary cause determination focused on failure of a rail-end head and web seperation at the bolted joint of the spring frog. The rail end in question is associated with the turnout closure rail (rail filling the space between the frog and switch heel) bolted to the toe of the frog. Review of the rail specimen fracture face showed a railhead portion of the head and web separation measuring 8-1/2 inches in length. The lower web and base area of the failure rail was lost or destroyed durig the train accident and ensuring clean up phase, and has not been recovered. The head and web separation was reported to have been dislodged from the confines of a joint associated with the toe portion of the spring frog turnout at this location.

The fracture face of the head and web separation showed polished friction batter that would be indicative of cyclical loading while partially separated prior to complete separation and failure. FRA Rail Integrity Group also determined that the fracture pattern showed a ductile type rupture had occurred to the specimen. This is normal to a stress break or "tear" of the parent metal, according to FRA Rail Integrity Group. No pre-existing fatigue was identified on the fracture face that would suggest a slow growth fatigue defect existed prior to the accident.

FRA Rail Integrity was able to obtain and review a copy of the ultrasonic test data representing the established failure location. The area was tested by Sperry Rail Service Detector Car 993 on December 3, 2010, 65 days prior to the train accident occurring on February 6, 2011. The test data confirmed that the test equipment functioned properly and responded to known rail features that would normally offer a reflector to the ultrasonic test probes within the area of the failed rail.

FRA Rail Integrity established the presence of the failed rail joint that was located at the toe end of the spring frog within the test data. At the established location, the data shows the detector car operator performed a manual hand test in an effort to determine the cause of abnormal equipment response's to web drilling conditions within the joint confines.

The operator apparently identified the abnormal drilling conditions that were identified in the rail specimens durint the course of the investigation, and annotated the data with the negative hand test result. In this instance, the operator was compliant in determining that no classifiable defect condition was present that would warrant further action per CFR 49; Part 213. No equipment response was present that would be indicative of pre-existing longitudinal head and web separation at time of test.

Probable Cause and Contributing Factors:

According to FRA Rail Integrity Group, no fatigue condition was identified on the specimen fracture face that would confirm a pre-existing condition was present before the ductile break occurred. Therefore, FRA Rail Inegrity concluded the failure occurred subsequent to test and developed rapidly, possibly as a result of previous eccentric loading or sudden load impact. This type of development is ofetn attributed to abnormal stresses associated to the

presence of a pumping or swinging joint condition that allows an unstable distribution load transfer. Although there is some friction batter present on the fracture face, it is difficult to accurately determine the amount of time that the longitudinal progression was present prior to the failure of the rail section.

Overall Conclusions:

On March 18, 2011, NS Research and Tests personnel submitted the following derailment cause: "Rail head broke out under previous train account head web separation (witin joint bar limits)." Fra Cause Code T211. The derailment cause submitted by NS Research and Test coincides with findings of FRA Rail Integrity Group.