



***Federal Railroad Administration
Office of Railroad Safety
Accident and Analysis Branch***

***Accident Investigation Report
HQ-2017-1218***

***CSX Transportation (CSX)
Hyndman, PA
August 2, 2017***

Note that 49 U.S.C. §20903 provides that no part of an accident or incident report, including this one, 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.

SYNOPSIS

On August 2, 2017, at 4:52 a.m., EDT, CSX Transportation (CSX) eastward Train Q38831 (Q388) derailed 32 cars, with the general pile up near Milepost (MP) BF 192.3 on Main Track No. 2 of CSX's Keystone Subdivision at Hyndman, Pennsylvania, in Bedford County. The actual point of the derailment was identified at MP BF 193.7, about 9,000 feet west of the general pile up. Train Q388 consisted of 5 locomotives and 178 cars, including 128 loads and 50 empty railcars; 70 of the cars were hazardous material cars. The train was 10,615 feet in length with 18,252 trailing tons. A fire ensued when multiple rail cars slid from CSX's right-of-way, down a small embankment, and into a residential area resulting in the evacuation of approximately 1,000 residents. Two homes were destroyed. No injuries were initially reported, but one local resident went to a local hospital in a private vehicle and a second resident alleges stress issues from a pre-existing condition. Fifteen of the derailed cars were hazardous material tank cars, including 3 loads of liquid petroleum gas (LPG), 8 loads of molten sulfur, and 2 loads of asphalt. Two residue phosphoric acid cars were among those derailed. Three of the loaded cars released hazardous material, including one LPG, one molten sulfur, and one asphalt. The LPG car was burning; an initial evacuation was set at ½-mile, then later expanded to 1 mile as the LPG continued to burn. The LPG car was allowed to burn remaining product through Thursday night, August 3, 2017, before it was safe for personnel to begin hazmat spill and contaminated soil clean-up, clearing of derailed rail equipment, and restoring railroad right-of-way. The railroad's two main tracks were blocked halting all passenger and freight traffic. Rail traffic resumed late morning, August 5, 2017, with the evacuation order lifted at 12:30 p.m. All but about 50 residents were permitted to return to their homes.

Initial costs and damage:

- \$2,130,312 mechanical
- \$650,000 lading
- \$ 68,450 track
- \$ 6,453.85 signal

Environmental and hazmat-related (Carrier DOT F 5800.1):

- \$ 250,000 property
- \$ 5,000,000 response
- \$ 1,500,000 remediation and clean-up

Crew members were tested under Title 49 Code of Federal Regulations Part 219, Subpart C, Post Accident Testing, test results were negative.

The weather at the time of the derailment was mostly clear with visibility of 10 miles; the temperature was 64 °F and the wind was calm.

The Federal Railroad Administration's (FRA) investigation determined the probable cause of the CSX derailment at Hyndman was wheel tread build up and will be listed in FRA's Factual Accident/Incident Report as cause code E67C - Damaged Flange or Tread (Build Up).


A contributing factor to the derailment was determined to be the failure of the train crew to properly release the hand brakes on cars in the train and will be listed in the FRA accident report as cause code H019 - Failure to release hand brakes on car(s) (Railroad Employee).

**TRAIN SUMMARY**

1. Name of Railroad Operating Train #1 CSX Transportation	1a. Alphabetic Code CSX	1b. Railroad Accident/Incident No. 000170611
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GENERAL INFORMATION

1. Name of Railroad or Other Entity Responsible for Track Maintenance CSX Transportation	1a. Alphabetic Code CSX	1b. Railroad Accident/Incident No. 000170611
2. U.S. DOT Grade Crossing Identification Number	3. Date of Accident/Incident 8/2/2017	4. Time of Accident/Incident 4:52 AM
5. Type of Accident/Incident Derailment		
6. Cars Carrying HAZMAT 70	7. HAZMAT Cars Damaged/Derailed 15	8. Cars Releasing HAZMAT 3
9. People Evacuated 1000		10. Subdivision KEYSTONE
11. Nearest City/Town HYNDMAN	12. Milepost (<i>to nearest tenth</i>) BF193.7	13. State Abbr. PA
14. County BEDFORD		
15. Temperature (F) 64 °F	16. Visibility Dawn	17. Weather Clear
18. Type of Track Main		
19. Track Name/Number # 2 Main Track	20. FRA Track Class Freight Trains-40, Passenger Trains-60	21. Annual Track Density (<i>gross tons in millions</i>) 70.1
		22. Time Table Direction East

 U.S. Department of Transportation Federal Railroad Administration		FRA FACTUAL RAILROAD ACCIDENT REPORT				FRA File #HQ-2017-1218							
OPERATING TRAIN #1													
1. Type of Equipment Consist: Freight Train					2. Was Equipment Attended? Yes		3. Train Number/Symbol Q38831						
4. Speed (recorded speed, if available) R - Recorded 24.0 MPH E - Estimated		Code R	5. Trailing Tons (gross excluding power units) 18252		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 0					
6. Type of Territory Signalization: <u> Signaled </u> Method of Operation/Authority for Movement: <u> Signal Indication </u> Supplemental/Adjunct Codes: <u> Q, J </u>													
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.)		FWTX 620111	35	no			0	0					
(2) Causing (if mechanical, cause reported)		FWTX 620111	35	no	9. Was this consist transporting passengers?			No					
10. Locomotive Units (Exclude EMU, DMU, and Cab Car Locomotives.)		a. Head End	Mid Train		Rear End		11. Cars (Include EMU, DMU, and Cab Car Locomotives.)		Loaded		Empty		e. Caboose
			b. Manual	c. Remote	d. Manual	e. Remote			a. Freight	b. Pass.	c. Freight	d. Pass.	
(1) Total in Train		5	0	0	0	0	(1) Total in Equipment Consist		128	0	50	0	0
(2) Total Derailed		0	0	0	0	0	(2) Total Derailed		20	0	12	0	0
12. Equipment Damage This Consist 2130312			13. Track, Signal, Way & Structure Damage 74903										
14. Primary Cause Code E67C - Damaged flange or tread (build up)													
15. Contributing Cause Code H019 - Failure to release hand brakes on car(s) (railroad employee)													
Number of Crew Members				Length of Time on Duty									
16. Engineers/Operators		17. Firemen		18. Conductors		19. Brakemen		20. Engineer/Operator		21. Conductor			
1		0		1		0		Hrs: 4 Mins: 57		Hrs: 4 Mins: 57			
Casualties to:		22. Railroad Employees		23. Train Passengers		24. Others		25. EOT Device?		26. Was EOT Device Properly Armed?			
Fatal		0		0		0		Yes				Yes	
Nonfatal		0		0		4		27. Caboose Occupied by Crew?					
								N/A					
28. Latitude 39.835867420				29. Longitude -78.748385740									

Accident Sketch



NARRATIVE

Circumstances Prior to the Accident

Initial/First Q38831 Crew Operating Train

The initial crew for CSX Transportation (CSX) Train Q38831 consisted of an engineer and conductor, on-duty at their away-from-home terminal in Cumberland, Maryland, at 1:45 p.m., on August 1, 2017. Both employees had received their required statutory off-duty rest. The crew moved Train Q21701 west from Cumberland to Connellsville arriving at 7:16 p.m.; they had sufficient time to work back to Cumberland and were called at 7:33 p.m., to move eastbound Train Q38831 from Connellsville to Cumberland. The outbound crew received a new dispatcher bulletin at the Connellsville Crew Room, and boarded the inbound train on Main Track No. 2. A job briefing was conducted with the in-bound crew; employees reviewed the train consist, train make-up, and location of hazmat cars. The outbound crew also conducted a job briefing with two employees on a two-unit helper consist that was already coupled to the rear of the train. Train Q38831 consisted of 5 locomotives on the head-end and 178 cars, including 128 loaded and 50 empty rail cars; it was 10,612 feet in length with 18,252 trailing tons. Two of the five lead locomotives were shut down. The train departed Green Junction (Connellsville) at 8:35 p.m. on a clear signal indication. The crew reported clear signals all the way east until stopping at Milepost (MP) BF 205.6. The Engineer said the train was sluggish and air pressure built-up slowly the entire trip. The train air brake system operating pressure was set at 90 psi. The Engineer indicated the Brake Pipe (BP) Pressure on the head-end-of-train did not get above 83 pounds and the rear-of-train BP Pressure, via his end-of-train device (ETD), never reached higher than 77 pounds. Air flow ranged from 20 to 48 cubic feet per minute (CFM) during the trip finally holding at 28 CFM. Air flow is required to be less than 60 CFM. One engine on the two-engine, rear-of-train helper ran out of fuel west of Sand Patch at Yoder(MP BF 218.4), but the train was still able to make Sand Patch Summit at MP BF 212.2. The Dispatcher Train Sheet showed Train Q38831 clearing the Sand Patch OS Circuit at 11:14 p.m. The helper was equipped with Helper Link and could cut-off at Manila MP BF 209.5, without the train stopping.

The BP air gage and EOT showed a decrease in BP pressure, indicating brake application at 11:22:55 p.m., while the train's locomotives were operating in throttle position T-5. BP pressure started to increase, indicating release of brakes at 11:24:47 p.m., as the Engineer started to throttle down to T-1 getting ready to go into dynamic brake (16 to 17 mph).

The BP air gage and EOT again showed decrease in BP pressure indicating brake application at 11:26:28 p.m., while in dynamic brake. The Engineer started to throttle up at 11:32:03 p.m., with air brakes applied. The BP pressure again started to increase indicating a release of the train brakes at 11:34:19 p.m. (17 mph), as the Engineer again started to throttle down to go into dynamic brake. At 11:34:58 p.m., as train speed increased, the Engineer made a full-service brake application to stop the train. Train Q38831 came to a stop at 11:36:42 p.m., at MP BF 205.6. The train's Conductor applied 58 hand brakes on the head-end of the train while performing a walking inspection of his train. An air leak was discovered on the one hundred and fifty-ninth car.

Relief /2nd Q38831 crew operating train at time of derailment

A home-based Cumberland crew relieved the initial Q38831 crew at MP BF 205.6 about 4 miles east of

Sand Patch Tunnel. The crew went on-duty at 11:59 p.m., on August 1, 2017, in Cumberland. The relief crew had a regular call time with ID: B248. The Engineer was the assigned Engineer, and the Conductor was called from the extra board. The Conductor was also a qualified Engineer. Both employees had received their required statutory rest.

The relief train crew arrived at the lead engine at about 1:30 a.m. A job briefing was conducted between the crews. Fifty-eight hand brakes were applied by the initial Conductor; he skipped 6 high-hand brakes (Cars 28 through 33), applying only the hand brakes with lower brake wheels as he proceeded to the rear of his train. The initial crew taxied to Cumberland to tie-up.

The relief Engineer applied the train's air brakes with a minimum brake application prior to the arrival of the car department employees. The car department workers finished the repair on the one hundred and fifty-ninth car at about 3:30 a.m. They replaced an intermediate hose (multi-piece hose with rigid center section of metal pipe) on the LW 62114; this was an empty 65-foot bulkhead flat car. The Engineer said prior to carmen repairing the car, air pressure on the rear of the train was 82 pounds; air pressure on the rear increased to 87 pounds following the repair.

The Engineer attempted to pull the train east but could not start the train with the air brake application. The Conductor walked west and released 25 of the head-end hand brakes returning to the lead engine about 25 or 30 minutes later, leaving thirty-three hand brakes applied. Train Q38831 started eastward movement down the mountain at 4:18 a.m., from MP BF 205.6. Train Q38831's Engineer said the brake pipe pressure was 81 pounds on the rear of his train and the airflow had decreased to between 0 and 18 CFM (the train's air brakes were still applied with the earlier minimum brake application). The Engineer was seated behind the engineer's console on the east/south side of the leading locomotive; the Conductor was seated in the conductor's seat on the east/north side in the locomotive cab.

The Engineer slowly throttled up to run 8 with speed increasing to 13 mph; he started back into dynamic braking at 4:23 a.m., maintaining speed at 12 mph until he saw the first eastbound signal at Philson. The train had clear signals all the way to Hyndman, Pennsylvania. The Engineer went back into power at 4:25 a.m., as the grade started to level out, advancing his throttle and increasing speed to 29 mph. The Engineer went back into dynamic brake at 4:28 a.m., maintaining speed at 27 mph until 4:30 a.m., when he went back into power pulling the train through Roddy's Sag and continued using power until the head-end of his train again started down the steep portion of the mountain.

The Accident

Train Q38831's Engineer was using dynamic brake along with first service brake application from 4:36 a.m. to just prior to the train going into emergency at 4:55 a.m. The dynamic brake had been fully applied from approximately 4:51 a.m. to 4:55 a.m. The Engineer had just set his distance counter for 9,800 feet and made an additional brake pipe reduction for a total brake pipe reduction of 10 pounds. The crew felt a lunge (slack change and emergency brake application about the same time) as the 32 cars left the rail at Shellsburg Street (Hogback Road) Crossing in Hyndman. The Engineer announced his train was in emergency over the radio and contacted the train dispatcher at 4:55 a.m.; the Conductor started walking the train. A motorist stopped and told the Engineer there had been an explosion; the Conductor saw derailed cars and flames. The Engineer called the Dispatcher at 5:01 a.m., advising the train had derailed and was on fire. The Dispatcher contacted emergency responders at 5:02 a.m., with the first responders on-site at 5:10 a.m. (times from recorded radio communication log). The Dispatcher stopped

two following eastbound trains (B261 at Fair Hope and Q252 at Glencoe).

Train Q38831 crew, shortly afterward, cleared the remaining three grade crossings in Hyndman to allow emergency vehicles easier access to the derailment site. The train went into emergency 37 minutes after departing MP BF 205.6; the distance moved was 13.3 miles. The general derailment was between MP BF 192.2 and MP BF 192.3.

Most the derailed 32 rail cars slid from CSX's right-of-way, down a small embankment into a residential area. Fifteen of the derailed cars were hazardous material tank cars, including loads of liquid petroleum gas (LPG), molten sulfur, and asphalt. Three of the loaded tank cars released product including one LPG, one molten sulfur, and one asphalt car; the escaping LPG was burning. The Hyndman Fire Chief initially called for a ½-mile evacuation, then later expanded the evacuation area to 1 mile, as the LPG continued to burn. Approximately 1,000 residents were evacuated. Two homes were destroyed; no injuries were initially reported, but at least one local resident afterward went to a local hospital in a private vehicle for treatment of a shoulder sprain, and a second resident alleges stress-related issues from a pre-existing condition. Two private contractors received first aid treatment on-site for minor cuts while repairing a crane; they continued working. Hyndman's population was listed as 875 in year 2016.

Emergency Responders included: the Hyndman Fire Department; Rescue Squad; and EMS; Bedford County EMS; Allegany County EMS; fire departments from Ellerslie, LaVale, Mount Savage, Cresaptown, District 16, and Midland Departments in Cumberland; Bedford, Shawnee Valley, Everett; and multiple other departments from nearby communities. The Pennsylvania Emergency Management Agency and Pennsylvania governor were on-site. Pennsylvania State Police also played an active part throughout the incident.

Both CSX Main Tracks were blocked; Amtrak Trains 29 and 30 between Pittsburgh and Washington, DC, were unable to operate for several days, and Amtrak passengers were bussed. Two eastbound trains on Main Track No. 2 were stopped behind Train Q38831. No westbound trains were moving on Main Track No. 1 between Cumberland and Hyndman.

Air quality issues delayed work Thursday, August 3, and early Friday morning, August 4. Engineering forces installed eight track panels on Main Track No. 2, and two track panels on Main Track No. 1. The railroad reopened Main Track No. 1 at 9:30 a.m., on Saturday, August 5, moving its first train since the derailment. Main Track No. 2 was reopened a short while later. The evacuation order was lifted at 12:00 p.m., on August 5, 2017, and most of the residents could return to their homes.

Post-Accident Investigation

The initial point of derailment (POD) was at MP BF 193.7 about 9,000 feet prior to the general pile-up in Hyndman at MP BF 192.3. The first car to derail was an empty; (FWTX 620111) the thirty-fifth car in the train (not counting the locomotives). The lead wheels on the lead/east truck climbed the high-side of the north rail and rode the top of the rail for 24 inches before dropping to the ties at MP BF 193.7. The car was coming out of an 8.375-degree, right-hand curve; the train was on a descending grade of 1.67 percent. The thirty-fifth car was the only car derailed until it impacted the highway grade crossing at Shellsburg Street/Hog Back Road (MP BF 192.3 DOT No. 145073M) in Hyndman. The lead engine stopped just east of Market Street Road Crossing (MP BF 191.7 Number 145071Y) approximately 500 feet after the train went into emergency.

Train speed was 24 mph at the time the first car derailed. The Engineer had a minimum brake pipe

reduction applied since starting down the hill, and was increasing dynamic brake from the number 6 to number 8 throttle position as speed increased from 24 to 29 mph, just prior to the general pile-up at Hyndman. The train went into emergency just seconds after the Engineer made an additional 2- to 3-pound reduction prior to releasing air brakes. Allowable freight track speed is 30 mph as listed in Baltimore Division Timetable for the Keystone Subdivision. CSX Air Brake and Train Handling Rule 5553.4 requires the increased brake-pipe reduction to allow for a cleaner release of the train's air brakes. Train Q38831 had three engines on-line with the equivalent of 21 axles of dynamic brake, and that was rated for up to 19,000 trailing tons. Train Q38831 had 18,252 trailing tons, and was permitted to run track speed of up to 30 mph, as listed in CSX Baltimore Division Timetable Special Instructions (TTSI) for the Keystone Subdivision. Train Q38831 had the equivalent of 21 effective dynamic brake axles (EDBA).

The lead locomotive is a newer type unit, having greater dynamic brake forces or an extra three axles of equivalent EDBA. Three of the 5 locomotives were on-line and working for a total of 18 powered axles, with 21 axle equivalent of EDBA.

Train Q38831 passed over a combination Hot Box equipment/dragging equipment detector at Glencoe MP BF 200.3; no defects were recorded.

The Engineer stated, in a post-accident interview, the train handled like any other train coming down the mountain. He reported experiencing no air or other problems; EOT communication was good. The lead engine event recorder did log two short periods of "no com" during the descent; the first one lasting 1-minute and the second lasting 1-½ minutes. Brief periods of 'no com' can occur as the train navigates around curves while descending between the hills in the steep grade territory. The Engineer noticed no difference in handling even with the hand brakes still applied.

The thirty-fourth through sixty-fifth car (not including locomotives) derailed in the community of Hyndman. The thirty-fifth car was the actual first car to derail about 1.7 miles west of the general pile-up of rail cars. Train Q38831 was 10,612 feet long and had a total of 18,252 trailing tons, with mostly empty cars on the head-end. Tonnage from the first car to the thirty-fifth car was 1,585 tons; the trailing tonnage behind the thirty-fifth car was 16,585 tons.

Five loaded cars were in positions 9, 10, 12, 13, and 14 with a total of 36 empty cars between the locomotives and forty-third car. Car position 1 is the first car behind the engine consist. Fifteen hazardous material tank cars derailed starting with the forty-fifth car; 13 of those cars were loaded; 2 were residue empty cars. Three of the loaded cars contained LPG/NA1075 Class 2.1 product, eight were loaded with molten sulfur/NA2448 Class 9 product, and two held asphalt/UN 3257 Class 9 products. The two hazardous residue empty cars last contained phosphoric acid/NA1805 Class 8. Three of the tank cars released hazardous material including one loaded car of LPG (Car 53), one loaded car of molten sulfur (Car 49), and one loaded car of asphalt (Car 46).

The Conductor on the initial crew had applied 58 hand brakes to hold the train at MP BF 205.6, while the air brake system was being recharged. He skipped the hand brakes on Cars 28 through 33 because of brake wheels being mounted higher on the cars making it more difficult to apply the brakes.

Train Q38831's relief crew had left 33 hand brakes applied prior to departing east from MP BF 205.6.

The last hand brake left applied was on Car 64. Thirteen hand brakes remained applied on empty cars and 20 hand brakes remained applied on loaded cars.

Crew interviews and post-accident fact-finding indicate the following hand brakes were left applied as the

train descended the mountain:

- Thirty-one hand brakes were applied (Cars 34 through 64)
- Two hand brakes were applied (Cars 26 and 27)

The train crew explained it was customary and permissible by rule to leave the hand brakes applied to help control speed should additional air problems be encountered (undesired emergency or unintentional release) as they moved down the mountain. The crew planned to stop and release the remainder of the hand brakes at the bottom of the mountain at Ellerslie, Maryland, MP BF 183.8.

Analysis and Conclusions

Analysis-Title 49 Code of Federal Regulations (CFR) 219 Subpart C Testing: the Engineer and Conductor of Train Q38831, operating the train at time of derailment, underwent Federal Railroad Administration (FRA) Post-Accident Testing at the Western Maryland Health System's Occupational Health Center in Cumberland. Results were negative.

Conclusion: FRA determined alcohol and drug use did not contribute to the cause or severity of the derailment.

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

FRA obtained hours of service (HOS) and fatigue-related information for the 10-day period preceding the derailment for both crews who handled Train Q38831. All employees had received their statutory off-duty rest periods. The analysis indicated employees from each crew had signs of varying degrees of fatigue below the baseline of 77.5 percent, however, fatigue was not a probable cause.

Conclusion: Upon analysis of the above information, FRA concluded that while the employees were operating under varying degrees of fatigued state, their actions were not a factor in the derailment.

Analysis-Video from Forward-facing and Inward-facing Locomotive Camera: FRA reviewed inward-cab and forward-facing lead locomotive camera video at the National Transportation Safety Board's (NTSB) labs in Washington, DC. Video was viewed from the point where Train Q38831's relief crew started eastward movement from MP BF 205.6 to the point where the train was going into emergency at Hyndman, MP BF 192.3.

Crew members appeared alert and engaged. There was no visible use of cell phones or personal electronic devices; there did not appear to be any distractions. No track irregularities were visible at the initial POD.

Conclusion: FRA determined the track and crew activities observed on the inward and outward facing cameras did not contribute to the cause or severity of this derailment.

Analysis-Electronic Devices (Cell Phones and Texting): A subpoena was secured to acquire cell phone records of employees operating Train Q38831 prior to the derailment. The Engineer's cell phone and text records showed no use. The Conductor had a pre-paid phone making it more difficult to secure records. Records also indicate that no phone calls were made prior to boarding the train and during the brief trip from MP BF 205.6 to the derailment site at Hyndman.

Conclusion: Based on review of documents provided to FRA and viewing locomotive cab video of train crew employees, FRA's investigation shows the use of cell phone/electronic devices was not a factor in

the derailment.

Analysis-Engineer and Conductor Certification and Training: FRA reviewed certification records for both crews that handled Train Q38831. CSX provided 6 years of data for each employee. Records included national and State driving records, vision and hearing, knowledge tests, skills tests, annual monitoring rides and annual efficiency tests.

The Engineer operating the train at the time of the derailment was re-certified on December 31, 2016, and his Conductor was re-certified December 31, 2015. The employees each have 19 years of service. The Engineer worked most of his career as an Engineer. The Conductor worked as an Engineer from February 2009 until July 25, 2017. The Conductor had just placed himself on the conductor's list the week prior to the accident.

FRA also reviewed certification records for the crew that was relieved at MP BF 205.6 after experiencing an undesired release of the train's air brakes. The Engineer was re-certified on December 31, 2014. He was hired as a conductor in 2004, and was promoted to engineer in 2012. The Conductor was certified on December 31, 2016; he was hired in March 2015.

Conclusion: Engineer certification and training for both engineers was current and in compliance with 49 CFR Part 240. Conductor certification and training for both conductors was current and in compliance with 49 CFR Part 242. Certification and training was not a factor in the cause of the derailment.

Analysis-Operational Testing and Rules Compliance: CSX managers conducted a total of 2,802 tests/observations on train and engine service employees on the Keystone Subdivision between January 2016 and July 2017. Tests were conducted during varying days of the week. Sixty-seven percent of the total tests were between the hours of 5:00 p.m. and 5:00 a.m. Three hundred and fifty-seven tests were conducted on weekends.

Operational tests for Q38831 employees operating train: (January through July 2017)

- **Engineer** – 14 tests with no failures. Tests included train movement rules, signal compliance, air brake inspections, hazmat rules, protection of shoving moves, and equipment clear of foul points.
- **Conductor** – Eight tests with no failures. Tests included train movement rules, protection while shoving equipment, and signal compliance.

Operational tests for initial Q388 crew relieved at MP BF 205.6: (January through July 2017)

- **Engineer** – 13 tests with no failures. Tests included train movement rules, air brake inspections, hazmat rules, protection of shoving moves, and equipment kept clear of fouling signal.
- **Conductor** – 13 tests with no failures. Tests included train movement rules, protection of shoving moves, on-track equipment safety, equipment clear of fouling points, and use of electronic devices.

Conclusion: Operational testing was in compliance with CSX Guidelines for Operational Testing and Data Reporting. Operational Testing procedures were not a factor in this derailment.

Analysis-Train Handling, Carrier Operating Procedures (including timetable special instructions and system and division bulletins): FRA reviewed carrier operating rules, train handling and equipment rules, timetable special instructions, and CSX System and Baltimore Division Operating Bulletins. Traffic Control System Rules are in effect; train movement is authorized and governed by signal indication. Positive Train Control for the territory was down for a scheduled outage; the train was equipped with Trip-Optimizer, but the train was under control of the Engineer. A Trip Optimizer does not function in heavy grade territory.

CSX System Bulletin 001 (page 22; (Effective July 1, 2017)), lists changes for Equipment Handling Rule 4466. The rule reads as follows:

When placing empty cars in mixed freight trains (1) When train tonnage exceeds 6,000 tons, do not place one or more empty flat cars over 80 feet within the first 10 cars, and (2) Do not place solid blocks of six or more loaded cars directly behind solid blocks of 30 or more empty cars.

Train Q38831 had multiple blocks of empty cars through-out the train but did not exceed the 30-car empty restriction ahead of loaded cars. The train had 36 empties located within the leading 42 cars of the 18,252-trailing ton train.

CSX Timetable Special Instructions (Effective July 1, 2016) Rule 5559 (page 63) requires a minimum of 20 EDBA on trains with more than 17,000 trailing tons to operate at 30 mph when descending Sand Patch Grade. CSX Air Brake Train Handling Rules (Effective April 2017) Rule 5507.6 (page 9-6) assigns dynamic brake axle value per locomotive class. Train Q38831 had the equivalent of 21 EDBA; only 3 of the 5 locomotives were on-line and working for a total of 18 powered axles. The lead locomotive is a newer type unit having greater dynamic brake forces or an extra three axles of equivalent EDBA.

The Engineer handled train within guidelines of CSX Train Handling and Operating Rules and Procedures. The Engineer was compliant with air and dynamic brake instructions, with the train being handled in accordance with signal indications, moving at or below posted speeds.

A railroad operating rule/procedure was reviewed during the investigation that contributed, in-part, to the cause of the accident. Keystone Subdivision ITEM 5559 STEEP GRADE (1 percent or more) TRAIN HANDLING (Page 62) of the Baltimore Division Timetable dated July 1, 2016, required crews to apply a minimum of 30 percent hand brakes when trains are stopped on the mountain to recharge the air system.

The rule permitted train crews, if needed, to leave hand brakes applied on cars to supplement air brakes while descending the rest of the grade. The instruction advised crews to avoid leaving hand brakes on empty cars; it did not indicate location for brakes left applied. The procedure required crews to stop after descending the mountain and release hand brakes. The carrier has allowed crews to leave hand brakes applied in lieu of using retainer valves.

After the repair was completed; Train Q38831's relief Engineer made a minimum brake application and attempted to start the train eastward down the steep descending grade. He was unable to move the train. The Conductor released 25 of the hand brakes on the head-end of the train but left the remaining hand brakes applied. Hand brakes were left applied on 13 empty cars and 20 loaded cars. Train Q38831 departed east down the mountain from MP BF 205.6. The initial POD was at MP BF 193.7; the lead/east wheels on empty Car 35 derailed. The lead truck on the empty car went 9,000 feet before reaching the highway rail grade crossing at Shellsburg Street when the remaining 31 cars derailed. The lead wheel on the first car to derail had a heavy tread build-up; the hand brake had been left applied.

There was also a tread build-up on the lead wheel of the trailing truck. Additional wheel sets on other cars had bluing of wheels and showed varying degree of tread build-up.

Conclusion: Train make-up was within guidelines of CSX Operating Rules and TTSI. Train Q38831 was operated in accordance with Train Handling Rules and Guidelines. TTSI Rule 5559 permitted hand brakes to remain applied on trains experiencing air problems on Sand Patch Grade, but failed to identify location of hand brakes in the train and restrict hand brakes applied on empty cars in manifest trains.

FRA determined the hand brakes left applied on the empty cars were a factor in the derailment.

Analysis-Mechanical (Locomotives): CSX Train Q38831 consisted of five head-end locomotives and no distributed power locomotives. Three of the locomotives were on-line (providing tractive effort) and two were dead-in-tow (moving for repair). FRA conducted a comprehensive inspection and review of the locomotives.

The lead locomotive (CSXT 3338) was a six-axle, two-truck design, 4,400 horsepower (hp), General Electric (GE) model ET44AC. It was built in 2015. The first trailing locomotive (CSXT 4040) was a six-axle, two-truck design, 3,000 hp, Electro-Motive Diesel model SD40-3. It was built in 1980. The second trailing locomotive (CSXT 8540) was a six-axle, two-truck design, 3,000 horsepower Electro-Motive Diesel model SD50-3. It was built in 1984. Periodic and daily inspections on locomotives were current. No defects were noted on the report as part of this inspection.

The third trailing locomotive (CSXT 5359) and fourth trailing locomotive (CSXT 7921) were being moved dead-in-tow for repair.

Conclusion: FRA concluded the mechanical condition of the locomotives was not a contributing factor in the derailment.

Analysis-Mechanical (Pre-Accident Inspection of Cars): CSX Train Q38831 was assembled and originated in Chicago, Illinois, with 136 cars on July 31, 2017. Twenty-eight additional cars were added in Lordstown, Ohio, and 14 were added in New Castle, Pennsylvania on August 1, 2017; making Train Q38831's train consist total 178 cars, at the time of the derailment.

Records reviewed indicated that Train Q38831 was assembled from two previously tested and mechanically inspected blocks of cars. The first block of 74 cars (1–74) received a Class I brake test and mechanical inspection by CSX-qualified mechanical department personnel in Chicago, on July 31, 2017, with no defects noted. The second block of 62 cars (75–136) received a Class I brake test and mechanical inspection by Belt Railway Company-qualified mechanical department personnel in Chicago, on July 31, 2017, with no defects noted. The assembled 136 cars had an ETD, CSXE 41811, applied and telemetry tested, also in Chicago, on July 31, 2017, at 9:40 p.m.

When Train Q38831 arrived at Lordstown, 28 additional cars were added to the head end of the train. These 28 cars received a Class I brake test and required inspection by CSX's transportation department personnel (train crew of Q38831) in Lordstown, on August 1, 2017, with no defects noted.

Leaving Lordstown, Train Q38831's consist had 164 cars as indicated by an AEI wayside detector.

When Train Q38831 arrived at New Castle, 14 additional cars were added near the head-end of the train (Cars 9–22). The 14 cars received a Class I brake test and required inspection by CSX's transportation department personnel (train crew of Q38831) in New Castle, on August 1, 2017, with no defects noted.

Leaving New Castle, Train Q38831's consist had 178 cars as indicated by an AEI wayside detector.

Conclusion: A comprehensive review of the available documentation and records was conducted. FRA determined there was no verification or validation of the presence of any noncompliant mechanical issues during the required FRA regulatory inspections performed prior to departure of Train Q38831 that would have been considered a contributing factor to this derailment.

Analysis-Mechanical (Defective Condition In-Route): As Train Q38831 proceeded past the Sand Patch Summit at MP BF 212.2, the Engineer indicated, and the event recorder confirmed, abnormalities with the train line airbrake pressures at the rear of the train compared to the front of the train; as indicated by the ETD to the head-of-train device. These observed abnormalities and the approaching descending grade

concerned the train crew enough to stop Train Q38831 at MP BF 205.6. The Conductor then disembarked the locomotive and proceeded to apply 58 hand brakes to the cars (1–27 and 34–64) to secure the train from an unintended air brake release. The hand brakes of Cars 28–33 were not applied due to the hand brakes being mounted high on the car. The information regarding which hand brakes were applied was established by the post-accident interview of the Conductor and post-accident investigation.

After securing the train, the Conductor made a walking inspection of Train Q38831. At Car 159 (LW 62114; a bulkhead flat), the Conductor found an air leak to the brake pipe train line at the car's B-end intermediate brake pipe hose. The Conductor then returned to the lead locomotive where he and the Engineer remained, while waiting for a relief crew, due to HOS.

Mechanical department employees replaced the hose, informed the train crew (relieving crew) of the repair, and remained on-site to provide additional assistance if needed.

After restoring the air to the brake pipe train line, the relief Conductor released 25 hand brakes leaving 33 applied prior to movement of the train eastbound towards Cumberland.

Conclusion: A comprehensive review of the defective condition and the repair was conducted. FRA concluded the defective condition observed, and subsequent repair, was not a contributing factor in the derailment.

Analysis-Mechanical: Train Q38831 had an undesired emergency brake application (UDE) occurring at about 4:55 a.m. (event recorder time) when the lead locomotive was near the grade crossing (Crossing ID: 145072F) at Center Street in Downtown Hyndman. The lead locomotive then travelled approximately 500 feet to a complete stop just east (timetable direction) of the grade crossing at Market Street (Crossing ID: 145071Y). The UDE was the result of train line brake pipe separation that occurred when 32 cars derailed.

The locomotives were disconnected (cut) from the remaining train and moved east about 7.5 miles, directly behind the Incident Command Center that was established at the Hyndman Ministry Center. FRA conducted an inspection and review of the locomotives at this location on the afternoon of August 2, 2017.

Midday, on August 3, 2017, the derailment site was partially open for investigation, allowing review of the equipment (cars) that remained on the rails and the POD.

The 33 cars (not including locomotives), in positions 1–33, east of the general pile-up were initially reviewed. Car 10 (TILX 261890), a loaded hazardous material tank car, was found with the hand brake partially applied due to the brake rigging binding on the crossover platform. There were no other notable findings. Thirty-one cars (positions 1–31) were moved from the derailment site to CSX's Yard in Cumberland, for further testing and inspection.

The 112 cars in positions 67–178 (not including locomotives) west of the general pile-up were reviewed.

A truck spring was found lying in the gage beneath the trailing-end of Car 178 (CAN 404841). Minor tie damage and displaced ballast was also observed beneath the cars inspected. There were no other notable findings. One hundred and eleven cars in positions 68–178 (not including locomotives) were moved from the derailment site to CSX's Yard in Connellsville, for further testing and inspection.

The POD was established by FRA investigators late on the afternoon of August 3, 2017. FRA found evidence that a wheel climbed the high-side of the north rail on Main Track No. 2, while coming out of an

8.375-degree, right-hand curve on a descending grade of 1.67 percent. This was followed by an additional wheel climbing within 30 feet on the north rail as well. Evidence of wheel flanges on the rail were evident. Flange marks on the ties, inside the gage, were also observed.

On August 3, 2017, investigation, restoration, and remediation activities commenced at the east-end of the general pile-up. All derailed cars were observed to have their hand brakes applied; except for those where the damage made it impossible to determine. Numerous overheated wheels, some with build-up tread, were identified.

The first car derailed (in direction of movement) in the accident was FWTX 620150 (position 34). The next car, FWTX 620111 (position 35), was observed coupled on the east-end to the west-end of FWTX 620150 (position 34), nearly perpendicular to Main Track No. 1 and No. 2, with both trucks displaced.

There was a separation of about 300 feet between FWTX 620111 (position 35) and FWTX 620064 (position 36).

During the investigation, restoration, and remediation activities on August 4, 2017, CSX personnel discovered a freight car truck with damage consistent with being derailed prior to the location of the general pile-up. The wheelsets from the truck were also identified. The lead truck and wheelsets were discovered approximately 100 feet southwest of the Schellsburg Street / Hogback Road crossing. (Crossing ID: 145073M)

On August 5, 2017, an initial review of the truck and wheelsets was performed. The post-derailment location of the FWTX 620111 (position 35) was approximately 600 feet east of where its lead truck was discovered. The trailing truck was found near the east-end of the general pile-up approximately 300 feet from the post-derailment location of FWTX 620111.

Midday, on August 6, 2017, an initial review of the trucks from FWTX 620111 was conducted. The examination showed evidence the lead truck had derailed prior to the general pile-up with excessive overheating and tread build-up observed on one wheelset. Additional damage indicated that both wheelsets had been off the rail/on the ground prior to the general pile-up. The trailing truck, car body, center plates, and body side bearings were also examined.

The head 31 cars of Q38831 received a Class I brake test and mechanical inspection at CSX's Cumberland Yard on August 3, 2017. FRA observed 13 defective/noncomplying air brake conditions, according to 49 CFR § 232.103(f)(3). Eleven cars did not apply brake cylinder pressure or did not maintain brake cylinder pressure after applied. These 11 cars were requested to have Single Car Air Brake Test (SCABT) performed.

The rear 111 cars of Q38831 received a Class I brake test and mechanical inspection at CSX's Connellsville Yard on August 4, 2017. FRA did not observe any defects during the inspection.

On August 9, and August 10, 2017, SCABT was performed at the CSX Yard in Cumberland to the 11 cars found with components requiring minor repairs during the initial testing performed on August 3, 2017. The testing confirmed the required minor repairs. All identified repairs were made by the railroad.

On September 6, 2017, the ETD, CSXE 41811, from Train Q38831 was tested at the manufacturer's (Siemens) facility in Marion, Kentucky, and witnessed by CSX and FRA. The test results indicated several failures. Most notable regarding the derailment, the ETD was leaking air near the connection to the brake pipe. The ETD was returned to CSX's Yard in Cumberland, for additional testing and review.

On September 19, and September 20, 2017, an extensive review of FWTX 620111 (position 35) and

review of documentation was conducted. FWTX 620111 became a primary car of interest at the derailment site. The truck and two wheelsets, identified as belonging to FWTX 620111, were found near the grade crossing at the west-end of the general pile-up. The indications the truck had derailed prior to the general pile-up included gouges on the bottom of the side frame (consistent with impact with the rails), damage to the inside vertical surfaces of the side frame (where the wheel made contact), and damage to the tread of the wheels (consistent with contact with the roadbed). This truck was identified to be from the A-end of the car. A review of supporting documentation indicated that the A-end was the leading-end (in direction of movement) of FWTX 620111 on Train Q38831 at the time of derailment. All the wheels of the car had indications of overheating. The overheating of the wheels of the number 4 and the number 2 axles (first and third axles in direction of movement) were observed with a reddish-brown discoloration on both the front and back of the rim; extending more than 4 inches into the plate. These are defective/noncomplying conditions according to 49 CFR § 215.103(h). The wheels of the number 4 and the number 2 axles were also observed to have extensive built-up tread caused by the wheels sliding on the rail.

On October 17, 2017, a review (brake pipe leakage test) of the EOT (CSXE 41811) and defective intermediate brake pipe hose from LW 62114 (position 159) of Train Q38831 was conducted at CSX's Yard, in Cumberland. To simulate Train Q38831, 147 cars were assembled with 4 locomotives. The review indicated that adding the EOT and defective brake pipe hose resulted in an additional 2 psi/6 CFM of brake pipe leakage.

FRA reviewed data from the previous wayside detector the train passed through prior to derailment. The detector was located at Glencoe MP BF 200.3; the train passed over the detector at 4:33 a.m. The Glencoe detector is located less than 7 miles prior to the POD and monitors axle journal bearings for overheating/failure. No defects were indicated by the Glencoe detector as the train passed through. The previous 90 days of wheel impact wayside detector data was requested and reviewed for the first 66 cars of Train Q38831. The 66 cars include all cars that derailed and any that passed beyond the general pile-up without derailing. The data was reviewed for the cars and they exhibited normal impact readings. The previous wheel impact wayside detector that FWTX 620111 passed over was the Sleepy Creek wayside detector at MP BA 117 on July 29, 2017, at 9:07 a.m. The report indicated that the car was loaded to a weight of 154.68 tons (309,360 pounds). The highest impact recorded to the car was 51.01 kips (51,010 psi) at the right-side number 4 wheel; well below the limit that the railroad industry has established for concern.

Conclusion: The identified air brake conditions to the east-end cars that did not derail were reviewed.

While minor repairs were required, these conditions were not contributing factors to the derailment. The leaking intermediate air brake hose on LW 62114 and EOT (CSXE 41811), contributed to the original train crew stopping Train Q38831 for inspection at MP BF 205.6. The actions of the train crew of Q38831 were consistent with both the railroad operating rules and general safety, and were not a contributing factor to the derailment.

The observed and documented wheel conditions to FWTX 620111, built-up tread, was concluded to be a contributing factor to the derailment.

Overall Mechanical Conclusion: FRA conducted a comprehensive and all-encompassing mechanical investigation of this derailment. FRA concluded that FWTX 620111, an empty car, had the hand brake

applied at MP BF 205.6 due to an en route condition requiring Train Q38831 to stop and be secured from movement. As normal movement was restored, the hand brake on FWTX 620111, plus the hand brakes on an additional 32 cars remained applied. As Train Q38831 descended the grade, approaching the POD, the wheels from FWTX 620111 began to overheat. The wheels on axle 4 and 2 (first and third in the direction of movement) overheated developing built-up tread caused by the wheel sliding on the rail.

As FWTX 620111 reached the POD, with the built-up tread (including the flange throat) on the leading north side wheel, it intersected an 8.375-degree, right-hand curve on a descending grade of 1.67 percent, producing lateral vs vertical (L/V) forces that were greater than the car could sustain to remain on the rail. The leading truck (in direction of movement) derailed at about MP BF 193.7, remaining derailed for about an additional 9,000 feet until reaching the Schellsburg Street/Hogback Road grade crossing where it impacted the grade crossing, causing the truck to be extricated from the car to the southwest. The trailing truck of the car remained attached as the rail was compromised and the cars behind began to derail and pile-up. The trailing truck was displaced approximately 300 feet east of the crossing, at the east-end of the subsequent general pile-up. FWTX 620111 detached from the car behind and was drug (on the ground without trucks) an additional 300 feet east, beyond the general pile-up, before stopping at the location it was observed post-derailment.

FRA's mechanical investigation determined the probable cause of the derailment was built-up wheel tread.

Analysis-Hazardous Material Train Consist and Shipping Documentation: Seventy of the 178 rail cars, were described as hazardous materials shipments (66 loads, 4 residue). Of the 32 rail cars involved in derailment, 15 were described as hazardous materials shipments (13 loads and 2 residue empties). 3 of the 15 rail cars (positions 46, 49, and 53) released hazardous materials.

The below listed cars do not include the locomotive consist.

- **Position 45** – GATX 3501, 1 C/L, UN3257, Elevated Temperature Liquid, N.O.S, (PG 64-22), Class 9, PG III. Not Leaking.
- **Position 46** – **UTLX 643949**, 1 C/L, UN3257, Elevated Temperature Liquid, N.O.S, (PG 64-22), Class 9, PG III. **Leaking, released approximately 14,092 gallons of Asphalt.**
- **Position 47** – SUJX 299101, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 48** – SUJX 299124, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 49** – **ITDX 5082**, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. **Leaking, released approximately 13,229 gallons of Molten Sulfur.**
- **Position 50** – WACX 151157, Residue, Last Contained, UN1805, Phosphoric Acid Solution, Class 8, PG III, RQ (Phosphoric Acid). Not Leaking.
- **Position 51** – SHQX 5290, 1 C/L, UN1075, Liquefied Petroleum Gas, Class 2.1, (Odorized). Not Leaking.
- **Position 52** – SHQX 5771, 1 C/L, UN1075, Liquefied Petroleum Gas, Class 2.1, (Odorized). Not Leaking.
- **Position 53** – **CBTX 781553**, 1 C/L, UN1075, Liquefied Petroleum Gas, Class 2.1, (Odorized). **Leaking, released approximately 29,712 gallons of LPG (Propane).**
- **Position 58** – TILX 140006, Residue, Last Contained, UN1805, Phosphoric Acid Solution, Class 8, PG III, RQ (Phosphoric Acid). Not Leaking.

- **Position 61** – TILX 135361, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 62** – SHLX 383, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 63** –FHRX 136000, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 64** –KLRX 136143, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.
- **Position 65** –FHRX 135930, 1 C/L, NA2448, Sulfur, Molten, Class 9, PG III. Not Leaking.

FRA performed a detailed review of the train crew's original train consist, notice to train crews document (CT 168), shipping papers, and emergency response information. Position of hazardous material rail cars was verified by use of AEI scan and determined that all hazardous materials cars were correctly positioned in the train as detailed on train documents in possession of the crew. FRA determined that CSX complied with Hazardous Materials Regulations regarding shipping documentation, hazardous materials description, emergency response information, and train placement.

Conclusion: FRA determined the carrier's documentation was not a factor in the derailment or emergency response.

Analysis-Shipper Pre-Transportation Function Assessment: FRA performed a detailed review of bills of lading, pre-trip inspection reports, and safety data sheets provided by the shipper for tank cars involved in the derailment.

FRA concluded that the shipper properly classed the material, selected the proper package, and prepared the shipments for rail transportation.

Conclusion: Shipper functions were not a factor in the outcome of this derailment.

Analysis-Tank Car Assessment: On August 4 and 5, 2017, a tank car damage assessment of the 15 tank cars involved was performed with NTSB and FRA present. Industry representatives from Trinity Rail Car and CSX Hazardous Materials Personnel were also present for these damage assessments.

The Hazardous Materials Group recorded two sets of observations: FRA/NTSB/CSX subgroup observations appear on FRA tank car damage assessment forms, while Trinity subgroup observations are recorded on separate tank car damage record forms. The following is the damage assessment for the three tank cars that released hazardous materials:

- **Position 46:** UTLX 643949, a DOT111A100W1 (jacketed, 4 inches of insulation) specification tank car, no headshield or thermal protection. Damage included the following:
 - A-end draft sill twisted and broken, coupler missing.
 - B-end draft sill in place, coupler broken.
 - 8-foot by 8-foot by 2-foot deep dent to shell/jacket on left side, center.
 - Bottom outlet valve nozzle and cap torn off.
 - Bottom outlet valve operating handle bent.
 - Bottom outlet valve was in place with ball valve in the open position.
 - Hazardous material (asphalt) released through the open ball valve.
 - Approximately 14,092 gallons of asphalt was released.
- **Position 49:** ITDX 5082, a DOT111A100W1 (jacketed, 6 inches of insulation) specification tank car, no headshields or thermal protection. Damage included the following:
 - 7-foot transverse mechanical shell tear to the center of the BR side.
 - 32 inches by 18 inches puncture to AL side, 7-8 o'clock position.
 - BL side bolster bent inboard with witness mark on bolster web.

- BL side shell flattening.
- Bottom outlet valve nozzle and cap sheared off.
- Bottom outlet valve operating handle bent.
- Bottom outlet valve was in place with ball valve in the open position.
- Hazardous material (molten sulfur) was allowed to release through mechanical tear, puncture, and opened ball valve.
- Approximately 13,229 gallons of molten sulfur was released.
- **Position 53:** CBTX 781553, a DOT112J340W (jacketed, .5-inch thermal protection) specification tank car, .5-inch head shields. Damage included the following:
 - Approximately 3.25-inch longitudinal puncture with approximately 1-inch leg on AR side, 3 o'clock position.
 - Shell bulge measuring 27 inches by 56 inches by 6 inches in height, located above AR side bolster web.
 - Hazardous material (propane) released through puncture.
 - Approximately 29,712 gallons of propane released.

Conclusion: FRA determined that although the tank cars received severe damage, none of these cars' conditions contributed to the cause of this accident, but were rather a secondary occurrence because of the accident.

Analysis-Signal System: The method of train operation on the Keystone Subdivision is by signal indication of a traffic control system (TCS), CSX Operating Rule 510. The "BB" train Dispatcher located at CSX's Baltimore Division office in Baltimore, Maryland, coordinates train movements with the signal system through a Union Switch and Signal (US&S) Computer Aided Dispatching System (CADS). The maximum timetable speed for trains operating near the derailment is 30 mph for freight trains and 35 mph for passenger trains. The signal system in the area of the derailment consists of GE ElectroLogIXS electronic track circuits. Control Point (CP) Hyndman is controlled via Vital Harmon Logic Controller (VHLC). Dispatch interface is accomplished via phone line with a cellular backup. The power-operated switch machines consist of US&S M-23A switch machines. The signals at CP Hyndman and the intermediate signal locations consist of Safetran color light signals. A combination dragging equipment and hot bearing defect detector is located at MP BF 200.3 on this track. FRA's signal inspector, during a field inspection on August 3, 2017, observed numerous tests performed by railroad signal maintenance personnel at CP Hyndman, signal location 1919, signal location 1944, signal location 1968, and signal location 1994. The testing performed at these locations included track circuit shunting and grounds tests as well as verifying input/outputs of electronic equipment and correct software revisions. FRA's Signal Inspector also verified the correct signal sequence by verifying proper aspects were displayed at all signal locations. FRA's inspector took exception to the circuit plans at CP Hyndman having more than one change in colored pencil. This defect did not affect the proper operation of the signal system. Signal test records for the previous 12 months were reviewed in a follow-up inspection. Data log downloads from CP Hyndman, signal location 1944, US&S CADS (CP Hyndman to CP Manila), and equipment defect detector were also reviewed and inspected. FRA took no exceptions to records or downloads reviewed. The signal system sustained minor damage as a result of the derailment. One gate mechanism was damaged beyond repair and was replaced at Shellsburg Street in Hyndman. The damage costs are estimated to be \$10,000.

Conclusion: CSX's signaling system was found to be operating as intended and was not a factor in the derailment.

Analysis-Track: This portion of CSX's Keystone Subdivision consists of double main track. An average of thirty trains move over the subdivision daily; CSX documentation indicates about 70.1 million gross tons of freight moved over the route in 2016. Rail is 136- to 141-pound continuous welded rail (CWR). The eastbound train traversed a grade ranging from .50 to 2.12 percent beginning at MP BF 210.8 (top of grade) to MP BF 192.3

(location of general pile-up); the train was on a descending grade of between 1.65 and 2.08 percent from MP BF 195.2 to the initial POD at BF 193.7. At the POD, the train was traversing a right-hand, 8.375-degree curve, with 3.21 inches of super-elevation (outer rail of curve elevated above the inner rail of curve). The wooden crossties measured 9-inches by 7-inches by 8-feet 6-inches long, spaced 19.5 inches on center (nominal). The rails were fastened to the crossties using Pandrol Plates fastened with one cut spike on the field and gage side of each rail, and two lag screws on the field and gage side of each rail. A Pandrol Clip is used on the gage and field sides of each rail. The fasteners are used to maintain gage and alignment of the track as well as restrain longitudinal movement of the CWR. The track was supported by granite rock ballast. CSX inspects and maintains track on this portion of the Keystone Subdivision to FRA's Track Safety Standards (TSS) for Class 3 track, which allows for a maximum operating speed of 40 mph for freight trains and 60 mph for passenger trains. Amtrak passenger rail trains operate over this line 7 days per week. It was determined the POD was at MP BF 193.7 on Main Track No. 2. A flange mark traversing was identified over the top of the rail head of the high-rail in the curve. The flange mark was determined to be about an 8-degree angle. Corresponding wheel departure marks were identified across the top of the rail head of the low rail of the curve. Investigators also documented flange and tread marks from the derailed car wheels that were found on various track components. The POD was 1.7 miles/8,976 feet west of the highway rail grade crossing (Shellsburg/Hogback Road) where the additional rail cars departed the tracks. Track note measurements taken in the derailment area revealed an average degree of curvature of 8.375-degrees, with about 3.2 inches of super-elevation. Based on FRA curve elevation and speed limitation (Vmax), the curve qualified to be operated at 32.5 mph for 3-inch unbalance. Track notes revealed that within the stations documented in the full body of the curve-track gage was 57 3/8 inches. Track alignment was uniform, crosstie conditions met applicable standards, no track surface conditions were noted, rail fasteners were in place, secure, and ballast and drainage conditions were acceptable. Some curve wear was evident on the high rail of the accident curve, but was within Federal and carrier specifications. Eight 40-foot track panels were installed on Main Track No. 2 and two 40-foot track panels were installed on Main Track No. 1. FRA reviewed track inspection reports for 1-year prior to the derailment, FRA's Track Geometry Car No. 2 (TGC2) track inspection data, and CSX's Track Geometry Measurement Vehicle number 2 (GMS 2) rail inspection records. Carrier surfacing, track disturbance, and rail change-out records were also reviewed.

Conclusion: Track and roadbed in the area preceding, and at POD met Federal and carrier track standards. Track condition was not a factor in the derailment.

Overall Conclusions

CSX Operating Rule/Item 5559 in Baltimore Division Timetable for Keystone Subdivision permitted crews to leave hand brakes applied on cars to supplement air brakes to descend Sand Patch Grade if trains were stopped to recharge the air brake system. Thirty percent hand brakes are required for this procedure. Verbiage indicated crews were to avoid leaving hand brakes on empty cars. The rule did not specify what position in the train hand brakes were permitted to be left applied. The hand brake left applied on the empty thirty-fifth car produced excessive brake component forces to the wheel surface for movement in a train, causing the wheels to overheat and slide, resulting in substantial wheel tread build-up on the lead wheel (including flange throat) on the north side of the lead truck on the car as it intersected an 8.375-degree, right-hand curve on 1.67 percent descending grade.

Probable Cause and Contributing Factors

The FRA investigation concluded the probable cause of the derailment at Hyndman was wheel tread build up, accident cause code E67C - Damaged Flange or Tread (Build Up).

A contributing factor to the derailment was determined to be the failure of the train crew to properly release the hand brakes on cars in the train, accident cause code H019 - Failure to release hand brakes on car(s) (Railroad Employee).