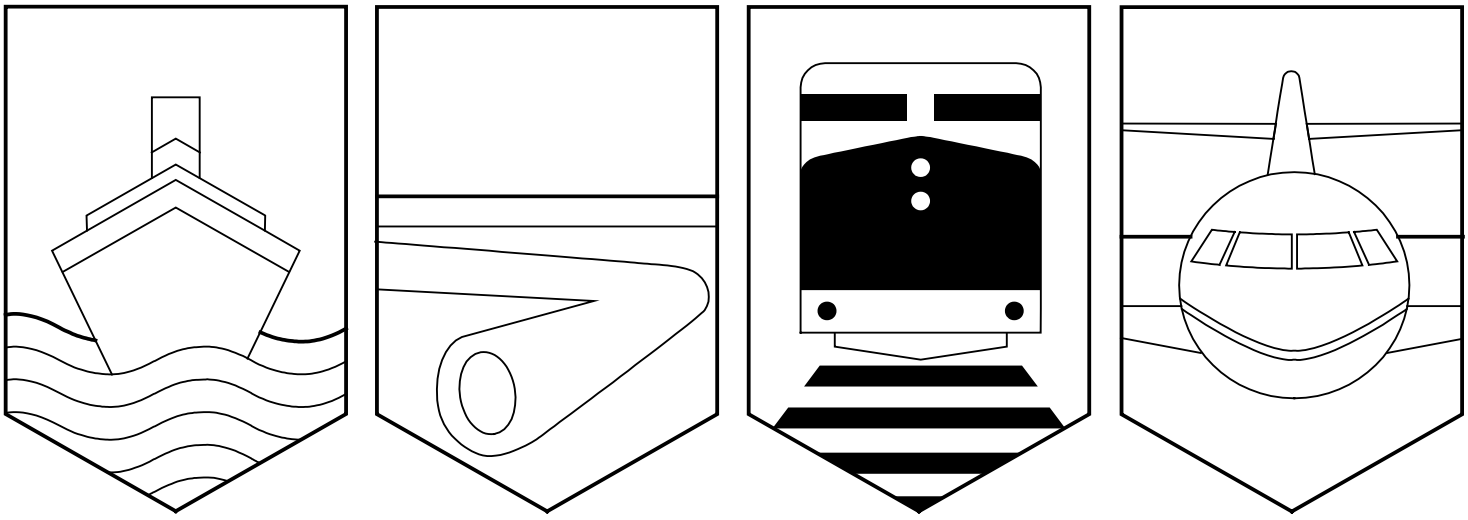
Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada



RAILWAY OCCURRENCE REPORT

MAIN TRACK DERAILMENT

CANADIAN NATIONAL
MILE 6.44, SUSSEX SUBDIVISION
RIVER GLADE, NEW BRUNSWICK
11 MARCH 1996

REPORT NUMBER R96M0011

Canada

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The TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

- conducting independent investigations and, if necessary, public inquiries into transportation occurrences in order to make findings as to their causes and contributing factors;
- reporting publicly on its investigations and public inquiries and on the related findings;
- identifying safety deficiencies as evidenced by transportation occurrences;
- making recommendations designed to eliminate or reduce any such safety deficiencies; and
- conducting special studies and special investigations on transportation safety matters.

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Railway Occurrence Report

Main Track Derailment

Canadian National
Mile 6.44, Sussex Subdivision
River Glade, New Brunswick
11 March 1996

Report Number R96M0011

Synopsis

On 11 March 1996, at approximately 0835 Atlantic standard time (AST), Canadian National (CN) eastward freight train No. 311-11-11 derailed 22 freight cars near River Glade, New Brunswick, Mile 6.44 of the Sussex Subdivision. Sixteen of the derailed cars were tank cars loaded with various dangerous goods. Approximately 455 litres of gasoline was released from one tank car and a small quantity of butane was released to the atmosphere from two leaking pressure tank cars. As a precautionary measure, the residents of two homes in the area were evacuated for about four hours. There were no injuries.

The Board determined that a rail head and web fracture, initiated by a vertical split head, led to the derailment. The vertical split head defect developed from a metallurgical flaw.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

The train departed Saint John, New Brunswick, Mile 86.9, travelling eastward, destined for Moncton, New Brunswick, Mile 0.0. As the train traversed a public road crossing at Mile 6.44, it experienced a train-initiated emergency brake application. After conducting the necessary emergency procedures, the crew members determined that 22 cars (the 27th car to the 48th car) had derailed. The derailed cars included 16 dangerous goods tank cars that contained gasoline, butane or fuel oil. Tank car CGTX 30413, loaded with gasoline, and tank car DCTX 34255, with a residue of butane, both leaked a small amount of product from punctures in their shells. Three days after the occurrence, car CGTX 63723 (another residue of butane) was found leaking.

Butane is a colourless flammable gas with a vapour pressure of 16.3 pounds per square inch gauge (psig) at 21 degrees Celsius. It has a faint odour and is mildly toxic if inhaled. Gasoline is a clear, volatile, aromatic flammable liquid. It affects the central nervous system, liver and kidneys if inhaled or absorbed through the skin.

The local police department immediately notified eight residents in two nearby homes of the potential danger posed by the derailment and requested them to evacuate the area. They were permitted to return approximately four hours later, after CN officials and the Moncton Fire Department inspected the site and determined there was no danger.

Eight of the dangerous goods tank cars (fuel oil and gasoline) were re-railed and moved, and product was transferred from six other cars before they were moved. The two butane cars were flared off and purged with an inert gas (nitrogen). The residents were apprised of the situation before the products were transferred. The evacuation was repeated three days later when car CGTX 63723 was found with a minor leak, the source of which was originally of undetermined origin.

Damage

Approximately 400 feet of track was destroyed and about 1,000 feet of track sustained extensive damage. Four of the derailed cars received minor damage and 18 cars were destroyed.

Train Information

The train, powered by 3 locomotives, was hauling 27 loaded cars, 17 empty cars and 9 residue cars. It was approximately 3,200 feet long and weighed about 3,500 tons.

Particulars of the Track

The subdivision is a single main track with a descending gradient of 0.1 per cent in the direction of travel at Mile 6.44. The authorized timetable speed is 50 mph for freight trains and 70 mph for passenger trains. Rail traffic is governed by the Occupancy Control System (OCS) authorized by the Canadian Rail Operating Rules (CROR) and supervised by a rail traffic controller (RTC) in Montreal, Quebec.

Through the derailment area, the track structure consisted of 100-pound jointed rail manufactured in 1950. The rail was laid in 1951 on double-shouldered tie plates on treated hardwood ties and anchored every six ties. The ballast was crushed rock with full cribs and 18-inch shoulders.

Recorded Information

Event recorder data indicated that the train experienced a train-initiated emergency brake application while proceeding at a recorded speed of 42 mph with the brakes released and the throttle in the No. 5 position.

Track Inspections

The assistant track supervisor inspected the track by Hi-rail vehicle on 07 March 1996 and no irregularities were noted. A track geometry car evaluated this location on 19 October 1995 with no exceptions noted. The rail was tested by an ultrasonic rail flaw detection car on 22 November 1995 and no defects were identified at Mile 6.44.

Occurrence Site Information

After the derailment, an approximate 18-foot gap in the north rail was discovered at the crossing at Mile 6.44. The north rail had consisted of a short rail approximately 16 feet long, joining two 39-foot sections of rail with the east end of the 16-foot rail located within the planks of the crossing. Pieces of broken rail determined to have been located just west of the crossing and west of the joint were found imbedded in the ballast on the east side of the crossing. A visual inspection of the pieces and the remaining stub of the rail still in place revealed that the rail head had fractured and broken away on the gauge side. The fracture had not propagated to the rail head surface.

Rail Testing

As a result of a derailment in 1990 where a rail fractured within the planks of a crossing (R90S0420), the TSB recommended that:

> The Department of Transport require federally regulated railways to establish a regular program for inspection of the entire rail at crossings, and to keep a record of test results for trend analysis.
>
> (R92-25, issued February 1993)

CN confirmed that it now requires flaw detector contractors to perform manual testing where the wheel probe surface is not in contact with the rail through a railway crossing.

Canadian Pacific Railway (CP) does not support manual testing with hand-held ultrasonic units as an alternative to the use of test cars because of the time (approximately 15 minutes) and the personal danger to an individual when manually testing a crossing. The use of hand-held audio gauges to test crossings was abandoned as these tests were less effective than those done by test cars. In addition, current devices place complete reliance on operator vigilance since manual probes do not provide a record of the inspections for later re-evaluation.

Transport Canada (TC) reviewed rail testing procedures and evaluated railway inspection programs. Federally regulated railways provide TC with reports summarizing rail defects, and these reports are considered adequate for safety monitoring purposes.

Evaluation of the effectiveness of different types of electronic rail testing methods in the identification of rail defects at crossings is being reviewed by TC, and further remedial action will be taken if deficiencies in testing technology are identified.

Tests and Research

Pieces of the broken north rail were forwarded to Canac Railroad Technologies in Montreal, Quebec, for analysis. The analysis concluded that the rail fractured as a result of a vertical split head (VSH) defect which had propagated within the head to the head/web junction. It then changed direction and propagated longitudinally along the junction. The VSH defect originated in a location containing stringers of non-metallic inclusions which would have been present in the rail since manufacture. The analysis also revealed that the vertical head wear measured 5 mm. The CN condemning head wear limit for 100-pound rail is 7 mm.

Class 112J Tank Cars

Tank cars DCTX 34255 and CGTX 63723 were both leaking butane and heavily damaged during the derailment. Both were built to DOT 112J340W specification. Car DCTX 34255, the initial car detected as leaking, had a minute leak in the area between the body bolster and the “B” end of the car. Car CGTX 63723 was initially checked for leakage immediately after the derailment and none was found. This car was one of the last to be salvaged and it remained undisturbed at the derailment site for several days. Before it was salvaged, it was tested again and found to be leaking. After the car was purged, removal of the jacket revealed a star-shaped series of cracks on the bottom of the tank shell in the middle of the tank car. The cracked area was removed and forwarded to the TSB Engineering Branch for analysis.

The TSB Engineering Branch analysis (LP 57/96) revealed that the tank shell cracks were caused by a brittle fracture that originated at the corner of the liquid eduction pipe anchor bracket where that bracket is welded to the tank. The bracket and the liquid eduction pipe were misaligned to the point that, over a period of time, they became distorted. The stresses created by this distortion were relieved, to a large extent, upon the fracture and distortion of the tank shell plate.

The material of the tank shell plate, specified as AAR-M128 steel (128 steel), was within specification for the chemical composition, but was classified as medium grain and did not meet the requirement for a fine grain structure. (Fine grain steels are more resistant to brittle fractures than medium or coarse grain steel.) Charpy V-notch energy absorption tests revealed that the tank plate had values of only 3 to 4 foot-pounds at a temperature of minus 45.6 degrees Celsius compared to the present requirement of 10 to 15 foot-pounds. The TSB Engineering Branch report also noted that Charpy V-notch testing was not required when the tank car was built. The report concluded that tensile stress induced at the time of the derailment caused the fracture.

Tank car CGTX 63723 was one of 25 cars built in 1965 under General American Transportation Corporation (Chicago, Illinois) building order No. 7466. It was originally identified as a GATX car and received its present identification when it was reassigned to Canadian service. The 25 cars were built to specification ICC 112A340W and were later retrofitted to specification DOT 112J340W (a protective jacket and insulation were added). One other car from this group, CGTX 63712, loaded with propane, failed at almost the same location in the car body on 10 January 1982 at Mile 84.7 of the CN Rivers Subdivision (file 31385.3918). The rupture in the car resulted in the ignition of the lading that created a fireball approximately 600 feet in diameter at ground level. Fragments of the car were thrown up to 250 feet from the track.

Tank cars in Class 112J are pressurized cars used primarily to transport liquefied petroleum gas (LPG) and anhydrous ammonia. The cars are insulated with a ceramic blanket covered with an outer steel jacket and are equipped with double-shelf couplers and head shields. Loading devices such as valves are also protected by a dome cover to prevent damage to these devices in the event of a roll-over at derailment. Several of the LPG cars sustained severe impact to their head shields during the derailment; however, the head shields did not fail. Since 01 January 1989, the heads and shells of pressurized tank cars have been required to be constructed of

ASTM 516 or TC128 normalized steel and, when specified for low-temperature service, the material must meet the Charpy V-notch energy absorption requirements of 10 to 15 foot-pounds at minus 45.6 degrees Celsius. The cars are manufactured to Association of American Railroads (AAR) standards.

Class 111A Tank Cars

Car CGTX 30413 was a DOT/CTC 111A minimum specification tank car. A tank car constructed to this specification does not provide the same degree of protection against loss of product as tank cars constructed to DOT/CTC 105, 112 and 114 specifications. This car, loaded with gasoline, sustained a leak from a 1/4-inch hole in the tank shell about 10 feet from the "B" end of the car. The indentation was approximately 3 inches deep and 12 inches long and elliptical in shape. The end plate at the "B" end of the car was struck and indented. The indentation measured approximately 12 inches in diameter and 3/4 inch deep. The head shield was not breached.

Car ACFX 95068, a Class 111A minimum specification car containing a residue of sulphuric acid, sustained numerous small dents and scrapes to the tank shell, but there were no perforations. The loading/unloading appurtenance covers and other devices were, however, sheared off during the derailment, but no product loss was experienced due to the car orientation after the derailment.

The susceptibility of Class 111A tank cars to release product upon derailment and impact is well documented, and yet there are many toxic and volatile liquids that are still permitted to be carried in 111A minimum specification tank cars.

Several of the LPG tank cars sustained severe impact damage to their head shields but resisted puncture.

Weather Information

The weather was clear with light west winds. The temperature was minus eight degrees Celsius.

Analysis

The train was being operated in accordance with government safety standards and railway operating procedures.

The derailment was initiated when the north rail broke under the train at Mile 6.44. The rail had experienced a head/web separation and a VSH defect that developed from undetected non-metallic inclusions present at the time of manufacture.

Neither the VSH defect nor the head/web separation were discovered when the last ultrasonic rail flaw detection car tested the derailment area, four months before the derailment. It is likely that the inclusion stringer that existed before the derailment was in a closed condition and could not be detected by the rail flaw detection equipment.

As a result of TSB recommendation R92-25, a joint project to test and develop new rail inspection technology is being conducted by the Transportation Development Centre, involving Canadian National, Canadian Pacific Railway, Tektrand International Inc., Canac International Inc., and Transport Canada. The focus of the project is on the following issues: the adequacy of testing equipment and technology, methods of data collection and the analytical processes, and alternate technologies for improved rail testing. TC has, however, determined that the technology currently being used is the best available at this time. When new technology becomes available, it will be closely monitored.

The VSH defect had not propagated to the surface of the rail head and would not have been visible when the track was inspected by maintenance forces by Hi-rail, four days before the derailment.

Metallurgical analysis of the tank material of car CGTX 63723 indicated that it did not meet the most current requirements for Charpy V-notch energy absorption, but it was not required to when the car was built in 1965. It is noted that, had the tank material been made of fine grain steel and met the latest Charpy V-notch requirements, it would have been more resistant to brittle fracture.

This is the second car from the original lot of 25 that failed in almost the same and unexpected location in the middle of the car. Both cars were built from steel which is inherently brittle in cold weather conditions. Since the steel used to construct the cars did not meet the fine grain criteria in effect when the cars were built, there may be as many as 23 other tank cars from the same lot built from material with similar properties. Although the specifications required the manufacturer to use a tank steel plate of fine grain quality, there was no requirement to check the steel to ensure that it met this standard.

The AAR syllabus for post-derailment tank car damage assessment is designed with the premise that all tank cars built with 128 steel are made from the plates produced to fine grain quality. As indicated in this report, that premise may not be valid.

In view of the vulnerability of Class 111A tank cars to product releases in accidents, the Board is concerned that the carriage of certain dangerous goods in such cars may be putting persons and the immediate environment at risk. These risks could be mitigated by reducing the probability of product releases through design improvements for protecting the cars, especially the protuberances that are prone to being sheared off in an accident.

TC has recognized the need to further restrict the transportation of the most dangerous/toxic chemicals to stronger built cars and has taken regulatory steps to address this concern. A revised tank car standard (CAN/CGSB-43.147-94) which further restricts the use of Class 111A tank cars has been implemented. The new standard prohibits the carriage of a further 80 commodities in these tank cars.

The timely actions of the emergency response team reduced the possibility of danger to local residents.

Conclusions

Findings

1. The train was being operated in accordance with government safety standards and railway operating procedures.

2. The train derailed when the rail fractured at Mile 6.44 as a result of a head/web separation that developed from a VSH defect. The defect developed from undetected non-metallic inclusions.

3. The ultrasonic rail flaw detection car did not detect the VSH defect during tests conducted on 22 November 1995 as it had not likely progressed sufficiently to be detected.

4. A brittle fracture developed in the shell of tank car CGTX 63723 due to tensile stresses created when the car sustained heavy impact during the derailment.

5. The tank shell material, 128 steel, met the appropriate chemical composition and tensile strength specifications but was of medium grain, not fine grain as intended. It did not meet the current requirements for Charpy V-notch energy absorption, but it was not required to when the car was built.

6. Had the tank material been of fine grain and met the latest Charpy V-notch requirements, it would have been more resistant to brittle fracture.

7. The AAR criteria for tank car damage assessment are valid only for tank cars built with 128 steel after 01 January 1989 because it is only pressurized tank cars built after that date which are required to be constructed of “normalized” steel.

8. The distortion of the bracket inside tank car CGTX 63723 may have created stresses as the distortion was progressing. Those stresses may have contributed to the tank failure. Twenty-three other cars built under the same certificate of construction may have similar problems.

9. Class 111A tank cars are more susceptible to release product upon derailment and impact than pressure tank cars, and yet there are a number of toxic and volatile liquids that are still permitted to be carried in minimum standard Class 111A tank cars.

10. Emergency response procedures were executed in a timely manner which reduced the risks to local residents.

Cause

A rail head and web fracture, initiated by a vertical split head, led to the derailment. The vertical split head defect developed from a metallurgical flaw.

Safety Action

Action Taken

CGTX has undertaken to inspect all sister cars and verify the integrity of the eduction pipes and guide brackets, ensuring that their alignment meets current norms. Additional measures in accordance with AAR M-1002 Appendix R will be taken to reduce the possibility of excessive stresses being generated at the welds connecting the guide brackets to the tank.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 24 March 1998.