Transportation Safety Board of Canada
Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R03T0026

YARD COLLISION

CANADIAN PACIFIC RAILWAY
CAR NO. HOKX 111044
MILE 197.0, BELLEVILLE SUBDIVISION
TORONTO YARD, AGINCOURT, ONTARIO
21 JANUARY 2003

Canada

Railway Investigation Report

Yard Collision

Canadian Pacific Railway
Car No. HOKX 111044
Mile 197.0, Belleville Subdivision
Toronto Yard, Agincourt, Ontario
21 January 2003

Report Number R03T0026

Summary

On 21 January 2003, at approximately 0717 eastern standard time at Canadian Pacific Railway's Toronto Yard, a residue tank car, last containing sodium hydroxide (UN 1824), was released from the hump into classification track C-34 and struck a stationary box car at an estimated speed of 12 mph. Although there was damage to both rail cars, there was no derailment, product release, or injuries. Between November 2002 and January 2003, four overspeed couplings involving dangerous goods occurred at Toronto Yard.

Ce rapport est également disponible en français.

Other Factual Information

On 21 January 2003, at approximately 0717 eastern standard time (EST),[1] car HOKX 111044, a residue tank car last containing sodium hydroxide – caustic soda (UN 1824) – was released from the hump at Canadian Pacific Railway's (CPR's) Toronto Yard (see Figure 1). This tank car was to be marshalled with other rail cars in classification track C–34. The ambient air temperature was -19°C. The weather was clear and the winds were calm.

The target exit speed for car HOKX 111044 leaving the master retarder was 13 mph. The measured exit speed was 13.28 mph. After leaving the master retarder, the hump process computer (HPC) routed the tank car through the Group 4 retarder with a target exit speed of 6.97 mph. The measured exit speed leaving the group retarder was 15.21 mph and the distance to couple (DTC) was determined to be 221 feet. With no other means to slow the tank car, an overspeed coupling occurred. The tank car coupled with a stationary box car loaded with paper (CP 220437), at an estimated speed of 12 mph. Both rail cars sustained minor damage; however, the rail cars did not derail. There was no release of product and no injuries.

Following this incident, CPR determined that an air pressure controller in the Group 4 retarder had failed. The air pressure controllers used by CPR at Toronto Yard are mechanical devices that require regular contact adjustments. This type of controller is checked and adjusted on a regular basis. Despite these checks, some controllers fail prematurely between inspections. Once the

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[1] All times are EST (Coordinated Universal Time minus five hours).

controller fails, the retarder is not able to apply the required braking pressure. Without adequate retardation, the tank car exited the group retarder at a speed that was more than double the target speed, resulting in the overspeed coupling.

This occurrence was one of four reported hump yard overspeed couplings involving dangerous goods (DGs) at Toronto Yard between November 2002 and January 2003. The other three occurrences were the following:

1. On 02 November 2002, car NCLX 3113, a hopper car loaded with plastic pellets, rolled freely without retarding force into track C−34, striking car ACFX 80099, a tank car loaded with anhydrous ammonia. This overspeed coupling buckled the B-end of the hopper car and caused major side sill and frame damage. Following the incident, equipment inspections and notifications were performed.

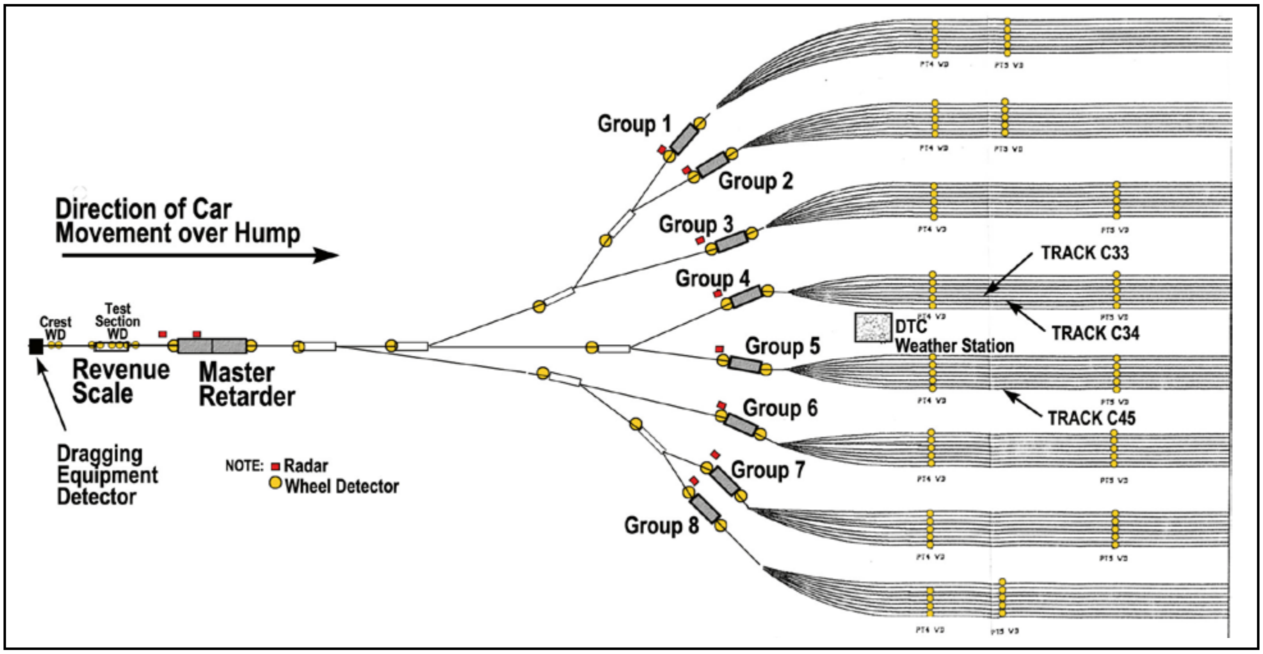
2. On 31 December 2002, car HOKX 111366, a tank car loaded with sodium hydroxide (UN 1824) exited the group retarder at 18.90 mph and collided with CP 220015, an empty steel box car in track C−45. Both rail cars sustained coupler and trainline damage. Following the incident, equipment inspections and notifications were performed.

3. On 19 January 2003, car UTLX 68506, a tank car loaded with naphthalene benzene, exited the group retarder at 15.92 mph and was released into track C−33, resulting in an overspeed coupling with box car QGRY 80064. Following the incident, equipment inspections and notifications were performed.

Toronto Classification Yard

Toronto Yard is an automated freight car classification yard. CPR operates three similar yard facilities in Calgary, Chicago, and St. Paul. These classification yards are typical of those in use throughout North America.

Arriving trains are routed into a receiving yard where locomotives are removed for servicing. Strings of inbound rail cars are then pulled from the receiving yard and uncoupled manually. To assist with assembling outbound trains in Toronto Yard, computer systems and specialized yard track equipment have been installed to allow the railway to automatically sort rail cars by their destination. Loaded and empty rail cars are sent over the hump and then routed to their designated classification track. The average daily capacity at Toronto Yard, which has a single hump, is approximately 1300 rail cars. Toronto Yard has 72 classification tracks that are divided into eight groups of nine tracks each (see Figure 2). Once the outbound rail cars have been humped, strings of sorted rail cars are pulled out of the classification tracks and are moved to the departure yard. At the departure yard, the outbound train is assembled with serviced locomotives.



The original HPC at Toronto Yard was manufactured by Union Switch & Signal and was installed in 1964. In 1980, this analog computer was replaced with a digital processor manufactured by General Railway Signal. In 1999, the digital processor was replaced with the current PROYARD II hump process control system originally manufactured by Proficient Solutions International Inc., which is now owned by General Electric Transportation System, Global Signaling.

Toronto Yard Hump Process

During the humping process, rail cars initially roll down an incline over a dragging equipment detector to check for dragging car components. Using rail-mounted wheel detectors, the axle count and the wheelbase of the rail car is determined. After the rail car is weighed, it is categorized by weight as follows:

- light cars weighing up to 35 tons;
- medium cars weighing between 35 and 60 tons;
- heavy cars weighing between 60 and 100 tons; and
- extra heavy cars weighing more than 100 tons.

Using speed data captured by wheel detectors that are spaced at pre-determined intervals, the HPC calculates the rail car's rolling resistance. Rolling resistance calculations are used to predict how well the rail car rolls when moving through the classification yard. Rolling resistance is affected by the amount of friction present in the bearings, in the centre pin/bowl, and in other running gear parts.

The HPC will evaluate many variables affecting rail car speed including rail car characteristics (e.g. type, weight, wheelbase, rolling resistance), environment characteristics (e.g. wind speed, wind direction, ambient temperature) and operational information (e.g. master retarder entry speed, distance to couple). Using this information, the HPC calculates the target exit speed at the master retarder and at the group retarder. The master retarder, which is located near the top of the hump, uses compressed air to activate parallel brake beams to

provide a clamping force to each side of the rail car wheels. As the rail car slows to the target speed, retarding pressure is reduced.
Rail car speed is checked as it leaves the master retarder. Speed is also checked at other locations between the master retarder and the group retarder. The HPC uses these speed measurements to calculate the retarding pressure required at the group retarder where the final speed adjustment is made. A group retarder is located on the lead track to each of the eight groups of nine tracks. Using the same braking mechanism as the master retarder, the group retarder slows the rail car down to the target exit speed. When calculating the target exit speed, the HPC will take into account the distance the rail car must roll to connect to the string of standing rail cars in the designated classification track. This length of clear track is referred to as the Distance to Couple (DTC).

CPR Inspection Requirements Following an Overspeed Coupling Incident

When overspeed couplings of tank cars occur, the two rail cars directly involved must be inspected. If there is no apparent damage and if DGs are not involved, the rail cars can be released back into service. Rail cars that contain DGs (including residue tank cars) must be moved to a repair track for inspection of the car's underframe and draft gear. CPR will normally repair damage to these components. If the rail car suffered extensive damage, it will be moved under estoppel to an owner-designated repair depot for stub sill and structural integrity inspection and repairs.

All repairs must be listed on the Damaged Car Report (Form 23D). A copy of this report is sent to CPR's DG and Mechanical Repair personnel and to the rail car owner. The information on Form 23D, which includes a description of work completed and the repair cost, is also sent to the Association of American Railroads, in compliance with the interchange rules. If there is no damage to the rail car, Form 23D does not have to be completed.

Classification Yard Incident Investigation Process

There is no practical or safe means to measure the high number of daily coupling events randomly distributed throughout a classification yard. CPR hump process compliance is determined using the North American industry standard of predicting coupling speeds calculated from retarder system exit speeds. If the rail car exits the group retarder at more than 3 mph over the target exit speed, CPR identifies this event as a potential overspeed coupling. An investigation process is then initiated, as outlined in Appendix A.

Transportation of Dangerous Goods Regulations

Section 10.7 of the *Transportation of Dangerous Goods Act* has specific requirements regarding the coupling of placarded rail vehicles used for carrying DGs. The regulations were established after conducting extensive research and testing at the National Research Council laboratory.

The following is a summary of Section 10.7 of the *TDG Act* (2002):

- Section 10.7 (1) states that rail vehicles containing DGs must not be coupled at relative coupling speeds greater than 9.6 km/h (6 mph).

- Section 10.7 (2) states that a single rail vehicle moving under its own momentum may be coupled at a relative coupling speed less than or equal to 12 km/h (7.5 mph) when the ambient temperature is above -25°C.

- Section 10.7 (3) states that, for all overspeed couplings of tank cars as defined in sections 10.7 (1) and (2), underframe and draft gears must be visually inspected before the car is moved more than 2 km from the place where the coupling occurred.

- A report must be sent to the owner of the tank car within 10 days after the coupling, detailing the results of the inspection and whether or not damage that may compromise the integrity of the underframe assembly or draft gear of the tank car was uncovered.

- Section 10.7 (4) states that the owner of the tank car must not use the tank car or permit the tank car to be used to transport DGs, other than the DGs that were contained in the tank car at the time of the coupling, until the tank car undergoes a stub sill inspection at a tank car facility and a visual and structural integrity inspection is done.

Transport Canada (TC) issued a Permit for Equivalent Level of Safety (ELS) to the railways on 22 November 2002. The ELS (SR 6234) indicates that tank cars having a gross weight of less than 65 000 kg (143 300 pounds) are permitted to couple at speeds up to 12.9 km/h (8 mph) when the ambient temperature is at or below -25°C, or to couple at speeds up to 15.3 km/h (9.5 mph) when the ambient temperature is above -25°C.

TDG regulations are based on relative coupling speeds. However, in the absence of a method to measure actual coupling speed for each coupling event as it occurs, CPR determines compliance to TDG regulations using a predictive method (i.e. group retarder exit speed). During interviews with TC staff who are involved in monitoring compliance at hump yards, it was indicated that:

- Regional TC inspectors have not been instructed on how to measure the railways compliance to coupling speed regulations.

- Regional TC inspectors are unsure of how the coupling regulations can be reasonably and practically complied with. However, regional inspectors are satisfied that a certain level of compliance exists.

- Regional TC inspectors are aware that CPR uses group retarder exit speed and DTC to predict coupling speed.

- Regional TC inspectors believe that group retarder exit speed allows a reasonable prediction of actual coupling speed. However, they do not consider group retarder exit speed a satisfactory alternative to measured coupling speed when determining compliance with TDG regulations.

- Although not verified during recent inspections, TC assumes that the railways are performing the required follow-up when a potential overspeed coupling occurs.

Following six overspeed incidents involving DG cars at CPR's Toronto Yard between July 1999 and January 2000, TC issued Protective Direction No. 28 on 07 February 2000. This directive required CPR to cease humping all tank cars and other cars loaded with DGs at Toronto Yard. In response to this directive, CPR implemented extensive immediate and long-term solutions and established a performance measurement system for hump operations. CPR's hump overspeed incidents were reduced dramatically with these measures and the Protective Direction was lifted on 15 May 2000.

TC indicated its intention to "approach the Railway Association of Canada to discuss a two-day sampling program at each rail hump yard in Canada to obtain further data." A hump yard coupling speed survey was conducted using a radar unit at CPR's Toronto, Calgary, and Winnipeg yards between 15 November 2000 and 07 December 2000. Of the 851 cars surveyed, only 2 cars measured coupling events greater than 8.5 mph.

CPR Hump Yard Requirements

Section 8, Part 5, of CPR's General Operating Instructions specifies the switching and humping requirements for DG cars:

5.1 (a) A loaded DG car, classified as Explosive 1.1 or 1.2, or Poison Gas 2.3 or if the flat car(s) is carrying a container(s) or trailer(s) bearing any placard, must not be cut off while in motion or must not be coupled onto by cars moving under their own momentum.

5.1 (b) In humping operations, any loaded tank car in placard group "C" (i.e. Explosives, Classes 1.3 and 1.6, or Classes 2, 3, 4 or 5) must be a single car cut over the hump, unless shoved to a coupling or rest. Also, the next car into the same track must be a single car cut unless shoved to a coupling or rest.

5.1 (c) Any impact suspected of being in excess of 6 mph, with or onto a DG car must be promptly reported to the appropriate railway supervisor for furtherance.

Maintenance of Yard Track Equipment

At Toronto Yard, maintenance-of-way crews in CPR's Engineering Department are responsible for maintaining the track, the switches, and the mechanical components of the retarders. Hump maintenance is generally performed during a four to six hour work block each Tuesday. The hump and the classification tracks are inspected on a four-week cycle. Normally, 18 tracks (i.e. two groups) are inspected and maintained each week. Turnouts are inspected monthly.

The non-mechanical components of the retarders, along with the associated signal systems, are maintained by Signals and Communications maintainers and technicians. Because the hump operates 24 hours a day, a walking inspection of the master retarder and the group retarders is performed each shift. This inspection involves monitoring the condition of brake beams, bolts, brake shoes, air cylinders, radar detectors, wheel detectors, and dragging equipment detectors. A more detailed inspection is also conducted each week for the air cylinders, brake shoes, and radar tracking. The master retarder gauge is checked bi-weekly and the gauge in the group retarder is checked monthly. Depending on age and condition, the brake shoes on the retarders are checked monthly and replaced if necessary. Electro-pneumatic switches are checked monthly.

Master retarders are replaced on a five- to eight-year cycle, depending on wear. At Toronto Yard, the bottom section of the master retarder was replaced in 1998, and the top section was replaced in 2000. In addition, a capital upgrade program was initiated in 2000, to replace the older air pressure controllers (Borden Tube) that operate the retarders with more reliable electronic controllers. Of the 20 controllers operating the 10 Toronto Yard retarders, 19 had been replaced with electronic controllers by March 2004. The remaining controller was scheduled for replacement by August 2004.

Analysis

The analysis will focus on the capability of hump yard equipment to control rail car speed and on regulatory inspections and requirements for hump yard operations.

The overspeed coupling incident on 21 January 2003 resulted from a defective air pressure controller that caused the group retarder to fail. Without adequate retarding pressure, car HOKX 111044 was permitted to exit the group retarder at a speed that was more than double the target speed. Since the group retarder is the last location where the hump process computer can control rail car speed, an overspeed coupling impact between the tank car and a loaded box car occurred. This occurrence was one of four overspeed incidents involving DGs at CPR's Toronto Yard between November 2002 and February 2003. The incidents were investigated internally by the railway and follow-up action, in compliance with TDG regulations, was taken.

The regulatory requirements regarding the coupling of rail vehicles were put into place withoutany means to measure speeds at all couplings.

TDG regulations are based on relative coupling speeds. However, CPR determines compliance with TDG regulations using the predictive method based on group retarder exit speed. TC Regional inspectors do not consider the use of group retarder exit speed, as opposed to actual coupling speed, a satisfactory measure of compliance. It is possible for a car to increase speed after exiting a group retarder. Speed increase is dependent on the distance the car(s) have to travel to couple and can be due to wind and the fact that classification tracks are built with a slight descending grade into the "bowl" of the yard. Although these factors are considered in the rollability calculations, exceptions do occur.

There is no clear, mutually acceptable coupling speed compliance measurement process between CPR and TC. However, the results of CPR's coupling survey in 2000 demonstrate that the hump control systems do control the coupling speeds as intended. Predicting coupling speeds based on retarder exit speeds allows for a reasonable prediction of coupling speed, and the confirmation of those predictions with periodic samples of radar measurements of actual speeds, as required by CPR's Standard Practice Circular (Signals and Communications) No. 19, Section 3.6.4, is considered an adequate process to determine compliance to TDG regulations.

The TDG regulations apply to placarded cars involved in overspeed coupling incidents. However, these regulations do not apply to non-placarded cars. Although TDG regulations indicate that placarded cars involved in overspeed couplings must receive visual and structural integrity inspections, there are no requirements to inspect non-placarded rail cars involved in similar occurrences, thereby increasing the risk for in-service failures of rolling stock.

Information from the Damaged Car Report (Form 23D), relating to the damage and the repair cost, is communicated to the Association of American Railroads. Form 23D provides important information on the rail car's history and allows the car to be flagged for more detailed inspections if necessary. If there is no apparent damage to the rail car, Form 23D does not have to be completed. However, without the completion of a Damaged Car Report (or other similar car inspection record) for all overspeed couplings, details on these occurrences may not be captured as part of the rail car's history. This situation increases the risk that these cars will not be monitored for potential latent damage that could lead to an in-service equipment failure.

Findings as to Causes and Contributing Factors

1. Residue tank car HOKX 111044 exited the group retarder at a speed more than double the target speed due to the failure of an air pressure controller in the group 4 retarder, resulting in inadequate retarding pressure being applied to the tank car. As a result, the tank car coupled with a stationary loaded box car at an excessive speed.

Findings as to Risk

1. While *Transportation of Dangerous Goods Regulations* require placarded tank cars containing dangerous goods that are involved in overspeed couplings to receive visual and structural integrity inspections, there is no requirement to inspect non-placarded rail cars involved in similar occurrences.

2. Not monitoring all rail cars for latent damage increases the risk of an in-service failure.

Safety Action Taken

Transport Canada

Transport Canada is investigating and assessing hump yards in Canada under a study entitled “Hump Yard Control Systems Assessment Study.”

Canadian Pacific Railway

In October 2003, Standard Practice Circular (Signals and Communications) No. 19, which details hump maintenance practices, was put in place. Section 3.6.4 requires the ongoing measurement of hump yard coupling speeds using hand-held radar guns to verify computer-predicted coupling speeds. These measurements are to be taken on 10 cars per class track over 12 months and should include a minimum of 20 per cent of tank cars.

As of December 2003, a number of mechanical upgrades and improvements have been completed to the hump yard system at Toronto Yard. These upgrades have reduced erratic hump yard air system dynamics and have allowed for more accurate and precise hump control.

As of December 2003, a number of software enhancements have been implemented to the hump yard control system at Toronto Yard. These enhancements, which ensure process control integrity, include:

- added software sequence to cycle master retarders for the automatic handling of catch-up situations in the master;
- raised low air alarm threshold to 95 psi, and added operator audible/visible hump STOP alert;
- added operator audible/visible low air warnings at 115 psi;
- added compressor failure alarm;

- changed retarder preset levels to one weight range below car weight to improve retarder readiness and reaction time; and

- adjusted weight range thresholds to improve heavy car handling and reduce empty car grabbing or pop-outs.

As of April 2004, several structural and electronic upgrades have been completed to the hump scale at Toronto Yard, including:

- the scale indicator electronics have been upgraded to meet Measurement Canada Certification tolerances;
- the system has been set to automatically use the heavier weight classification if either scale fails or if there are significant discrepancies; and

- a scale test monitor car has been made available at Toronto Yard to monitor the accuracy of the scales on a regular basis.

Several operational and administrative changes have been implemented to help ensure compliance at Toronto Yard, including:

- full automatic process control by restricting manual operator intervention to emergency grab and emergency STOP;
- limit humping speed to 1.5 mph (normal) and 1.0 mph (slow);
- handle all loads as single car cuts;
- limit multi-car cuts to a maximum of six empties;
- work with shippers of contaminated cars to improve car cleanliness; and
- hold twice weekly cross-functional hump meetings to discuss operational issues.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 22 September 2004.

Visit the Transportation Safety Board's Web site (www.tsb.gc.ca) for information about the Transportation Safety Board and its products and services. There you will also find links to other safety organizations and related sites.

Appendix A – Classification Yard Incident Investigation Process

1. An alarm will sound and a message appear on the Yard Classification Supervisor's computer screen.

2. The Yard Service Employee who is on the ground in control of the movements over the hump is notified through an alarm bell and a red indication on the hump signal light.

3. The Yard Classification Supervisor will contact the Yard Service Employee to stop humping operations.

4. If necessary, the Yard Service Employee will set the master retarder to maximum force to stop any following rail cars that have just started over the hump.

5. The tracks affected by the incident are then locked out.

6. Employees working in the area of the incident are advised of the occurrence.

7. The rail cars involved are checked to determine if they are carrying dangerous goods.

8. The Train Yard Coordinator will gather all facts surrounding the incident and advise the Yard Manager.

9. The Yard Manager will contact and notify Canadian Pacific Railway's (CPR's) Network Management Centre in Calgary.

10. The Network Management Centre will advise Transport Canada, the Transportation Safety Board, and CPR's Marketing Department.

11. CPR's Marketing Department will advise the affected customer and car owner.

12. The Train Yard Coordinator will contact CPR's Engineering, Mechanical, and Signals and Communications representatives to arrange a site meeting.

13. A Hump Incident Report will be prepared based on information stored on the hump process computer. This report identifies car destination track, car weight, retarder class, wind speed, direction and temperature, master and group retarder target exit speeds and actual exit speeds, speed at various timing points in the classification yard, and any speed variance.

14. Engineering Services will inspect the track and switches for defects and damage and will arrange for repairs (if necessary).

15. Mechanical Services will inspect the equipment and lading involved in the incident. For an overspeed coupling, all rail cars involved must be inspected.

16. If there is no apparent damage, non-dangerous cars are released.

17. Tank cars containing dangerous goods (including residue cars) will be moved to a repair track where an underframe and draft gear inspection is performed.

18. If the rail car must be repaired, transhipping of the product will be performed.

19. If the rail car suffered extensive damage and cannot be repaired at CPR's repair facility, the car will be moved under estoppel to the owner's designated repair depot.

20. All repairs and costs will be indicated on Form 23D. A completed copy of this form will be sent to all concerned.

21. Signals and Communications personnel will review the hump yard computer operations, inspect all signal apparatus, inspect wheels and retarder brake shoes for contamination, and inspect the master retarder and group retarders.

22. CPR's cross-functional team will review the facts and come to an agreement on the cause of the overspeed coupling.