Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

TRANSPORTATION SAFETY

REFLEXIONS

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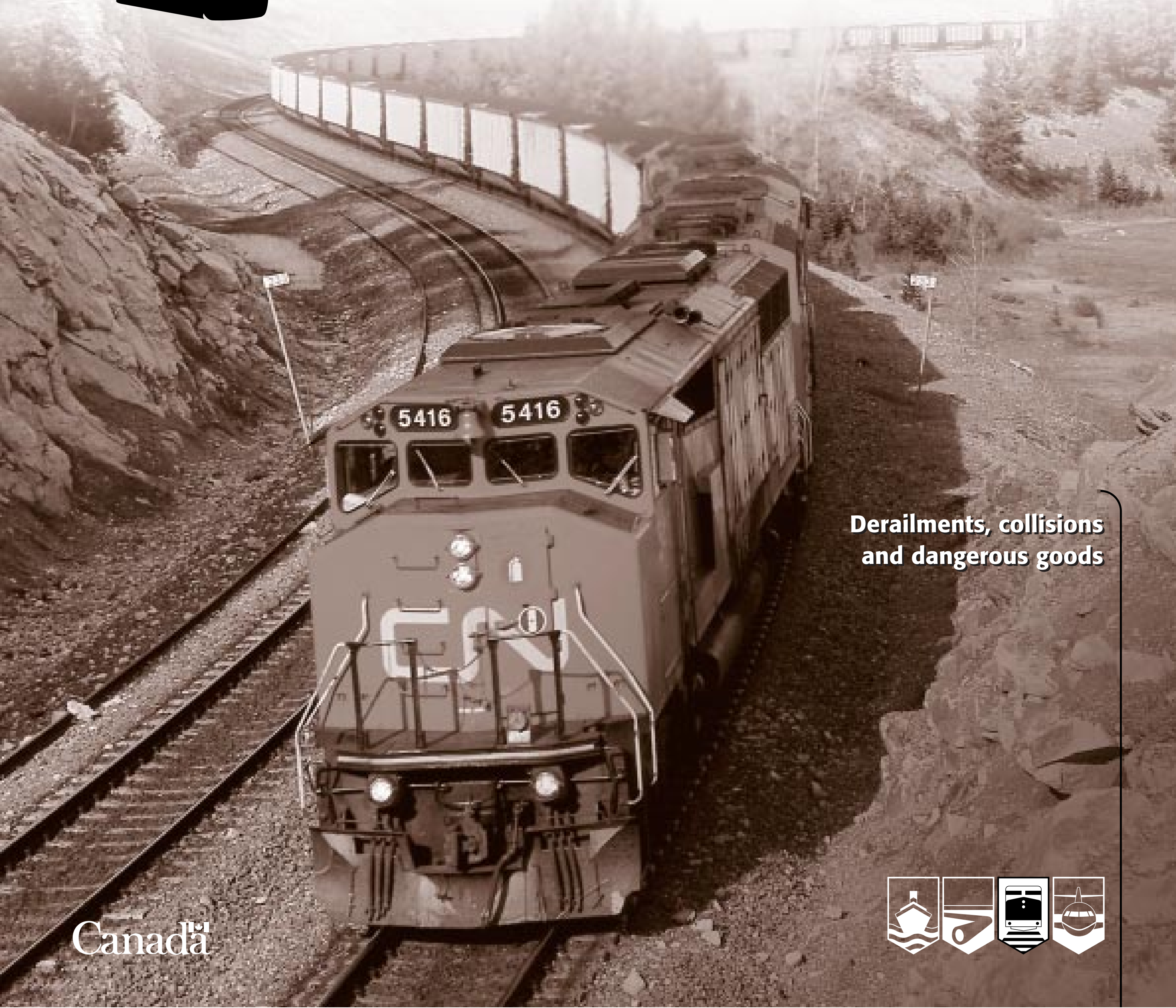
RAIL



Derailments, collisions and dangerous goods

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Reflexions is a safety digest providing feedback to the transportation community on safety lessons learned, based on the circumstances of occurrences and the results of TSB investigations.

Pass it on!
To increase the value of the safety material presented in *Reflexions*, readers are encouraged to copy or reprint, in part or in whole, for further distribution but should acknowledge the source.

The articles in this issue of *Reflexions* have been compiled from the official text of TSB reports.

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Safety at the Centre of Your Organization

It is well accepted by safety experts that each accident is unique—each resulting from a unique combination of multiple failures in the system. This issue of *Reflexions* only reinforces that point.

Each of the six accident investigations highlighted here encompasses a range of functional areas: infrastructure, equipment and operations, as well as the transportation of dangerous goods. Moreover, as you will read, any number of human and technical factors such as policies and procedures, and environmental and cultural elements were causal or contributed to these occurrences.

The good news is that lessons have been learned and safety actions have been taken. The TSB role is to identify safety deficiencies that it believes government and the transportation industry should address to mitigate the risks involved and reduce injury, property loss, and environmental damage. All together, four recommendations stemmed from these investigations. They were as diverse as the accidents themselves, addressing, for instance, the inspection and quality control of thermite rail welds, the transportation of dangerous goods, the survivability of locomotive event recorders, and train braking methods.

A safer transportation network will benefit everyone. This requires a greater awareness of safety issues among all stakeholders, including regulators, industry leaders, railway workers, and management alike. Moreover, it calls for an environment where employees can easily share information, as well as identify and mitigate risks on a regular and ongoing basis.

Many organizations work towards this end, but their best efforts can be thwarted by internal and external forces driving this dynamic, competitive industry. Ironically, such pressures can obscure the "big picture" as individuals focus on immediate issues that are close at hand.

The following pages illustrate that each accident may be unique, but organizations can adopt a universal strategy to mitigate risk. It all begins with a greater awareness of safety issues on the part of both the front line and management. We hope this edition of *Reflexions* broadens your understanding of these issues and, in turn, encourages you to keep safety at the centre of your organization.

Charles H. Simpson
Acting Chairperson

As a result of the derailment, dangerous goods spilled. Most of the dangerous goods burned in the fire and some had to be transferred

Track Maintenance and Dangerous Goods

On 30 December 1999, Canadian National (CN) train No. U-783-21-30 (train 783) was westbound on the north track of the Saint-Hyacinthe Subdivision, while CN train No. M-306-31-30 (train 306) was eastbound on the south track. At Mile 50.84, near Mont-Saint-Hilaire, Quebec, cars from train 783 derailed and were struck by train 306. The two crew members in the locomotive of train 306 were fatally injured. — Report No. R99H0010

Of the 35 tank cars on train 783 that derailed, 11 were carrying approximately 1 million litres of gasoline (UN 1203) and 24 contained approximately 2.3 million litres of heating oil (UN 1202). Approximately 790 000 litres of gasoline and 1.9 million litres of heating oil burned in the resulting fire or were not recovered. Approximately 255 000 litres of gasoline and 330 000 litres of heating oil were transferred to tanker trucks and tank cars.

The cars on train 306 that derailed included a hopper car containing 79 900 kg (176 020 pounds) of sodium chlorate, about half of which was released in the accident. The sodium chlorate and the soil it contaminated were transferred to specially prepared containers when the site was cleaned up.

The hydrocarbons from train 783 and cargo from some cars from train 306 burned for four days, creating a smoke plume about 500 m high. The smoke affected

The head section of the thermite weld separated shortly before the derailment.

air quality in the immediate area of the accident site, necessitating the evacuation of approximately 350 families.

Wreckage from the derailment was spread over a wide area

The investigation determined that train 783 derailed when the south rail of the north track broke at a thermite weld which had an existing pre-crack. Since little damage from wheel pounding was observed on the fracture surfaces of the weld, it was concluded that the fracture was very recent and that the head section of the thermite weld separated shortly before the derailment. In all probability, the 15th car derailed when the rail head section separated.

Thermite Welding

Stresses generated by the wheel loads, thermal stresses caused by a drop in temperature, and residual welding stresses were present at the point of fracture. For the temperature at the time of the accident (-11˚C), an impact load in excess of 100 000 pounds would have been sufficient to break the weld at the existing pre-crack. Such impact loads are common.

Although the regulations did not require any testing for internal defects in thermite welds, CN was performing manual ultrasonic testing on the ground surface of the welds shortly after their completion. This additional measure of safety was unique in the industry and was not practiced by other North American railways. However, as the rate of the defects in thermite welds decreased and became less than 0.5 per cent due to the considerable improvement in the area of thermite welding, CN discontinued the procedure in 1995 and relied upon the automatic inspection by the rail flaw detection car. CN's decision to discontinue the manual ultrasonic inspection was applied to all subdivisions, regardless of local conditions, tonnage, speed, or traffic type and density. In the United States, the Federal Railroad Administration (FRA) had adopted an approach tailored to the risks; for instance, the FRA requires field welds on high-speed tracks to be inspected for internal defects shortly after their completion.

Thermite welding is a process prone to human error.

Thermite welding is a process prone to human error; a weld execution requires 13 distinct steps that must be performed in a precise order by a well-trained operator. Moreover, defects located in the base of the weld cannot be detected by automatic inspection methods, and the probability of detecting cracks at the time they emerge in the web is relatively minimal because, once started, this type of crack propagates rapidly. Without an ultrasonic inspection of the entire periphery of the weld and quality control by independent personnel, inappropriate materials or work procedures, which can lead to defective field welds, cannot be identified. Welds are critical elements of the track infrastructure and as such need particular attention.

Other railways in Canada reduce train speed to 30 mph when the impact load exceeds 140 kips.

Therefore, the Board recommended that:

> *Transport Canada review the requirements for the inspection and quality control of thermite welds to ensure that an adequate level of safety is maintained on all types of tracks.*
>
> ***R02-05***

The rail fractured at a thermite weld

In its response, Transport Canada (TC) said that it had initiated a review on all types of rail welds currently performed by railways, as well as the type of inspection and testing conducted on these welds. TC expected that the review would be completed by 31 December 2002. Once completed, the review would provide the necessary information to determine the adequacy of inspections, maintenance, and quality control of thermite welds on all types of tracks. To assure consistency among railways in Canada, the results of the review would be analyzed by TC's working group on *Railway Track Safety Rules*, comprised of representatives from the railways, unions and TC. It was anticipated that, on the issue of field welds, the working group would consider improvements to existing railway policies or that new policies would be issued, where required.

Wheel Impact Load Detectors

CN's wheel impact load detectors (WILDs) generate alarms when wheel impact loads reach thresholds of 100 kips (one kip is 1000 pounds), 125 kips and 140 kips. When the impact load exceeds 140 kips, the car involved must be set off. If the train is heading towards a terminal, the car must be removed at the terminal, and if the train is leaving a terminal, the car must be removed at the first siding.

It is recognized by the industry that wheels producing high impact loads may cause damage to equipment (axles and journals) and track infrastructure. CN's analysis of data collected between 1992 and 1995 clearly established the causal link between high impact loads and broken rails. Despite this link, CN does not reduce the speed of cars that have generated impact loads greater than 140 kips and does not require special inspection of the track in the section over which the defective wheel travelled, whereas other railways in Canada reduce train speed to 30 mph when the impact load exceeds 140 kips.

Unlike other wayside inspection systems, the WILD does not transmit information regarding wheel condition to train crews. After a train has passed over a WILD site, the field system processes the information, then transmits data by modem to a central office processor, located at the rail traffic control system in Edmonton, Alberta. The technician responsible for WILD system monitoring is also responsible for maintaining the rail traffic control consoles, communication systems, and wayside inspection systems (WIS). The normal duties of the technicians keep them away from the WILD system maintenance screen sometimes for lengthy periods of time. There was no system in place to warn the technician that communication had been lost to any of the field WILD sites.

In the five days before the accident, communication with the Bagot WILD, 20 miles east of the accident site, was lost several times. The communication system did not function between 1210 on December 26 and 1132 on December 28. During this period, 51 trains went by and 40 alarms indicating impact loads of more than 100 kips were generated, including 5 greater than 125 kips. On December 29, there were more communication breakdowns;

between 1330 and 1533, 6 trains went through Bagot, and the results of these were not received until 1709. One of these readings indicated that, at 1440, a train went by and generated impact loads of 146.3 kips. The train was travelling westward and should have been stopped at the Saint-Lambert Yard to set off the car with the defective wheel. Because of the delay in communication, the car was not set off until Coteau, Quebec. Since the WILD communication system is not fail-safe, a communication breakdown may hamper its operation and allow defective wheels to continue in service at the risk of breaking or breaking a rail.

Unit Trains and Dangerous Goods

Train 783, commonly known as the Ultratrain, was a unit train, composed of identical cars dedicated to the transportation of hydrocarbons in a continuous circle between Saint-Romuald and Montréal, Quebec, with a train passing every 16 to 24 hours. The introduction of unit trains carrying hydrocarbons through urban areas creates unusual operating conditions that are not adequately addressed by the existing safety regulations. Although the accident occurred in a sparsely populated area, the Ultratrain's route takes it through many urban areas where the risk is much greater. The *Transportation of Dangerous Goods Regulations* already take these risks into consideration for products listed in Schedule I and, consequently, require specific emergency response plans for the transportation of these products. However, neither the shippers nor the transporters are required to establish specific emergency response plans for unit trains, such as the Ultratrain, because the hydrocarbons carried are not listed in Schedule I. A comprehensive emergency response plan based on TC's document TP 9285, where roles, resources, and priorities for emergency response are well defined ahead of time, would undoubtedly enhance the emergency response and alleviate post-accident risks. Without a similar emergency response plan, it is difficult to ensure immediate implementation of the appropriate action in the event of an accident involving dangerous goods. Therefore, the Board recommended that:

> *Transport Canada review the provisions in Schedule I and the requirements for emergency response plans to ensure that the transportation of liquid hydrocarbons is consistent with the risks posed to the public.*
>
> ***R02-03***

TC responded that, in light of the TSB recommendation, a discussion paper was developed and presented in November 2002, at both the Federal-Provincial/Territorial Transportation of Dangerous Goods (TDG) Task Force and the TDG General Policy Advisory Council Meetings. The discussion paper provided an overview that describes the central purpose of Emergency Response Assistance Plans (ERAPs) and current criteria used to mandate the use of ERAPs; outlined the possible new criterion of large quantities of flammable commodities requiring an ERAP; and reviewed the circumstances at Mont-Saint-Hilaire. Members of both the TDG Task Force and the General Policy Advisory Council were asked to provide their comments on the decision paper before the end of 2002.

Without a comprehensive emergency response plan, it is difficult to ensure immediate action in the event of an accident involving dangerous goods.

The TDG Task Force has met with both CN and Ultramar. CN and Ultramar have delivered TransCARE, a Community Awareness and Emergency Response program, to the communities along the route of the unit train. In January 2004, CN and Ultramar also delivered a very detailed and voluntary Emergency Response Plan to TC.

Event Recorders

The TSB has succeeded in recovering event recorder data for the vast majority of investigated railway accidents; however, in the case of catastrophic accidents, where locomotives were subject to high impact, fire or water, the data could not be retrieved. For instance, in this accident, the behaviour and response of the crew on train 306 could not be determined because the event recorders on both locomotives were damaged. The data on the recorder on the second locomotive would have been saved had that recorder been designed and manufactured according to crashworthiness standards similar to other modes of transportation.

Event recorders play a paramount role in the advancement of safety.

The ability to understand the nature of rail-related accidents and to analyze trends in railway safety is a key element to the success of safety initiatives. By providing a historical record of both the situation (speed, throttle position, etc.) and the actions (brake applications, acceleration, etc.) just before an accident, event recorders play a paramount role in the advancement of safety.

The issue of survivability of locomotive event recorder data is not limited to Canada and is being examined by the FRA. After a catastrophic derailment in Cajon Pass, California, in 1996, a working group, under the auspices of the FRA Rail Safety Advisory Committee (RSAC), was set up in 1997 to amend the locomotive event recorder rules (49 CFR 229.135). A draft regulatory document was completed and was made available for review in January 2002. It requires that locomotives be equipped with an event recorder that incorporates a certified crashworthy memory module. Furthermore, it prescribes the requirements for certifying a memory module as crashworthy. The testing methods and performance criteria in conditions of fire, impact, static crush, fluid immersion, and hydrostatic pressure have been adapted from the international civil aviation standards.

However, crashworthiness requirements for event recorders are one of several options available to ensure the survivability of the data. Other methods, such as real time transfer of the event recorder data and relocation of the memory module, can also be considered. The ultimate goal is to enhance the quality and survivability of information available for post-accident investigations, which will ensure more thorough accident investigations and lead to initiatives aimed at reducing the probability and consequences of subsequent accidents involving similar circumstances.

Locomotives crossing the United States–Canada border will be subjected to the new FRA rule; however, locomotives dedicated solely to Canadian trackage will not be affected, as the existing Canadian regulations or industry standards do not contain any provisions for the design and construction of locomotive event recorders. This lack of design and construction standards impedes the efforts to understand rail accidents and advance the safety of rail transportation in Canada. Therefore, the Board recommended that:

> *Transport Canada ensure that the design specifications for locomotive event recorders include provisions regarding the survivability of data.*
>
> ***R02-04***

TC said that it supported the recommendation and noted that the FRA in the United States was developing a rule on the crashworthiness of locomotive event recorders that would be similar to the standards for aeronautical and marine event recorders.

The investigation identified shortcomings in the existing procedures used in the electronic data interchange system that could lead to hazardous conditions.

The Notice of Proposed Rulemaking has been published in the U.S. Federal Register. It addresses several safety recommendations made by the National Transportation Safety Board to improve the quality of data available for post-accident analysis. The proposed regulations are intended to prevent the loss of data that results from train accidents involving fire, water, and significant mechanical damage.

The proposed rule would establish standards to make sure event recorders survive accidents in new and existing locomotives. It would phase out the use of magnetic tape as a data storage medium within current "black boxes." The FRA is also proposing that improved event recorders collect and store additional data, including emergency braking systems, locomotive horns, and text messages sent to the engineer's display regarding directives and authorized speed. The proposed rule would simplify existing standards for inspecting, testing, and maintaining event recorders by railroads.

TC said that it was closely following the development of the United States rule.

Electronic Data Interchange Shortcomings

Under the *Transportation of Dangerous Goods Act* and the *Transportation of Dangerous Goods Regulations*, the shipping documents accompanying the cars may be electronic copies generated at intermediary points using the electronic data interchange (EDI) system.

The EDI system provides flexibility to train crews and allows them to have access to up-to-date train consists. However, the investigation identified shortcomings in the existing procedures used in the system that could lead to hazardous conditions, such as the absence of a control system to detect and compensate for errors.

The EDI system is particularly vulnerable to operator error since it receives data from a large number of users and has no protection mechanism against normal human error. To expedite operations, in the absence of data or in the case of incomplete data on a car that is being picked up, information can be entered in the system by the transporter without input or confirmation from the shippers. Furthermore, amendments to the shipping documents are validated by CN; however, the verification is not performed in real time as the system does not automatically amend documents and "suspends" any new data. Erroneous information is not frozen when new data are "suspended." There are no control procedures for verifying and physically comparing the electronic shipping documents to the original copies nor to the train consist.

Since the shipping documents are used by the train crews and the emergency response personnel, their availability and accuracy are critical to safety. The TSB is concerned that the risks identified with the EDI system and the potential inaccuracies in the train consist were not addressed and still create unsafe conditions to which emergency response personnel and the general public may be exposed.

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Rail safety = taking all risks into consideration.

Derailed tank cars overturned and resting in ditch

Toxic Spill

More than 71 tonnes of anhydrous ammonia were spilled into the atmosphere from an overturned tank car after a derailment in Red Deer, Alberta, on 02 February 2001. Approximately 1300 local residents and businesses were evacuated, and 34 persons were treated at the Red Deer Hospital and released. One person who was overcome by the vapours while crossing the railway right-of-way later died in hospital.
— Report No. R01E0009

Canadian Pacific Railway (CPR) train CP 966-02 was travelling at less than 4 mph at Mile 95.4 of the Red Deer Subdivision when a train-initiated emergency brake application occurred at about 2023 mountain standard time, stopping the movement. The locomotive engineer tried to release the train brakes but was unsuccessful. He advised the conductor of this and began to walk back along the cut of cars to find the reason for the emergency brake application and noticed a "steam like" cloud along the track. The locomotive engineer did not get close enough to ascertain the extent of the derailment, but returned to the locomotive and advised the conductor, who consulted the train list and advised that the cloud could be anhydrous ammonia.

The locomotive engineer consulted the *2000 Emergency Response Guidebook* for the properties of and proper response to anhydrous ammonia. Upon identifying the potential hazards, he disconnected the locomotive from the rail cars and left the scene. The conductor immediately went to the CPR yard office, located approximately 1500 feet from the overturned cars, to alert management and employees to the situation.

The hazards reflected by the placarding of vessels, as prescribed by the latest regulations, are not appropriate for this product.

Exposure to Fumes

When the first responding fire captain arrived on the scene, he was exposed to anhydrous ammonia fumes, and within seconds, his eyes were swollen shut. In addition, two other firefighters suffered minor inhalation injuries before they activated their breathing apparatus. The ambulance attendants who transported the fire captain to the hospital were also exposed to the fumes from the anhydrous ammonia.

In the course of establishing the safety perimeter, three constables were exposed to the ammonia vapour and reported to the hospital for examination. The constables did not have any emergency respiratory protection against toxic gases available for their use, nor did they have the necessary training to effectively respond to this type of chemical spill.

At the time of this occurrence, the *Transportation of Dangerous Goods Regulations* (TDG regulations) classified anhydrous ammonia as a Class 2, Division 4, corrosive gas, with product identification number UN 1005 (United Nations dangerous goods identification number). Placards to be used for "Gases – Corrosive" were designed in a white diamond-shape with a picture of a compressed gas cylinder.

Also, the *2000 Emergency Response Guidebook* identifies anhydrous ammonia with UN 1005 and lists this product as "Gases – Corrosive."

In August 2002, revised TDG regulations came into effect. These amendments reclassified anhydrous ammonia as "non-flammable, non-toxic gas, Class 2.2." At the same time, however, anhydrous ammonia diluted with up to 50 per cent water was reclassified as "toxic gas, Class 2.3." Paradoxically, based on the encyclopedic data and the method set out in the regulations to calculate the inhalation toxicity of the mixtures, a toxic designator will be applied to a compound that is less toxic than another compound classed as a "non-toxic" gas. Anhydrous ammonia, being immediately asphyxiating at 2500 parts per million (ppm), falls below the regulatory threshold of 5000 ppm, and should be classified as a "toxic gas, Class 2.3."

Inaccurate Description

Medical and other published research on anhydrous ammonia demonstrates how it affects the life and health of individuals. The nature of this chemical, as illustrated by the fatality in this occurrence, indicates that the description as "non-flammable and non-toxic" is not accurate. The research further indicates that emergency response personnel should be aware of the actual hazards associated with this product and that the hazards reflected by the placarding of vessels, as prescribed by the latest regulations, are not appropriate for this product.

The reclassification of anhydrous ammonia raises emergency response issues. Placarding associated with the new reclassification level does not adequately warn of the full extent of the risks. For example, first responders would encounter its flammable and toxic nature, even though the new classification does not classify it as such a product. In addition, first responders such as police and volunteer firefighters in small communities, with little knowledge of dangerous goods, may make their first estimates of danger based on the colour and shape of the displayed placard. Therefore, the reclassification of anhydrous ammonia from a corrosive gas, Class 2.4, to a non-flammable and non-toxic gas, Class 2.2, and the associated placarding obscure the risks posed to first responders and the general public by a release of large quantities of concentrated anhydrous ammonia. The new Class 2.2 placard is green in colour, a colour frequently interpreted to mean a product with a lower risk, whereas the current Class 2.3 and Class 2.4 placard indicates a toxic or corrosive substance. First responders would exercise more caution in their initial approach to products in these latter categories.

The product is considered to be stable by some and extremely reactive by others.

Different jurisdictions require different information to be included in the Material Safety Data Sheet (MSDS). Any producer of regulated material must provide this information. The safety issue arises from the fact that each jurisdiction has its own interpretation of the meaning of common, everyday words. This leads to a situation where ammonia is considered flammable and slightly explosive by fire authorities, but non-flammable by transportation and environmental authorities. The latter have considered it as either corrosive, toxic, or non-toxic, depending on the particular authority. Along similar lines, the product is considered to be stable by some and extremely reactive by others. However, the manufacturer of the product is obliged to somehow include all this conflicting information on the same MSDS. Having anhydrous ammonia classified differently in different jurisdictions increases the risk of misunderstandings and errors of perception by the general public and first responders when identifying the dangers of an accidental release.

As a result of a 1999 derailment involving the release of anhydrous ammonia (TSB report No. R99T0256), the TSB was concerned that first responders such as firefighters and police in small communities, with little exposure to dangerous goods, may incorrectly make their first estimates of danger based in part on the colour and shape of a placard, instead of relying on the specific characteristics of the product.

The Board recommended that:

> *The Department of Transport review the classification and safety marks for anhydrous ammonia to ensure that it is in a class and division consistent with the risks it poses to the public.*
>
> ***R02-01***

Transport Canada (TC) responded that, with respect to safety marks, there are three sources of information that must be visible on the tank car: the words "ANHYDROUS AMMONIA" in letters at least 100 mm high on each side of the tank; the words "Inhalation Hazard" or "Inhalation Hazard/Dangereux à inhaler" in letters at least 100 mm high on each side of the tank; and a placard visible on both sides and on both ends to indicate the class assigned to anhydrous ammonia.

This matter was discussed at the Minister's Advisory Council and Federal/Provincial Task Force meetings. TC now intends to proceed with an amendment to the *Transportation of Dangerous Goods Regulations* reclassifying anhydrous ammonia as Class 2.3 (8). TC has also consulted the U.S. Department of Transportation on the proposed changes in classification, and it does not foresee any immediate obstacles in cross border movements.

The Derailment

The derailment was initiated when the lateral force of the train on the rail caused the rail to shift, the gauge to widen, and the wheels on the opposite rail to leave the track. The derailed car travelled 90 feet until it came into contact with the wing rail of a frog, causing a lateral stress on the opposite rail at a point where the guard rail was connected to the running rail with a bolt, which then caused a fracture of the rail. The break was found to have originated from a damaged bolt hole where the guard rail was connected to the running rail.

The wide gauge condition of the track at the point of derailment was not detected by regular inspection, since gauge widening occurred only when

The broken rail at the point of divergence

> **This section of the track had not been tested by the track evaluation car; had it been tested, the likelihood of a wide gauge condition going undetected would have been reduced.**

the track was subjected to the heavy load of a rail car or an engine. This section of the track had not been tested by the track evaluation car; had it been tested, the likelihood of a wide gauge condition going undetected would have been reduced.

The bolt hole in the web of the rail had significant long-term damage caused by the bolt rubbing against the hole, indicating that, at some point in time, the bolt had not been adequately tightened. Because the nut of the bolt on the field side of the rail and a spacer block on the gauge side completely concealed the bolt hole, visual turnout inspections did not detect the damage. Monthly visual turnout inspections and detailed semi-annual turnout inspections, as outlined in CPR's Standard Practice Circulars – Track (SPC) No. 33 (effective 01 April 2000), may not be adequate to ensure the detection of damage to bolt holes in high-risk sections of the track.

The damage to the bolt holes caused two pre-cracks to form in the rail. Their location was such that they too would not have been detected during the monthly turnout inspections. Both pre-cracks were large enough to reduce the strength of the rail to such an extent that the lateral stresses caused by the derailed car hitting the frog were great enough to fracture the rail.

This section of track had not been tested by a rail flaw detector car, used to detect internal rail flaws such as bolt hole cracks. However, if the rail flaw detector car had been used, the likelihood of an internal rail flaw going undetected would have been reduced. Main-track sidings are tested at least twice a year; however, yard track was not tested as it did not meet CPR's minimum testing standards.

CPR advised that, in addition to testing main-track sidings at least once a year, it is now testing all sidings.

Tank Car Cracks

The tank car that discharged the anhydrous ammonia had three shallow pre-cracks on the surface of the manway plate. It is likely that these were formed as a result of thermal stresses induced by the welding of the manway nozzle to the shell of the tank at the time of construction in 1968. While pre-cracks may exist for many years without compromising the integrity of the plate under normal operating conditions, a brittle failure may occur when the pre-cracks are exposed to abnormally high stress levels at low ambient temperatures. In this incident, the stresses caused by the impact to the manway nozzle when the derailed car overturned exceeded the structural design capabilities of the tank, resulting in a brittle fracture and the gradual release of ammonia.

Pre-cracks on the surface of the manway plate

Within a week of the derailment, Procor Limited mapped the distorted areas of the overturned tank car to learn the distribution of the stresses to which the car was exposed. In addition, designs of the manway area of other tank cars were analyzed in a similar fashion. This work may ultimately lead to improvements in car design applicable to the whole North American fleet. Procor performed material testing over and above that performed by the TSB, in order to confirm the material properties of tank car welds. Through the participation of the Association of American Railroads Tank Car Committee, upon conclusion of the design analysis work, TC continued to work closely with Procor Limited, other car owners, and the Tank Car Committee to ensure the integrity of the top fitting protection.

REFLEXION

Change is good, but is sometimes insufficient to ensure safety.

Some of the damage to lead locomotive VIA 6450. Note displaced front truck under centre of locomotive (which damaged the battery boxes and diesel fuel tank) and impact marks on collision posts on the front of the locomotive. (Source: *Miramichi Leader* newspaper)

Switches, Speeds and Stopping Distance

The locomotive engineer was vigilant to train operation, but the poor condition of the switch target, tip assembly, and mast prevented the misaligned main-track crossover switch from being detected from a distance sufficient to avert the collision. — Report No. R00M0007

That was one of the findings as to the cause of a collision between VIA Rail Canada Inc. (VIA) passenger train VIA 14 and 11 stationary freight cars at Miramichi, New Brunswick, on 30 January 2000. Of the 127 people on board the VIA train, 43 were taken to hospital. Six passengers, one on-train service crew member, and one emergency responder were admitted with serious injuries.

Communications Breakdown

A New Brunswick East Coast Railway (NBEC) crew had performed switching movements in the Miramichi Yard as planned. It had been clearly understood that the locomotive engineer would reline the inside and main-track crossover switches once the movement was clear of the main track. However, the conductor could not initially get the box car to

The manner of handling main-track switches, as changed from the work plan, was not confirmed by either crew member.

roll freely due to snow conditions. The conductor then walked back to the east end of the car, saw the locomotive engineer getting ready to line the inside crossover switch to its normal condition and radioed him to wait because he may need the locomotives to move the car. The locomotive engineer complied. The conductor reapplied the hand brake, released it, and kicked the brake rigging. The car then started to roll into track NC-23.

The conductor then radioed the locomotive engineer to the effect that he would not need the locomotive engineer to assist him in moving the box car into track NC-23 and for the locomotive engineer to continue. He did so, assuming that the conductor would place the main-track crossover switch into its normal position as he would walk by it on his way to the wye track.

While the conductor secured the box car in track NC-23 and lined the NC-23 switch for the main track, he saw the locomotive engineer placing the inside crossover switch at track NC-22 in its normal position and assumed that the locomotive engineer had previously restored the main-track crossover switch at Mile 65.1. As the conductor and locomotive engineer had agreed to meet at the east leg of the wye track, the conductor started to walk to that location. The locomotive engineer proceeded west, with the two locomotives and trailing car to that location as well. The conductor walked past the main-track crossover switch, not noticing that it had been left lined and locked in the reverse position. He went to the east wye track switch on track NC-22, as the locomotives and car were operated onto the east leg of the wye track.

The manner of handling main-track switches, as changed from the work plan, was not confirmed by either crew member once the distraction occurred and their work plan was interrupted. The basic requirement for conductors and locomotive engineers is to confirm main-track switch position when practicable. There was no additional requirement to ensure that each crew member understood where the main-track switch was and to confirm the actual switch position.

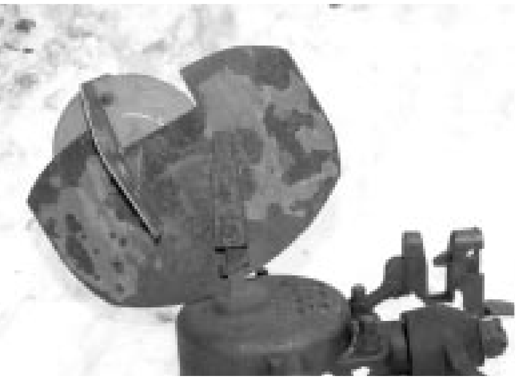
VIA 14 Approaches

Meanwhile, VIA 14 was approaching Miramichi from the west. The train was travelling at about 70 mph as it approached the cautionary limits of the Miramichi Yard at Mile 67.0 of the Newcastle Subdivision. One of the locomotive engineers broadcast a message announcing the train's approach. The locomotive engineers received a radio message that all was clear in the yard from the yard crew.

VIA 14 stopped at the Miramichi Station for boarding and then departed the station. After a pull-by inspection by the NBEC crew, the train accelerated to 41 mph. The VIA 14 locomotive engineer at the controls recalled that he saw that the main-track crossover switch at Mile 65.1 was lined for the reverse position just as the lead locomotive passed the NC-23 switch, which was 330 feet west of the main-track crossover switch. The locomotive engineer could not recall exactly what led him to believe that the main-track crossover was lined in the reverse position – the switch target, the switch points, or both. Realizing that the train was going to be diverted into track NC-22, the crew members applied the emergency brakes and threw themselves to the floor and braced for impact, which occurred at 29 mph.

The switch stand at Mile 65.1 did not meet specifications.

The switch stand at Mile 65.1, a 36-D low, rigid type, did not meet specifications. The mast extension was 12 inches in length, not 25 inches as stipulated. It was fractured in two pieces, one seven inches long, the other five inches long. Construction was of forged steel with a cross-section measuring about 3/4 inch square



Switch target and tip assembly from 36-D switch at the main-track crossover at Mile 65.1 immediately after the accident, as viewed in the direction of travel by the VIA train crew

with an integral one-inch-square socket and set screw. It conformed to a Canadian National (CN) specification for a part to be used in a target tip assembly for forged switch masts, and was not designed for use with a large target switch. It was not painted black and was completely rusted, including the fracture surfaces.

The locomotive engineer detected the unsafe condition at about the same time that such an observation was possible.

It can be calculated that the VIA 14 locomotive engineer became aware of the unsafe condition between 253 feet and 374 feet from the switch. A simulation showed the switch target to be first discernible from 300 feet. It is apparent, therefore, that the locomotive engineer was watchful and alert to the condition of the track and detected the unsafe condition at about the same time that such an observation was possible.

As the simulation also demonstrated, a standard painted switch target and tip assembly in good condition could be identified from about 900 feet. Considering the estimated stopping distance of 1170 feet for VIA 14 (including a four-second reaction time) and the position of the standing equipment (about 595 feet east of the main-track crossover switch), it can be calculated that an operating crew vigilant to track conditions could have stopped its train up to 325 feet before the standing cars. Therefore, it can be concluded that, although the locomotive engineer was vigilant to train operation, the poor condition of the switch target and tip assembly prevented the misaligned switch from being detected from a distance sufficient to avert the collision.

Evolution of the Newcastle Subdivision

For decades, the Newcastle Subdivision was operated by CN under the *Uniform Code of Operating Rules* (UCOR), using the timetable train orders method of operation. There was a superiority of trains under which passenger trains had priority. In the Miramichi area, an Automatic Block Signal (ABS) system gave added protection by informing approaching train crews of the presence of other trains or open main-track switches. Most trains were required to proceed at a restricted speed (maximum 15 mph) within yard limits on the main track, unless the main track was known to be clear.

Over time, the operating environment and traffic levels changed. CN abandoned timetable train orders on the Newcastle Subdivision, and changed over to the Manual Block Signal system of the UCOR. Reference to train superiority disappeared, and timetable authority no longer governed the movements of trains and engines. ABS signals were removed from service, but the yard limits restriction of UCOR rules 93 and 93A still applied; that is, stopping within one-half the range of vision.

With the change from the UCOR to the *Canadian Rail Operating Rules* (CROR) in 1990, yard limits were removed from the operating timetable, requiring all main-track movements to have operating authority. In addition, the introduction of cabooseless train operations required that crews be able to leave the main-track switches of sidings lined and locked in the reverse position. Rule provisions governing hand-operated switches reflected these changes in operating practice. At Miramichi, the timetable designated upper yard track NC-41 as a siding. The rules required all other main-track switches, including crossover switches, to be lined and locked for the main track. Subsequent changes to the timetable introduced cautionary limits to the area, eliminating the requirement for main-track movements to have operating authority. With the introduction of cautionary limits, trains using the main track were required to move at caution speed, which before 1994 was defined to include the requirement not to exceed 15 mph.

Crews routinely operated at speeds up to the zone maximums.

After the 1994 rule change, the caution speed definition in the CROR allowed trains and engines to operate at any speed up to the authorized maximum speed for the zone, provided that they were capable of stopping within one-half the range of vision of equipment or a track unit. If the main track was seen to be clear and conditions of visibility were good, crews routinely operated at speeds up to the zone maximums. Within cautionary limits at Miramichi, the timetable zone speed for that portion of the Newcastle Subdivision was 40 mph for all trains.

The provisions of CROR Rule 94.1, requiring that trains be prepared to stop short of switches lined and locked in the reverse position, were not invoked until CN established cautionary limits. CN relinquished ownership of the Newcastle Subdivision to NBEC in 1998. NBEC continued to use the CROR Occupancy Control System rules as a basis for train operation. NBEC has continued the use of CROR Rule 94.1 to designate specific switches within cautionary limits from operational start-up. No other switches within cautionary limits were considered to require Rule 94.1 protection.

Under the more restrictive interpretation of CROR Rule 94.1, as applied by Canadian Pacific Railway train crews, the crew on VIA 14 would have been required to operate at a speed that permitted stopping short of the main-track crossover switch in the prevailing conditions, and with train operation at that speed, the collision would have been averted. The less restrictive interpretation of Rule 94.1 – that the rule only applies to designated switches – reduces the error tolerance of the system, thereby increasing the risk posed to rail operations by misaligned switches.

As a result of this occurrence, NBEC and its parent company, Quebec Railway Corporation, took a number of steps to enhance the safety of their operations. These steps included a risk management initiative; inspection and maintenance of switch targets; operating practices related to VIA passenger trains; operating practices related to main-track switches; and overall supervision.

Rail Safety Advisory

A Rail Safety Advisory sent to Transport Canada (TC) on 20 July 2001 noted four general categories relating to passenger safety: passenger preparedness, occupant protection, evacuation, and emergency response and rescue. The Advisory concluded that many relatively minor issues relating to passenger safety remain unaddressed, which on their own do not pose a significant risk, but when taken in combination, indicate a possible systemic risk situation. It stated that:

> *Transport Canada and industry may wish to examine these issues and in view of the potential combined risk, evaluate the adequacy of their existing regulatory and safety management approaches in these areas.*

In October 2003, TC provided a progress report confirming the actions taken by VIA in regards to rail passenger safety issues. These include placing emergency information cards on passengers' seats so that they are readily available and making sure that boarding passengers are referred to the safety pamphlets in the pockets of the seats in front of them or on their seats in aft-facing seats. All luggage racks have restraint netting.

REFLEXION

If the locomotive engineer had not been so vigilant, the consequences would have been a lot worse.

Aerial view of accident site on the day of occurrence

Stop . . . but When?

The issue of how and when a train should be stopped following an alarm transmitted by a wayside inspection system (WIS) was analyzed by the TSB in its investigation of a freight train derailment and collision in Ontario on 21 February 2003. — Report No. R03T0080

Canadian Pacific Railway (CPR) train 410-16 (train 410) was proceeding eastward on the main track of CPR's Belleville Subdivision at 0536 eastern standard time when the train passed through a hot box and dragging equipment detector system (the scanner) at Mile 82.1, where wheels and axles are monitored. An alarm tone was generated when heat was detected from one of the axle bearings on the train. Once the entire train cleared the scanner, its automated voice communication function advised the crew that a hot bearing had been detected approximately 122 axles behind the lead locomotive. The message also told the crew to stop the train for inspection. Approximately two miles further down the track, train 251-19 (train 251) was standing at Mile 80.5 in the Lonsdale Siding, clear of the main-track switch.

On the Belleville Subdivision, detectors are located on average every 20 miles, with a maximum spacing of 26 miles. CPR indicated that trains do not have to stop immediately after an alarm at some locations if it is not practicable. Due to the presence of curves, grades, and road crossings, along with the close proximity to the Lonsdale Siding, the scanner at Mile 82.1 was identified as a location where it is not practicable to stop the train immediately.

Speed Limit of 5 mph

CPR's timetable identified the inspection location as the Lonsdale Siding (but not beyond the east end switch of

Without stopping the train to perform the inspection, it is unlikely that the train crew would know the exact location of the defective equipment.

the siding). Further instructions advise that the train should not exceed 5 mph when moving defective equipment over facing-point switches. Without stopping the train to perform the inspection, it is unlikely that the train crew would know the exact location of the defective equipment and be able to slow the train sufficiently to allow defective equipment over a facing-point switch at less than 5 mph. Train 410 encountered a facing-point switch at the west end of the siding.

Data from the locomotive event recorder showed that, at 0530:11, train 410 was travelling at approximately 35 mph in throttle position 8 (maximum throttle) as it approached the scanner at Mile 82.1. At 0535:37, while the train was travelling at 42 mph, the throttle was reduced to position 6. At 0535:49, the independent brake was bailed off while in throttle position 6 and with

The derailed car continued eastward towards the switch point at Mile 80.5, where it took the diverging route into the Lonsdale Siding.

the speed constant at 42 mph. At 0536:04, an in-train emergency brake application was recorded.

Despite being advised of potential defective equipment, the decision not to slow the train down to 5 mph or less when travelling over the facing-point switch resulted in a more serious derailment outcome.

At approximately 0540, a wheel set on the 27th car of train 410 derailed to the south side of the main track at Mile 80.9. The derailed car continued eastward towards the switch point at Mile 80.5, where it took the diverging route into the Lonsdale Siding. The 27th car then struck the side of the first locomotive on train 251. The following two cars from train 410, the 28th and 29th cars, ran in behind and derailed to the north side of the track. The next seven cars of train 410, the 30th to 36th cars, were tank cars loaded with liquefied petroleum gas (LPG). The first loaded tank car derailed and struck the right front corner of the first locomotive of train 251 and exploded on impact. The second tank car also derailed and then exploded after heavy impact damage. This sequence was followed by explosions of the third and fifth LPG tank cars within 15 minutes of sustaining severe damage from derailed cars piling in from behind. Shortly after, the remaining three loaded LPG tank cars ruptured as a result of impact damage. Both crew members of train 251 suffered burns from the fireballs of the punctured tank cars; the crew of train 410 was not injured.

The fire burned for three days. Smoke plumes from the fires and the burning propane caused some concern for the air quality in the immediate area. About 300 residents were evacuated as a safety precaution.

TSB Simulation

In a TSB simulation of the events leading up to the derailment using an actual train of similar weight and length as train 410, the train was operated using safe operating practices, which complied with Transport Canada (TC) requirements and CPR instructions. Using dynamic brakes initially, followed by a combination of train and dynamic brakes, the train was safely stopped approximately 520 feet west of the facing-point switch at the Lonsdale Siding. The simulation indicated that, had efforts been made to control train speed from the time of the initial alarm, followed by normal braking when the voice message was broadcast, the train could have been stopped before reaching the Lonsdale Siding, thereby minimizing the severity of the derailment.

An examination of the derailed rolling stock determined that a burnt-off journal at the No. 2 wheel on the 27th car had occurred. Just prior to the derailment, the roller bearing overheated and seized. The axle then extruded, resulting in a reduction of cross-sectional thickness. After sufficient thinning, the overheated axle could no longer support the weight of the car, leading to a complete axle failure. Based on derailment marks on the track, it

Burnt-off journal and wheel assembly from car SOO 18748

Since 1992, there have been five other rail accidents investigated by the TSB in which data from the event recorder were lost due to fire exposure or water contamination.

was determined that the axle failed approximately 3800 feet east of the scanner located at Mile 82.1. The cause of the overheated bearing could not be determined.

In this occurrence, the lead locomotive on train 251 was subjected to extreme fire and heat conditions, resulting in damage to the event recorder and the complete loss of data. Since 1992, there have been five other rail accidents investigated by the TSB in which data from the event recorder were lost due to fire exposure or water contamination.

Although federally regulated railways are required to install event recorders in locomotives when operating on main track, there are no performance requirements related to the survivability of the recorder under extreme conditions. Consequently, the absence of design and performance standards for locomotive event recorders impedes the effort to investigate rail accidents and to improve railway safety.

As mentioned in the first article of this magazine, a Notice of Proposed Rulemaking published in the Federal Register addresses several safety recommendations related to event recorders. TC said that it was closely following the development of the United States rule.

Subsequent to this occurrence, CPR modified the software on all wayside detectors such that, while passing the detector, the alarm tone is immediately followed by a radio announcement identifying the nature of the defect (e.g. dragging equipment, hot box or hot wheel).

Damaged tank car
CHAX 225

Long Trains and Brakes

While there have been only five occurrences from 1998 to 2001 where train derailments resulted from an emergency brake application by the locomotive engineer, the consequences associated with those occurrences are of concern to the TSB.

One of those accidents occurred on 06 October 2001, when Canadian National (CN) freight train No. M-306-31-05 (train 306) derailed 15 cars after striking a stalled automobile at a farm crossing at Mile 178.67 of the Napadogan Subdivision in Drummond, New Brunswick. The three occupants had evacuated the automobile before the collision and were not physically injured. One of the tank cars suffered damage to the top protective housing and fittings, causing a release of butane.
— Report No. R01M0061

Train 306 consisted of 3 locomotives, 60 loaded cars, 52 empty cars, and 18 residue cars. It was about 8700 feet long and weighed approximately 10 000 tons. As the train approached the farm crossing, the locomotive engineer saw the car stopped on the crossing, sounded the horn and then made an emergency brake application. The emergency toggle switch, with which all Train Information and Braking Systems are equipped and which can initiate tail-end emergency brake propagation, was not activated, although CN has a directive requiring locomotive engineers to do so.

Effects of Braking

On trains equipped with conventional air brakes, an emergency brake application from the lead locomotive does not result in the simultaneous braking of all cars as the braking action takes time to propagate from the head end of the train to the tail end. The time of propagation results in the cars at the tail end of the train receiving effective braking last. In longer trains, or trains containing cars with end-of-car cushioning devices, the brake pipe length is increased, further delaying the onset of effective braking action in the tail end

Braking may be fully applied at the head end before any initiation of braking in the tail end.

– braking may be fully applied at the head end before any initiation of braking in the tail end. Therefore, when the train is stretched, a run-in of train slack will occur and in-train buff forces will be generated.

CN initiated a program to equip its operating fleet of approximately 1600 road locomotives with an end-of-train system that automatically initiates synchronous braking from both the locomotive and the tail end during emergency and service applications. As of year end 2004, CN has equipped 169 locomotives and acquired 338 end-of-train devices for use in its Canadian operations. Transport Canada (TC) revised the *Railway Locomotive Inspection and Safety Rules* in September 2002, to require new locomotives to meet Association of American Railroads (AAR) standards for the automated and simultaneous activation of two-way end-of-train devices.

These TC safety initiatives will improve emergency brake performance in the long term. However, CN and other Canadian railways have not committed to a program that would accelerate the replacement of existing systems with newer technology. Therefore, the remaining existing locomotives will continue to use older end-of-train units until they reach the end of their service life. Given that Canadian railways are equipped with a relatively young locomotive fleet, and given the evolution of freight train operations to longer trains, the risks inherent to emergency situations on long freight trains will remain unaddressed. Therefore, the Board recommended that, as a priority:

> *Transport Canada encourage the railway companies to implement technologies and/or methods of train control to assure that in-train forces generated during emergency braking are consistent with safe train operation.*
>
> ***R04-01***

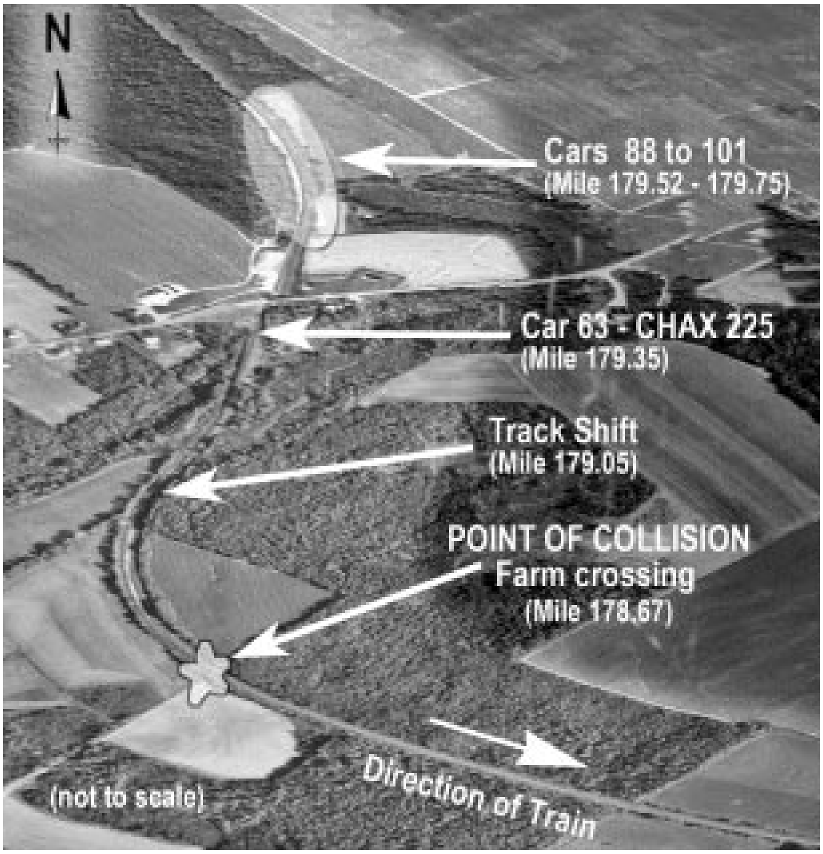
Most of the loaded cars on train 306 were located in the tail-end portion of the train. There were several long-long and long-short car combinations in the consist. Ten of the cars were equipped with end-of-train cushioning devices.

Tonnage Distribution not Constrained

CN's marshalling General Operating Instructions (GOIs) and train planning systems have no constraints on tonnage distribution and train length; rather, they use sequential destination blocking (i.e. the sequence of the blocks of cars corresponds to the sequence of their destination stations). Therefore, trains are not systematically configured to allow an effective control of the buff forces. On curved track, these buff forces, acting on long-long or long-short car combinations, generate a larger lateral force on the track structure, increasing the risk of derailment. Due to the inclination of the drawbars between empty and loaded cars, the buff forces will subject an empty car located between loaded cars to high compression and lifting forces, which can derail or buckle the car.

For instance, train 306 was a long train marshalled with most of the weight in the tail end. At the time of the accident, the train was negotiating an ascending grade and was, therefore, fully stretched. As the emergency brake was applied from the locomotive, a run-in occurred, and high buff forces were generated. Although the track met CN's Standard Practice Circulars and TC's *Railway Track Safety Rules*, the action of the buff forces on the 88th to the 101st cars, where several long-short car combinations were located on curved track, generated high lateral forces that exceeded the resistance of the track structure, causing gauge widening, rail rollover, and the derailment of cars. Furthermore, the buff forces generated compressive stresses that exceeded the design specifications of the 63rd car, an empty tank car located between loaded cars, causing the tank car to derail and buckle.

On 27 May 2003, TC wrote to the Railway Association of Canada to discuss the development and implementation of train design specifications that take train tonnage and train length into consideration, and suggested that train handling instructions be written to help locomotive engineers with regards to weight distribution, to avoid excessive braking forces whenever possible.



Aerial photo of accident site **(Source: Natural Resources Canada)**

Butane Leak

In this occurrence, the liquid eduction valve was damaged, causing butane to leak when tank car CITX 4240 overturned while train 306 was travelling at 27 mph. This type of damage also occurs in yard accidents where the speed is relatively low, as was observed on tank cars involved in yard derailments at the MacMillan Yard and Red Deer (TSB report No. R98T0292 and report No. R01E0009). (See the article on the Red Deer derailment elsewhere in this issue.) Following these derailments, TC indicated that issues relating to design requirements applicable to top fitting protection would be examined when the standards were reviewed. In August 2002, new dangerous goods containment standards were issued; however, the requirement for rollover or skid protection for top fittings was not improved. Therefore, the shortcomings identified in the protection of top fittings remain unaddressed and will continue to present a risk to the public and the environment.

The AAR Tank Car Committee Task Force on Top Fitting Protection was reviewing these issues:

- ability for manway to withstand gentle rollover;
- determination of loads on the manway generated from a slow rollover;
- review of “Texas wedding ring” style construction manway strength as compared to other designs; and
- appropriate vertical design loads for manways.

To date, the AAR Tank Car Committee has established requirements for sulphuric acid tank cars that are now found in AAR M–1002 in section 2.2.3. The new protection requirements have been applied to a portion of the Canadian fleet of acid cars, with a completion date of 01 August 2011. However, no resolution has been put forth for pressure tank cars. The task force, which met and discussed the need for top fittings protection for all tank cars, did not put forth any proposals and is now inactive.

The local police dispatched to this occurrence were not experienced with large train derailments involving dangerous goods. They approached the accident site without protective equipment for dangerous goods or information about the products involved in the derailment, even though they had received basic dangerous goods awareness training. This behaviour reinforces the safety concern expressed by the TSB after the accident near Britt, Ontario (TSB report No. R99T0256), that, due to the low frequency of exposure to railway accidents, some first responders in small communities may not have the level of awareness necessary to adequately assess the risks associated with railway accidents involving dangerous goods. Consequently, they continue to take inappropriate actions and expose themselves to dangerous goods in the performance of their duties.

Railway Occurrence Statistics

	2004 (Jan.–Sept.)	2003	1999–2003 Average
Accidents	**862**	**778**	**804**
Main-track train collisions	5	6	7
Main-track train derailments	118	116	102
Crossings	179	185	193
Non-main-track train collisions	90	76	81
Non-main-track train derailments	339	287	294
Collisions/Derailments involving track units	22	17	14
Employee/Passenger	7	6	7
Trespassers	73	54	60
Fires/Explosions	12	19	28
Other	17	12	19
Incidents	**192**	**226**	**239**
Dangerous goods leaker	99	119	133
Main-track switch in abnormal position	6	10	9
Movement exceeds limits of authority	72	73	75
Runaway rolling stock	8	11	9
Other	7	13	13
Million Train-Miles*	**67.60**	**66.60**	**67.10**
Accidents/Million Train-Miles	**12.75**	**11.68**	**11.99**
Accidents Involving Dangerous Goods	**163**	**165**	**173**
Main-track train derailments	28	31	21
Crossings	7	2	5
Non-main-track train collisions	36	24	35
Non-main-track train derailments	84	101	103
Other	8	7	9
Accidents with a Dangerous Goods Release	**5**	**8**	**6**
Accidents Involving Passenger Trains	**63**	**46**	**52**
Fatalities	**70**	**60**	**70**
Crossings	14	20	27
Trespassers	52	35	40
Other	4	5	2
Serious Injuries	**68**	**69**	**62**
Crossings	39	43	31
Trespassers	22	18	19
Other	7	8	12

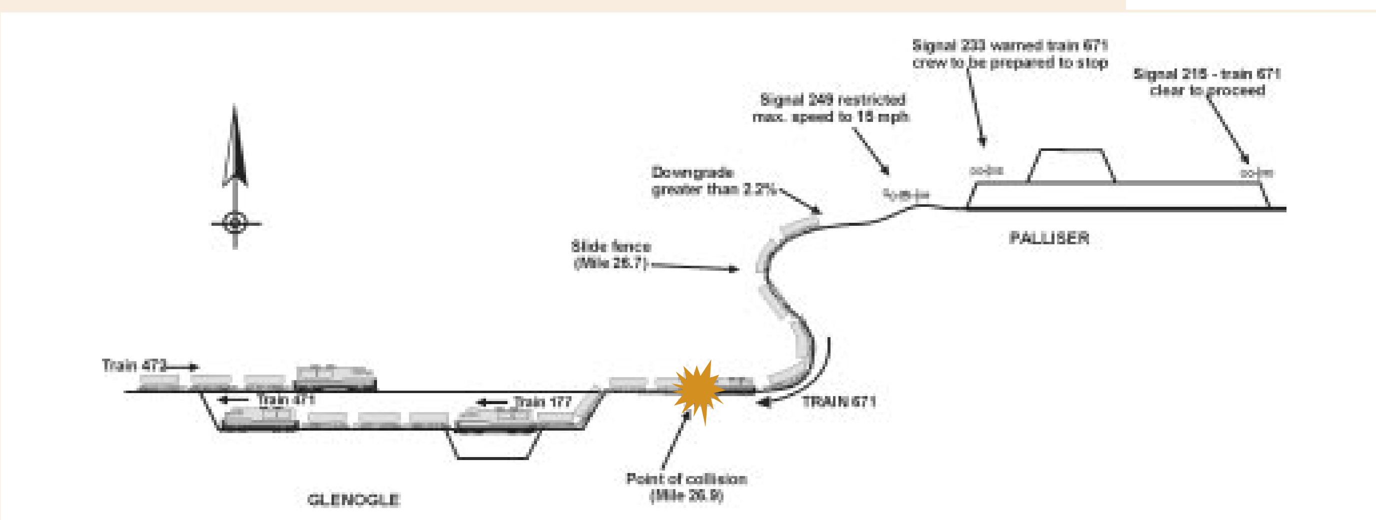
* Train-miles are estimated. (Source: Transport Canada)
Figures are preliminary as of 12 October 2004.
All five-year averages have been rounded. The totals occasionally do not coincide with the sum of these averages.

RAILWAY Occurrence *Summaries*

DECOYED BY A SLIDE DETECTOR

Canadian Pacific Railway (CPR) freight train 671, travelling westward at Mile 26.9 on the Mountain Subdivision near Glenogle, British Columbia, on 24 March 2002, struck train 177 that was stationary on the main track. The two lead locomotives of train 671 and the last three cars of train 177 derailed. The locomotive engineer suffered minor injuries.
— Report No. R02C0022

Train 671, en route from Field, British Columbia, passed Signal 215 at the east switch at Palliser, British Columbia, which displayed a "Clear" signal indication. A few minutes later, the train encountered a "Clear to Stop" signal indication at Signal 233, located at the west switch at Palliser. A "Restricting" signal indication was displayed at Signal 249. The train's speed was reduced to 17 mph in advance of a slide detector fence at Mile 26.7, the train crew assuming that the "Restricting" signal indication was displayed as a result of a rock fall or slide.



Sketch showing position of trains and signals

Had the crew of train 671 been aware of the location of stationary train 177, it is unlikely that the collision would have occurred.

The locomotive engineer had been informed by another locomotive engineer that the slide detector had been activated several hours earlier and the crew was unaware that the slide detector had been placed back in service about two hours earlier. Furthermore, the slide detector activated frequently, particularly at that time of year.

Having passed the slide detector without observing any obstructions, train 671 continued at 17 mph around a five-degree right-hand curve. As the train negotiated the curve, the conductor situated on the left-hand side of the locomotive noticed, and indicated to the locomotive engineer, that there was a train ahead on the main track. The emergency brake was applied, but not in time to avert the collision.

The rail traffic controller had told train 177 that there would be a meet at the siding, but omitted to tell train 671. In the absence of an external clue to alert the crew of train 671 that their assessment of the "Restricting" signal indication was incorrect, the train crew proceeded without reducing speed. Had the crew of train 671 been aware of the location of stationary train 177, it is unlikely that the collision would have occurred, as the crew would have attributed the signal to the presence of train 177, rather than to faulty slide detector activation.

MISSED SIGNAL

Canadian Pacific Railway (CPR) train 121 was westward on the main track of the Belleville Subdivision in Ontario, on 22 February 2002, when it collided with the side of eastward CPR train 158 as it entered the siding at Port Hope, Ontario, at Mile 143.9. Both crew members on train 121 were seriously injured jumping from their train. — Report No. R02T0047

Train 121 transports road highway trailers between Montréal, Quebec, and Toronto, Ontario. The train, referred to as an "expressway" Class 1 CPR premium service freight train, receives priority handling en route. This type of train is allowed to travel 5 to 10 mph faster than restricted freight trains. At single track meets, opposing trains generally take the siding unless they exceed its length, allowing the expressway train to hold the main track and only incur minimal delays.

There is a single aspect intermediate signal at Mile 140.3 (Signal 1403), in advance of Signal 1425, that governs westward movements over the switch at the east end of the Port Hope Siding. Train 121 passed by Signal 1403 at a speed of approximately 45 mph in throttle position 4. The crew stated that Signal 1403 displayed a "Clear" indication, telling them to proceed to Signal 1425.

Signal 1425 was displaying an aspect of "Clear to Stop" (yellow over red). This signal aspect indicates to the crew that they may proceed, preparing to stop at Signal 1439, which governs westward movements over the west siding switch at Port Hope. The crew members of train 121 did not call out the signals as they approached and passed Signal 1425. The crew reported that, approaching Signal 1425, located at the end of a curve, the setting sun was directly behind Signal 1425, making it impossible to determine the indication displayed.

The crew anticipated that the signal would be permissive.

The crew anticipated that the signal would be permissive based on past experience. It was their intent to proceed to the next signal, at Mile 143.9, at the west end of the Port Hope Siding, expecting it also to display a permissive signal.

The crew on train 121 did not hear any radio communication involving train 158 and was not aware that train 158 was in the area, nor that the trains were to meet at Port Hope.

As train 158 approached Signal 1440, which governs eastward movements over the west siding switch at Port Hope, the crew members prepared to enter the siding when they observed train 121 approaching on the main track. Realizing that train 121 was not going to stop, the crew of train 158 decided to continue entry into the siding rather than put the train brakes into emergency, in the hope that they could enter the siding and avoid a head-on collision. Train 121 collided with the fourth car behind the locomotives.

Train 121 was being operated by the conductor under the unofficial supervision of the locomotive engineer. The practice of allowing an unqualified employee to operate the locomotive was not permitted by CPR, and the locomotive engineer had been directed to cease this practice three weeks before the accident.

Subsequent to this accident, CPR reiterated to its crews that only qualified persons may operate locomotives.

CPR also improved the visibility of Signal 1425 by changing the signal lens from 10 degrees to 20 degrees, to account for track curvature at that location.

DYNAMIC BRAKING OR NOT?

On 26 April 2002, Canadian National (CN) freight train E-201-31-24 departed Winnipeg, Manitoba, along the north main track of the Redditt Subdivision. As the train traversed a crossover from the north to the south main track, eight cars derailed at Mile 251.3. — Report No. R02W0060

In the westward direction of travel, the track profile leading to the crossover consists of a 0.6 per cent ascending grade, beginning at Mile 249.3. At approximately Mile 250.0, the ascending grade decreases to 0.4 per cent, leading to the crest of the elevation at Mile 250.33. After the crest, the grade reverts to a 0.5 per cent descending grade to Mile 251.0, where a No. 10 crossover from the north track to the south track is encountered. From that point, the track profile is level for the next 1 1/2 miles.

As the train ascended the grade, it passed lead Signal 2499A at Mile 249.9. This signal displayed a "Clear to Stop" indication, requiring that the train proceed and prepare to stop at the next signal. The train crested the top of the grade, proceeded around a left-hand curve, and descended toward the crossover. The next signal encountered, 2511A, governed movement through the crossover and indicated "Slow to Clear," requiring a maximum speed of 15 mph through the crossover. The locomotive event recorder indicated that, in the two miles approaching the crossover, the train was primarily controlled through a combination of throttle manipulation and dynamic brake (DB). With the throttle in idle and the train travelling at 20 mph in a descending grade, the locomotive engineer made a fast, hard application of DB in an effort to control the speed of the train as it approached the crossover. With the throttle in the same position and the DB applied, the train proceeded through the crossover at 19 mph and the train experienced a train-initiated emergency brake application.

The use of DB as the train entered the crossover bunched the locomotives and the cars on the front end of the train and allowed the train's trailing tonnage to run in as the rear of the train crested the grade. The run-in of slack, combined with sustained DB, generated buff forces severe enough to initiate wheel lift, derailing the lead wheel of the lead truck of an empty bulkhead centre-beam flat car near the head end of the train as it travelled through the crossover.

A locomotive engineer's ability to get a "feel" for how efficiently the DB is working is an essential element of train handling and, since the train had just departed, there had not been sufficient time to make that determination. The train's approach to the crossover at a speed higher than the signal indication necessitated a choice of speed-reduction technologies. The selection of DB as the initial braking force is a technique emphasized by the railway; however, the train speed approaching the crossover did not comply with the operating requirements dictated by the signal indication.

Alternative train handling methods were available to the locomotive engineer.

Alternative train handling methods were available to the locomotive engineer. If selected, they would have ensured safe operation of the train at this location. The train speed could have been reduced earlier, permitting a reduction in DB as the head end of the train traversed the crossover, as suggested by known industry best practices. Train automatic air brakes could have been used alone, without DB. This method is also an accepted railway practice in slowing trains in cresting grade situations. The railway's train handling instructions, however, do not encourage the use of DB as the primary braking force. A heavy application of DB made in attempt to control the train's speed as it traversed the crossover – when there were long-wheel base empty cars close to the locomotives, with 90 per cent of the train's tonnage trailing on a descending grade – was inappropriate for the conditions and operating requirements at that location.

Investigations

The following is *preliminary* information on all occurrences under investigation by the TSB that were reported between 01 September 2003 and 30 September 2004. Final determination of events is subject to the TSB's full investigation of these occurrences.

DATE	LOCATION	COMPANY	EVENT	OCCURRENCE NO.
OCTOBER 2003 19	Upsala, Ont.	Canadian Pacific Railway	Main-track derailment	R03W0169
24	Swansea, B.C.	Canadian Pacific Railway	Main-track derailment	R03C0101
JANUARY 2004 08	New Hamburg, Ont.	VIA Rail Canada Inc.	Main-track derailment	R04S0001
14	Whitby, Ont.	Canadian Pacific Railway	Main-track derailment	R04T0008
22	Bolton, Ont.	Canadian Pacific Railway	Main-track derailment	R04T0013
FEBRUARY 07	Montmagny, Que.	Canadian National	Main-track derailment	R04Q0006
17	Winnipeg, Man.	Canadian National	Non-main-track derailment	R04W0035
MARCH 04	Penhold, Alta.	Canadian Pacific Railway	Main-track derailment	R04E0027
17	Linton, Que.	Canadian National	Main-track derailment	R04Q0016
APRIL 18	Linacy, N.S.	Cape Breton and Central Nova Scotia Railway	Main-track derailment	R04M0032
JUNE 28	Richmond, Ont.	VIA Rail Canada Inc.	Crossing accident	R04H0009
JULY 08	Bend, B.C.	Canadian National	Movement exceeds limits of authority	R04V0100
25	Burton, Ont.	Canadian National	Main-track derailment	R04T0161
AUGUST 08	Estevan, Sask.	Canadian Pacific Railway	Non-main-track derailment	R04W0148
17	Lévis, Que.	Canadian National	Main-track derailment	R04Q0040

Final Reports

The following investigation reports were released between 01 September 2003 and 30 September 2004.
*See article or summary in this issue.

DATE	LOCATION	EVENT	REPORT NO.
00-01-30	Miramichi, N.B.	Collision and derailment	R00M0007*
01-01-16	Mallorytown, Ont.	Main-track derailment	R01T0006
01-02-15	Trudel, Que.	Main-track derailment	R01Q0010
01-08-29	Montréal, Que.	Non-main-track derailment	R01D0097
01-10-01	Kemnay, Man.	Main-track derailment	R01W0182
01-10-06	Drummond, N.B.	Crossing accident and derailment	R01M0061*
02-02-15	Dartmouth, N.S.	Non-main-track derailment	R02M0007
02-02-22	Port Hope, Ont.	Main-track collision	R02T0047*
02-03-18	Éric, Que.	Main-track derailment	R02Q0021
02-03-24	Glenogle, B.C.	Main-track collision and derailment	R02C0022*
02-04-26	Winnipeg, Man.	Main-track derailment	R02W0060*
02-04-28	Natal, B.C.	Main-track collision and derailment	R02V0057
02-07-03	L'Assomption, Que.	Main-track derailment	R02D0069
02-07-08	Camrose, Alta.	Main-track derailment	R02C0050
02-07-23	Carstairs, Alta.	Main-train derailment	R02C0054
02-08-13	Shubenacadie, N.S.	Main-track derailment	R02M0050
03-03-27	Lennoxville, Que.	Main-track derailment	R03D0042
03-05-21	Brechin East, Ont.	Main-track derailment	R03T0157
03-10-19	Upsala, Ont.	Main-track derailment	R03W0169

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