



## **RAILWAY OCCURRENCE REPORT**

### **COLLISION**

**CN NORTH AMERICA  
LOCOMOTIVES CN 9552 AND CN 5294  
MILE 1.5, LAC-SAINT-JEAN SUBDIVISION  
GARNEAU YARD  
SAINT-GEORGES, QUEBEC  
07 JUNE 1994**

**REPORT NUMBER R94Q0029**

## **MANDATE OF THE TSB**

The Canadian Transportation Accident Investigation and Safety Board Act provides the legal framework governing the TSB's activities. Basically, the TSB has a mandate to advance safety in the marine, pipeline, rail, and aviation modes of transportation by:

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

It is not the function of the Board to assign fault or determine civil or criminal liability. However, the Board must not refrain from fully reporting on the causes and contributing factors merely because fault or liability might be inferred from the Board's findings.

## **INDEPENDENCE**

To enable the public to have confidence in the transportation accident investigation process, it is essential that the investigating agency be, and be seen to be, independent and free from any conflicts of interest when it investigates accidents, identifies safety deficiencies, and makes safety recommendations. Independence is a key feature of the TSB. The Board reports to Parliament through the President of the Queen's Privy Council for Canada and is separate from other government agencies and departments. Its independence enables it to be fully objective in arriving at its conclusions and recommendations.



The Transportation Safety Board of Canada (TSB) investigated this occurrence for the purpose of advancing transportation safety. It is not the function of the Board to assign fault or determine civil or criminal liability.

## Railway Occurrence Report

### Collision

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Locomotives CN 9552 and CN 5294  
Mile 1.5, Lac-Saint-Jean Subdivision  
Garneau Yard  
Saint-Georges, Quebec  
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### *Synopsis*

A two-unit locomotive consist, travelling northward, collided with a four-unit locomotive consist backing southward on the main track at Mile 1.5 of the CN North America (CN) Lac-Saint-Jean Subdivision in Garneau Yard in Saint-Georges, Quebec. The collision occurred on a six-degree curve where sight-lines were restricted. Three employees were injured.

The Board determined that the two locomotive consists, moving in a location with limited visibility, were being operated at speeds that prevented either from stopping before colliding with the opposing movement. A contributing factor was the fact that the yardmaster accepted the unnecessary responsibility of controlling train movements within cautionary limits.

Ce rapport est également disponible en français.

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## *1.0 Factual Information*

### *1.1 The Accident*

The locomotive consist for train No. 418 (train 418), comprising locomotives CN 9552 and CN 2339, was travelling northward on the main track (Lac-Saint-Jean Subdivision), en route to the switch at Mile 1.78 to enter onto the yard extension track to couple to train 418 which was standing on track No. S-253.

Train No. 421 (train 421) arrived in Garneau Yard from Montreal, Quebec, and was yarded on track No. S-263. The crew uncoupled the four locomotives (CN 9639, CN 5137, CN 5327 and CN 5294) from the train and operated the locomotive consist northward on the yard extension track to the main track switch at Mile 1.78. The locomotives entered the main track and their movement was reversed southward, destined to the Garneau Yard locomotive shop.

At approximately 1535 eastern daylight time (EDT), the two movements collided on a six-degree curve at Mile 1.5.

### *1.2 Injuries*

The trainman on train 418 sustained a broken shoulder blade, the conductor suffered bruises and the locomotive engineer was shaken up and treated for shock.

### *1.3 Damage to Equipment*

The leading locomotive of train 418 and the trailing locomotive of train 421 were extensively damaged.

### *1.4 Personnel Information*

The crew on train 421 included a locomotive engineer and a conductor. The crew on train 418 included a locomotive engineer, a trainman and a conductor. The crew members of both trains were qualified for their positions and met fitness and rest standards established to ensure the safe operation of trains.

### *1.5 Method of Train Control*

The train movements were governed by the requirements of cautionary limits of the Canadian Rail Operating Rules (CROR). Cautionary limits extend between Mile 0.0 and Mile 2.4 of the Lac-Saint-Jean Subdivision.

#### *1.5.1 Cautionary Limits*

Cautionary limits are defined in the CROR as "that portion of the main track or main tracks within limits defined by cautionary limit signs."

A cautionary limit sign is a square yellow reflectorized sign located adjacent to the track at the entrance to cautionary limits.

#### *1.5.2 CROR Rule 94*

CROR Rule 94 (c) states that "a third class, fourth class, extra train or engine must operate at caution speed within cautionary limits."

#### *1.5.3 Caution Speed*

Caution speed is defined in the CROR as "a speed that will permit stopping within one-half the range of vision of equipment or a track unit."

### *1.6 Weather*

The weather was cloudy and calm. The temperature was 19 degrees Celsius.

### *1.7 Recorded Information*

#### *1.7.1 Event Recorder - Train 418*

At a recorded time of 1534:38 EDT, locomotive No. 9552 was recorded as travelling at 27 mph in throttle position No. 4. Speed had been constant for the previous 18 seconds and minor throttle adjustments between throttle position No. 1 and No. 4 had occurred. At 1534:42 EDT, the throttle was moved to the "idle position" and a full independent brake application occurred. Speed is then shown to decrease as brake cylinder pressure rose. At a recorded time of 1534:52 EDT, and at a recorded speed of 9 mph, the event recorder ceased to function.

#### *1.7.2 Event Recorder - Train 421*

At a recorded time of 1533:42 EDT, locomotive No. 9639 was depicted as travelling at 13 mph with the throttle in the idle position. Speed gradually built to 20 mph at a recorded time of 1534:34 EDT. At a recorded time of 1534:46 EDT, a full independent brake application was initiated. At a recorded time of 1534:53 EDT, brake cylinder pressure rose while train speed suddenly dropped from 20 mph to 10 mph. Recorded train speed then quickly decreased, registering 0 mph at a recorded time of 1535:00 EDT.

### *1.8 Occurrence Site Information*

Travelling north to south, the single main track descends at 0.2 per cent on a six-degree right-hand curve at Mile 1.5.

Dense foliage on the west side of the curve restricted the sight-line distance to 524 feet in the arc around the collision site.

The lead extension track, which is approximately 1,878 feet in length, runs parallel to and east of the main track. The north end of Garneau Yard, which consists of 19 yard tracks, is located immediately southwest of the occurrence site.

The locomotives came to rest at approximately Mile 1.5. The leading wheels of CN 9552 derailed and marked the ties for a distance 39 feet southward. The second and third locomotives on train 421 uncoupled. A circuit-breaker supplying electrical power to the event recorder on the lead locomotive of train 418 was tripped at impact.

## *1.9 Tests and Research*

### *1.9.1 The Simulation*

Tests were conducted at the accident site on 13 June 1994, in similar weather conditions and at about the same time of day, to determine the approximate stopping distances of the respective locomotive consists. Braking was initiated at speeds depicted by event recorder information as the speeds at the time of the respective brake applications.

The independent brakes of two locomotives proceeding northward were fully applied at a recorded speed of 27.5 mph. The event recorder data indicated that the train stopped in approximately 427 feet. The event recorder data from a similar test with four locomotives proceeding southward at a recorded speed of 19.9 mph indicated that they stopped in approximately 285 feet.

## *1.10 Other Information*

### *1.10.1 Yardmaster*

A yardmaster is on duty at Garneau Yard 24 hours each day except Saturday and Sunday. Shifts change at 0730, 1530 and 2330. The yardmaster's duties include supervising the switching operations of yard crews, issuing instructions to incoming and outgoing trains, transmitting and receiving information from the rail traffic controller (RTC) located in Montreal, providing appropriate information to car department and locomotive shop personnel at Garneau Yard and, when necessary, providing information to track maintenance personnel concerning the movement of trains in the Garneau Yard area. The yardmaster makes and receives telephone calls and uses the computer and fax machine. He also occasionally drives the yard taxi to accommodate train crew members.

A yardmaster's job description was requested, but CN management was unable to furnish one that was in force at the time of the collision.

In a large organization, a valid job description is a vital management tool. A job description is produced from job analysis and describes the tasks to be performed and the working conditions involved. "If thorough and complete, job analysis provides a deeper understanding of an individual job and the



behavioral requirements and, therefore, creates a firm basis on which to make job related decisions."<sup>1</sup> The value of job analysis has been confirmed by safety authorities as follows:

There is enormous pressure to reduce costs while at the same time improving quality. In addition, humanitarian and liability concerns require greater levels of safety, both for those who do the work, as well as for the customer or client. The single most useful tool to meet these objectives is to systematically analyze the work which is done and to establish appropriate procedures or practices to ensure that it is consistently done the proper way.<sup>2</sup>

#### 1.10.2 *Yardmaster's Office*

The yardmaster's office is located approximately 30 feet above ground level, in a tower on top of the yard office building, at Mile 0.0 of the Lac-Saint-Jean Subdivision. Windows on all four sides of the office provide an excellent view of ongoing yard activities in and approaching Garneau Yard; however, there was no status board or job aid to help the yardmaster remember or confirm the situation or plans. The office is equipped with telephones, a computer, a fax machine and a railway radio with channels providing access to the RTC, train and yard crews and maintenance-of-way personnel within radio range in the area.

#### 1.10.3 *Yardmaster Activity*

At times, the yardmaster at Garneau Yard is very busy. Two incumbents stated that, on some shifts, they do not have time to eat a meal. On weekdays, the latter part of the afternoon can be very hectic. The yardmaster's office was observed for two brief periods. During an eight-minute period, starting at 1440 EDT on 21 June 1994, the yardmaster received or made five radio transmissions, two telephone calls, one fax, and had to go downstairs to photocopy some material and speak to a clerk. From 1615 to 1630 EDT on the same day, a second observation was conducted. The situation was less hectic, but busy. During the 15-minute period, the yardmaster prepared switch lists, received four radio calls and one telephone call, and went downstairs once on related business.

Both yardmasters stated that the workload at shift change in the afternoon usually is hectic. They are rarely able to concentrate on a task for long because of distractions from the radio, telephone calls, visits from train crew members, and tasks requiring them to go downstairs, leaving the office unattended for brief periods.

The yardmasters said that they have clerks to perform some of the administrative tasks, such as updating the computer, but at the end of June 1994, the clerks positions were to be abolished. The yardmasters stated that they will be expected to perform many of the clerks' duties and that a new computer terminal will be installed in the yardmaster's office. An additional task being added to their duties will be the reproduction and distribution of Daily Operating Bulletins (DOBs) to the train crews.

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<sup>1</sup> Wayne F. Casio, *Applied Psychology in Personnel Management* (Reston, Virginia: Reston Publishing Company Inc., 1982).

<sup>2</sup> Frank E. Bird and George L. Germain, *Practical Loss Control Leadership* (Loganville, Georgia: Institute Publishing, 1985), page 147.

The photocopy machine is located on the main floor of the building as there is apparently no room for it in the yardmaster's office. This will result in additional time away from their office in the tower.

#### 1.10.4 *Situational Awareness and Information Processing*

Situational awareness can be defined as "all the knowledge that is accessible and can be integrated into a coherent picture, when required, to assess and cope with a situation."<sup>3</sup> A person performing a complex job, such as a yardmaster, depends on situational awareness when making and implementing plans to expedite the switching and movement of trains, and minimize or avoid conflict between trains.

Situational awareness does not happen instantaneously, but develops on three different levels. First, the person has to perceive the situational elements from information displays, communication, or from viewing the scene. The person then integrates the information by using his/her experience and knowledge. Finally, the person projects the information into the future to make and modify plans as tasks are completed or delayed and new developments arise.

The development and maintenance of situational awareness are helped by experience and knowledge of how aspects of the situation (in this case, the yard, the trains, and people) work together and affect each other. Situational awareness is impaired by inadequate feedback or information available on the system.

Inability to focus on the situation at hand because of distractions or the need to attend to different, unrelated tasks also impairs the development and maintenance of situational awareness.

People have a limited capacity for information processing and attention at any given time. Bits of information are attended to and retained for future use if they are relevant, important or useful. Some information may be lost or overlooked:

- a) if it is not perceived to be relevant or important;
- b) if the volume of information is too great to be processed all at once; or
- c) if distractions displace the information, preventing it from being processed and retained.

#### 1.10.5 *Yardmaster Transfer*

On the day of the occurrence, the day yardmaster began transferring responsibility to the afternoon yardmaster at about 1515 EDT. Although there was no requirement for yardmasters to prepare and sign a written transfer, the yardmasters used a computer-generated status report which was printed at 1455 EDT, 35 minutes before the actual change of shift. During the transfer, both yardmasters reviewed the status report and discussed plans for train movement and control. There was no documentation of plans or changes occurring after the printing of the status report nor was there a

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<sup>3</sup> N.B. Sarter and D.D. Woods, "Situation Awareness: A critical but ill defined phenomenon", *The International Journal of Aviation Psychology*, 1 (1) (1991), pp. 45-57.

handover acceptance procedure to ensure that the incoming yardmaster understood the situation and plans at the time of the transfer.

At the actual time of transfer, the day yardmaster verbally communicated the following to the afternoon yardmaster:

- a) train 421, arriving from Montreal, was being yarded on track No. S-263, and the locomotives were then to return to the locomotive shop via the main track;
- b) the locomotives for train No. 411 (train 411), departing Garneau Yard for Chambord (Lac-Saint-Jean Subdivision), were about to couple to their train on track No. S-262; and
- c) the conductor of train 418 had been verbally instructed by the day yardmaster that, after repairs were completed to locomotive CN 2339 at the locomotive shop, they were to proceed, via yard track No. S-260, with their two locomotives to the north end of the yard to couple to their train which was standing on track No. S-253.

The yardmaster's office was very busy during and following the transfer of responsibility. The afternoon yardmaster was receiving telephone calls and communicating with several parties by radio on different items when the day yardmaster returned upstairs to remind him about the locomotives from train 421 returning from the yard to the locomotive shop via the main track. The day yardmaster went to the top of the stairs but did not enter the yardmaster office. He claims that he delivered a short reminder to the afternoon yardmaster but no acknowledgement was received to this communication.

#### *1.10.6 Work Practices at Garneau Yard*

The train crews agreed that they all depend on the yardmaster to control access to and movement on the main track within the cautionary limits between Mile 0.0 and Mile 2.4, as well as on the yard tracks in Garneau Yard. The yardmasters are not required to exercise this control on the main track, but they accept the responsibility and provide the service to the crews in the interest of efficiency.

The crews of trains 418 and 421 were questioned on their speeds before the collision. All the responders said that their speed on that day was normal for the location and operation, although they did not recall exactly what those speeds were. Train crews also said that it was normal practice to use the main track to return from the yard to the locomotive shop and to go to the north end of the yard to couple to their train.

#### *1.10.7 Train 418*

##### *1.7.10.1 Trainman*

At approximately 1525 EDT, after repairs had been completed to CN 2339 and the locomotives had returned from the locomotive shop to the main track, the trainman on train 418 went up to the yardmaster's office. He asked the afternoon yardmaster, who was just starting work, if it would be permissible to use the main track to go to the north switch at Mile 1.78 and back down the lead extension track to couple to their train. The afternoon yardmaster who was very busy answering

telephone and radio calls at the time claims that he said 'yes', that he advised to watch out for outgoing CN train 411, and that the locomotives from train 421 were coming back to the shop via the main track after yarding their train on track No. S-263. The trainman stated that he was left with the impression that they only had to watch out for train 411.

The trainman descended from the tower and informed the locomotive engineer and conductor to watch out for a movement at the north end of the yard. Their movement (train 418) then left Mile 0.0 travelling northward on the main track. The trainman seated himself in the middle seat of lead locomotive CN 9552. Shortly after their departure, he noticed the locomotives of train 411 in the north end of the yard and assumed that that was the movement to which the yardmaster was referring.

The trainman stated that he had just received a new portable train radio and, while their movement was approaching the occurrence site at Mile 1.5, he was looking down, attempting to understand the instructions to operate the radio in case of an emergency. As the trainman is Francophone, the problem was compounded by the fact that the French operational instructions had not yet been made available to him. Just before the collision, he happened to look up and saw the four locomotives directly in front of him and threw himself onto the floor in an attempt to avoid injury.

The trainman was, however, obliged by CROR Rule 117 to voice test the radio as soon as practicable after the crew commenced duty. The company maintains that the trainman could have requested a radio demonstration because the French language instructions were not yet available.

#### *1.10.7.2 Conductor*

The conductor entrained with the trainman and seated himself on the seat on the left side of the cab of lead locomotive CN 9552. He confirmed the instructions received from the afternoon yardmaster through the trainman that they could use the main track to get to their train. The conductor stated that, while the consist was approaching the occurrence site at Mile 1.5, he saw the locomotives of train 421 approaching but he thought that they were on the adjacent yard extension track until it was too late to take action to stop their movement.

The conductor stated that the main radio speaker in the cab was turned to a low volume because the irritating sound of the excessive static on the radio gave him a headache. He could not hear communications on this radio.

#### *1.10.7.3 Locomotive Engineer*

The locomotive engineer was seated at the controls on the right side of the cab of leading locomotive CN 9552 with the short nose leading when the movement left Mile 0.0 travelling on the main track toward the point of the collision. He stated that the movement obtained speeds of up to 29 mph before it was slowed approaching the curve at Mile 1.5. While negotiating the curve, he saw train 421 approaching and initially thought that it was on the adjacent yard extension track until approximately 200 to 300 feet away. When he realized that it was on the main track closing on their movement, he made an application of the brakes. There was insufficient time to vacate the locomotive cab so he got behind the locomotive engineer's seat and waited for the collision.

He stated that their movement had stopped when the collision occurred.

#### *1.10.8 Train 421*

##### *1.10.8.1 Conductor*

After the crew members detached the locomotives from train 421 on track No. S-263, they proceeded northward on the lead extension track and entered the main track through the switch at Mile 1.78. After entering the main track, the movement was backed southward and stopped clear of the switch. The conductor realigned the switch for the lead extension track and the locomotive engineer advised the crew on train 411 by radio that the switch was lined to facilitate the northward departure of their train via the lead extension track from track No. S-262 in Garneau Yard. This would have precluded the need for train 411 to stop and a crew member to line the switch for themselves. The conductor stated that he then walked southward and entrained on the leading platform of trailing locomotive CN 5294 for the movement to the locomotive shop track. The conductor stated that, nearing the location where the collision occurred, he bent down to get the train waybills out of his bag for delivery to the yard office staff on arrival at the yard office. He heard the locomotive engineer of train 411 warn his locomotive engineer on his radio that train 418 was closely approaching. He then saw the approaching locomotives and quickly climbed down the corner ladder and jumped off the moving locomotive toward the lead track.

The conductor had suffered the partial loss of sight in his left eye as a result of a personal accident several years ago and, without a corrective lens, vision in his left eye was 25 per cent. He did not have the corrective lens in place at the time of the collision and his impaired eye was toward the direction of their travel as he bent down to retrieve the waybills from his bag.

##### *1.10.8.2 Locomotive Engineer*

The locomotive engineer was seated at the controls on the northeast side of locomotive CN 9639 with the short nose forward or at the north end when the movement was backing southward toward the collision point. He was unable to see the conductor on the rear locomotive during the reverse movement. An independent brake application was made to slow the movement entering the curve nearing the collision site just before a radio call was received from the locomotive engineer on train 411 standing on track No. S-262, advising that the locomotives for train 418 were travelling northward on the main track.

#### *1.10.9 Train 411*

The conductor, trainman and locomotive engineer were in the cab of the leading locomotive standing on track No. S-262. They were performing a brake test before departure from Garneau Yard when they noticed that the two locomotive consists were approaching one another on the nearby main track. They saw train 418 travelling northward but could not see train 421 backing southward. The locomotive

engineer, sensing the danger, called the locomotive engineer on train 421 on the train radio, warning him that train 418 was approaching on the main track, but it was then too late to avert the collision.

*1.10.10 Continuous Radio Monitoring*

CROR Rule 119 (a) states that "when not being used to transmit or receive a communication, mobile radio receivers (and portable receivers when practicable) must be set to the appropriate standby channel and at a volume which will ensure continuous monitoring."

## 2.0 *Analysis*

### 2.1 *Introduction*

The analysis concentrates on the involvement of the yardmasters and the operation of the two locomotive consists.

### 2.2 *Consideration of the Facts*

#### 2.2.1 *Train Operation and Yardmaster Involvement*

Both trains were on the main track in accordance with instructions or permission received from the yardmaster. Although the afternoon yardmaster said that he warned the crew of train 418 to watch out for both trains 421 and 411, it is unlikely that he would have knowingly placed them in a conflicting situation when he had a clear route for train 418 to follow; namely track No. S-260 through the yard and over to track No. S-253. He allowed both trains to use the main track, resulting in an unnecessary risk.

The afternoon yardmaster arrived at the office at about 1515 EDT and a transfer was conducted between the day and afternoon yardmasters. The transfer was based on a computer-generated status report which was 20 minutes old by the time the transfer began. The day yardmaster told his replacement about the changes since the printing of the status report, but there was no written documentation of the changes or the plans for late developing train movements. Reliance on verbal briefings, unsupported by documentation, can result in the loss of critical information. Combining these informal procedures with a series of distractions makes communication even more difficult. This would impair the incoming yardmaster's ability to develop adequate situational awareness. The incoming yardmaster would have had a difficult time integrating all the information into a coherent picture of the situation.

When the day yardmaster departed, the afternoon yardmaster had to rely on his memory of the transfer briefing because there was no up-to-date status board or other job aid to help him remember or confirm the situation or plans.

During the first few minutes of his shift, the afternoon yardmaster continued to be busy. For the most part, he was able to cope with the work. To determine the situation in the yard, he had only to look out the windows. Train 421, however, was out of sight. He had not dealt with train 421 himself, and there were no cues to trigger his awareness of its location except that the day yardmaster stated that he returned upstairs to the yardmaster's office to warn the afternoon yardmaster about the presence of train 421. The day yardmaster admits that he received no acknowledgement of that communication. When the trainman from train 418 asked if they could use the main track to go to their train, the afternoon yardmaster gave his permission. Yardmaster permission was not required; however, the common practice at Garneau Yard was to rely on the yardmaster to control movements on the main track within the cautionary limits.

It is likely that the afternoon yardmaster was not consciously aware of the location of train 421. If he had been aware, he would probably have routed train 418 through the yard. His appreciation of the situation was incomplete or inaccurate probably because of the manner of the transfer. The transfer from outgoing to incoming yardmaster was conducted in a busy environment with several distractions which would impair the yardmaster's ability to integrate all the information. The only documentation prepared for the transfer was 20 minutes old when the transfer began and 40 minutes old when the collision occurred. Except for what could be seen from the office windows, there were no cues to remind or inform the yardmaster of the location of train 421. It has been found that people in system control jobs are particularly susceptible to this type of critical information loss following a shift change, a break, or change of control position.

The afternoon yardmaster said that he warned the trainman on train 418 to watch out for trains 411 and 421; however, the trainman did not understand that there were two trains to watch for. The crew of train 418 proceeded northward on the main track, believing that they had a clear track to the switch at Mile 1.78. They saw train 411 in the yard preparing to leave. They believed that this was the train they were to watch out for, which reinforced their belief that they had a clear track to the switch at Mile 1.78.

The workload of the yardmaster at Garneau Yard varies. At times, the yardmaster is very busy responding to numerous demands, including occasionally performing taxi service for train crews, a service that takes him away from his work station in the tower. Without a valid job description, the yardmaster and his supervisor or manager could have difficulty establishing priorities at busy times. This can lead to the yardmaster trying to deal with too many tasks at a time, resulting in poor situational awareness, forgetting tasks, or poor communication.

The two incumbents expected that reduction of clerical staff in the yard office would affect their jobs, but were not sure what tasks might change, be added or deleted. The planning for the changes should start with a definition of the job as it exists, but no definition was available.

### 2.2.2 *Locomotive Operation*

The event recorder data indicate that both locomotive consists approached the area of Mile 1.5 without braking. The speed of train 418 had been maintained at 27 mph with throttle modulation and the speed of train 421 had been allowed to build on the descending grade with the throttle in "idle". Although the locomotive engineer on train 421 had initiated a minimal independent brake application before becoming aware of approaching train 418, the full independent brake applications on both trains were apparently initiated in reaction to the imminent collision.

The time of impact recorded on the respective event recorder downloads is when power was interrupted by the "tripped" circuit-breaker on train 418 (1534:52 EDT) travelling at a recorded speed of 9 mph and when the brake pipe pressure loss from the uncoupling of the second and third locomotives occurred on train 421 (1534:53 EDT) travelling at a speed of 20 mph. Train 418 is therefore estimated to have travelled approximately 321 feet in 11 seconds to impact after the brake application and train 421 travelled about 200 feet in 7 seconds.

It is not clear that train 418 was, in fact, travelling at 9 mph at the time of the collision. The operating crew recalled that the train had stopped, which is not consistent with the event recorder data. While the



recorder data may not be exact, an error of 9 mph is implausible. The post-accident simulation also indicates that train 418 could not have stopped in the distance available. It is therefore concluded that train 418 was moving, at a speed of up to 9 mph, at the time of the collision.

With the exception of the collision speed of train 418, the event recorder data support the respective crew's versions of the accident events and also indicate that, in all likelihood, the crew of train 421 reacted to the warning from the crew of train 411 before it was actually possible to see train 418.

Two factors that determine the distance to stop a train are reaction time and braking distance. The simulation indicated that the braking distance from the point of brake application would have been some 427 feet for train 418, and 285 feet for train 421. It has been estimated that the normal reaction time from the instant an object is observed until a person reacts is two to five seconds. A speed of 60 mph equates to 88 feet per second. Thus, for example, at 15 mph, a train could travel between 44 feet and 110 feet during the time between the sighting of an obstacle and the application of the brakes. Even assuming a reaction time at the low end of the above range (i.e. two seconds), at the speeds involved in this occurrence, the reaction time would add some 79 feet to the stopping distance for train 418 and 58 feet for train 421. The calculated stopping distances are therefore 506 feet and 344 feet, respectively. While there is certainly some imprecision in these numbers, both are sufficiently greater than 262 feet (the CROR Rule 94 limit of "one-half the range of vision", based on a sight-line of 524 feet) that it can be concluded that both trains were exceeding the regulatory speed limit.

The most probable reason for the speeding is the fact that human behaviour is governed not only by rules and regulations, but also by locally accepted habits. The normal speed on the main track was well above that which would have allowed a stop to be made within one-half the range of vision of approaching equipment on the same track. This was not believed to be unsafe because, according to local practice, the yardmaster controlled the main track. The train crews depended on the yardmaster to protect them.

The CROR defines caution speed as a "speed that will permit stopping within one-half of the range of vision of equipment or a track unit." The logic underlying this concept is intuitively appealing and would appear to ensure that, regardless of the track condition and train characteristics, collisions will be prevented. The rule, however, cannot be totally successful in preventing collisions for several reasons.

The use of the term "range of vision" may be too vague to accomplish the aim. While a crew member on a train may be able to see a considerable distance, the range at which a hazard can be detected will depend on the size, shape, colour and location within the field of view. Under identical conditions, a locomotive will be seen and identified at a much greater distance than will track equipment. The perceptual task can be made more difficult if sight-lines are obstructed or the stimulus is ambiguous. In this case, the conductor and locomotive engineer on train 418 thought that the approaching locomotives were on a parallel track. The key to averting accidents is the range at which a hazard can be identified, which may be considerably less than the range of vision.

As indicated above, reaction time (after a hazard has been identified) is not instantaneous. This time is an additive factor in the total distance required to stop. Furthermore, the stopping distance for a train varies according to the weight and composition of the train, the type and condition of the brakes, and track condition (e.g., wet, dry, snow, gradient, etc.).

Relying on train crew members to comply accurately with the requirements of caution speed may not be feasible in every instance.

### 2.2.3 *Radio Monitoring*

The main radio speaker in the locomotive cab of train 418 was set at a low volume because the static on the radio irritated the conductor. If it had been set at a volume to ensure continuous monitoring as required by CROR Rule 119 (a), the crew members on train 418 probably would have heard the warning given by the crew of train 411 to train 421. This might have prevented the collision or reduced its severity.

### 2.2.4 *Safety Management*

In the course of the investigation, several long-standing conditions and practices were discovered which set the scene for this collision to occur. Addressing these factors in a timely manner might have prevented the collision or reduced its severity.

Specifically:

- a) brush had grown on the inside of the curve in the vicinity of Mile 1.5, obstructing the range of vision of train crews;
- b) train crew members stated that they had been operating routinely at speeds that have subsequently been proven to be unsafe as they apparently felt that the track was clear because the yardmaster was controlling the main track;
- c) the transfer between the day and afternoon yardmaster was usually conducted in a distracting environment and in a manner which was not conducive to the incoming yardmaster developing good situational awareness; and
- d) the train crews were depending on the yardmaster to control the main track within cautionary limits and the yardmaster was accepting the responsibility.



## 3.0 *Conclusions*

### 3.1 *Findings*

1. The two locomotive consists were closing on the occurrence site with its inherent vision restrictions at speeds that made it improbable for either to stop before colliding.
2. The transfer between yardmasters was susceptible to error.
3. As a result of the depletion of staff, the yardmasters, at times, could be overloaded with other-than-normal yardmasters' duties (i.e., performing taxi service for train crews), and become subject to distractions from safety-related duties.
4. The day yardmaster had verbally instructed the conductor of train 418 to proceed with two locomotives to their train to couple via yard tracks. The afternoon yardmaster authorized a requested change in these instructions which resulted in both train 418 and train 421 using the main track in opposing directions.
5. The trainman on train 418 had the impression that there was only one train to look out for and did not inform his other crew members that there were two trains to watch for: train 411 and train 421.
6. Train crew members relied on the yardmaster for permission to use the main track within cautionary limits when they should have been complying with the rules governing the operation of train movements within those limits as required by the Canadian Rail Operating Rules.
7. Obstructed sight-lines, work practices, lack of an official yardmaster job description, ineffective transfer between yardmasters and routine speeding by train crews indicate a lack of safety management.
8. The radio in the cab of train 418 was turned to a low volume, thereby reducing or eliminating the opportunity for the crew to hear the warning given by the crew of train 411 to train 421 about train 418 approaching on the same track.

### 3.2 *Cause*

The two locomotive consists, moving in a location with limited visibility, were being operated at speeds that prevented either from stopping before colliding with the opposing movement. A contributing factor was the fact that the yardmaster accepted the unnecessary responsibility of controlling train movements within cautionary limits.

## 4.0 *Safety Action*

### 4.1 *Action Taken*

#### 4.1.1 *Canadian Rail Operating Rules (CROR) - Reduced and Caution Speeds*

In July 1995, the TSB recommended that the Department of Transport review the application of CROR Rule 105 (reduced speed) to ensure that an appropriate safety factor is maintained with opposing rail movements (Recommendation R95-02). CROR Rule 105 is similar to the governing rule in this occurrence, CROR Rule 94 (caution speed), in that both rules govern speed as a function of the range of vision and the stopping capability of the train.

Transport Canada (TC) has now indicated an intention to review both the appropriateness of CROR Rule 94 and the locations where cautionary limits apply, focusing on how the various aspects of human performance can have an impact on the way rules are interpreted. The Board supports this action since, as stated in its substantiation for Recommendation R95-02, it believes that, in an opposing traffic situation, even the most competent crews would have difficulty assessing the variables affecting their stopping distance in time to effectively comply with either CROR Rule 105 or Rule 94.

#### 4.1.2 *Corrective Measures by CN*

Following this occurrence, a job description specific to the yard coordinator's position at Garneau Yard was updated. In addition, an awareness program on CROR Rule 94 was implemented for all yard coordinators, operating crews, and engineering forces, emphasizing the requirements and proper application of caution speed, cautionary limits, yardmaster transfers, and other operating practices.

CN also advised that the brush which may have reduced the sight-lines in this occurrence has been removed.

## 4.2 *Safety Concern*

### 4.2.1 *Safety Management*

Transportation accidents are rarely attributable to a single cause; typically, a set of conditions interact with a series of actions resulting in an accident or incident.

In the Garneau Yard, it was normal for the yard coordinators to control movements on the main track. This practice may have been intended to promote efficiency and safety; however, it was not formally part of the yard coordinator's job. Furthermore, this practice was not in agreement with the CROR or, as subsequently indicated, was not acceptable to the company. Yet, for this practice to have continued, it required at least implicit supervisory concurrence.

The work practices of the yard coordinator, the routine speeding on the main track and the obstructed sight-lines are indicative of shortcomings in senior management's overview of operations at the yard

level. Corrective measures taken by CN with respect to the yard coordinators, operating crews, and engineering forces in Garneau Yard may prevent further accidents under similar circumstances in this yard. However, the Board is concerned that such latent errors and unsafe conditions could combine with another series of actions, resulting in further occurrences in other yards.

*This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson, John W. Stants, and members Zita Brunet and Maurice Harquail, authorized the release of this report on 08 December 1995.*

## TSB OFFICES

### HEAD OFFICE

#### HULL, QUEBEC\*

Place du Centre  
4<sup>th</sup> Floor  
200 Promenade du Portage  
Hull, Quebec  
K1A 1K8  
Phone (819) 994-3741  
Facsimile (819) 997-2239

### ENGINEERING

Engineering Laboratory  
1901 Research Road  
Gloucester, Ontario  
K1A 1K8  
Phone (613) 998-8230  
24 Hours (613) 998-3425  
Facsimile (613) 998-5572

### REGIONAL OFFICES

#### ST. JOHN'S, NEWFOUNDLAND

Marine  
Centre Baine Johnston  
10 Place Fort William  
1<sup>st</sup> Floor  
St. John's, Newfoundland  
A1C 1K4  
Phone (709) 772-4008  
Facsimile (709) 772-5806

#### GREATER HALIFAX, NOVA SCOTIA\*

Marine  
Metropolitain Place  
11<sup>th</sup> Floor  
99 Wyse Road  
Dartmouth, Nova Scotia  
B3A 4S5  
Phone (902) 426-2348  
24 Hours (902) 426-8043  
Facsimile (902) 426-5143

#### MONCTON, NEW BRUNSWICK

Pipeline, Rail and Air  
310 Baig Boulevard  
Moncton, New Brunswick  
E1E 1C8  
Phone (506) 851-7141  
24 Hours (506) 851-7381  
Facsimile (506) 851-7467

#### GREATER MONTREAL, QUEBEC\*

Pipeline, Rail and Air  
185 Dorval Avenue  
Suite 403  
Dorval, Quebec  
H9S 5J9  
Phone (514) 633-3246  
24 Hours (514) 633-3246  
Facsimile (514) 633-2944

#### GREATER QUÉBEC, QUEBEC\*

Marine, Pipeline and Rail  
1091 Chemin St. Louis  
Room 100  
Sillery, Quebec  
G1S 1E2  
Phone (418) 648-3576  
24 Hours (418) 648-3576  
Facsimile (418) 648-3656

#### GREATER TORONTO, ONTARIO

Marine, Pipeline, Rail and Air  
23 East Wilmot Street  
Richmond Hill, Ontario  
L4B 1A3  
Phone (905) 771-7676  
24 Hours (905) 771-7676  
Facsimile (905) 771-7709

#### PETROLIA, ONTARIO

Pipeline and Rail  
4495 Petrolia Street  
P.O. Box 1599  
Petrolia, Ontario  
N0N 1R0  
Phone (519) 882-3703  
Facsimile (519) 882-3705

#### WINNIPEG, MANITOBA

Pipeline, Rail and Air  
335 - 550 Century Street  
Winnipeg, Manitoba  
R3H 0Y1  
Phone (204) 983-5991  
24 Hours (204) 983-5548  
Facsimile (204) 983-8026

#### EDMONTON, ALBERTA

Pipeline, Rail and Air  
17803 - 106 A Avenue  
Edmonton, Alberta  
T5S 1V8  
Phone (403) 495-3865  
24 Hours (403) 495-3999  
Facsimile (403) 495-2079

#### CALGARY, ALBERTA

Pipeline and Rail  
Sam Livingstone Building  
510 - 12<sup>th</sup> Avenue SW  
Room 210, P.O. Box 222  
Calgary, Alberta  
T2R 0X5  
Phone (403) 299-3911  
24 Hours (403) 299-3912  
Facsimile (403) 299-3913

#### GREATER VANCOUVER, BRITISH COLUMBIA

Marine, Pipeline, Rail and Air  
4 - 3071 Number Five Road  
Richmond, British Columbia  
V6X 2T4  
Phone (604) 666-5826  
24 Hours (604) 666-5826  
Facsimile (604) 666-7230

\*Services available in both official languages