RAILWAY OCCURRENCE REPORT
R97T0299

COLLISION

GO TRANSIT
COMMUTER TRAIN NO. 831 AND
COMMUTER TRAIN NO. 841
TORONTO TERMINALS RAILWAY
TORONTO, ONTARIO
19 NOVEMBER 1997

Transportation Safety Board
of Canada

Bureau de la scurit des transports

du Canada

Railway Occurrence Report

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Toronto Terminals Railway
Toronto, Ontario
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Synopsis

At approximately 1616 eastern standard time, 19 November 1997, commuter train No. 831 collided with commuter train No. 841 on track No. 1 at Union Station, Toronto, Ontario. One cab car and one coach car from commuter train No. 831 derailed. Fifty-four passengers and two crew members sustained minor injuries.

The Board determined that the collision occurred because the crew reversed train No. 831 without the exchange of critical information necessary to perform the movement safely. Contributing factors include the limited visibility of track No. 1, the inability of the crew to establish intercom communication, and the limited accessibility to the two 'emergency' brake valves closest to the cab control station.

Ce rapport est également disponible en français.

1.0 Factual Information

1.1 The Accident

1.1.1 Commuter Train No. 841

Commuter train No. 841 (train 841) was stationary in track No. 1 at Union Station, Toronto, Ontario, boarding passengers for a scheduled departure at 1615[1]. At approximately 1616, the conductor contacted the locomotive engineer and indicated that they were ready to depart. The locomotive engineer released the locomotive brakes and prepared for their departure. There were over 800 passengers on board.

1.1.2 Commuter Train No. 831

Commuter train No. 831 (train 831), scheduled to arrive in track No. 1 at 1616 at Union Station, had no passengers and was stopped in track No. 4. At approximately 1610, train 831 pulled eastward out of track No. 4 and stopped clear of signal No. 391 and signal No. 385 (see Figure 1). The train waited several minutes at this location for the Scott Street tower train movement director (TMD) to line the switches for the intended westward movement into track No. 1. When the signals changed from red to yellow, the conductor, who was controlling the movement while positioned in the leading car, noted that track No. 1 appeared to be clear. At approximately 1614, the conductor relayed to the first locomotive engineer, via intercom, that the signal lights had changed and that it was now permissible to reverse the movement into track No. 1. The signal aspect and the distance to reverse were not discussed between the two crew members. The first locomotive engineer then began to reverse the train into track No. 1. As the train was moving slowly along the track, the first locomotive engineer contacted the conductor, via intercom, and they had a brief discussion about the specific location to spot the train in track No. 1. The conductor stated that, during the westward movement towards track No. 1, he had taken his coat off, sat down in the cab car[2], turned on the bell and dimmed the lights. Nearing the platform area, he realized that there was a train standing in track No. 1, approximately 200 feet away.

The conductor immediately attempted to communicate with the first locomotive engineer via intercom. He did not preface his communication by depressing the intercom buzzer. The locomotive engineer was not on the intercom channel. The conductor then removed the handle for the automatic brake valve from its storage location on the cab car console and tried to apply it to the adjacent automatic brake valve. This task requires that the handle be lined directly over the valve and lowered. The conductor was unsuccessful in applying the handle in the short time available.

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1 All times are eastern standard time (Coordinated Universal Time (UTC) minus five hours) unless otherwise stated.

2 A cab car is a specially equipped bi-level coach car that has a cab control station at one end from which a locomotive engineer can control train movements. The cab car is located at the opposite end of the train to the locomotive.

The door of the cab control station was secured in the 'open' position. The conductor indicated that he did not attempt to pull the conductor's emergency valve which was located in the aisle behind the door. When the locomotive of stationary train 841 was immediately in front of him, he dove out the doorway of the cab control station onto the seats across the aisle to better protect himself from the force of the anticipated impact. At approximately 1616, train 831 struck train 841. As a result of the collision, the cab car and one of the bi-level coach cars (coach) on train 831 derailed, and train 841 was pushed approximately 35 feet westward before coming to a stop.

1.2 Injuries

The conductor of train 831 and the second locomotive engineer of train 841 sustained minor injuries. Fifty-four passengers on board train 841 were transported to hospital and treated for minor injuries.

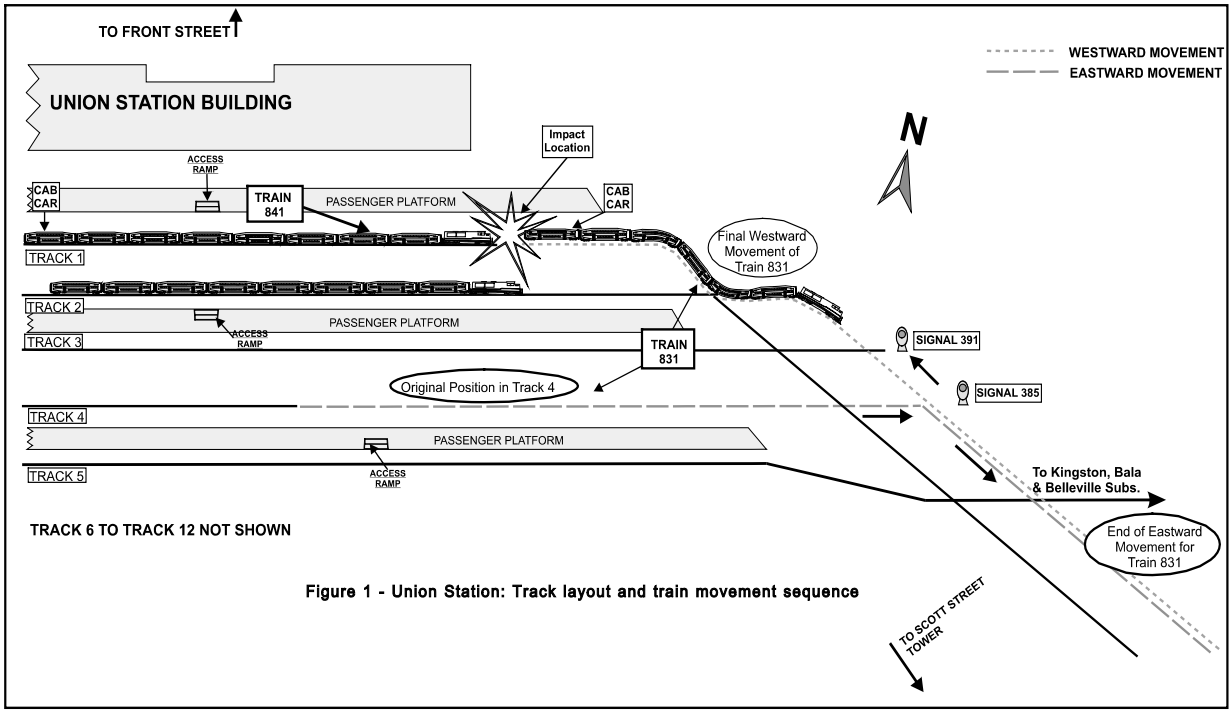

Figure 1 - Union Station: Track layout and train movement sequence

1.3 Damage to Equipment

The locomotive and six coaches on train 841 were slightly damaged. On train 831, the cab car and three other coaches were extensively damaged and two coaches received minor damage.

1.4 Other Damage

Approximately 500 feet of track was slightly damaged and approximately 120 feet of rail required replacement. A commuter train positioned on track No. 2 immediately adjacent to train 841 was unaffected by the collision and derailment.

1.5 Recorded Information

Trains 831 and 841 were equipped with Bach-Simpson model locomotive event recorders. Neither train was equipped with cab voice recorders. The lack of a means for investigating crew voice communications in railway operations continues to be a matter of some interest to the Board as contained in the TSB's Key Safety Issues for 1998, which state:

> Too often, TSB investigators are unable to conduct a complete analysis of the events preceding an occurrence because there is not enough information available . . . . While rail operations depend heavily on voice communications, there is no means for recording—and subsequently evaluating—a crew's voice communications preceding an accident . . . . Much work remains to be done to develop and implement regulatory provisions for on-board recorders . . . and for the effective enforcement of these provisions.

1.5.1 Train 841

The event recorder for the locomotive on train 841 indicates that, between a recorded time of 1558:52 and 1614:55, the speed was 0 mph, and the throttle was set in the idle position. At 1615:31, the locomotive direction changed from neutral to reverse and, at 1615:49, the speed increased to 2 mph. At 1615:57, the train speed decreased to 0 mph.

1.5.2 Train 831

The event recorder data from the locomotive on train 831 showed that train speed was 0 mph between a recorded time of 1611:30 and 1614:14[3]. Between 1614:18 and 1615:22, the engine throttle varied between position No. 2 and position No. 4, and speed was recorded as 8 mph or less. From 1615:22 to 1615:34, the engine throttle decreased from position No. 3 to position No. 2, and speed increased to a maximum 12 mph. Between 1615:34 and 1615:40, speed reduced from 12 mph to 0 mph. At 1615:36 and a speed of 5 mph, an operator-initiated brake application was registered.

The hang-up switch on the locomotive radio was recorded to be in the "off-hook" position from 1614:02 to 1614:08, and from 1614:40 to 1615:05.

The event recorder data from the cab car indicate that the bell was activated at 1615:20 and the radio hang-up switch was in the "off-hook" position from 1609:56 to 1702:14.

1.6 Personnel Information

[3] The recorded times for the event recorders on train 841 and train 831 were within 16 seconds of each other.

GO Transit train crews were supplied by contract by either Canadian National (CN) or St. Lawrence & Hudson Railway (StL&H), depending on whose tracks the particular trains ran. Most crew members worked a regular assignment on GO Transit trains. Other potential crew members were available as required when there were temporary vacancies because of the unavailability of the assigned crew members. Crew members were trained by CN or StL&H and underwent familiarization trips on GO Transit before operating in commuter service.

1.6.1 Train 841

The crew of train 841 consisted of two locomotive engineers and a conductor. They all were working their regular assignment, and met regulatory and company qualifications, and rest and fitness requirements established for their positions. The first locomotive engineer was positioned in the cab car and was controlling the movement. The second locomotive engineer was located in the locomotive, and the conductor was positioned in the accessibility coach[4]. All crew members were experienced in the operation of their assignment.

1.6.2 Train 831

The crew of train 831 consisted of two locomotive engineers and one conductor, who was also a qualified locomotive engineer. All crew members met regulatory and company qualifications, and were in compliance with established rest and fitness requirements. Two crew members were involved in the movement of train 831 into track No. 1. The first locomotive engineer was positioned in the locomotive and the conductor was in the cab car. The second locomotive engineer was not on board the train at the time of the accident[5].

The first locomotive engineer entered GO Transit service in September 1997, and occupied a regular position on another assignment. During his GO Transit service, he filled a temporary vacancy on the assignment for train 831 for several weeks, and worked with two different crews. Each crew used a different method to move into track No. 1. The crew that the first locomotive engineer spent the most time with normally changed ends so that the movement was controlled from the leading end. The other crew did not change ends, but reversed into Union Station. It was common practice for this crew to wait for signal No. 385 and signal No. 391 to both display a green light before reversing. The first locomotive engineer stated that the only time that he had controlled the locomotive during the reverse movement into track No. 1 was on the day of the occurrence.

The conductor first entered GO Transit service in 1994, and since then, worked various positions as brakeman, conductor, and locomotive engineer, accumulating approximately one year worth of experience. In the 18 months before the accident, he had been working in CN freight service. He returned to a GO Transit assignment seven working days before the accident. On 19 November 1997, the conductor was not working his

4 An accessibility coach is a specially equipped coach for passengers who use mobility devices, such as wheelchairs. There is at least one accessibility coach per train and it is normally positioned as the fifth car in every train.

5 Local operating instructions allow the movement of empty GO Transit trains with two qualified employees.

regular assignment, as he had exchanged the afternoon portion of his split-shift with a co-worker. The conductor did not normally perform reverse movements on his regular assignment. He stated that this was the first time he had performed the reverse movement of train 831 into track No. 1. It was also the first time that the conductor and the first locomotive engineer had worked together in GO Transit operations.

Both the first locomotive engineer and the conductor had more than 22 years' experience in railway operations.

1.7 Train Information

1.7.1 General

The GO Transit rail fleet consists of 45 General Motors locomotives (F59PH) and 329 coaches. Of this latter total, 42 are accessibility coaches and another 42 are cab cars (equipped with a cab control station).

The cab control station is a small operating compartment located in one end of the cab car which is positioned at the tail end of the train. It is equipped with a console from where a crew member can control the train. An automatic brake valve is located within the cab control station. Local operating instructions require that the brake valve handle be removed and stored on the console when changing train control from the cab car to the locomotive (see Figure 2).

Figure 2 - Interior view of cab control station (automatic brake valve and handle storage location indicated by arrows)

Each of the 329 coaches is equipped with four conductor's emergency valves, which are used for initiating an emergency brake application. In each cab car, there is an additional conductor's emergency valve located in the aisle adjacent to the cab control station. Access to the conductor's emergency valve is obstructed when the door to the cab control station is left in the open position (see Figure 3).

Due to the size of the operating compartment and its location on the leading end of the train, it is not uncommon for a crew to leave the door to the cab control station open, secured in the aisle by a door stop.

1.7.2 Train 841

Train 841 consisted of one locomotive, seven bi-level coaches and one cab car. It weighed approximately 560 tons and was about 740 feet in length. It was marshalled with the locomotive at the east end and the cab car at the west end.

1.7.3 Train 831

Train 831 consisted of one locomotive, five bi-level coaches and one cab car. The train weighed approximately 460 tons and was about 570 feet in length. It was marshalled with the locomotive at the east end and the cab car at the west end.

1.8 Particulars of the Track

The track structure consisted of 115-pound jointed rail, laid in 39-foot sections on hardwood ties spaced 21 inches apart. The rail was laid on 14-inch tie plates and secured with four spikes per tie; the ballast was crushed rock. All track components were in good condition. According to the timetable, permissible track speed was 30 mph for passenger trains, except through turnouts, where movements were not to exceed 15 mph when crossing from one track to another.

1.9 Occurrence Site Information

1.9.1 GO Transit

GO Transit is an interregional heavy-rail passenger transportation system for the Greater Metropolitan Toronto region, serving a population of 4.5 million in an area of more than 8,000 square kilometres. On a normal weekday, about 100,000 commuters travel on approximately 150 GO Transit trains which operate on seven main corridor routes.

1.9.2 Union Station

Union Station is owned and maintained by Toronto Terminals Railway (TTR), a consortium that is owned equally by CN and Canadian Pacific Railway (CPR). The station building takes up an entire city block in downtown Toronto and is the hub of the GO Transit network. The railway tracks around Union Station are used by GO Transit, Ontario Northland Railway, VIA Rail Canada Inc. (VIA), Amtrak, CN, and CPR. An extensive track layout and signal system facilitates the heavy traffic through the terminal area.

The station area consists of 12 tracks with concrete platforms for boarding and detraining passengers efficiently (typically 3 to 5 minutes per train). The platforms are equipped with stairwells and elevators, and are located

within a shed on the south side of the station building. The roof of the shed is supported by large steel columns which are positioned between the tracks in the passenger platform areas.

On tracks No. 1 and No. 2, the trains are positioned for boarding further to the west (see Figures 4a and 4b). The front of a locomotive positioned standing in track No. 1 or track No. 2 is recessed 160 feet in comparison with the east end of trains on the other tracks, 100 feet of which is inside the train shed. During daylight hours, trains in tracks No. 1 and No. 2 are not as easy to see as trains located in the other tracks, where the fronts of the GO Transit locomotives are plainly visible.

Artificial lighting within the shed is of the 'sodium-vapour' type and is directed primarily towards the passenger platform areas, rather than the train tracks.

A 35-foot-long access ramp was installed on many station platforms for the convenience of passengers who use mobility devices, such as

wheelchairs. There is only one ramp per platform and it is used by both eastward and westward movements. The access ramp for track No. 1 was located in the mid-platform area, approximately in the centre of the station building (see Figure 1). Train crews are required to position their trains so that the doors for the accessibility coach are adjacent to the access ramp.

1.10 Method of Train Control

Train movements in the vicinity of Union Station are governed by TTR. The TMDs, located at the interlockings[6] of John Street, Scott Street, and Cherry Street towers, control 545 signals and signal appliances within 4.5 miles surrounding Union Station. The TMDs line the automatic switches for the scheduled train movements.

1.10.1 Signals

The signals for the interlockings are predominantly of the single dwarf design[7]. When the TMD has not authorized use of the track or if there is a circuit malfunction, these signals will display a red aspect. When the use of the track has been authorized by the TMD, the signals will normally display a yellow or green aspect, depending on track occupancy.

A single green dwarf signal is a 'slow to clear' signal and is defined by the Canadian Rail Operating Rules (CROR) as "Proceed, slow speed passing signal and through turnouts." Slow speed is defined by the CROR as "A speed not exceeding fifteen miles per hour."

A single yellow dwarf signal is a 'restricting signal' and is defined by the CROR as "Proceed at restricted speed." Restricted speed is defined in part as "A speed that will permit stopping within one-half the range of vision of equipment, . . . and in no case exceeding SLOW SPEED" (15 mph).

The signal system for the routes taken by trains 831 and 841 were checked on 20 November 1997 and found to be operating as designed.

Sections within the TTR have 'preferred route signalling', where tracks are designated for directional movement of traffic. For example, there are six main tracks between Scott Street and Cherry Street, with the designated direction alternating between successive tracks. In preferred route signalling, yellow signals are not upgraded to green when a movement is running against the track's normal designated direction of traffic. This means that trains on these tracks will receive only yellow lights even when all track sections are empty.

Interviews were conducted with other GO Transit crews having more experience operating within the TTR interlocking. The existence of preferred route signalling was not common knowledge among many operating employees.

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6 Interlockings are an arrangement of interconnected signals and signal appliances so interconnected that their movements must succeed each other in proper sequence and for which interlocking rules are in effect.

7 A dwarf signal is a fixed low signal located at the entrance of a route or block used to govern trains entering and using that route or block. Figure 4b shows single dwarf signals Nos. 385 and 391.

1.10.2 Train Movements

Both the TMDs and the train crews are in possession of general operating information which provides assignment descriptions, track allotments, pre-planned arrival and departure schedules and special instructions for each assignment. Train crews move their trains within Union Station in accordance with their train schedules, and are governed by the signal indications for their assigned tracks.

The TMDs monitor radio communications for train movements involving CN, CPR, VIA and GO Transit trains. When GO Transit trains are running according to schedule, there is normally little direct communication between the TMD and the GO Transit train crews. If a problem is encountered, GO Transit train crews notify GO Commuter Central[8], which then relays the information to those affected. The east end of Union Station is controlled by a TMD located at the Scott Street tower.

The requirement for reverse movements is very common in most rail operations; however, there are very few assignments in GO Transit operations that require a reverse movement into a station area.

Special Instructions relating to movements within the TTR state that:

1. All movements within TTR limits must have operative air brakes. Movements not headed by engine or control cab must have emergency braking capabilities, and an operating whistle or horn on leading car.

1.10.3 Canadian Rail Operating Rules

CROR Rule 12.2, *Switching by Radio*, states in part that:

> When radio is used to control a switching movement, and after positive identification has been established, the following procedures are required:
>
> (i) direction in relation to the front of the controlling unit must be given in the initial instruction and from then on whenever the direction of movement is to change;
> (ii) distance to travel must be given with each communication; and
> (iii) movement must be stopped at once if no further communication is received when the movement has travelled one-half the distance required by the last instruction.

CROR Rule 115 (a), *Pushing Equipment*, states in part that:

[8] Commuter Central is a GO/CN operations management office located on the concourse level of Union Station which oversees overall GO Transit train operations.

> When equipment is pushed by an engine, a crew member must be on the leading car or on the ground, in a position to observe the track to be used and to give signals or instructions necessary to control the movement.
>
> EXCEPTION: A crew member need not be so positioned when the portion of the track to be used is seen or known to be clear . . . .

CN *Special Instruction - Rule 115* states in part that:

> "Seen or known to be clear" is defined as seeing the portion of the track to be used as being clear and remaining clear of equipment . . . . This determination must be made by a crew member, yard supervisor or other qualified employee who can observe the track and has radio contact with the employee controlling the movement. Where a track that has been seen to be clear, and no access to that track is possible by another movement, the track may be considered as "known to be clear".

1.10.4 Work Planning

A reverse movement requires teamwork, the success of which depends on the development of effective work plans. Work planning helps to ensure that the crew members have a clear understanding of the work to be done, who will be carrying out specific tasks, as well as when and how the task will be performed. Essentially, these factors contribute to crew members developing a shared mental model and common expectations. Rules and instructions, which typically guide the work practices of crews, can be viewed as tools that assist in the development of effective work plans.

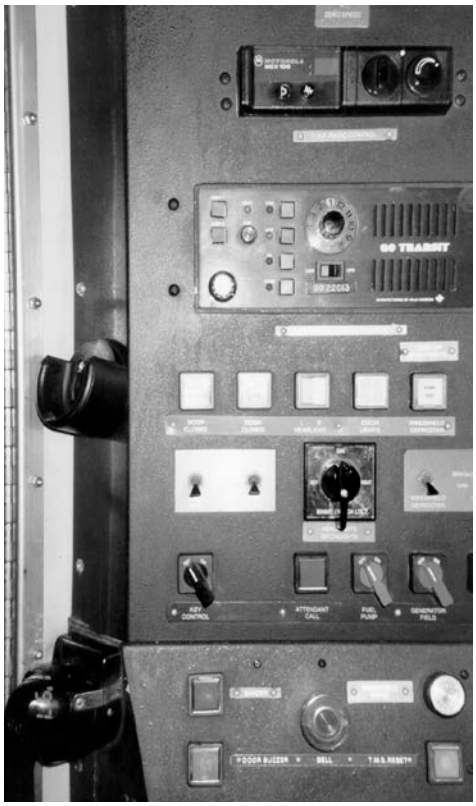
1.11 Communications

1.11.1 Communication Hardware

GO Transit locomotives and cab cars are all equipped with an Integrated Communications Control Unit (ICCU) that incorporates four communication systems:

1. Public address (PA)
2. Private intercom
3. GO Transit - UHF radio
4. CN/CPR - VHF radio

To select a communication system, one of the four push buttons (see Figures 5a and 5b) must be depressed. The corresponding LED indicator will illuminate, showing which communication system is activated and being controlled by the ICCU.



The communications are handled through one telephone-style handset that is stored in a cradle. The private intercom system is 'hard wired' (i.e. transmission does not use radio waves) and transmissions are emitted through only the speaker in the handset. The radio wave transmissions of the VHF and UHF system are emitted through the handset and external loudspeakers. The handset has a push-to-talk (PTT) button which, when

depressed, illuminates a yellow LED indicator light labelled 'XMIT' (transmit) on the ICCU face. The handset cradle has a built-in switch which performs the following functions when the handset is hung up[9]:

1. Reverts the VHF radio to the selected standby channel.
2. Deselects any selected function.
3. Resets the UHF decoder if the UHF function was selected.

9 *GO Operator's Manual*, Section 6.3.3, Operation of the I.C.C.U.

4. After the handset is hung up on the cradle, all the functions have been deselected. Any one function may now be selected; however, the handset push-to-talk (PTT) switch and MIC Audio [microphone and audio lines] is connected so that no calls may be originated until the operator removes the handset from its cradle.
5. Resets the Train Monitor System.

A second handset cradle is mounted just above the first one in the cab car. This cradle does not have the built-in switch and allows train crews to place their handset in a cradle without activating the 'deselect' function.

The TSB Engineering Branch examination (Engineering Report LP 177/97)[10] of the intercom system on the GO Transit equipment revealed the following:

1. The ICCU in both locomotive 548 and bi-level cab car 227 were serviceable at the time of the collision.

2. The handset in locomotive 548 was in its cradle for the 29-second period before the collision.

3. The handset in cab car 227 was off the cradle before, during and after the collision.

1.11.2 Radio Communications Around Union Station

There is a high volume of radio communication during rush hours around Union Station because of the number of train crews as well as any ongoing track maintenance. For this reason, many train crews on GO Transit trains use the intercom system instead of the radio when verbal communication is needed between crew members. When using the intercom system, communications cannot be heard, interrupted or confused with conversations taking place between other train crews.

1.11.3 Operational Procedures for Intercom Communication

To initiate a private intercom call, the operator must pick up the handset, depress the intercom selection push button on the ICCU, and hold it for a second or two to activate an audible 'buzzer' in the locomotive, the cab car and all the coaches. (The buzzers will sound as long as the push button is depressed.) The call is answered by lifting the handset and selecting the ICCU intercom push button. The PTT button in the handset must be depressed to talk, but does not have to be released to listen. If one party disconnects from an established intercom connection by hanging up or changing channels, the other party will have no aural indication,

[10] This report is available upon request from the Transportation Safety Board of Canada.

as there is no dial tone associated with the line. The absence of conversation will be the only indication that the other party has hung up, or has put the phone down. Contact may be re-established by pressing the push button again to sound the buzzer.

The *CN Operating Manual for GO Transit Service* allows crews to communicate audible signals for simple commands, such as stop and start (e.g., two 'buzzes' indicates a 'stop' is required, or conversely, 'start', if the train is already stopped) by use of a communicating signal located to the right of the ICCU. The *GO Operator's Manual* references two other methods of communicating by using audible signals. Section 6.3.1 states that signals "can also be sent between the cab car and the locomotive cab by using the attendant call system," and section 6.3.5 states that an operator "can send a series of buzzer signals by alternately pressing and releasing I.C. [the intercom] push button."

The rules and regulations pertaining to radios found in both the CROR and General Operating Instructions (GOI) do not specifically reference intercom systems. Section 6.12, Public Address and Intercom Systems, of the *CN Operating Manual for GO Transit Service* contains information on the proper use of the PA system; however, there is no similar information offered for the intercom system.

1.12 Supervision and Overview

1.12.1 GO Transit

GO Transit's Rail Services Division consists of a Rail Operations and a Rail Equipment Branch. The Rail Operations Control Centre coordinates GO Transit trains, and is responsible for reporting and responding to safety and environmental occurrences affecting GO Transit-owned properties.

GO Transit contracts the rail operation to CN and StL&H. GO Transit's System Safety Program Plan Policies and Procedures state:

> GO Transit recognizes that these railways have the authority and responsibility of train movement by qualified personnel through Transport Canada rules and regulation and their own Canadian Rail Operating Rules (CROR), General Operating Instructions, Timetable Instructions, Safety Rules, and labour agreements.

The Rail Equipment Branch of GO Transit oversees those services pertaining to the maintenance, inspection, and acquisition of all the rolling stock (i.e. locomotives and rail cars). Bombardier Inc. is the major contractor that performs the routine maintenance and inspection services on behalf of GO Transit, principally at GO Transit's maintenance shops located at Etobicoke, Ontario (Willowbrook).

GO Transit is a member of the American Public Transit Association (APTA) and had been subject to their Rail Safety Audit Program since 1993.

1.12.2 Canadian National

CN has a separate and dedicated management team to oversee CN operations pertaining to GO Transit trains. Management personnel are assigned to the scheduling of train crews, the training and qualification of crew members, and the day-to-day supervision of train operations. The CN Operations Service Centre, located in Moncton, New Brunswick, is responsible for ensuring the assignment of qualified employees throughout the CN network, including the needs of the GO Transit operation.

1.12.3 Regulatory Overview

Transport Canada (TC) is responsible for administering and enforcing the provisions of the *Railway Safety Act*. The new Railway Passenger Car Inspection and Safety Rules came into effect in February 1998. Passenger safety and evacuation standards are presently under development by the railway industry.

TC achieves its mandate through a combination of monitoring, auditing and inspection efforts. TC inspectors regularly ride GO Transit trains, monitoring the activities of the train crews and inspecting the condition of the equipment. Inspection and monitoring records for the six months before the accident were reviewed. These records related to monitoring GO Transit trains operating between various stations from Oshawa to Willowbrook. Several minor exceptions were noted pertaining to crew performance. These exceptions did not pertain to communications between crew members or their qualifications. Monitoring of any reverse movements was not mentioned. A Safety Notice was issued by TC to GO Transit in 1994 in relation to the distraction of locomotive engineers when operating from the cab control station. TC stated that there is no evaluation by TC of the effectiveness of crew training programs. Crew performance is monitored and, if it is observed that there is a decrement in performance linked to training, TC follows up. TC records did not include any comments pertaining to decrements in crew performance related to training.

1.13 Weather

The sky was clear, and visibility was good. The temperature was one degree Celsius.

1.14 Other Information

1.14.1 Emergency Response

The initial evacuation efforts by the GO Transit operating crew were met with relative calm. There were a few distraught and panicked passengers. Most of the 800 plus passengers detrained with little or no help.

Local police, fire and ambulance services, and employees from GO Transit, TTR, CN, and VIA immediately responded. Forty nurses trained in basic trauma life support, who were attending a convention nearby, assisted emergency response personnel in administering first aid and helped with the evacuation.

Front Street, adjacent to Union Station, was immediately closed to public traffic to allow unrestricted access of emergency response vehicles and equipment. Twenty-two ambulances and four ambulance buses were used to transport the injured to six local hospitals.

The efforts of the responders were coordinated by the Metro Toronto Fire Service. The Metro Toronto Ambulance Authority subsequently assumed control, the primary nature of the response being medical.

1.14.2 Passenger Safety Considerations

Subsequent to the collision, a number of GO Transit coaches were examined by TSB investigators at both GO Transit's Willowbrook repair facility and at Bathurst Yard. The following observations were made:

- Locked first-aid kits were located in every car. During train operation, only the train crew had access to the key. The first-aid kits were not equipped with any portable lights (flashlights), nor were they required to be.

- There were 18 windows identified as emergency window exits in each car. Before the occurrence, GO Transit had initiated a program to replace the glass in every window with a higher standard of safety glass. An expedited program was focussed on the emergency exit windows. However, at the time of the occurrence, only 4 emergency exit windows on each car had been replaced and labelled as "EMERGENCY WINDOW - For emergency exit use only." The 14 others were labelled "Attention - For emergency exit use." On one car, all 18 windows were checked, and only the 4 windows that had been replaced were operative.

- Manual operation of the sliding exit doors by a passenger results in only one side of the door opening to a maximum width of 25 inches. The other side of the door can be opened by a trained crew member. The standard model of wheelchair is 25 inches wide (when non-collapsed); however, they can vary up to 40 inches.

- The cab control station door swings into the aisle, towards the end corridor door and can be left secured in the open position by use of a door stop (see Figure 3).

- The cars were equipped with ceiling-mounted emergency lighting.

The Railway Passenger Car Inspection and Safety Rules prescribe the minimum safety standards for passenger cars operated by railway companies subject to the jurisdiction of the *Railway Safety Act*. GO Transit has modified its equipment to meet the requirements of the new rules, which include minimum safety standards for first-aid kits, emergency lighting and emergency window exits.

The *CN Operating Manual for GO Transit Service*, Section 4.1, states that "accessible service will provide barrier free transportation to individuals with special needs. GO Transit's philosophy of a self serve transit system is not altered by accessible service and patrons will be expected to board and detrain without assistance from crew members"[11].

1.14.3 Simulated Train Stopping Distance

A train consist similar to train 831 was used to establish the approximate emergency stopping distance when reversing on the same section of track. Weather and track conditions were similar to those on the day of the accident. A conductor was located in the leading cab car, and a locomotive engineer was located in the locomotive at the trailing end of the movement. Neither was told of the exact location of the brake application. While travelling at 12 mph (17.6 feet per second), the same recorded speed of train 831 before impact, the crew was requested to immediately stop the train. The distance was measured between the location where the train was positioned when the request was given, and the location where the train came to a final stop. The emergency stopping distance of the test train at 12 mph under these conditions was determined to be approximately 85 feet, or one car length. Human performance considerations of the time to perceive and react to an emergency situation were not considered.

1.14.4 Training and Qualification of Train Crews

CN required both locomotive engineers and conductors operating in GO Transit service to be familiar with the GO Transit equipment and territory. This includes the station stops, switches and signals, as well as how to operate the special equipment, such as the doors, PA system, and access ramps. Familiarization for both locomotive engineers and conductors consisted of a minimum of three days on GO Transit trains, and was completed in one of two ways: if the company required the employee to move, the company paid for the three

[11] *CN Operating Manual for GO Transit Service* (1997), Section 4.1.

familiarization trips; if the employee exercised seniority, the trips were expected to be completed at the employee's expense.

During the familiarization trips, the employee's performance was not formally assessed by peers or supervisors. Furthermore, records were not always kept of the dates and times that these familiarization trips were made. Upon completing the familiarization trips, employees sometimes contacted the Operations Service Centre (OSC) directly to provide the updated information on their qualifications. The OSC would use this information to update their files without verification. Similar procedures were followed in the spring and fall, at time change, when employees advised the OSC of those subdivisions on which they had worked over the last six months.

Data collected during the investigation revealed that an attempt was made to standardize training on GO Transit equipment and operations. A list documenting key areas that were unique to GO Transit operations, such as emergency procedures and equipment, was produced. The CN Metro Toronto Safety and Health Committee was in the process of developing a manual to assist in this regard. Furthermore, certain assignments were identified as being particularly useful for training purposes. A review of local training records revealed that the initiative was not being consistently applied.

2.0 Analysis

2.1 Introduction

The conductor in charge of protecting the leading end of train 831 during the reverse movement stated that, when the signal lights turned yellow, he looked towards track No. 1 and thought that it was empty. Consequently, he informed the locomotive engineer that they could reverse into the track. He did not notice until later that train 841 was still in track No. 1. The conductor tried to relay this information to the locomotive engineer, but communications were not established. Finally, the conductor tried to place the train into emergency himself, but could not do this in time to avert the collision. The analysis will focus on the reverse movement of train 831 into track No. 1 and the crew's inability to stop the train, having identified the need to stop.

2.2 The Reverse Movement of Train 831 into Track No.1

A number of factors contributed to the crew's decision to reverse into track No. 1 at 1615, including: crew communication, the control and scheduling of trains, the visual considerations of track No. 1, and crew inexperience. Each of these will be discussed separately.

2.2.1 Crew Communication and Procedures for the Reverse Movement

The crew did not establish an effective plan for accomplishing the reverse movement. Although certain aspects of the reverse movement were discussed, for example where to stop the train in track No. 1, the crew did not clearly exchange critical pieces of information, such as the signal aspect, the distance of clear track, and whether they would maintain intercom communications throughout the reverse movement. Research has shown that crews that have high levels of communication perform more effectively and commit fewer operational errors[12]. A clear-cut crew communication protocol is particularly important for crew members that have never worked together, as was the case with this crew.

Had the locomotive cab been equipped with a voice recorder, it may have been possible to determine more definitively the effectiveness of the crew's communications as they approached the accident location. The supervision of communication protocols has typically involved monitoring the airways. In the case of the intercom in use at GO Transit, this method of supervision was not possible as intercom communications are hard-wired, and therefore, not transmitted over the airways.

With respect to reverse movements, aside from the requirement to have emergency braking capability and an operative whistle or horn on the leading car, there were no specific local instructions for GO Transit trains entering Union Station. This provided a high degree of operating flexibility, but did not provide additional

12 R. Helmreich and H. Foushee. (1993). Why crew resource management? In E. Weiner, B. Kanki, & R. Helmreich (Eds.) *Cockpit Resource Management.* Academic Press Inc.: New York, pp. 3-34.

safety in an area of high concentration of traffic. Consequently, crews developed their own methods of performing reverse movements, including:

- maintaining control from the locomotive for the reverse movement versus changing ends to control from the leading end;
- if control was from the locomotive, preparing the automatic brake valve in the cab car for emergency use by placing the handle on the valve versus removing and storing the handle on the console, as required by local operating instructions; and
- waiting at the governing signal until it indicates that the track is clear versus entering the track when the signal indicates that the track may be occupied.

The absence of specific local instructions for performing the reverse movement into Union Station increased the likelihood that the crew members brought different expectations of how the movement was to be performed. Without an effective work plan, the crew members did not exchange critical information before commencing and during the reverse movement.

2.2.2 Control and Scheduling of Trains

During rush hours, Union Station needs to accommodate a large number of trains in a relatively short period of time. Track No. 1 is the busiest platform and trains are sometimes scheduled to operate within one or two minutes of each other. It is not unusual for trains to depart a minute off scheduled departure time to accommodate late-arriving commuters; however, neither the train crews nor the TMDs are always informed when this happens. Consequently, scheduling trains on the same track to within one minute of each other, as in the case of trains 841 and 831, increases their risk of collision. The risk is further increased by the requirement to spot successive trains at the same location on the track to make use of the accessibility ramp.

It is also noted that passengers can board quickly once trains are ready to be boarded; therefore, train 831 was not required to be in position at 1616 in order to maintain an on-time departure of 1630. Minor adjustments, such as increasing the intervals between train schedules, could reduce the overall risks without compromising the objectives of on-time performance.

Because GO Transit train movements are scheduled with little or no communication between the crew and the TMD, crews have limited information available to them for developing awareness of other train movements and locations.

2.2.3 Visual and Conspicuity Considerations of Track No. 1

The conductor attempted to visually ensure that track No. 1 was clear before issuing instructions to reverse train 831. However, he did not see train 841 from his location at signal No. 385 and incorrectly concluded that the track was clear. TSB's assessment of the site suggests that the conductor's direct line of sight into the loading area of track No. 1 was limited because of a westward curve, and a lateral view of the loading area was largely obscured by a train located in track No. 2. The crew would have experienced some difficulty in seeing track occupancy because of the contrast in brightness between outside and inside the shed. The physical structure of the shed (such as the support columns for the roof, and the stairwells) can also interfere with one's ability to clearly determine track occupancy. Within the shed, existing artificial lighting does little to enhance the visibility of trains. Outside the shed, aside from the signal indications which convey movement authorities, there is no indicator dedicated to the specific purpose of conveying track occupancy. Once in motion, crews approaching the station area must divide their attention between the dwarf signals and switch points, located at ground level, and the route ahead.

2.2.4 Crew Experience

The bulk of the crew's previous work experience was with simpler and more traditional signal systems as compared to the complexity of the TTR interlocking. Both were performing a specific task that neither had much experience doing.

The conductor was aware that a yellow signal required movement at restricted speed, which by its definition implies that the crew proceed in an anticipatory mode, being observant for a number of different safety considerations (e.g. other movements and switches not lined for the intended route). A number of cues led the conductor to believe that events were unfolding as planned and that the track was empty, including: he did not see a train in track No. 1; he believed that the TMD would not line their train into an occupied track; and the switches were lining up and the signals were turning from red to yellow according to schedule. His erroneous conclusion that the track was empty led him to proceed without the degree of vigilance that would otherwise be associated with a restricted signal.

In the absence of a clear view of the status of the platform area of track No. 1, while operating on a restricting signal, the conductor communicated movement instructions to the locomotive engineer. The locomotive engineer commenced the reverse movement of train 831, and was not aware of, nor did he request, the signal aspects under which he was moving, nor the distance he was authorized to move. Both pieces of information would have been helpful to the locomotive engineer as he was controlling the locomotive, pushing the equipment into track No. 1.

2.3 The Crew's Inability to Stop the Train

2.3.1 Communicating Train Movement Instructions via Intercom

Upon seeing train 841 immediately in front of him, the conductor tried to rapidly relay this information to the locomotive engineer via intercom, which was the crew's established method of communication. The conductor did not precede the call with an alerting "buzz" as he assumed that the locomotive engineer was still on-line from their discussion less than 30 seconds before, and he had no immediate way of knowing otherwise. However, the locomotive engineer had replaced his handset in the cradle after their last conversation, as he normally did, and was unaware that the conductor was trying to contact him. The TSB considered the question of why a "buzz" was not initiated by the conductor, or why the two-way radio was not used. It is generally recognized that individuals will react appropriately if they are 'well practised' in the applicable emergency response procedures. In this case, the conductor had no experience using the intercom for communicating in an emergency situation, and he had very little time to decide on a course of action and react.

Although the intercom provides crews with uninterrupted communication in the congested airways surrounding Union Station, this occurrence highlights a number of disadvantages when using this intercom for communicating train movement instructions, particularly in a time-sensitive emergency, including:

1. both the sender and the receiver must select the appropriate channel;
2. when hung up, the channel disconnects and reverts to neutral, thus disabling the receive mode in the case of the intercom;
3. there is no feedback (e.g. aural or visual light) to indicate whether a connection has been established;
4. the sender must sound the "buzzer" to attract the receiver's attention;
5. there is nothing to distinguish a routine "buzz" from one that is urgent and must be responded to immediately;
6. it is not uncommon for the "buzzer" to go undetected by crew members, because of surrounding noise or attentional factors; and
7. the system cannot be operated or monitored "hands-free", and therefore it can interfere with ongoing tasks.

Together, these features limit the effectiveness of this system for conveying train movement instructions. As a result of these limiting features, employees using the intercom system cannot ensure delivery of an urgent message in a time-sensitive emergency.

2.3.2 Inaccessibility of Emergency Braking Capability

As he was trying to establish communications with the locomotive engineer, and with a collision less than 10 seconds away, the conductor tried to put the train into emergency himself. His options consisted of using the automatic brake valve in the cab control station or using any one of the conductor's emergency valves located throughout the car. Access to the conductor's emergency valve in the aisle was impeded by the open cab door, and the other conductor's emergency valves were farther away than the automatic brake valve immediately in front of him. Consequently, the conductor opted to use the automatic brake valve; however, the design of the handle/valve interface required a precise alignment, and he was unable to quickly put the automatic brake valve handle in place.

The conductor's inability to successfully use either of the two emergency braking systems available illustrates the necessity of designing emergency equipment and procedures that can quickly and easily be applied by crew members during a rapidly unfolding emergency.

2.3.3 Train Stopping Distance

The recorded information shows that the bell in the cab control station was applied approximately 27 seconds before impact, while proceeding at a recorded speed of 8 mph. Given the higher recorded speeds during the last 27 seconds, this would have placed the leading end of train 831 more than 350 feet (more than four car lengths) from the point of impact when the bell was applied. The conductor's estimate that he first saw the train 200 feet away would have placed him adjacent to the east end of the platform area for track No. 2, which extends beyond the train shed. At this distance, the train would be proceeding through the switches that bring the movement directly into track No. 1. The second locomotive engineer of train 841 stated that he saw the conductor in the leading end of the cab car as train 831 rounded the westward curve near the entrance of the train shed. Therefore, although the exact distance at which the conductor saw train 841 could not be determined, it is likely that he had seen the train by the time that he neared the easternmost portion of the train shed which is located 160 feet from the point of impact.

Because the simulation showed that an emergency brake application can stop the train within approximately 85 feet, recognition of, and reaction to, the hazard from anywhere outside of the train shed would have provided sufficient distance to stop. It is also recognized that, given the normal shock absorbing capabilities of the equipment, train speed did not have to be reduced to zero to minimize the extent of the injuries.

2.4 Training and Qualification of Train Crews

The skill sets involved in passenger or commuter operation differ from those required for freight operations. Even though the actual train operations are somewhat similar, there are added responsibilities associated with the safety and security of the travelling public.

In GO Transit service, although employees were required to be familiar with the territory and specialized equipment, the absence of supervision or evaluation during these trips meant that management had no means to establish the adequacy of the employees' knowledge. Furthermore, because records were not always kept of the dates and times that these familiarization trips were made, particularly when employees were doing so at their own expense, management had no way to ensure that all employees who staffed GO Transit commuter trains had the necessary skills specific to GO Transit operations.

2.5 Passenger Safety Issues

Currently, there is no comprehensive standard in rail operations governing the safe evacuation of passengers in an emergency. These issues are discussed extensively in the Board's report on a recent accident near Biggar, Saskatchewan (TSB report No. R97H0009). While the new Railway Passenger Car Inspection and Safety Rules establish some safety requirements for the design of rail cars operated by federal railways, a number of risks to passengers are still apparent. For instance, there is no requirement that first-aid kits be accessible to passengers, nor are there requirements for the location and type of emergency lighting that is required. There are also no particular provisions dealing with the egress of persons with a disability in emergency situations. For instance, there is no requirement that emergency door exits be wide enough to allow the egress of passengers using mobility devices, such as wheelchairs.

The concern for the inaccessibility of first-aid kits to passengers is driven by the fact that, similar to train 841, the ratio of passengers to conductors may exceed 800:1. In an emergency, the conductor on board the train may be located elsewhere in the consist or may be incapacitated, and passengers should be able to access the first-aid supplies.

Although GO Transit had modified 42 cars specifically to allow wheelchair passengers barrier-free access to their train service, the width of the emergency door exits may inhibit passengers in wheelchairs exiting in an emergency, when the doors are opened manually by passengers.

Ceiling-mounted emergency lighting is known to be ineffective under many fire and smoke conditions. Ergonomic design principles recommend that lighting used to illuminate emergency egress routes be located at or near ground level so that, if smoke is present, the lighting will not be obscured.

The labelling on the 4 operative emergency exit windows was similar to that on the 14 inoperative exit windows. Had passengers needed to exit via an emergency exit window, the misleading signage would have added to any panic or confusion, as well as increased the risk of injury.

Passengers trying to use the end corridor door as an alternate escape route may be impeded by the cab control station door if it is left secured (or jammed) in the open position. Furthermore, to close the cab control station door, it must swing away from the end corridor door; i.e., in the direction opposite to the route of egress.

3.0 Conclusions

3.1 Findings

1. Unless informed otherwise, the TMD lined routes for train movements in accordance with pre-planned arrival and departure train schedules, irrespective of track occupancy.

2. As there was no requirement for regular communication, neither the TMDs nor train crews were always aware when movements were being made into occupied tracks.

3. Some train schedules were unnecessarily tight and allowed little room for error.

4. Many railway operating employees interviewed in connection with this accident did not have a thorough knowledge of the preferred route signalling capability of the TTR signal system.

5. The conspicuity of trains occupying track No. 1 inside the shed was decreased because of the contrast in brightness between outside and inside the shed, the obstructions created by a train stationed in track No. 2 and the physical characteristics of the building. The artificial lighting within the shed was not designed to illuminate the tracks.

6. The crew members of train 831 did not establish an effective plan for accomplishing the reverse movement: they did not clearly communicate critical pieces of information, such as the signal aspect and the distance of clear track, and they did not maintain continuous communication throughout the reverse movement.

7. Section 6.12 of the *CN Operating Manual for GO Transit Service* did not provide meaningful guidelines to employees as to how to communicate train movement instructions with the intercom system.

8. The use of the intercom system between crew members necessitated that the intent to communicate be established prior to actual communication.

9. The deselect feature of the ICCU disconnects the operator from the chosen communication channel each time the handset is replaced in the cradle, activating the radio hang-up switch.

10. Due to a number of limiting features, employees using the intercom system could not ensure delivery of an urgent message in a time-sensitive emergency.

11. There was no structured program in place to ensure that all employees who staffed GO Transit commuter trains had training specific to GO Transit operations, specialized equipment, and the type of responsibility associated with commuter travel.

12. The conductor's emergency valve that was closest to the cab control station was not readily accessible because the cab door was secured in the open position, and the automatic brake valve handle had previously been removed in accordance with local operating instructions.

13. The cab control station door swings into the aisle and, if left secured in the open position, may impede emergency exit through the end corridor door.

3.2 Causes

The collision occurred because the crew reversed train No. 831 without the exchange of critical information necessary to perform the movement safely. Contributing factors include the limited visibility of track No. 1, the inability of the crew to establish intercom communication, and the limited accessibility to the two 'emergency' brake valves closest to the cab control station.

4.0 Safety Action

4.1 Action Taken

4.1.1 Operating Procedures

On 22 November 1997, CN issued Notice No. 97-058 (originally issued as 97-055) concerning restrictions for GO Transit train consists operating within the TTR. It stated that:

> Effective immediately, if movement in the opposite direction of the controlling end is required within TTR limits, then the Locomotive Engineer must change ends so that the controlling end is always the leading end in the direction of train movement.

StL&H issued the following monthly bulletin that was included in its June 1998 timetable:

> When a GO movement in the opposite direction of the controlling end is required within TTR limits, the Locomotive Engineer must change ends so that the controlling end is always the leading end in the direction of movement.

This effectively prevents any further reverse movements of GO Transit trains within the TTR.

On 21 November 1997, the TTR issued a bulletin to all TMDs stating:

> Until further advised, Depot Track 1 must be unoccupied before any other movement is allowed in.

Although the bulletin does not prevent TMDs from lining movements into other occupied tracks, it does reduce the risk of collision of trains operating on track No. 1. These instructions have been added to the TMDs' Quarterly Bulletin.

In November 1997, a number of 'standard response procedures' were developed by CN for the use of its supervisory personnel involved in commuter operations. These procedures provide employees with 'task sheets' prescribing the order and priorities that should be followed in the initial critical minutes of a wide range of emergency situations.

4.1.2 Training and Qualification of Train Crews

Both CN and StL&H have modified their procedures for staffing GO Transit assignments. Now, employees are not authorized to work in GO Transit service until they are deemed qualified by a supervisor or assistant superintendent. The supervisor or assistant superintendent, once satisfied that the employee has received the appropriate training and familiarization, formally advises the respective crew management centre of the employee's status.

The CN Metro Toronto Safety and Health Committee has developed a one-day 'hands-on' training course for locomotive engineers and conductors involved in GO Transit train operations. The course focusses on emergency evacuation procedures and GO Transit equipment familiarization. The development of the course was initiated before the occurrence, and has now been formalized. This training course is considered mandatory for all CN and StL&H operating crews; refresher training will be provided every three years.

4.1.3 Transport Canada

On 24 November 1997, TC requested that CN:

1. re-issue Notice 97-055 as a Bulletin;
2. initiate an extensive monitoring of its train crews in GO Transit rail service to ensure crew attentiveness and CROR compliance;
3. monitor a significant number of GO Transit train movements into Union Station to ensure compliance with the terms of the bulletin replacing Notice 97-055; and
4. submit a report to TC showing the trains monitored and the results of the monitoring.

On 11 December 1997, CN's response indicated that all of the above TC requests had been implemented.

4.1.4 Passenger Safety

GO Transit has upgraded the emergency equipment on all of its cars to meet the new requirements of the Railway Passenger Car Inspection and Safety Rules. GO Transit has modified all its first-aid kits so that they are accessible to crew members and passengers, and has equipped the trauma kit in each cab car and accessibility coach with four portable flashlights. (Four additional flashlights are available to crew members in each locomotive.) Effective 07 July 1998, every window emergency exit in the active fleet has been replaced and appropriately labelled.

GO Transit is also considering and will review with the TTR changes to the physical surroundings at Union Station (e.g. improved track lighting) to provide further safety features in the train shed area.

4.2 Action Required

Railway operating manuals contain radio regulations advising employees how to properly use the radios, including how to initiate an emergency radio broadcast. However, there are no equivalent instructions pertaining to the intercom system, even though there is widespread use by employees of this method of communication. The intercom system does not work in the same manner as regular radios and these differences can present a problem to operating employees when trying to communicate in a time-sensitive emergency. The unique features of the intercom limit the effectiveness of this system for the conveyance of train movement instructions. Particularly, the way the ICCU is designed, the channel that the employee has chosen is deselected every time the hand set is returned to its cradle, and there is no auditory or visual feedback to the sender to indicate whether the communication link has been interrupted. Safety-critical information must be easily and

reliably conveyed. Systems that are regularly used should be designed to reduce the preparatory steps required to initiate communication in a time-sensitive emergency, and employees must be provided with meaningful instruction and training as to how to use such systems, particularly during an emergency. Therefore, the Board recommends that:

> GO Transit review its communication protocol as well as the design and installation of the Integrated Communications Control Unit (ICCU) to ensure that safety-critical information can be reliably transmitted and received.
>
> R99-03

Once the chosen method of communication failed between the crew members, a secondary defence mechanism (the emergency brake) was relied upon to prevent the accident. The cab car, which was the leading car of the reverse movement, was equipped with five strategically located conductor's emergency valves and an automatic brake valve, any of which, when activated, would have initiated an emergency brake application. The conductor was positioned in the cab control station where he could use the ICCU, observe the route ahead, and sound the bell before entering the train shed. He recognized the immediate hazard presented by the stationary commuter train, and would have had sufficient time to stop the movement had he been successful in applying the emergency brake with either the automatic brake valve within the cab control station or the conductor's emergency valve located closest to him. However, the automatic brake valve handle was not in place and the closest conductor's emergency valve was blocked by the open cab control station door. The inability of the conductor to initiate an emergency brake application with either of these two valves illustrates the necessity of designing and locating emergency equipment that can quickly and easily be applied by crew members in an emergency. Therefore, the Board recommends that:

> GO Transit review the emergency brake valves on all cab cars to ensure that they can quickly and easily be applied in an emergency situation.
>
> R99-04

4.3 Safety Concern

The cab control station door swings into the aisle towards the end corridor door. Although these doors are not the primary routes of egress, they are designated as emergency exits in the pictogram located in each car, and each cab car ("A" end) door has a decal providing instructions on how to open the door in an emergency. Passengers are known to use the closest and most convenient door as a means of escape. To close the door, it must be swung away from the end corridor door, which is the opposite direction to the route of egress. Should the cab control station door be secured in the aisle, it may block or impede emergency egress and/or assistance.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benoît Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 03 February 1999.

Appendix A - Glossary

APTA	American Public Transit Association
CN	Canadian National
CPR	Canadian Pacific Railway
CROR	Canadian Rail Operating Rules
GOI	General Operating Instructions
ICCU	Integrated Communications Control Unit
LED	light emitting diode
MIC	microphone
mph	mile(s) per hour
OSC	Operations Service Centre
PA	public address
PTT	push-to-talk
StL&H	St. Lawrence & Hudson Railway
TC	Transport Canada
TMD	train movement director
TSB	Transportation Safety Board of Canada
TTR	Toronto Terminals Railway
UHF	ultra high frequency
UTC	Coordinated Universal Time
VHF	very high frequency
VIA	VIA Rail Canada Inc.
XMIT	transmit