RAILWAY INVESTIGATION REPORT
R98T0141

COLLISION

ST. LAWRENCE & HUDSON RAILWAY
MILE 37.8, GALT SUBDIVISION
CAMPBELLVILLE, ONTARIO
17 JUNE 1998

Railway Investigation Report

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Mile 37.8, Galt Subdivision
Campbellville, Ontario
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Summary

On 17 June 1998, at approximately 1545 eastern daylight time (EDT), St. Lawrence & Hudson Railway freight train No. 501-16, travelling westward on the south main track of the Galt Subdivision, struck two stationary track units (a small crane and a lorry) at Mile 37.8. The wheels of the lorry became entangled underneath the second locomotive and punctured the fuel tank, spilling approximately 2,000 gallons of diesel fuel oil. There were no injuries.

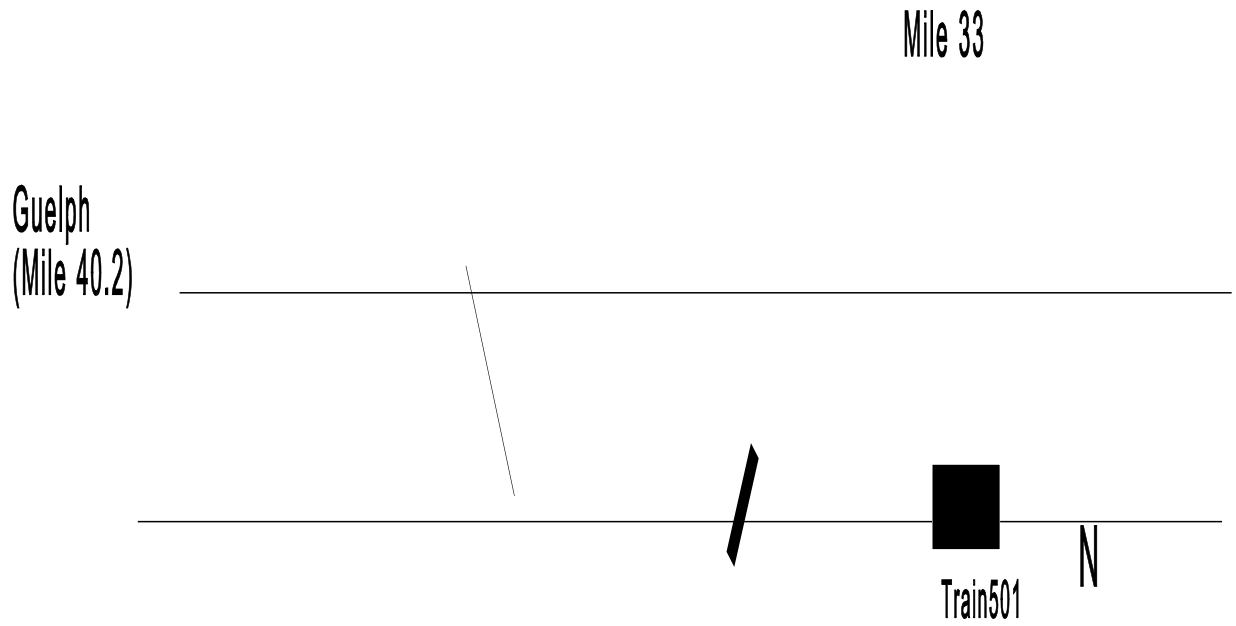
Ce rapport est également disponible en français.

Other Factual Information

St. Lawrence & Hudson Railway freight train No. 501-16 (train 501) departed westward from Agincourt Yard at Scarborough, Ontario, on 17 June 1998, destined for London, Ontario. The train was routed over the Belleville Subdivision to Leaside, the North Toronto Subdivision from Leaside to West Toronto, and was to travel on the Galt Subdivision from West Toronto to London. The train consisted of 3 locomotives, 25 loaded intermodal freight cars and 2 empties. The train was approximately 3,300 feet in length and weighed about 2,700 tons.

In the area of the collision, the Galt Subdivision consisted of two main tracks, identified as the north main track and the south main track. Train movements were controlled by the Centralized Traffic Control System (CTC), authorized by Canadian Rail Operating Rules (CROR) and supervised by a rail traffic controller (RTC) located in Montreal, Quebec. The authorized speed was 75 mph for passenger trains and 50 mph for freight trains, reduced to 50 mph and 45 mph respectively on curves between Mile 33 and Mile 39.4. Typically, 10 Government of Ontario (GO) commuter trains and 24 freight trains traversed this area daily. Movements from one main track to the other were made through crossovers, remotely controlled by the RTC. Track circuit occupancy is indicated on the RTC's control screen when electrical current flows across the rails or if current flow in a single rail is interrupted. Rolling stock wheels and axles complete a circuit between rails, permitting electrical current flow across the rails and generating a track circuit occupancy indication. Some track units activate track circuits in the same manner as rolling stock while others are insulated against current flow and can occupy track without activating the circuits. Both the RTC and the foreman were aware that track units did not always activate track circuits.

A track maintenance work program involving the replacement of track ties was in progress. At the time of collision, the main body of the tie gang was working on the south main track, between Signal 402 at Mile 40.2, the west end of Guelph Junction, and Signal 388-3 at Mile 38.85, Guelph Junction East (Figure 1). A smaller group was working under the direction of a sub-foreman on the south main track at Campbellville, approximately one mile east of the main gang, unloading ties from a lorry with a tie crane.



Work on both main tracks was being protected by CROR Rule 42, Planned Protection, which was in effect between Mile 33 and Mile 40.2 between 0800[1] and 1700. Warning flags had been placed at the proper mileages alongside the tracks as required. Rule 42 requires that the foreman requesting the working limits communicate with the RTC sufficiently in advance of the start of the time limitations to enable the RTC to ensure that all trains approaching the limits are in possession of the applicable General Bulletin Order (GBO). The foreman must obtain confirmation from the RTC that the GBO protection has been issued to trains before commencing work. In this instance, the foreman contacted the RTC the previous evening to place his request for work protection for the following day. On the morning of 17 June 1998, the foreman contacted the RTC before starting work to confirm that the protection had been provided. The RTC confirmed that Daily Operating Bulletin (DOB) No. Z168, effective at 0001, 17 June 1998, contained GBO No. U232 which specified:

> . . . be governed by rule 42 on June 17 1998 from 0800 until 1700 on north track and south track between Mile 40.2 and Mile 33.0. Galt sub . . . .

With the GBO in place, the foreman placed his flags alongside the track and commenced work.

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[1] All times are eastern daylight time (Coordinated Universal Time (UTC) minus four hours) unless otherwise stated.

At approximately 1531, the RTC contacted the foreman to advise him that two westward freight trains were approaching from Toronto on the Galt Subdivision and a northward freight train was approaching from Hamilton on the Hamilton Subdivision. The train from Hamilton would be required to enter onto the south track at Guelph Junction and proceed west. In addition, the RTC questioned a track circuit indication on the CTC control screen for the south main track at Guelph Junction[2]. The foreman responded that the tie gang was on the south main track at Guelph Junction. The foreman then questioned whether the CTC showed a track occupancy east of the "power switch at the Junction". There was one dual-control switch at Guelph Junction and there were five dual-control switches at Guelph Junction East. The foreman did not specify to which dual-control switch he was referring. In response to this question, the RTC again confirmed that the system displayed a track occupancy indication on the south main track at Guelph Junction between Signal 388-3 (Guelph Junction East) and Signal 401-3 (the location where the north main track and south main track of the Galt Subdivision converge). The RTC had assumed that the dual control switch at the converging point of the north and south main tracks was the referenced "power switch". The foreman apparently did not notice that the RTC had again described the occupancy of the track circuit where the main gang was working. The RTC then questioned the foreman as to whether he would be able to accommodate a train from Hamilton, entering his limits at Guelph Junction to proceed westward. The foreman indicated that he would be prepared to let the train pass through his limits in approximately five minutes.

The RTC recalled that he established routing for train 501 to travel westward on the south main track entering the Rule 42 limits at Mile 33, to the crossover switches at Guelph Junction East, Mile 38.7, crossing over to the north main track and continuing westward through the remainder of the foreman's limits.

St. Lawrence & Hudson Railway rail traffic control procedures did not formally require that the RTC communicate with the foreman to establish the desired routing for trains. It was the railway's view that operational necessity dictated that the RTC and the foreman would communicate with each other to establish where and when trains would operate.

The foreman communicated, as required, with the sub-foreman working on the south track at Campbellville advising him that train 501 was approaching and received his concurrence to permit the train to pass by on the north main track.

Train 501, travelling westward on the south main track, passed Signal 321-3, Mile 32.1 at Milton, on a clear signal indication. This was the last location where this train could be routed from the south main track to the north main track before the point of collision. Approaching the red flag at Mile 33, the crew members called the foreman by radio, identified themselves, gave their location and requested instructions. The crew did not advise the foreman on which track they were approaching, nor were they required to. The foreman instructed train 501 to "proceed on the north track " through the working limits with "one restriction - 30 mph by men and machines on the south track at Guelph Junction." The train crew repeated this instruction as ". . . proceed on the main track . . . ." The foreman acknowledged the repeat of the crew with a repeat time and recorded 1535 on the appropriate form. The foreman recalled that, at the time of the crew's repeat, he was distracted by another employee who had begun talking to him. The crew recalls having recorded the foreman's instructions on the

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[2] There is one CTC track circuit indicator for the south main track at Guelph Junction between the crossover switches at Guelph Junction East (Mile 38.7) and the converging point of the north and south main tracks of the Galt Subdivision (Mile 40.2) on the CTC control screen.

DOB. The actual DOB was not recovered.

Situational awareness is a term used to describe an individual's awareness of operational conditions and contingencies. Under general operating conditions, situational awareness develops on three different levels.[3] Initially, a person perceives situational elements from information displays, communications or other references. This information is then integrated into an overall understanding of the situation by the application of past experience and a knowledge of how the system works. Finally, the person projects the acquired information into the future to make and modify plans as tasks are completed or delayed as new developments arise. Cues or information about the situation can vary from clear to ambiguous. The clearer the cues, the less mental effort is required to interpret them and the more accurate the diagnosis of the situation is likely to be.

The process of communication is complex and subject to error because of the imprecise nature of natural language coupled with the expectancies of the situation[4]. A number of countermeasures have been advocated to prevent hearing or speaking errors, such as employing redundancy, precision, and awareness of the dangers of imprecision in communication. The following industry rules and special instructions outline procedures that are intended to ensure accuracy of communication:

CROR Rule 42, Planned Protection, requires in part:

> (b) A train or engine in possession of the Form Y must not proceed beyond the red signal prescribed by paragraph (a), clause (i), enter the track limits stated in the GBO, or make a reverse movement within such track limits until instructions have been received from the foreman named in the GBO. When a specific track is to be used, instructions from the foreman must specify the track upon which the instructions apply.
>
> (c) The instructions must be repeated to, and acknowledged by, the foreman named in the GBO before being acted upon.

Railway System Special Instruction in the application of Rule 42 (c) requires:

- instructions to enter or move within the protected limits must be recorded in writing by the foreman and a crew member.

CROR Operating Rules Notes (v) requires:

> When the term "in writing" is used in these rules, special instructions and general operating instructions, if the written permission, authority or instruction referred to is not received personally by the receiving employee, it must be copied by the receiving employee and repeated back to the sender to ensure it was correctly received.

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3 Endsley, M.R., (1994a)." Situational awareness in dynamic human decision making: Measurement". In *Situational Awareness in Complex Systems, Proceedings of a CAHFA Conference, February 1-3, 1993*, Fl: Embry-Riddle Aeronautical University Press, pp. 79-97.

4 Weiner, E.L. & Nagel, D.C. (1988). *Human Factors in Aviation.* Academic Press Inc: CA, USA, p. 284.

CROR Rule 42 does not specify how the acknowledgement will be achieved; however, railway procedures have adopted the concept of acknowledgement described in CROR Rule 140, Repeating and Completing, which states in part:

> (b) . . . If [the repeat is] correct, the RTC will respond complete, the time and the initials of the RTC, which will be recorded and acknowledged by the employee copying. The employee copying must acknowledge the complete time by repeating the complete time and the initials of the RTC to the RTC.

CROR Rule 134, Brevity, Clarity and Pronunciation, states in part:

> (c) In transmitting and repeating by voice communication , all words and numbers must be clearly pronounced. When the communication is required to be in writing, numbers will be pronounced in full, then repeated stating each digit separately. Numbers represented by a single digit must be pronounced, then spelled.

Appendix "A" to CP Form V280, Rules for the Protection of Track Units and Track Work, requires, in part:

> (e) The foreman must not instruct a train or engine to enter or move within the limits of the TOP [track occupancy permit] or Form Y protection until each sub-foreman is clear of the track or portion of the track to be used and the track is safe for train or engine movements.

Approaching the point of collision, the sight-line from the locomotive was restricted to approximately 800 feet due to track curvature. On noticing the track machines on the track, the train crew immediately applied the train brakes in emergency, initiated an emergency radio broadcast and sounded the locomotive horn, thereby alerting the track maintenance employees. All employees were able to move away from the machinery and avoid injury. After contact, the machinery was pushed westward for approximately 400 feet, coming to a stop with the second locomotive on the Guelph Line Road public crossing within the town of Campbellville. The crane struck and broke a hydro pole in the south-west quadrant of the crossing and the lorry became entangled underneath the second locomotive, puncturing the fuel tank and spilling approximately 2,000 gallons of diesel fuel.

The immediate area of the collision was on the Niagara Escarpment. There was a stream 1,000 feet downhill and to the east of the crossing. The local fire department and the Ontario Provincial Police responded. Vehicle traffic was re-routed away from the blocked roadway.

Much of the spilled fuel oil was quickly absorbed into the porous soil adjacent to the track. Specialized equipment was dispatched to the scene to remove fuel oil from drainage pits that had been hastily constructed to contain the spill using barrier dams. The Guelph Line Road public crossing remained blocked for approximately four hours. There was no derailment of train rolling stock.

Locomotive event recorder data indicate that the train brakes were applied in emergency at approximately 1545 while the train was travelling at 40.9 mph. The data further indicate that the train travelled approximately 1,000 feet before stopping.

The operating crew of train 501 consisted of a locomotive engineer and a conductor. They were qualified for their respective positions and met fitness and rest standards. The foreman was qualified for his position and was well rested.

The RTC was qualified for his position. He began his shift at 1500, following a formal transfer with the RTC he was relieving. The transfer included a discussion about the track work underway between Milton and Guelph Junction and the fact that three trains (501, 509 and the Hamilton Turn) would soon be in a position to require passage through the foreman's work
limits. The RTC recalled that, when he took control of the desk at approximately 1515, train 501 was proceeding westward on the south main track in the vicinity of Streetsville, Mile 20.3, and was routed on the south track through the remainder of the Galt CTC territory, to Mile 40.2.

At the time of the accident, the sky was clear with a temperature of 24 degrees Celsius. The winds were light and variable, out of the north-west with no precipitation.

Analysis

The communication processes between the foreman, the train crew, and the RTC led these individuals to develop inaccurate situational awareness. Neither the RTC nor the train crew knew that there were track units on the south track at Mile 37.8, and the foreman did not know that a train was travelling on the south track. In addition, there were procedural gaps and a number of instances where procedures were not strictly followed.

The main sources of information available to the RTC regarding the location of the track work were the track circuit occupancy indications on the control screen and communication with the foreman. Track circuit occupancy is not a reliable way of identifying where track work is taking place because track units do not always activate track circuits; therefore, the role of communication becomes critical.

Although the conversation between the RTC and the foreman was intended to establish on what track the trains should be routed upon approaching the foreman's limits, the use of non-standard language and unstructured communication procedures led to misunderstanding. When the foreman questioned if there was a track circuit occupancy showing on the control display, east of the power switch at Guelph Junction, he was likely trying to establish if the
sub-foreman's location was known to the RTC. The foreman was referring to the track circuit east of the crossover switches at Guelph Junction East. When the RTC replied, he identified the

block using signal numbers. The foreman did not recognize that he had described occupancy of the track circuit west of the crossover switches at Guelph Junction East, the location of the main tie gang, for the second consecutive time.

The outcome of this exchange was that the RTC believed the entire tie gang was located on the south main track, west of the crossovers at Guelph Junction East. The foreman believed he had successfully apprised the RTC of the location of his sub-foreman, east of those crossovers. Based on his understanding of the tie gangs' whereabouts, the RTC left train 501 routed on the south main track up to the crossovers at Guelph Junction East, on the same track where the
sub-foreman was working.

The two main sources of information available to the foreman to develop situational awareness were communications with the RTC and the train crew. It is likely that the foreman, in trying to establish whether the sub-foreman's crane and lorry had activated a track circuit, was attempting to verify if the location of the sub-foreman's work activities was known to the RTC. However, the use of imprecise language led to misinterpretation by both communicating parties. The absence of a standardized communication procedure for the establishment of specific train routing (for train movements in Rule 42 limits in multi-track CTC territory) left the foreman and the RTC to determine what needed to be discussed. Without sufficient guidance in this regard, their conversation focussed on track circuit indications and fell short in establishing appropriate routing. Railway special instructions issued shortly after this collision formalized communication requirements between foremen and RTCs to establish train routing and closed this procedural gap.

Concerning the communication between the foreman and the train crew, railway procedures did not require the train crew to advise the foreman on what track they were travelling as they approached his working limits. The foreman believed the RTC had a clear understanding of the location of the sub-foreman and therefore would have routed trains on the north track. The foreman was aware that there were no crossovers between the red flag at Mile 33.0 and the location where his sub-foreman was working. Had the foreman been advised by the crew on what track the train was approaching, he may have taken some action to avert the collision.

Train crews develop situational awareness of the location of work activities through communications with foremen. In CTC territory, a common misleading cue in the environment can be a signal indication; for example, the crew might see a permissive signal indication ahead, yet they are not authorized to proceed on that track unless the foreman issues permission. In this case, the signal for westward movements on the south track immediately before the entrance to the work limits was clear. Although in issuing instructions to the crew, the foreman had specified that they proceed on the north track, the crew repeated "main track" instead of "north track", and the foreman did not detect the error and verified the repeat as correct. The distraction the foreman experienced at the time of the repeat may have contributed to his omission of the error, and the train crew's belief that the RTC and foreman were required to ensure trains were routed on the appropriate track may have led them to ascribe less importance than required to this critical communication.

The railway depends on strict adherence by employees to the procedures and rules as defences against communication errors. To achieve compliance, the railway relies upon supervisory activities, such as radio monitoring and proficiency testing, as well as employee knowledge of the ramification of communication inaccuracies. Although existing procedures were "roughly" followed, the necessary structured approach of the language used was not maintained. Furthermore, there was no structured process for the RTC and the foreman to establish proper routing of trains and no requirement for the train crew to apprise the foreman on what track they were approaching.

Findings

1. In the absence of a requirement to establish the routing of trains through the foreman's working limits, the foreman and the RTC engaged in *ad hoc* communication, using non-structured language, that resulted in both parties developing inaccurate situational awareness.

2. Inaccurate situational awareness led to the RTC's decision to route the train over the south track where the sub-foreman was located and contributed to the foreman not detecting an error in the train crew's read-back of his instruction.

3 Interruption of the foreman by a third party at the time of the train crew's read-back contributed to his not detecting an error in that read-back, and he verified the error as correct.

4 The train crew did not give sufficient attention to the routing portion of the foreman's instructions due to the belief that the correct routing would have been previously established between the foreman and the RTC.

5 The clear signal indication at Signal 321-3 was inaccurately interpreted by the train crew as an indicator that the correct routing had been previously established.

6. The safety effectiveness of CROR Rule 42, Planned Protection, in multi-track CTC territory, was lowered by the absence of procedures requiring the RTCs and foremen to develop a clear understanding of the desired routing of trains, and procedures requiring that train crews advise foremen of the track upon which they are approaching the working limits.

Causes and Contributing Factors

The collision occurred when the train was operated against the foreman's instructions on the south track into the working limits. A series of procedural gaps and mis-communications between the foreman and the RTC and between the foreman and the train crew led to the inappropriate routing of the train and resulted in critical errors remaining undetected.

Safety Action

Safety Action Taken

Transport Canada

On 19 June 1998, Transport Canada formally expressed concern with the number of TSB reportable occurrences that had taken place involving foremen since June 1997, particularly those involving St. Lawrence & Hudson Railway trains entering a foreman's limits without permission. The railway was specifically requested to provide details as to intended corrective action to prevent future occurrences of this nature.

Following an occurrence on the St. Lawrence & Hudson Railway Belleville Subdivision on 14 July 1998, in which a train was operated into a foreman's limits without permission, Transport Canada issued a Notice to the railway under Section 31 of the *Railway Safety Act*. The Notice described a threat to safe railway operations due to trains entering foremen's limits without obtaining proper instructions from the foremen. The Notice indicated that the failure to communicate properly could cause injury, death or result in collisions.

Transport Canada advises that the reply to TC's Section 31 Notice indicated that the railway has taken or has planned action as follows:

1) increased its focus on CROR 42 proficiency testing and on the RTC education program;
2) created a full-time site dedicated rules instructor position in the Network Management Centre located in Montreal;
3) established a Health and Safety committee in the new centre;
4) conducted a full-day refresher program across Ontario and Quebec in late 1998 and early 1999.
5) will educate field operations staff through various communication methods including bulletins, safety meetings and one-on-one discussions;
6) is developing a Safety Awareness Series training module "Communication" to be implemented in early 1999;
7) developed a policy of multi-track protection for maintenance personnel working in double-track territory; and

Transport Canada advises that the remedial actions taken by StL&H were satisfactory to the department and the Section 31 Notice was rescinded on 16 November 1998.

Canadian Pacific Railway (St. Lawrence & Hudson)

On 22 July 1998, Canadian Pacific Railway issued the following special instruction to CROR Rule 42(b) which states:

> Within CTC, where there is more than one potential route for train or engine movements, approaching or within Rule 42 limits, RTC and foremen must communicate the track(s) to be used prior to authorizing movements into the limits.

> RTC will ensure the route is lined for movement on the track(s) to be used.
>
> When the same route is granted for multiple train or engine movements, such instruction must be recorded by the RTC and repeated to the foreman to ensure proper understanding.

This instruction formalized the requirement for the foreman and RTC to establish routing of trains in multi-track CTC territory before the arrival of the trains at the work limits.

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 07 July 1999.