

Transportation Safety Board
of Canada



Bureau de la sécurité des transports
du Canada

**RAILWAY INVESTIGATION REPORT
R11T0113**



NON MAIN-TRACK COLLISION

**CANADIAN NATIONAL RAILWAY
0600 PLANK ROAD SWITCHING ASSIGNMENT AND
0800 BUNKHOUSE SWITCHING ASSIGNMENT
SARNIA YARD, MILE 57.2, STRATHROY SUBDIVISION
SARNIA, ONTARIO
22 MAY 2011**

Canada

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

Railway Investigation Report

Non Main-Track Collision

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Mile 57.2, Strathroy Subdivision
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Summary

On 22 May 2011, at approximately 1225, Eastern Daylight Time, Canadian National Railway 0600 Plank Road switching assignment was pulling westward out of track A-6 with a cut of 72 cars when the lead locomotive collided with the 28th car of the 0800 Bunkhouse switching assignment which was also pulling westward through a converging lead track. As a result of the collision, 2 loaded bi-level auto carriers and the locomotive consist of the 0600 assignment as well as 6 dangerous goods tank cars from the 0800 assignment derailed. There was no release of product, and no injuries.

Ce rapport est également disponible en français.

Other Factual Information

The Accident

On the morning of 22 May 2011, the Canadian National Railway (CN) 0600 Plank Road switching assignment (0600 assignment) was switching in the A-Yard section on the west lead at Sarnia Yard in Sarnia, Ontario (see Figure 1). The 0600 assignment was a 2-person belt-pack assignment consisting of a yard conductor and an assistant conductor. It was powered by a remote control locomotive and a slave unit. Both crew members met fitness and rest standards, were qualified for their respective positions, and were familiar with the territory.

Meanwhile, the CN 0800 Bunkhouse switching assignment (0800 assignment) was performing switching in the C-Yard section of Sarnia Yard. The 0800 assignment, also a 2-person belt-pack assignment consisting of a yard conductor and an assistant conductor, was powered by a remote control locomotive and a slave unit. Both crew members met fitness and rest standards, were qualified for their respective positions, and were familiar with the territory.

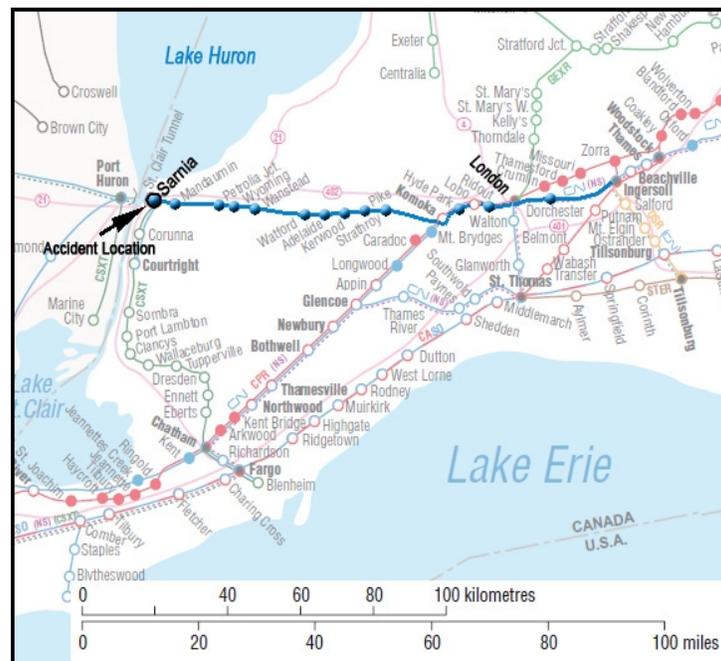


Figure 1. Accident location

The 0800 assignment had travelled from C-yard through the point protection zone (PPZ)¹ and on to the west lead into A-Yard to pick up cars from track A-30 and return with them to C-Yard. At about 1225,² after lifting cars from track A-30, the 0800 assignment departed A-Yard and proceeded westward back towards C-Yard.

¹ Point protection zones (PPZ) are signalled yard tracks used for pull-backs which are bonded at each end and provide signal indication to employees, allowing them to determine if the route can be considered as “known to be clear”, thereby relieving them of the requirement to physically ride the point of the movement.

² All times are Eastern Daylight Time.

At the same time, the 0600 assignment was in the process of making a long pull with a cut of 72 cars that was 5187 feet long and weighed 5214 tons. It was pulling back on the west lead towards the PPZ signal from where it had just come prior to initiating the long pull. The assistant conductor, who was in control of the belt-pack, looked towards the point of his movement from a position on the ground and assumed the route was still clear.

While travelling at 8 mph through the west lead and PPZ, the 28th car of the 0800 assignment was struck by the lead locomotive of the 0600 assignment which was travelling at approximately 9 mph, also in the westward direction. The collision occurred at the point where the 2 tracks converge on the west lead. As a result of the collision, 6 dangerous goods (DG) tank cars from the 0800 assignment derailed to the south side of the west lead track. Two loaded bi-level auto carriers and the locomotive consist of the 0600 assignment derailed to the north side of the west lead track (see Photo 1). There was no release of product, and no injuries. Approximately 400 feet of track was damaged.



Photo 1. Derailed cars – looking southeast

The weather at the time of the occurrence was clear skies, light winds and a temperature of 15°C.

Sarnia Yard Information

Sarnia Yard is one of CN's main processing yards in southwest Ontario. It is located at Mile 57.2 of the Strathroy Subdivision and is immediately east of CN's Sarnia/Port Huron tunnel to the United States. Its main function is to support the major petrochemical industry in the Sarnia area. The commodities handled at this yard include petrochemicals, fertilizer, phosphate rock, liquefied petroleum gas (LPG), condensate, sulphuric acid, sulphur dioxide and other DGs.

The yard is primarily divided into 2 zones. The first zone is A-Yard which consists of approximately 47 tracks running from east to west. It is primarily used for assembling and disassembling trains and for classifying traffic. All movements within A-Yard, including those on the main track and at the entry and exit to the yard, are controlled by the tower yard coordinator who is located in the main tower, in the center of the east end of A-Yard.

The second zone is C-Yard, which is a separate switching yard located west of A-Yard. C-Yard consists of approximately 30 tracks also running from east to west. It is used for significant industrial trackage. It functions as the primary hub for servicing the local industries and assisting with classification of freight traffic (see Figure 2). When a roving yard coordinator (rover) is on duty, the rover governs all movements within C-Yard and the industrial spur lines.

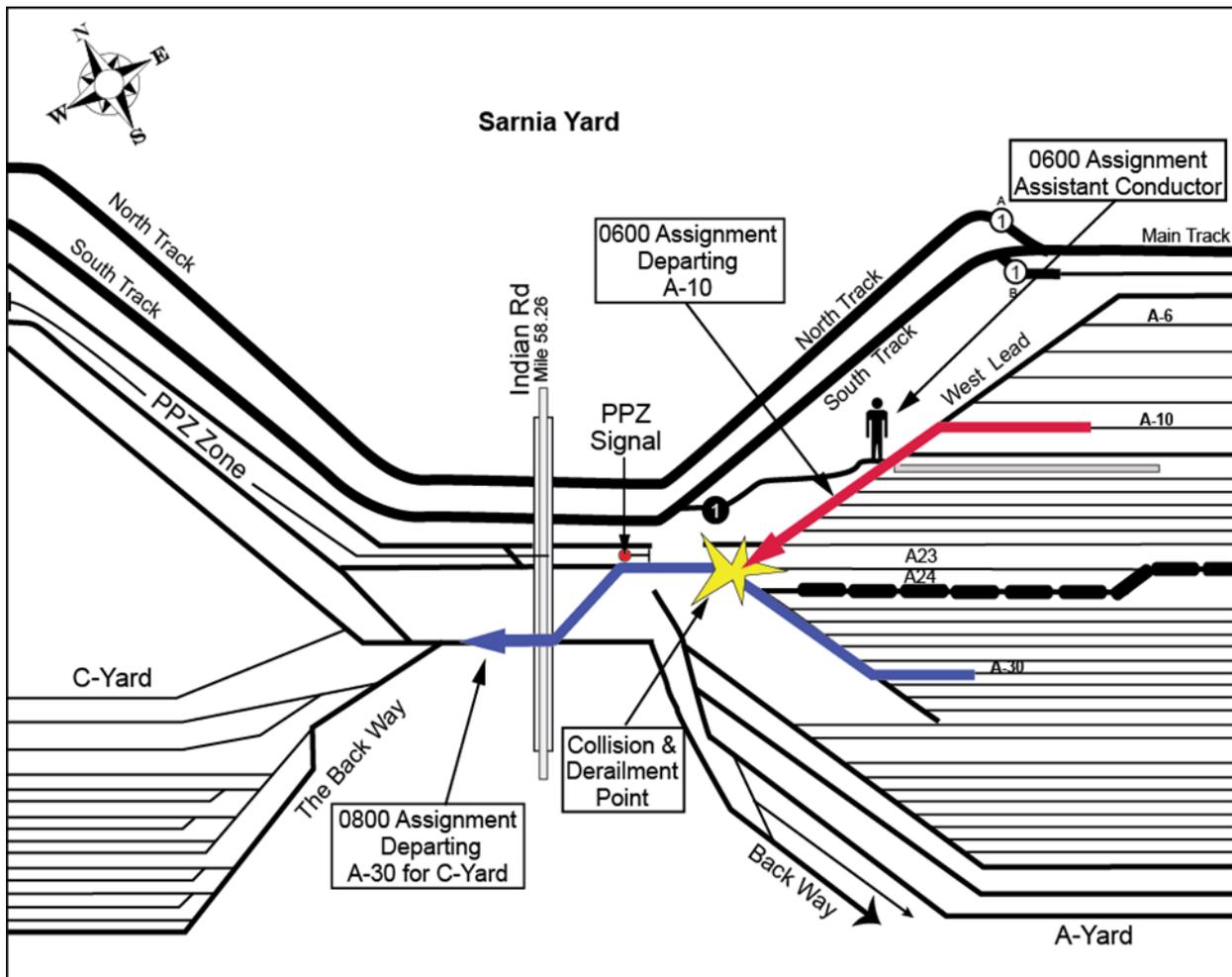


Figure 2. Sarnia Yard schematic

Tracks in Sarnia Yard primarily consist of 115-pound rail. Turnouts are either number 09 or 10 with 17B switch stands. All switch targets were in good condition. The number 09 turnout in the vicinity of the collision consisted of 115-pound rail with a left hand-operated switch. The turnout was equipped with a Samson stock rail and points with protectors. The track at this location was fully spiked with good ties. In the vicinity of the accident, approximately 80% of the ties had been renewed in 2007. The track surface and gauge were in good condition.

Sarnia Yard Operations and Crew Assignments

At the time of the accident, 2 yard coordinators were on duty, the tower yard coordinator and the rover. All train and yard movements in A-Yard work under the direction of the tower yard coordinator. As specified in the Sarnia Terminal Operating Manual, all movements entering A-Yard are required to contact the tower yard coordinator for permission to enter A-Yard prior to using any of the tracks. This allows for the coordination of all movements within A-Yard by one individual. The tower yard coordinator advises trains and yard crews when other movements are in the vicinity and establishes the priority for which movements are to occur. The tower yard coordinator has a 360° view from the tower in order to monitor the entire yard. The collision occurred at the extreme west end of the A-Yard, approximately 5000 feet from the tower.

When a rover is on duty, the 2 yard coordinators are in regular contact with each other by radio and cell phone. Each yard assignment uses a dedicated radio frequency to facilitate yard switching operations. The rover carries a radio capable of switching between all radio frequencies within the yard in order to be able to communicate with the various train crews, as required.

The 0600 assignment, which started out in A-Yard, was working under the direction of the tower yard coordinator. The 0800 assignment, which started out at the west end of C-Yard, was working under the direction of the rover when in C-Yard.

On 21 May 2011 (the day before the accident), the same crews and assignments had been performing work at Sarnia Yard that was very similar to the work that was being accomplished on the day of the accident. The 0600 assignment had been working in A-Yard and the 0800 assignment had been working in C-Yard. Just before 1200, the 0800 crew were instructed to retrieve a cut of cars from A-Yard. When the 0800 crew contacted the tower yard coordinator as they entered A-Yard, they were advised that the 0600 crew was on lunch and there were no trains in the yard. Subsequently, they proceeded with their work without having to coordinate with other movements.

On the day of the accident, the same 2 crews were again working in A-Yard and C-Yard.

The 0600 Plank Road Assignment

The 0600 crew was working in A-Yard and had not been informed of the presence of any other crews working in the vicinity. The 0600 assignment was in the process of pulling all cars from track A-10. The assistant conductor was located on the switching lead in order to throw the switch at track A-6 after the entire train was pulled clear.

From this location, he could not clearly see the indication of the PPZ signal ahead of his locomotive consist and he did not have a clear view of the yard south of his train as it was obscured by a cut of stationary tank cars in track A-24. However, as the 0600 assignment had just moved through the PPZ and the west lead track a few minutes earlier, he believed that the track was still clear. The yard conductor, positioned at the east end of the A-Yard in order to

protect the point for the eventual eastward move, had been driven there by the rover. The rover did not advise the 0600 crew that the 0800 assignment was in the A-Yard picking up cars from track A-30, nor was he required to.

The 0800 Bunkhouse Assignment

At approximately 1200, the 0800 crew were instructed by the rover to take the locomotive consist to A-Yard, pick up a cut of cars from track A-30, and return to C-Yard. The rover did not advise the tower coordinator that the 0800 crew was entering the A-Yard to do this, nor was he required to. When the 0800 crew approached A-Yard, the 0600 assignment was not in sight.

Believing that the 0600 crew were again on lunch and that there were no other trains operating in the vicinity, the 0800 crew proceeded into A-Yard through the PPZ and the west lead without contacting the A-Yard tower coordinator, as required by written operating procedures. The 0800 assignment picked up the cars from track A-30 and, as it was leaving A-Yard, the collision occurred.

Rule 115 of the Canadian Rail Operating Rules

Rule 115 of the *Canadian Rail Operating Rules* (CROR), Shoving Equipment, states (in part):

(a) When equipment is shoved by an engine or is headed by an unmanned remotely controlled engine, a crew member must be on the leading piece of equipment or on the ground, in a position to observe the track to be used and to give signals or instructions necessary to control the move.

EXCEPTION: A crew member need not be so positioned if the track to be used is known to be clear.

(b) Known to be clear is defined as seeing the portion of track to be used as being clear and remaining clear of equipment and as having sufficient room to contain equipment being shoved. This determination must be made by a qualified employee who can observe the track and has radio contact with the employee controlling the movement. Where a track 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".

Note: When it can be determined that other movements are not on duty or will not be performing work in the track to be used, the requirement of "known to be clear" can be considered to be fulfilled continuously.

Rule 105 of the Canadian Rail Operating Rules

CROR rule 105, Speed on Non-Main Track, states (in part):

Unless otherwise provided by signal indication, a movement using non-main track must operate at REDUCED speed and be prepared to stop short of the end of track or red signal prescribed by rule 40.1.

(b) Unless otherwise provided by signal indication or special instructions, movements operating on non-main tracks must not exceed (15) MPH.

Reduced speed is defined as speed that will permit stopping within one-half the range of vision of equipment. Equipment is defined as one or more engines and/or cars which can be handled on their own wheels in a movement.

Sarnia Terminal Operating Manual

Train operations at Sarnia Yard are performed in accordance with the Sarnia Terminal Operating Manual which contains the following rules (excerpts):

3.2 Yard Coordinators

All movements within the sub yards of Sarnia Yard are to be made under the authority of the Yard Coordinator.

EXCEPT: When ROVING YARD COORDINATOR is working, the Rover will govern all movements within the C-Yard zone and industrial spur lines.

6.3 Sarnia PPZ Operating Procedures

1 - Movements using either of the 3 point protection zones (PPZ) for pull back purposes must observe the applicable PPZ signal for the route to be used.

2 - If a PPZ signal is yellow, belt pack operators are to remain on the ground in a position to observe the PPZ signal and let the movement continue unmanned into the PPZ Zone. Point protection beyond the PPZ signal is not required.

3 - When a movement occupies a Zone; the corresponding PPZ signal will begin to **FLASH RED**.

4 - Operator must continue to observe the PPZ signal while pulling back and if signal changes to **SOLID RED**, the movement must be stopped.

5 - If the PPZ signal is not yellow **then point protection must be arranged**.

6 - No switches may be opened or any movement foul or enter a PPZ Zone unless permission is received from the Yard Coordinator.

6.4 Point Protection

Unless relieved of point protection, if the portion of track to be used is not seen or known to be clear, then a crew member must be positioned on the leading point of the movement and the movement must be made at a speed which will permit stopping within one half the range of vision.

Adaptations to Rules and Procedures

Operating rules and procedures in the workplace define the envelope of safe work practices in all situations, including worst-case scenarios and adverse conditions. Thus, the rules have a built-in safety margin under normal work conditions. In the modern workplace, management must be concerned with both safety and liability. In some situations, the tendency can be to provide an even larger safety margin by adding more rules and restrictions, which can make the work slower and more costly.

For various reasons, routine adaptations to rules and procedures can develop over time within rule-based work environments. Sometimes they develop when experienced employees use their judgement to maintain what they believe is adequate safety, while doing the work more efficiently. In other cases, employees do it because they feel pressure to get the work done even though they do not have sufficient time or the required resources. In these situations, they may take small risks in order to get the work done. In addition, there may be circumstances where the rules cannot be applied because the rules are out of date or poorly designed (i.e., they do not take into account the real-world work context).

Adaptations to rules and procedures can result in productivity gains for the company and can make the job easier for the worker. Because of the safety margins built into the rules, there are normally no adverse consequences to these adaptations. Management may be unaware of the adaptations or may knowingly accept them, only seeing the end result. Sometimes adaptations become the unofficial accepted practice and production quotas and expectations are adjusted accordingly. This could then make it difficult to meet the revised quotas without using the adaptation. Informal practices may spread through the company. In addition, these practices may be indirectly reinforced by management if reward structures are based on productivity without fully considering rule compliance.

Non-Main Track Accidents at Sarnia Yard

Since 2007, the total number of accidents at Sarnia Yard has decreased significantly. The Yard has reported only 1 collision in the past 3 years, down from an average of over 5 collisions per year for the rest of the decade (see Figure 3). Sarnia Yard has been recognized for its low accident rate and had previously received a company award in recognition of this achievement.

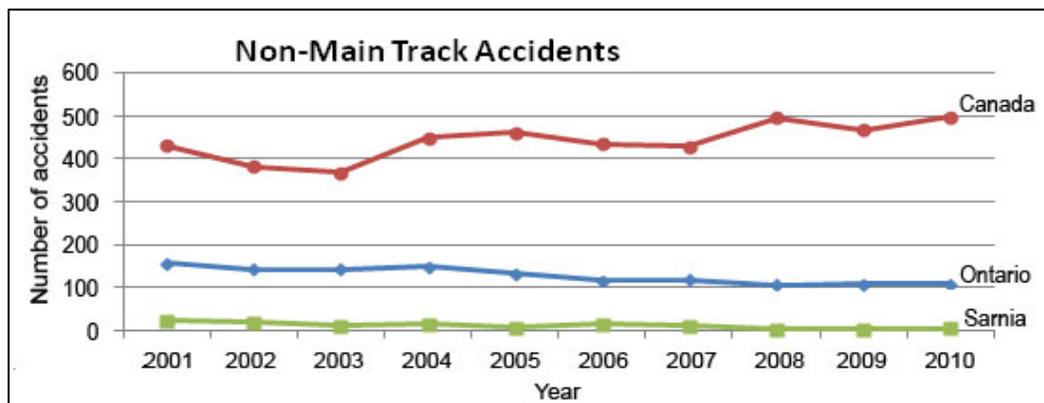


Figure 3. CN non-main track accidents reported for Sarnia Yard, Ontario and Canada

Analysis

In this occurrence, there were no equipment or track defects present that were considered contributory to the accident. The analysis will focus on the application of CROR rules, terminal operating procedures, and the associated human factors.

The Accident

The 0600 assignment thought the west lead track was “known to be clear” under the provisions in CROR Rule 115, as the assignment had previously lined its route, and was not advised there was another yard assignment working in the area. Therefore, the 0600 crew did not protect the leading end of their movement prior to entering the PPZ zone. The collision and subsequent derailment occurred when the 0600 assignment pulled back on the west lead and the lead locomotive struck the side of the 0800 assignment which was using the same west lead track to depart A-yard.

0800 Assignment

Prior to entering A-Yard, the 0800 crew did not notify the tower yard coordinator. However, the 0800 crew believed that they could safely proceed with their work in A-Yard as the assigned work was similar to a movement that they had performed the previous day when the 0600 crew had stopped for lunch. The assigned work was of a short duration, and would be conducted at slow speed and with good visibility. In addition, the rover, who had assigned the work, was in A-Yard and had advised them to pick up cars on track A-30. What’s more, the 0800 crew was aware that the tower yard coordinator and the rover were in frequent contact.

Given the good weather conditions of the day, the 0800 crew likely expected that their assignment was visible to other trains and to the tower yard coordinator. Moreover, the 0800 crew believed that if another crew was operating in the yard, they would operate in accordance with CROR Rule 105 and they would be able to see them and stop within one-half the range of vision. The 0800 crew’s experience from the previous day, and the work request from the roving yard coordinator just prior to the 0800 assignment entering A-Yard, contributed to the crew’s confidence that they could safely carry out the work in A-Yard without fulfilling the requirement to contact the tower yard coordinator.

0600 Assignment

The switching tasks assigned to the 0600 crew required the crew members to be in different places in the yard within a short period of time. To complete these tasks, a crew member would need to:

- check that the cut of cars they were picking up from track A-10 were properly coupled;
- line the switch at track A-10 for the lead after the tail end of the movement had cleared;
- line the switch into track A-6 before the assignment reversed into track A-6 to set out the correct cars; and,
- couple to the cars in track A-6.

During these activities, the crew was expected to protect the point while the yard assignment moved in either direction. However, under the provisions in CROR Rule 115, the assistant conductor for the 0600 assignment believed that the west lead track was “known to be clear” and that it was not necessary to visually protect the point of his movement prior to entering the PPZ zone.

The 0600 crew were experienced employees and based on previous experience, they believed that they would be notified by radio of the presence of any other movements working in the vicinity. Since they had not received any such notification, the 0600 crew believed that the intended route into the PPZ zone was still clear, even though they could not clearly observe the PPZ signal and the south side of their train was not entirely visible to the assistant conductor, who was positioned on the ground near the A-6 switch. The switching move would take the front of the train almost 6000 feet from the position of the assistant conductor. Both the yard conductor of the 0600 assignment and the rover were aware of the move, and did not question the assistant conductor’s choice of location during the movement. The assistant conductor likely interpreted the lack of questioning as implicit approval. In addition, the confidence of the crew in the safety of their approach may have been reinforced by Sarnia Yard’s reputation for safety.³

In order for the assistant conductor to visually protect the point, he would have had to have boarded the locomotive and then ask the yard conductor to line the switch. Or, alternatively, he would have had to have walked back and line the switch himself. Both of these options to visually protect the point would have required additional time to complete the switching task. However, by staying at the A-6 switch, the assistant conductor ensured that the switching move could be completed in less time and with reduced effort. This choice (of not visually protecting the point) reflects the natural tendency to accept low probability risks with potentially severe outcomes in order to avoid a low-severity negative consequence, such as lost time and reduced productivity.⁴ When adaptations are made to yard procedures, safety margins built into the rules are often reduced, which increases the risk of unsafe operations and yard accidents.

The Yard Coordinators

The rover had a radio capable of switching between the radio frequencies of the 2 assignments. The rover was aware of the intended movements of the 0800 assignment under his direction. As he had just dropped off the 0600 conductor in his vehicle, he was also aware of the activities of the 0600 crew. However, he was not aware that the 0800 crew had entered into A-Yard without permission from the yard tower coordinator. The rover did not notify the yard tower coordinator nor the 0600 crew of the presence of the 0800 assignment in A-Yard.

³ The theory of high reliability organizations (HRO) describes the paradox that for organizations with few accidents, it is challenging to maintain a “preoccupation with failure” (i.e., an awareness of the dangers and a high level of vigilance). Karl E. Weick and Kathleen M. Sutcliffe (2001). *Managing the Unexpected - Assuring High Performance in an Age of Complexity*. San Francisco, CA, USA: Jossey-Bass. pp. 10-17.

⁴ This common phenomenon is referred to as prospect theory or framing bias. See Tversky and D. Kahneman (1981) “The framing of decisions and the psychology of choice”, *Science* 30: 211 (4481), pp. 453-458. See also Transportation Safety Board report M10L0074.

Under Sarnia Terminal Operating Procedures, the rover was not required to communicate the detailed movements of the 2 trains. However, there were multiple opportunities to communicate this information to the 0600 crew or the tower yard coordinator during the course of his duties. When movement information is not effectively communicated between the yard coordinators and operating crews, there is an increased risk that unsafe operating decisions will be made.

Findings as to Causes and Contributing Factors

1. The collision and subsequent derailment occurred when the 0600 assignment pulled back on the west lead and the lead locomotive struck the side of the 0800 assignment which was using the same west lead track to depart A-yard.
2. The 0800 crew's experience from the previous day and the work request from the roving yard coordinator just prior to the 0800 assignment entering A-Yard both contributed to the crew's confidence that they could safely carry out the work in A-Yard without fulfilling the requirement to contact the tower yard coordinator.
3. Under the provisions of rule 115 in the *Canadian Rail Operating Rules*, the assistant conductor for the 0600 assignment believed that the west lead track was "known to be clear" and that it was not necessary to visually protect the point of his movement.
4. The roving yard coordinator, who was aware of the intended actions of both yard assignments, did not communicate this information to the tower yard coordinator nor to the train crews.

Findings as to Risk

1. When adaptations are made to yard procedures, safety margins built into the rules are often reduced, increasing the risk of unsafe operations and yard accidents.
2. When movement information is not effectively communicated between the Yard Coordinators and operating crews, there is an increased risk that unsafe operating decisions will be made.

Safety Action Taken

Transport Canada

On 29 November 2011, Transport Canada (TC) issued a Notice to CN outlining that incidents and accidents were occurring in Sarnia Yard involving yard switching assignments handling dangerous commodities. TC indicated that these occurrences can lead to situations where a person could be injured or made to be ill, and that damage could be caused to the environment or property. TC requested that CN respond in writing, demonstrating how it will resolve the hazards or conditions.

Canadian National Railway

CN Sarnia Yard management increased its efficiency testing with a focus on point protection, as well as on crew to crew, crew to coordinator and coordinator to coordinator communications. Daily yard crew briefings were held focusing on point protection and communications. A risk assessment was performed with regards to items outlined in the report. As a result of the risk assessment:

- CN installed signs on the switches within the current PPZ zone to remind employees that they must call the yardmaster prior to entering the other PPZ with any equipment.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board authorized the release of this report on 15 December 2011.

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