

RAILWAY OCCURRENCE REPORT

CANADIAN NATIONAL
COLLISION
BETWEEN TRAIN NO. A 420-21-21
AND LOCOMOTIVES OF TRAIN NO. 145
MILE 146.2, SAINT-LAURENT SUBDIVISION
TASCHEREAU YARD
SAINT-LAURENT, QUEBEC
23 JUNE 1995

REPORT NUMBER R95D0097

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.

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SUMMARY

On 23 June 1995 at approximately 0745 eastern standard time, at Canadian National (CN) Taschereau Yard in Montreal, Quebec, train No. A 420-21-21 (train 420) collided with the locomotives of train No. 145 (train 145). One employee was slightly injured.

Ce rapport est également disponible en français.

OTHER FACTUAL INFORMATION

Upon arrival at Taschereau Yard, the crew of train 420 received authorization by radio from the switchtender at yard control tower "M" to enter the yard from the Saint-Laurent Subdivision and proceed to the west yard. The switchtender had been advised of the impending arrival of train 420 before being called by the crew and had contacted the tower "M" yardmaster for yarding instructions. The tower "M" yardmaster had advised the switchtender that train 420 would be yarded in "west" yard. The switchtender had then contacted the "west" yard yardmaster who had requested that train 420 be lined into track No 2. The switchtender had then lined the appropriate switches, which included routing train 420 over track DX-03. Train 420 was powered by 2 locomotives and was handling 62 loaded cars and 16 empties. It weighed approximately 7,700 tons and was about 4,600 feet in length.

Moments after the arrival of train 420, the tower "M" switchtender was contacted by the locomotive engineer of train 145 who requested routing for their three locomotives coming off the outbound diesel shop track to their train at Turcot Yard. Turcot Yard is on the CN Montreal Subdivision about three miles east of Taschereau Yard. There is a sign across from switch SS3 on the shop track requiring movements to obtain permission from the yard tower "M" switchtender before entering track DX-03. The switchtender advised the crew of train 145 to stand by. He attempted to contact the tower "M" yardmaster to advise him that train 145 would be coming around the loop into the receiving yard en route to Turcot Yard; however, the telephone line was busy. He then contacted the crew of train 145 and gave them permission to exit the diesel shop outbound track onto track DX-03. This instruction authorized train 145 to proceed on the same track as train 420 which had just been authorized to proceed in the opposite direction. The three locomotives of train 145 weighed approximately 450 tons and totalled about 200 feet in length.

After authorizing the movement of train 145, the switchtender realized that he had already authorized train 420 on the same track. He then attempted to contact the crew members of both trains to advise them that they were opposing each other on the same track, but it was too late to avert the collision. Train 420, travelling southward in a curve on departure track DX-03, collided head on with the locomotives of train 145, travelling northward on the same track. As a result of the impact, the front truck of the lead unit of train 420 derailed. The locomotive engineer on train 145 sustained a cut above his left eye.

Track DX-03 runs parallel to track DX-04, looping around in a semi-circle. Both of these tracks curve nine degrees. Sight-lines were restricted by foliage in the vicinity of the collision to approximately 1,000 feet. There is no track gradient at this location. The point of impact was at the approximate mid-point of the curve.

The crew members of both trains reported observing the opposing train before braking and both stated

that they initially assumed that the opposing train was on the adjacent track. The locomotive engineers immediately applied the brakes when they first observed that their respective movements were on the same track, but they were unable to stop in time to avert the collision.

To the point of impact, train 145 had travelled approximately 900 feet from switch SS3 and train 420 had travelled approximately 1,200 feet on track DX-03.

It was clear and calm with good visibility. The temperature was 20 degrees Celsius.

Each train crew consisted of a conductor and a locomotive engineer who were in the lead locomotives of their respective trains.

All crew members were qualified for their positions and met fitness and rest standards to ensure the safe operation of railway equipment.

Event recorder data from train 420 indicate that the train was travelling at 13 mph when the brakes were first applied. The brake pipe pressure started to drop eight seconds before impact. It travelled with the brakes in emergency for a recorded time of five seconds when the event recorder stopped working on impact at a recorded speed of 12 mph.

Event recorder data from train 145 indicate that the brakes were applied when the train was travelling at 16 mph. After eight seconds, the speed decreased to eight mph, then suddenly it dropped to four mph at impact.

Train and engine movements on tracks designated as other than main track are required by Canadian Rail Operating Rules (CROR) Rule 105 to operate at "reduced speed". Reduced speed is defined as a speed that permits stopping within one-half the range of vision of equipment. The railway requires movements on tracks designated as "other than main track" to be prepared to stop short of a track unit. The railway has also set a maximum speed of 15 mph on most yard tracks (note: an exception exists, for example, at Foothills Industrial Park in Calgary in 1993 where the maximum speed is 10 mph -- reference TSB report R93C0103).

The switchtender work station in tower "M" was equipped with two control panels for controlling various switches and the route signals in Taschereau Yard. The panels display the position of the switches and illuminate the routes selected by the switchtender. Switch SS3, routing movements off the diesel shop outbound track onto track DX-03, is a spring switch. The position of this switch is not displayed on the switchtender's control panel nor can the switchtender in tower "M" see locomotives moving over the switch when they leave the diesel shop track. There were no block signals applicable to train 145 between switch SS3 and the point where the collision occurred.

On-the-job training was provided under the supervision of a qualified person. The switchtender had been trained and was experienced with the duties in the tower "M" work station.

A person performing a complex job in a continuously changing environment, such as a switchtender, must be continuously aware of the operational situation when making and implementing plans to control train movements. Situational awareness for a switchtender requires the perceiving of information from a number of sources and coordinating that information to expedite the movement of trains and avert conflict with other movements.

In July 1995, following an investigation into a head-on collision in the Foothills Industrial Park in Calgary, Alberta, the TSB recommended that:

The Department of Transport review the application of CROR Rule 105 with a view to ensuring that an appropriate safety factor is maintained with opposing movements. R95-02

In forwarding the recommendation, the Board attempted to bring focus onto why apparently competent and qualified crews fail to stop their trains in time to avoid collisions in opposing traffic situations. It was recognized that the railway industry is a competitive, commercial environment and that pressures, both real and perceived, exist to complete work schedules in a timely manner. Hence, crews would tend to operate their units at maximum authorized speeds. However, in response, Transport Canada (and apparently the railway industry) essentially rejected this recommendation stating that: "Ultimately, the issue appears to be one of non-compliance with fundamental rules of railway operations, and not the adequacy of the rule."

ANALYSIS

The crew members of both train 420 and train 145 had obtained the required permission from the switchtender moments apart to enter track DX-03, and therefore move toward each other in opposing directions. Neither crew was aware that the other had been authorized to operate on the same track. The switchtender momentarily lost situational awareness when he gave train 145 permission to operate on the same track that had just been given to train 420. This inadvertently established the circumstances where a collision was possible. Protection against collision was left to the secondary defences of CROR Rule 105, company maximum speed restrictions and the ability of the crew to comply with those criteria.

In effect, the railway relied on a verbal system, whereby the switchtender authorized the movement of trains from the shop track onto track DX-03 en route to Turcot Yard, to minimize the risk of collision. However, in this instance, the switchtender did not accomplish the intended objective. If there had been a block signal in place to display an indication for train 145 to enter track DX-03 at switch SS3, the risk of this collision probably would have been less .

The crew members of both trains observed the opposing train before the collision. However, neither crew was expecting to encounter an opposing movement on the same track, and therefore, when the opposing train was first seen, both crews presumed the approaching train was on the adjacent track. When each crew realized that the opposing movement was on the same track, and braking was applied, there was insufficient time for the brakes to stop the trains prior to collision.

The event recorder data suggest that both crews had been operating their trains in accordance with the company's maximum speed restriction of 15 mph. Although the recorded speed of train 145 was 16 mph when the brakes were applied, the recorder data may not be perfectly accurate. Moreover, a 1 mph overspeed would be within the range of normal speed fluctuation.

The brake pipe pressure began to drop on train 420 eight seconds before impact with train speed at 13 mph. The emergency brake was applied five seconds before impact at the same speed. The train was travelling at 12 mph for two seconds just prior to impact. At eight seconds before the collision, train 420 was about 150 feet from the impact point; at five seconds, it was about 100 feet away.

The brakes were applied on train 145 about eight seconds before impact with train speed at 16 mph. Based on the recorder data over the next eight seconds, the calculated distance travelled from brake application to impact was just over 150 feet.

Therefore, the total distance travelled by the two trains from braking to impact was approximately 250 to 300 feet. However, both trains were still moving at the instant of impact, and the combined

maximum braking distance for both these trains to stop would have exceeded 300 feet.

A second factor that determines the distance to stop a movement, in addition to the minimum braking distance, is crew reaction time. Reaction time is defined as the time from receipt of a visual stimulus to a physical reaction, such as activation of a mechanical device. Even under ideal conditions, there is always a finite time requirement associated with human reaction. It has been determined that reaction time can take up to five seconds and even longer depending upon the operational circumstances. Thus, theoretically, using a reaction time of five seconds, train 420, moving at 13 mph, could travel a distance of 93 feet, and train 145, moving at 16 mph, a distance of 117 feet during the time between the sighting of an opposing movement and the application of the brakes.

While there is certainly some imprecision in these numbers, it is apparent that, even at relatively slow speeds, reaction time consumes considerable available stopping distance and has a great impact on the reduced speed stopping limit of "one-half the range of vision." When there are adjacent tracks, the time taken to conclude the opposing train is on the same track consumes even more available stopping distance.

The logic underlying the concept of "reduced speed" is intuitively appealing. If complied with, it appears, at first glance, to ensure that, regardless of the track condition and train characteristics, collisions will be prevented. However, if the range of vision is greater than the distance at which a hazard can be detected, there is an invalid premise in the concept. Such appears to be the case in this accident and other non-main track collisions investigated by the TSB.

The use of the term "range of vision" may be too vague to accomplish the concept's aim. While a crew member on a movement may be able to see a considerable distance, the range at which a hazard can accurately be detected will depend on the size, shape, colour and location in a field of view. The perceptual task can be made more difficult if sight-lines are restricted or the stimulus is ambiguous. Operation on a track that has an adjacent track further hampers the crews' ability to comply. The key to averting collisions is to operate at a speed such that the train can be stopped well within the range of vision at which a hazard can be identified, which may be considerably less than the range of vision, and possibly within half the range of vision.

As previously outlined, reaction time is not instantaneous. Reaction time is an additive factor in the total distance required to stop. Furthermore, the stopping distance for a movement varies according to the weight and composition of the train, the type and condition of the brakes, and track condition (e.g., wet, dry, snow, gradient, etc.). Relying on crew members to comply accurately with the requirements of reduced speed may not be feasible in every instance.

CROR Rule 105 is intended to apply equally to trains approaching stationary objects or opposing

movements. The safety margin afforded by the concept of "reduced speed" is, however, different between these two circumstances. To explore this difference, it is assumed that a theoretical situation exists of a crew operating a train at a speed ("S") that is a speed whereby the train can be stopped exactly within half the range of the crew's vision ("D") after observing a hazard and then applying the emergency brake at speed "S". In the case of a stationary object coming into the range of vision, an alert and vigilant crew could stop their train in a distance of $D/2$. This leaves a distance of $D/2$ between the stopped train and the stationary object — which theoretically constitutes a safety margin of a distance equal to half the range of the crew's vision. In the case where there is an opposing movement of two identical trains, moving at the same speed (S) on the same track, and where both crews have the same range of vision, see each other's train at the same time and apply the emergency brake, each train will stop in a distance of $D/2$. This would leave no distance between the two lead locomotives once they stop — which would constitute no safety margin. While experienced locomotive engineers can become quite adept at judging the stopping distances of their trains, no crew could know exactly what the stopping distance is over a range of different speeds, track conditions, etc. Furthermore, crews may not be aware of the impact of reaction time on stopping distance. Therefore, for the crew stopping to avert collision with a stationary object, there may well be less than $D/2$ between the object and the locomotive once stopped, and the two opposing movements may collide. Therefore, it is clear that the safety margin offered by CROR Rule 105 is reasonable for averting a collision with a stationary object, but it is not always reasonable for averting a collision between two opposing movements even though the crews may diligently try to comply with the rule.

Given this, where opposing movements on non-main line track are possible, the only way for crews to avert collision with some safety margin to account for reaction time and reasonable errors in estimating train braking distances over a range of speeds, is to operate at a speed well below that which will permit stopping within half the range of vision. Operating in this way would undoubtedly reduce productivity or lengthen the time of duty for a crew seeking an "early quit".

FINDINGS

1. The switchtender momentarily lost situational awareness and granted authority for the movement of train 420 and train 145 opposing each other on the same track, which created a circumstance where a collision was possible.
2. The crews were operating their trains within or very close to the maximum provisions of reduced speed and did not expect an opposing movement on the same track.
3. The crews of both trains incorrectly identified the position of the opposing train as being on the adjacent track up to a point where it was too late to react and apply the brakes soon enough to avert the collision.
4. The requirement of CROR Rule 105 for trains to stop within one-half the range of vision does not provide an adequate safety margin to avert collision between opposing movements operating at similar speeds on the same track.
5. A block signal at the location where train 145 entered onto track DX-03 could have reduced the risk of this accident happening.

CAUSE

The collision was caused by the crews from train 420 and train 145 having been authorized to operate on the same track in opposing directions and operating at speeds from which they were unable to stop in the distance available when the hazard was recognized. A contributing factor was the lack of adequate safety margin offered in the provisions of CROR Rule 105 when there are two opposing movements.

SAFETY ACTION TAKEN

CN indicated that the following actions are being implemented at the district level:

- Train crews cannot be authorized to leave the shop while incompatible movements are in progress.
- A switchtender log containing information on traffic movements in the area of the yard under their jurisdiction is now being maintained. The log will be maintained for two years.

- A warning system is being designed to increase the reliability of the operation.
- An additional signal will be installed at the shop's exit.
- A specialized training program is being evaluated for new employees assigned to related tasks or when there are major technical changes.

SAFETY ACTION REQUIRED

The Board is concerned that Transport Canada (TC) and the railway industry place over-reliance on CROR Rule 105 (and Rule 94) to prevent collisions between opposing movements. Once again, two opposing units, authorized to be on the same track and relying on CROR Rule 105 for protection, collided. In this investigation, and in three others, the Board has found that relying solely on CROR Rule 105 to provide a margin of safety during opposing movement operations is unrealistic. Notwithstanding that the Board has elaborated on many of the difficulties that even a highly experienced and diligent crew would have in effectively applying CROR Rule 105 safely in all circumstances involving opposing movements, TC and the railway companies have attributed accidents of this nature simply to non-compliance with the rules. It appears to the Board that insufficient consideration has been given to the human performance context and to the mathematics of situations involving opposing movements.

The Board acknowledges that thousands of movements are made safely each day involving the application of CROR Rule 105 (and Rule 94, Caution speed). These rules provide what has proven to be a reasonable margin of safety in situations involving a moving train and a stationary object. However, there is no safety margin in situations involving two opposing movements operating at similar speeds. To prevent collisions between opposing movements, it is necessary to take account of the human performance limitations that prevent perfect compliance with CROR Rule 105 (or Rule 94). TC had undertaken to better understand how the various aspects of human performance can impact on the way rules in general are interpreted. However, the Board is not aware of any TC initiatives to establish whether, taking human performance issues into consideration, such rules are able to meet their object.

¹R93C0103, R94Q0029, and R95V0122.

²CAUTION SPEED: A speed that will permit stopping within one-half the range of vision of equipment or a track unit and in no case exceeding SLOW SPEED.

This report concludes the Transportation Safety Board's investigation into this occurrence. Consequently, the Board, consisting of Chairperson Benôt Bouchard, and members Maurice Harquail, Charles Simpson and W.A. Tadros, authorized the release of this report on 17 September 1997.