Transportation Safety Board of Canada

Bureau de la sécurité des transports du Canada

RAILWAY INVESTIGATION REPORT
R15V0046

MOVEMENT EXCEEDS LIMITS OF AUTHORITY
CANADIAN PACIFIC RAILWAY
FREIGHT TRAIN 672-024
MILE 103, CRANBROOK SUBDIVISION
CRANBROOK, BRITISH COLUMBIA
11 MARCH 2015

Canada

Transportation Safety Board of Canada
Place du Centre
200 Promenade du Portage, 4th floor
Gatineau QC K1A 1K8
819-994-3741
1-800-387-3557
www.tsb.gc.ca
communications@bst-tsb.gc.ca

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Railway Investigation Report R15V0046

Movement exceeds limits of authority
Canadian Pacific Railway
Freight train 672-024
Mile 103, Cranbrook Subdivision
Cranbrook, British Columbia
11 March 2015

Summary

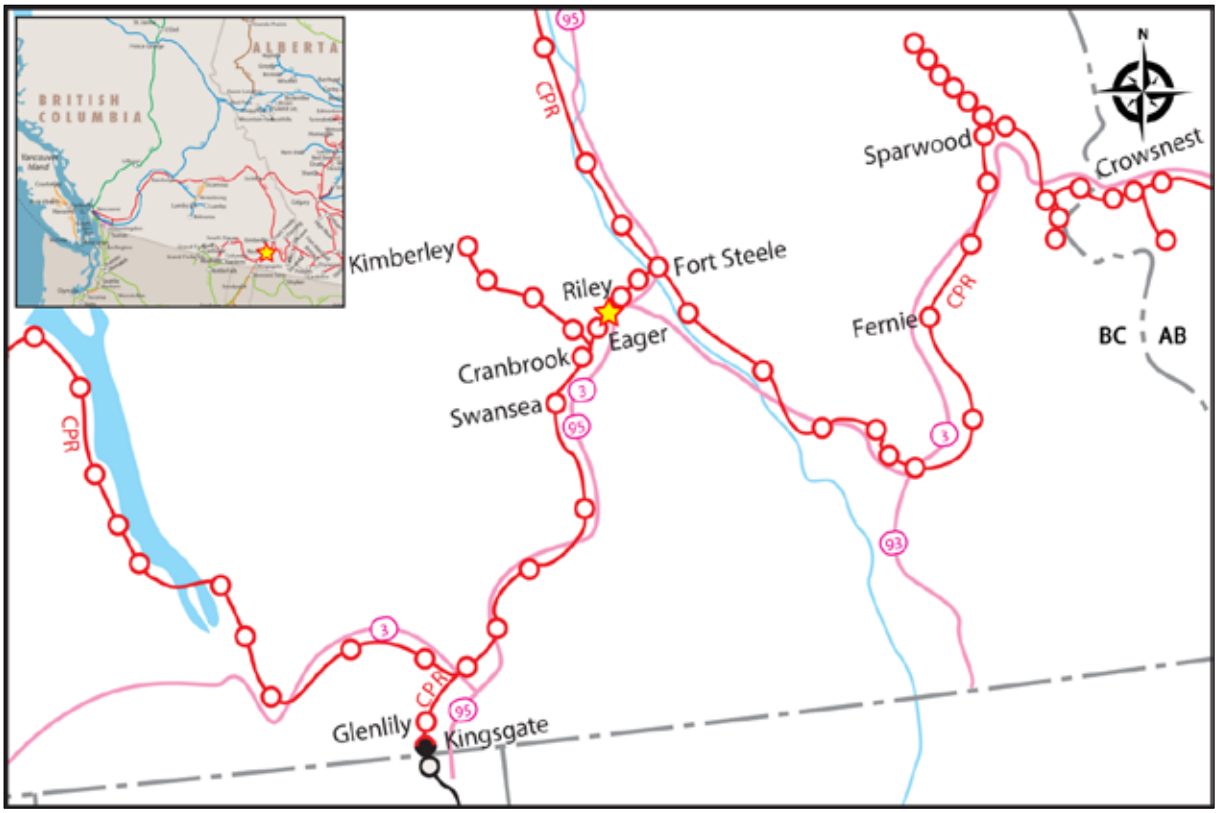
On 11 March 2015 at approximately 0130 Pacific Daylight Time, a rail traffic controller at Canadian Pacific Railway stopped train 672-024 near Mile 102 on the Cranbrook Subdivision after the train had departed Cranbrook, British Columbia, and travelled east for 5 miles without authorization. There were no conflicting movements.

Le présent rapport est également disponible en français.

Factual information

On 11 March 2015, a Canadian Pacific Railway (CP) rail traffic controller (RTC) in Calgary, Alberta, stopped train 672-024 (the train) near Mile 102 on the Cranbrook Subdivision. The train had departed Cranbrook, British Columbia, and had travelled east for about 5 miles without authorization (Figure 1). There were no conflicting movements and no injuries. The train consisted of 2 head-end locomotives and 130 empty cars. It was 6257 feet in length and weighed 3673 tons. The weather at the time of the occurrence was clear and −4°C.

Figure 1. Map of the occurrence location (Source: Railway Association of Canada, *Canadian Railway Atlas*, with TSB annotations)



The occurrence

At 2000[1] on 10 March 2015, a CP management train crew[2] was called to deadhead by taxi from Fort Steele, British Columbia (Mile 95.6 on the Cranbrook Subdivision), to Kingsgate, British Columbia (Mile 51.0 on the Moyie Subdivision). The train crew was assigned to pick up the train and return to Fort Steele.

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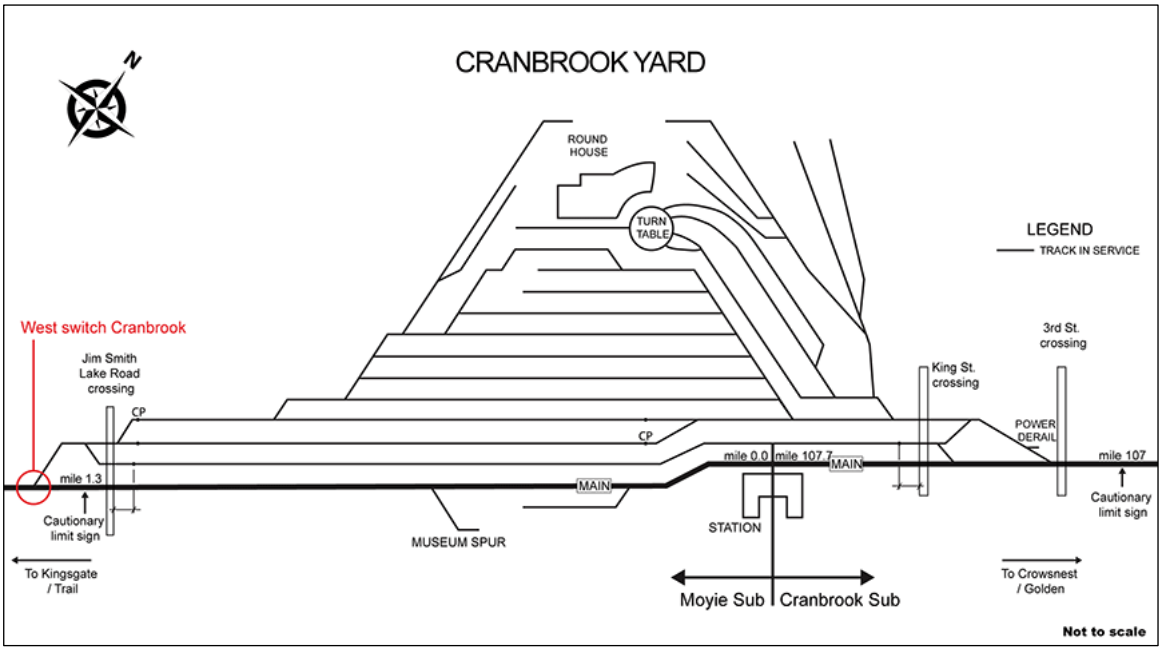
1 All times are Pacific Daylight Time (Coordinated Universal Time minus 7 hours).

2 All crew members were management employees.

Prior to departing Kingsgate at Mile 51, and after getting under way, the crew copied several occupancy control system (OCS)[3] clearances, giving them authority on the main track from Glenlily, British Columbia (beginning of OCS, Mile 48.9 on the Moyie Subdivision), to the west siding switch at Swansea, British Columbia (Mile 9.4[4]). At Swansea, the train took the siding for an opposing train. While at Swansea for the meet, the train crew copied another OCS clearance giving them authority on the main track from the east siding switch at Swansea to the beginning of the cautionary limits at Mile 1.3, near the west switch at Cranbrook Yard (Figure 2).

Figure 2. Track schematic of Cranbrook Yard (Source: Canadian Pacific Railway, with TSB annotations)



Cautionary limits are defined in the *Canadian Rail Operating Rules* (CROR) as the "portion of the main track or main tracks within limits defined by cautionary limit sign(s) " or by special instructions.

In accordance with CROR Rule 94, train movements must comply with the provisions of CROR Rule 105(c), which requires that the movement must observe reduced speed: it must be able to stop within half the range of vision of a track unit, and must be able to stop short of a switch not properly lined.

Approaching the cautionary limits at Cranbrook at about 0120, the train crew was contacted by a local supervisor who had lined the west main track switch at Cranbrook Yard in advance of their arrival to restore it to the normal position. At about this time, the train crew contacted the assistant trainmaster at Fort Steele, who informed them that they were "OK on the main track through Cranbrook, all the way to Fort Steele."

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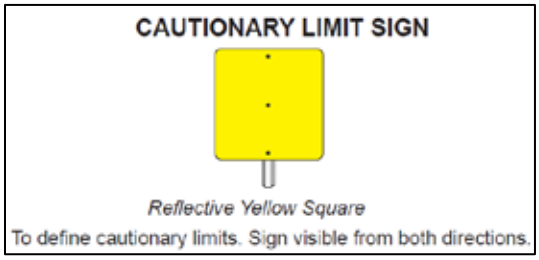
3 Occupancy control system (OCS) is a method of train control authorized by the *Canadian Rail Operating Rules* (CROR).

4 Mileage is for the station name sign at Swansea.

The train then passed the west cautionary limits sign (Figure 3) and continued into the cautionary limits on the Moyie Subdivision at Cranbrook. When the tail end of the train cleared the west main track switch, the train crew contacted the RTC for the Moyie Subdivision. The train crew provided a track release[5] and confirmed that the main track switch was restored to normal.

Figure 3. Cautionary limit sign



Following the communications with the RTC, the train crew discussed the cautionary limits. The crew consulted the timetable for the Moyie Subdivision, but did not consult the timetable for the Cranbrook Subdivision where the beginning of OCS limits on the Cranbrook Subdivision was defined. With this discussion and the earlier communications with the assistant trainmaster, the train crew concluded that the cautionary limits extended all the way to Fort Steele.

After entering the Cranbrook Subdivision, the train continued past the east cautionary limit sign at Mile 107. The train was back in OCS territory, but no additional OCS clearance had been obtained. Train 672 was travelling at 15 mph as it entered the OCS territory. When the train was near Mile 103, the RTC contacted the train crew and requested its location. Realizing that the train had entered OCS territory without authorization, the RTC immediately instructed the train crew to stop the train. With the train now travelling at 20 mph, the train crew initiated a controlled stop, bringing the train to a stop just west of Mile 102.

About 1 hour later, the train crew was issued an OCS clearance authorizing the train to proceed to Riley, British Columbia (Mile 100.8), where the crew members were relieved from duty.

The train crew

The train crew was composed of 3 CP management employees.[6] The locomotive engineer and the conductor were normally employed as trainmasters, who supervise day-to-day train operations on their assigned territory. Prior to joining the ranks of management as trainmasters, the locomotive engineer and conductor had been trained and had qualified for the positions. The third train crew member, who was making a familiarization trip, was normally employed as a service design specialist, which is not a an operations-related position.

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5 When a track release is provided, the train crew confirms to the RTC that the tail end of the train has cleared a specific identifiable location. The RTC then enters the track release into the OCS computer system and the released portion of main track becomes available to the RTC for use.

6 At CP, in 2015, a total of 3213 managers made 2457 trips.

All 3 train crew members were qualified for their positions as per the *Railway Employee Qualification Standards Regulations*. The train crew members had also met the regulatory requirements of the *Work/Rest Rules for Railway Operating Employees*. However, the locomotive engineer had been working irregular hours (different start and end workday times) as a supervisor in the weeks before the occurrence.

Subdivision information

The Moyie Subdivision begins at Cranbrook (Mile 0.0) and runs westward to International Boundary (Mile 51.1), near Kingsgate. The Cranbrook Subdivision begins at Crowsnest, British Columbia (Mile 0), and runs westward to Cranbrook (Mile 107.7).

Train movements on both subdivisions were controlled by the OCS system, as authorized by the CROR and supervised by the RTC Centre in Calgary, Alberta. The maximum track speed for freight trains in the area of the occurrence was 30 mph.

In August 2014, CP examined the Moyie and Cranbrook Subdivisions and determined that these routes were candidates for consolidation. In November 2014, CP determined that removing the cautionary limits at Cranbrook would make the operation safer and improve train operations. However, changes to yard trackage were required before the consolidation could take place. These were not completed at the time of the incident.

Occupancy control system

OCS is a computer-assisted method of train control in which the RTC issues track authorities to protect trains and track maintenance activities. For this system of control, there is no physical connection between the office control devices in the RTC centre and the field locations. Computer software that contains track information such as mileages, sidings, and identifiable locations is used. The software is equipped with CROR rules logic that is intended to ensure track authorities are issued, facilitating safe movement of trains and protection of track maintenance activities.

Railway radio is used to verbally transmit track authorities to train crews and track maintenance foremen. Employees receiving a track authority must make a written record and repeat the information to the RTC. The RTC will verify the repeated information before completing the track authority and entering the information into the OCS system.

If required, an approved electronic communications method (such as a fax machine) may be used to record, verify, and transmit track authorities to fixed locations, such as crew change locations.

Train crew familiarity with territory

Before the occurrence, the locomotive engineer had not operated a train on the Moyie Subdivision or on the Cranbrook Subdivision. The conductor had operated over the Cranbrook Subdivision westward from Fort Steele to Kingsgate about 6 months earlier, but

had not operated eastward from Kingsgate to Fort Steele. The third crew member, who was making a familiarization trip, had not yet operated over this territory.

Prior to actively working a train, management employees who acquire qualification as train crew members are expected to gain familiarization on a new territory. For the new territory, the management employee is provided with an information package that includes the CROR, general operating instructions, the current timetable, and summary bulletins that are relevant to the territory. During the familiarization process, there is normally interaction with local management. Management employees are permitted to self-evaluate to determine when they are sufficiently familiar with a territory to begin working trains as an active crew member.

Regulatory requirements for the training and certification of railway operating employees

The regulatory requirements for the training and certification of railway operating employees are established in the *Railway Employee Qualification Standards Regulations* (SOR/87-150). These regulations establish the minimum qualifications for locomotive engineers, conductors, and yard foremen. These regulations apply to all railway employees performing the duties of the specified occupational category, whether or not the employee is unionized.

The regulation states (in part):

> 5. (1) No railway company shall permit any employee to work as a locomotive engineer, conductor, or yard foreman unless the employee,
>
> (a) has qualified for that occupational category in accordance with section 14; and
>
> (b) in the case of a locomotive engineer has received a passing mark for on-job training in that occupational category.

Within the regulations, the following criteria have been established:

- The employee must achieve an overall passing mark of 80% in the required subjects.
- Recertification must occur at 3-year intervals.

In addition, for on-the-job training instructors, the following criteria have been established:

- An overall passing mark of 90% is required for certification of classroom and on-the-job training instructors.
- On-the-job training instructors for locomotive engineers must have a minimum of 2 years of service as a locomotive engineer and at least 3 months of service in the area where the locomotive engineer[7] is to give the on-the-job training.

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[7] *Railway Employee Qualification Standards Regulations,* Section 15(b).

These are the required subjects for conductors and locomotive engineers:

- Regulations No. 0-8, *Uniform Code of Operating Rules*
- railway radio regulations
- dangerous commodities
- train marshalling
- air brake systems and tests
- freight car and train inspections
- passenger evacuation procedures[8]

For locomotive engineers, additional required subjects include locomotive operation and train handling.

Training management employees to operate trains

To mitigate the risk of disruptions to train operations due to crew shortages and labour disputes, CP implemented a plan to ensure that there were sufficient qualified "management employees" (non-unionized employees, or managers) to operate trains. To encourage interest in this program, online introductory material from CP's plan indicated (in part) that

> it is the single best way for a management employee to learn what the business is truly about and it is a fundamental cornerstone to the development of our railway culture.

Initially, CP had required management employees with an operational background to maintain their operational certification and to operate trains, potentially as part of a crew composed of managers. In 2012, CP expanded this program to include management employees with a non-operational background as well.

Internal promotional material relating to CP's program indicated (in part) that

> In Canada and the US, all operation managers are required to be conductor or locomotive engineer qualified and maintain their qualifications. Employees who have held other qualifications in the past, such as, rail traffic controller, it is the priority to maintain this qualification first, before enrolling in the management conductor program.
>
> For all other non-union employees, it is a job expectation to become conductor or locomotive engineer qualified. However, we do understand that some employees may have medical restrictions that prevent them from participating in the program. Should you be deemed medically unfit for the conductor position, you are required to complete part 1 (2 weeks of classroom training) of the program.

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8 This is a required subject for conductors only.

Conductor training

The following training was established in CP's program for management employees to qualify as a conductor:

- a safety critical medical exam
- an initial 2 weeks of classroom training
- a critical task sign-off[9] prior to field training
- 2 to 4 weeks of on-the-job training that includes yard and road trips with a coach
- an additional 2 weeks of classroom training
- additional on-the-job training under the supervision of a coach until qualified as a conductor (a minimum of 20 trips)

Locomotive engineer training

Training was also established for management employees who were primarily mechanical or engineering employees to qualify as locomotive engineers. This training was called locomotive engineer "street to seat" training. Internal promotional material relating to this aspect of CP's program indicated (in part) that

> The target audience of this program is primarily mechanical and engineering non-union employees. However, it is open to any individual that has the confidence to operate a locomotive and has some mechanical aptitude. Employees who have held other qualifications in the past, such as RTC, it is the priority to maintain this qualification first, before enrolling in the Street to Seat Locomotive Engineer program.
>
> If you register for the "street to seat" locomotive engineer program, you will go through the same medical process as a conductor. Further, you will need to complete an on-line aptitude assessment before being accepted into the program.

The "street to seat" locomotive engineer program was an amalgamation of the existing conductor and locomotive engineer programs.

The training for management employees to qualify as locomotive engineers had the following elements:

- successful completion of an aptitude test administered by the human resources department
- completion of the conductor training program (without final certification)
- 2 weeks of classroom training relating to locomotive mechanical systems
- on-the-job training in the field until qualified as a locomotive engineer

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9 A critical task sign-off is an assessment of the employee's physical ability to perform the tasks required of conductors.

The training was based on a total of 6 weeks' classroom instruction broken into 3 two-week segments with on-the-job training following each segment. There was no prerequisite regarding number of years' experience as a conductor prior to starting this training.

Notification to Transport Canada for the operation of trains by management employees

In 2012, Transport Canada (TC) met with CP about the increased use of management employees as train crew members. CP later submitted its plan to TC, outlining the process for training management employee candidates from entry-level to qualified conductors or locomotive engineers.

CP did not submit a risk assessment as part of its notification to TC. The railway did not consider the training for non-operational management employees to become qualified conductors and locomotive engineers as an operational change that required a risk assessment as per Section 15.1(c)(v) of the *Railway Safety Management System Regulations*.

The Teamsters Canada Rail Conference response to the Canadian Pacific Railway's plan

The labour organization representing the operating employees, the Teamsters Canada Rail Conference (TCRC), noted in its April 2013 response to CP that the *Railway Employee Qualifications Standards Regulations* (SOR/87-150) stipulate that only qualified personnel (i.e., unionized or not) were to be used to operate trains, and that it therefore had concerns about CP's plan in the following respects:

- Management crews would not get enough familiarization trips.
- The initial training of the "street to seat" locomotive engineer program might be insufficient. Unionized employees, in comparison, have to work for 2 years as a conductor before being eligible to take locomotive engineer training.
- Management employees taking the "street to seat" locomotive engineer program would not work enough hours to acquire the same skill as a unionized employee.

Implementation of plan to use management crews for train operations

CP established a process to determine when management crews were required to operate trains. The process was implemented as follows:

- At each terminal, crew requirements were to be forecast regularly, based on traffic levels.
- Crew availability would then be determined based on crew members on rest and crew members who were not available due to annual vacation, illness, or discipline.
- When crew shortages were identified, the manager responsible for contingency planning was contacted. Qualified management employees were then selected to work from that terminal.

- The selected management employees were required to travel to the terminal, be rested, and be available for duty when required.

Management employees working as train crew members are governed by the same work/rest rules as regular train crew members. These rules specify the maximum hours of duty and set the requirements for mandatory time off duty. When calculating the allowable hours on duty, management employees are required to include their time worked as a manager.

Section 5, subsection 5.1.7, of the *Work/Rest Rules for Railway Operating Employees* states (in part) that

> Where a supervisor, non-operating employee or 3rd party is deemed to be an operating employee, the on-duty times of the supervisor, non-operating employee or 3rd party, in the immediately preceding 24 hour period, shall be taken into account in calculating maximum available on-duty time and mandatory off-duty times in section 5. Such persons must be able to demonstrate compliance with these rules.

To better manage compliance with the *Work/Rest Rules*, CP endeavoured to have management employees in position (that is, at the terminal) and off duty at least 24 hours before being called upon to work in train service.

Training requirements for unionized train crew members

At CP, the training program for new conductors (unionized employees) included

- 2 weeks of initial classroom training;
- a critical task sign-off prior to field training (assessment conducted in the field to confirm that the trainee is physically able to perform critical tasks);
- 4 to 6 weeks[10] of on-the-job training, including yard and road trips with a coach;
- 2 weeks of additional classroom training;
- on-the-job training under the supervision of a coach until a supervisor deemed the employee to be qualified as a conductor (no minimum number of trips, but would typically be about 73 trips[11]).

The training program and prerequisites for new locomotive engineers included

- a minimum of 2 years of service as a conductor before starting this training;
- 2 weeks of classroom training relating to locomotive mechanical systems;

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10 Time spent in the field would vary depending on the size of the terminal.

11 For the years 2014 and 2015, the average number of on-the-job training trips made by new hire conductors at CP was 73. The average period of time to complete this on-the-job training was about 160 days.

- on-the-job training until a qualified supervisor deemed the employee to be qualified as a locomotive engineer.

Movement exceeds limits of authority

Before July 2014, the *Transportation Safety Board Regulations* (hereafter, TSB Regulations) required federally regulated railways in Canada to report "a movement of rolling stock exceeds the limits of its authority."[12] This category also included incidents in which a train was operated past a stop signal.

Starting on 1 July 2014, the revised TSB Regulations require federally regulated railways in Canada to report these types of incidents:

> Rolling stock occupies a main track or subdivision track, or track work takes place, in contravention of the Rules or any regulations made under the *Railway Safety Act*;
>
> Rolling stock passes a signal indicating stop in contravention of the Rules or any regulations made under the *Railway Safety Act*.

The wording in the new TSB Regulations was modified to clarify the situations in which railways must report occurrences relating to "movement exceeds limits of authority." This resulted in an increase in the number of reported incidents over earlier years. In addition, CP implemented a 439 (stop signal) alarm feature in its rail traffic control centres on 31 July 2014. This new feature provides the RTC with both a visual and an audible alarm when an unexpected occupancy occurs. This new alarm has resulted in more violations being identified. For example, in 2015, there were 6 CP incidents where the tail end slack of a train ran out into a controlled location. Due to this safety-enhancing change, more incidents of this nature are being identified, which is reflected in the occurrence statistics.

For the 11-year period from 2005 to 2015 (Figure 4), which includes the change in the TSB Regulations, the reporting category of "movement exceeds limits of authority" for the rail industry in Canada showed a general increase. The number of occurrences increased from about 90 in 2010 to 142 in 2015.

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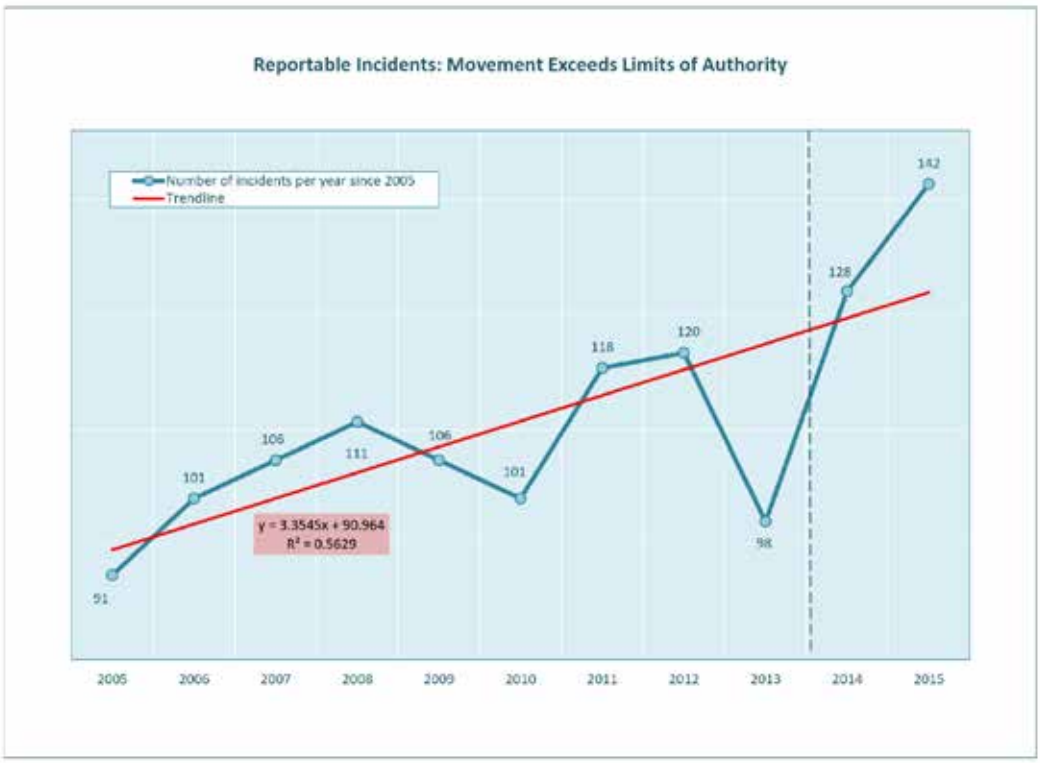
[12] This incident category captures a wide range of events, including Track & Engineering (T&E) employees who are outside their limits of authority, as well as 439 (stop signal) violations where movements foul a signal bond (even by a short distance). In 2015, TSB statistics for CP reveal 70 "movement exceeds limits of authority" incidents; 46 of those involved T&E crews. Of the 46, only 1 (this incident) involved a full manager crew.

Figure 4. Movements exceeding limits of authority reported to TSB from 2005 to 2015 (Note: The dotted vertical line depicts when the change in TSB reporting requirements occurred and when Canadian Pacific Railway added the stop signal alarm.)



Situational awareness and mental models during train operations

Situational awareness (SA) in relation to operational matters refers to the train crew members knowing what is happening in the immediate environment. A crew member's SA comes from various information sources, including radio transmissions, signal indications, in-cab displays, observations of the track, environmental conditions, and written information. Railway rules and operating instructions (e.g., CROR and general operating instructions, which provide information to operating crews) also affect SA.

When operating a train, the crew's decisions and actions greatly depend on the crew's assessment and understanding of the operational situation. There are 3 stages of SA:[13]

- "Perception" refers to the recognition that new, unambiguous cues exist.
- "Comprehension" refers to understanding the order of importance of the new cues.
- "Projection" refers to the ability to forecast future events based on information given.

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13 M.R. Endsley and D.J. Garland, *Situation Awareness Analysis and Measurement* (Mahwah, NJ: Lawrence Erlbaum Associates, Inc., 2000).

Accurate SA is highly dependent on switching attention between different information sources. While switching attention, people can engage in a phenomenon called attention narrowing or tunnelling. In these circumstances, people tend to lock in on certain cues or features of the environment they are trying to process and intentionally or inadvertently drop their scanning of other information sources. For example, in the first case, people believe that devoting limited focus to the previous information source is sufficient because the situation they are attending to is most important. In the second case, people fixate on one information source and forget to reinstate their scan of other available information sources. Either situation can compromise SA.

Circadian rhythm and reduced alertness

Humans have a number of daily (circadian) biological rhythms that influence the body's internal and external functions. Research suggests that hundreds[14] of these types of rhythms exist, such as body temperature, heart rate, subjective fatigue, attention, drowsiness, peak expiratory flow, and grip strength. There are also circadian rhythms for performance and cognitive functioning.[15]

Performance and cognitive functioning are generally worst during the period when circadian rhythms dictate sleep. Performance on specific measurements, such as reaction time,[16] arithmetic and signal detection,[17] and reaction to train safety alarm alerts[18] have all been demonstrated to be worse during the night.

There are 2 periods of maximum drowsiness in every 24-hour period. Although these times can vary from person to person, the principal drowsiness period for diurnal workers generally occurs between 0300 and 0500. A second drowsiness period occurs between 1500 and 1700. During these periods of drowsiness, physiological systems are at their lowest level. Irrespective of motivation and circumstances, a person can have a difficult time remaining alert during periods of maximum drowsiness.

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14 J. Aschoff, (ed.), *Biological Rhythms* (New York: Plenum Press, 1981).

15 T.H. Monk, "Shiftwork: Determinants of coping ability and areas of application," *Advances in the Biosciences*, Vol. 73 (1988), pp. 195–207.

16 A.J. Tilley, R.T. Wilkinson, P.S.G. Warren, et al., "The sleep and performance of shift workers," *Human Factors*, Vol. 24, Issue 6 (1982), pp. 629–641.

17 D.I. Tepas, J.K. Walsh, and D.R. Armstrong, in: L.C. Johnson, D.I. Tepas, W.P. Colquhoun, et al. (eds.), *Biological Rhythms, Sleep and Shift Work* (New York: Spectrum Publishing, 1981), pp. 347–356.

18 G. Hildebrandt, W. Rohmert, and J. Rutenfranz, "Twelve and twenty-four hour rhythms in error frequency of locomotive drivers and the influence of tiredness," *International Journal of Chronobiology*, 2 (1974), pp. 97–110.

Analysis

The mechanical condition of the train and the condition of the track infrastructure did not play a role in this occurrence. The analysis will focus on crew member familiarity with the territory, training and certification for management employees who operate trains, periods of reduced alertness when operating trains, and the mentoring of operating employees.

The occurrence

The occurrence happened when the train was operated past the east cautionary limits sign at Cranbrook, British Columbia, without the required clearance. The train continued to operate a further 5 miles into the occupancy control system (OCS) territory before being requested to stop by the rail traffic controller. Although the management crew members were qualified for their respective positions, they were not familiar with the territory.

During the train's approach to Cranbrook, the train crew had contacted the assistant trainmaster at Fort Steele, British Columbia, by radio. The assistant trainmaster informed the train crew that they were "OK on the main track through Cranbrook, all the way to Fort Steele." The train crew interpreted this statement as confirmation that the cautionary limits at Cranbrook extended all the way to Fort Steele. With an incorrect understanding of the boundaries of the cautionary limits at this location, the train crew's mental model was that no additional authority (OCS clearance) was required to operate on the main track all the way to Fort Steele.

Believing that no additional authority was required, the train crew proceeded past Cranbrook without contacting and requesting a clearance from the rail traffic controller.

Management crew familiarity with territory

At Canadian Pacific Railway (CP), management employees who are qualified to operate trains as conductors or locomotive engineers are permitted to perform a self-evaluation of their level of familiarity with the territory before operating the train. This self-evaluation would not necessarily require input and comments from a qualified trainer.

For train crew members, particularly locomotive engineers, familiarity with the physical characteristics of the territory is often considered essential information for the safe operation of trains. While it is important to have access to documentation on the territory (such as timetable and track profiles), this documentation is not sufficient to replace the need for knowledge of and experience on the territory.

Unlike operating employees whose primary job is to operate trains, management employees who operate trains on a part-time basis are not likely to gain the same level of experience and familiarity with the territory. This level of familiarity extends to knowing the limits of operating authority in advance (without requiring further confirmation from other operating personnel or the need to continually verify the limits using hard copy documentation). If railway management employees who operate trains are not familiar enough with the

territory, the limits of operating authority may not be consistently observed, increasing the number of occurrences and the associated risks of movements exceeding limits of authority.

Training and certification for railway operating employees

The regulatory requirements for the training and certification of railway operating employees are established in the *Railway Employee Qualification Standards Regulations* (SOR/87-150). The minimum qualifications established for locomotive engineers and conductors apply to all railway employees performing these duties, whether or not the employee is unionized. These regulations were enacted at a time when management crews were used only in the event of labour stoppages, and only managers with an operational background were used.

To mitigate disruptions to train operations due to crew shortages, qualified management employees at CP were being scheduled to operate trains. Initially, management employees with an operational background were required to maintain their operational certification and to be available to work as conductors or locomotive engineers. In 2012, CP expanded this program to include management employees with a non-operational background.

Before implementing the program, CP submitted its plan to Transport Canada, outlining the process for the training of management employees to be qualified conductors or locomotive engineers. The railway did not consider this training program for management employees (including non-operational managers) to be an operational change. Therefore, no risk assessment (as per the *Railway Safety Management System Regulations*) was conducted.

When comparing the 2 training programs, management employees were being provided with similar training content to that received by the full-time conductors and locomotive engineers. However, the management training program for conductors was typically shorter, as the on-the-job training component was about 2 weeks fewer. Management employees would also participate in fewer on-the-job training trips before obtaining conductor certification (a minimum of 20 on-the-job training trips versus about 73 on-the-job training trips for full-time conductors). The primary difference in the management training for locomotive engineers was that for management employees, there was no prerequisite regarding the number of years of experience as a conductor. For full-time conductors, a minimum of 2 years was required before training as a locomotive engineer could start.

With shorter training periods, fewer on-the-job training trips, and fewer prerequisites prior to starting training, it may be difficult for management employees to acquire the necessary knowledge and experience to become fully proficient with operating trains. For railway management employees who operate trains, if the regulatory framework does not adequately address the requirements for training, certification, and territory familiarization, trains can be crewed with management employees who are not sufficiently experienced or familiar with the territory, increasing the risk for unsafe train operations.

Train operations during periods of reduced alertness

Human beings are known to perform best when they are well rested and fully alert. In this occurrence, the crew members had obtained sufficient rest before reporting for duty. In the weeks before the occurrence, the conductor and the third crew member, who was on a familiarization training trip, had been working day shifts. The locomotive engineer had been working irregular hours as a supervisor. However, all 3 crew members considered themselves to have been sufficiently rested and alert. Fatigue research[19] shows that humans are poor judges of their own levels of fatigue and alertness. In addition, the research indicates that even people who are not fatigued can succumb to lower levels of alertness at certain times of day.

When operating a train, decisions and actions greatly depend on the crew's assessment and understanding of the operational situation. In this occurrence, the train was entering the cautionary limits at Cranbrook at about 0120, a time of day that is close to a known circadian rhythm low point when alertness can be compromised. At this location, train crews would typically assess the need for an additional OCS clearance to operate east of Cranbrook. The train crew did contact the assistant trainmaster at Fort Steele by radio and was informed that they were "OK on the main track through Cranbrook." The train crew misinterpreted this statement as confirmation that no additional OCS clearances would be required prior to Fort Steele. During periods of reduced alertness, such as low circadian rhythm, there is an increased risk of inadvertent errors, such as the misinterpretation of communications with other railway employees.

Mentoring of train crew members

The third crew member was on the train to gain experience and familiarity with the territory. Novice employees can gain this knowledge and experience by observing the physical surroundings and the actions of experienced employees. As specified in the *Railway Employee Qualification Standards Regulations*, one of the requirements for being an on-the-job training instructor for locomotive engineers is that the instructor should have at least 3 months' service in the area as a locomotive engineer to give on-the-job training.

In this occurrence, the circumstances were somewhat different, in that the employee gaining familiarization was a management conductor. However, the principle of requiring on-the-job training instructors to be experienced and familiar with the territory is valid. If employees who must gain familiarity with a territory are mentored by crew members who are not familiar with the territory, operational knowledge and experience will not be effectively transferred, increasing the risk that some employees will remain unfamiliar with the territory.

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[19] Maury Hill and Associates Inc., *Adaptive Safety Concepts: A Study of the Role of Human Factors in Railway Occurrences and Possible Mitigation Strategies* (August 2007), Section 4, "Summary of Effects of Fatigue on Performance."

Movements exceeding limits of authority

Between 2005 and 2015, there was a general increase in the number of occurrences involving movements exceeding limits of authority. This time frame includes a change in the *Transportation Safety Board Regulations*, as well as the addition of a stop signal alarm feature at CP's rail traffic control centres. Both of these changes occurred in July 2014.

This incident category captures a wide range of events, including Track & Engineering employees who are outside their limits of authority, as well as 439 (stop signal) violations where movements foul a signal bond (even by a short distance).

For any occurrence in which there is significant exceedance of limits, there is the potential for a catastrophic accident. If the number of occurrences involving movements exceeding limits of authority continues to increase, there is an increased risk of more serious accidents, such as collisions between trains or between track units and trains, leading to derailments, injuries, and fatalities.

Findings

Findings as to causes and contributing factors

1. The occurrence happened when the train was operated past the east cautionary limits sign at Cranbrook, British Columbia, without the required clearance. The train continued to operate a further 5 miles into the occupancy control system (OCS) territory before being requested to stop.

2. Although qualified for their respective positions, the management crew members were not familiar with the territory.

3. During earlier radio communications with the assistant trainmaster at Fort Steele, British Columbia, the crew had misinterpreted a statement as confirmation that the cautionary limits at Cranbrook extended all the way to Fort Steele.

4. With an incorrect understanding of the boundaries of the cautionary limits at Cranbrook, the train crew's mental model was that no additional authority (i.e., OCS clearance) was required in order to operate on the main track all the way to Fort Steele.

5. Believing that no additional authority was required, the train crew proceeded past Cranbrook without contacting and requesting a clearance from the rail traffic controller.

Findings as to risk

1. If railway management employees who operate trains are not sufficiently familiar with the territory, the limits of operating authority within the territory may not be consistently observed, increasing the number of occurrences and the associated risks of movements exceeding limits of authority.

2. For railway management employees who operate trains, if the regulatory framework does not adequately address the requirements for training, certification, and territory familiarization, trains can be crewed with management employees who are not sufficiently experienced and familiar with the territory, increasing the risk for unsafe train operations.

3. During periods of reduced alertness (such as low circadian rhythm), there is an increased risk of inadvertent errors, such as the misinterpretation of communications with other railway employees.

4. If employees who must gain familiarity with a territory are mentored by crew members who are not familiar with the territory, operational knowledge and experience will not be effectively transferred, increasing the risk that some employees will remain unfamiliar with the territory.

5. If the number of occurrences involving movements exceeding limits of authority continues to increase, there is an increased risk of more serious accidents, such as collisions between trains or between track units and trains, leading to derailments, injuries, and fatalities.

Safety action

Safety action taken

Canadian Pacific Railway

Following this occurrence, Canadian Pacific Railway (CP) initiated the following safety action:

- In May 2015, a number of yard tracks were removed at Cranbrook Yard, in Cranbrook, British Columbia, and this location was redesignated as a siding.
- In June 2015, the cautionary limits at Cranbrook were removed and the 2 subdivisions were combined to operate as one.
- In July 2015, CP formalized and posted minimum requirements for management crews, including familiarization, on CP's Operations Management Programs intranet site. These requirements were also emailed to qualified managers in the company.

This report concludes the Transportation Safety Board's investigation into this occurrence. The Board authorized the release of this report on 08 June 2016. It was officially released on 21 July 2016.

Visit the Transportation Safety Board's website (www.tsb.gc.ca) for information about the TSB and its products and services. You will also find the Watchlist, which identifies the transportation safety issues that pose the greatest risk to Canadians. In each case, the TSB has found that actions taken to date are inadequate, and that industry and regulators need to take additional concrete measures to eliminate the risks.