TSE Team Report

Osgoode Interlocking Incident Report

February 3, 2021

TRANSIT SYSTEMS ENGINEERING

Rail Transport Engineering

Introduction

Transit Systems Engineering is pleased to provide its report on the Osgoode interlocking incident, which occurred on June 12, 2020. This report is based on information provided by Toronto Transit Commission (TTC), a review of TTC project documents and discussions with TTC staff.

Transit Systems Engineering is a transit system consulting firm based in Emeryville, CA. This report has been compiled by the team consisting of Robert MacDonald, Dr. Nabil Ghaly and Paul Van Der Wel. The "TSE Team" has more than 80 years of train control experience.

Summary

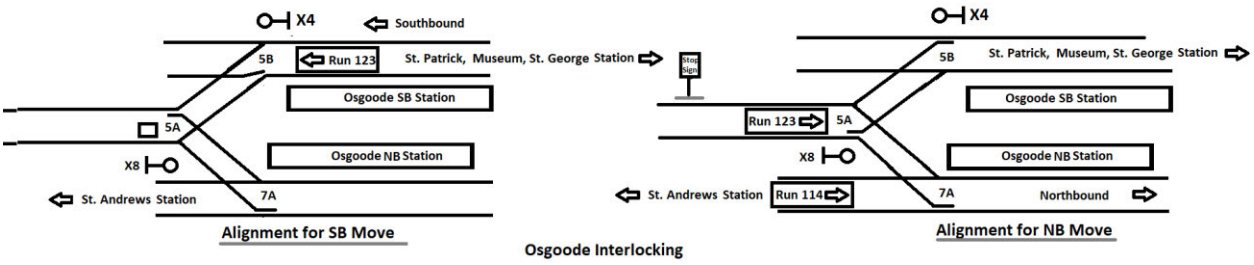
This report provides a summary of the events and circumstances, which led to the near miss incident that occurred at the Osgoode Interlocking on June 12, 2020. Further, the report identifies the factors that contributed to the incident and provides recommendations related to Line 1 ATC installation and operation.

Upon receiving a request from TTC to provide technical support for incident investigation and to assess the factors associated with the incident, the TSE Team held a number of meetings (conference calls) with TTC representatives and reviewed documents provided by TTC. The near miss incident occurred when a six-car train designated as Run 123 moved in manual mode northbound out of the Osgoode storage track without clear authorization, and nearly fouled revenue train Run 114 operating in automatic train control mode on the mainline track approaching Osgoode Station.

The preliminary investigation and analysis by the TSE Team concluded that a number of factors may have contributed to the incident. These factors include:

- Clarity of Operations Control Center (OCC) verbal instructions to the Trip 123 operators,
- Movement of train northbound Trip 123 without automatic train control system protection (GAMA Feature).
- Familiarity of the train operator with the northbound Trip 123 move with manual operation in ATC territories and understanding of the in-cab-display.
- Lack of flank protection (overrun protection) for mainline train operation at the Osgoode Interlocking.
- Familiarity of train operators with the in-service status and functionality of automatic train stops, and the use of legacy train movement instructions.

Resulting Investigation



The events leading up to this incident started on June 11th, 11.53 p.m. and continued to 12:10 a.m. June 12th, 2020, and are summarized as follows:

a. Run 114 northbound has a medical emergency at St. Andrew requiring the train be held for emergency services (the time to resolve emergency was unknown).
b. Operations Control Center radio calls to Run 126 at St. George southbound with instructions to unload at St. George and reverse direction.
c. Run 123 southbound instructed by Operations Control Center to unload passengers and reverse direction at Osgoode Pocket track. Run 123 was to return northbound to Osgoode platform in manual mode with Signal X8 favorable (i.e., Signal X8 displaying a clear aspect).
d. Run 114 reports the emergency is off the train and receives a clear signal northbound for service northbound from St. Andrews to Osgoode Stations
e. Operations Control Center instructed Run 126 at St. George to cancel request to reverse direction and return to normal service southbound at Museum Station.
f. The southbound motor-person (operator) of Run 123 accepts route to Osgoode pocket track southbound and stops before reaching the marked stop position. This leaves the rear of the train clear of the Osgoode interlocking limits. However, the train location prevented the northbound operator off Run 123 from clear sighting of Osgoode Interlocking Signal X8.
g. The motor person on Run 123 during the southbound move into the storage track now becomes the train guard located at the south end of the train. The guard, [redacted], during the move southbound now becomes the northbound motor person.
h. The facing point switch 5A, into Osgoode northbound, changes direction, as it is the other end of the southbound switch 5B for the move into the storage track; this is required for the next southbound move into Osgoode Station (this is this a normal condition).
i. Run 123 northbound motor-person [redacted] takes control of the Run 123 and watches switch 5A, the southbound end of the two switches required for the train northbound move to align for the Osgoode Station northbound track.
j. The second northbound switch 7A required to be in reverse position for a move into the station from Osgoode pocket track did not move because it was locked normal by the signal system for the approach of Run 114 entering Osgoode Station platform on the mainline.
k. Run 123 then proceeds out of Osgoode Pocket Track northbound in manual and without any clear communications with the Operations Control Center. The X8 signal protecting the Osgoode Interlocking northbound move did not change from its restrictive indication but was hidden from the northbound operator due to the position of the train.
l. The Run 123 motor person [redacted] applies the Emergency Brakes after a warning from the southbound end guard. At this time revenue service Run 114 passes by on the mainline at full authorized speed.
m. Run 123 came to a stop 5.8 meters before fouling revenue service Run 114.

n. Run 123 motor person backs the train into the Osgoode pocket track, without authorization. Transit Control Center contacts the train to ask the crew if the train had moved out of the pocket track; and tells the train operator to stop and stay.

Analyses & Recommendations

Following the above-described account, the TSE Team reviewed the video clip of the incident, voice recordings, written documentation associated with the near miss event, as well as the operating rules and procedures relevant to the incident. Based on this review, there appears to be several factors related to the to the automatic train control operating modes, along with documented changes to subway operations and signal protection, which could have caused confusion to operating personnel, and resulted in a violation to the normal operation of the Line 1 fleet. The following is the team's analysis and recommendations.

1. The northbound move of Run 123 out of the Osgoode pocket track into the main line was based on operating the train in Manual Mode within ATC territory. The safety of train operation during this Manual Mode is highly dependent on compliance by operating personnel – OCC Dispatchers and Train Operators (Motor Persons) – to relevant operating rules and procedures. Rules 20.5.1 & 20.5.2 require the train operator to receive authorization from the OCC before operating the train in Manual Mode. During this incident, while the initial direction given to the Run 123 crew was to operate in Manual Mode during the northbound move out of the pocket track, the TSE Team could not find a verbal authorization from the OCC to the Run 123 Train Operator to proceed from the pocket track to the main line. This is evidenced from listening to the voice recordings and reading the interview transcripts. Therefore, there are questions regarding the clarity of the instructions provided to the crew of Run 123, and compliance by the Train Operator with Operating Rules 20.5.1 and 20.5.2.

   Based on the interviews conducted, it is reasonable to conclude that central control instruction given to the Run 123 operators to move into and out of the Osgoode pocket track (turnback move) was not sufficiently clear or adequate for this situation. The TSE Team has been advised that the Osgoode pocket track is seldom used and that the manual mode of operation in ATC territory is not often utilized.

   Included in all TTC documentation, is a requirement for train operators to be directed by Transit Control (OCC) prior to any move in manual mode [redacted].

[redacted].

2. Based on the video "of near miss from TR 5601 Forward Cam" as provided, there appears to be no overrun protection at the Osgoode interlocking, which increased the operational risk for the northbound train 114 movement on the main line. The video shows that when Run 123 entered the interlocking and passed the axle counter and Signal X8 defining interlocking limits, Run 114 continued to move on the main line at full authorized speed, without a brake application when approaching the station platform. The normal route locking safety standard for unrestricted trains passing a restrictive signal and entering an interlocking is to put all signals protecting an established interlocking route to restrictive. Such protection, if implemented at Osgoode Interlocking, would normally have caused train 114 to immediately brake to a stop or at a minimum slow the speed prior to any fouling by Run 123. The video clearly shows that Run 114 proceeded at full authorized speed under ATC system control into Osgoode Station without any effort to stop or slow the train.

   At present, the TSE Team has no information related to the test procedures that were used to certify Osgoode interlocking for revenue service. Therefore, we have no ability to determine if route locking testing was checked when an approaching train was in manual. Also, it is not clear how the hazard associated with lack of overrun protection, which was exported by Alstom to TTC, was mitigated. [redacted].

3. There appears to be some confusion on the part of the northbound operator with respect to which equipment he should rely on to receive operational information necessary for a safe northbound move. Specifically, the relevant equipment for such northbound move includes Signal X8 (part of the wayside signal installation) and the in-cab display (part of the ATC system). The facts of this incident indicate that the northbound operator moved the train without checking the wayside Signal X8 and relied entirely on the in-cab display that provided a speed command without automatic train protection and without any information as to the availability of the necessary interlocking route for the move to the main line. The in-cab display provides speed limit information to the operator during the manual mode and whenever the stop command is not active. However, depending on the operational circumstances, the display of proceed information (in this case a restricted speed limit) may not be protected by the automatic train control subsystem (normally referred to as automatic train protection), which is not active in manual mode of operation. Therefore, Run 123 proceeding out of Osgoode pocket track with an in-cab

display that indicated a restricted speed limit was not protected by the automatic train control system. Based on the written interview, the northbound operator of Run 123 did not appear to know the difference between an in-cab display that provides limited information related to overspeed protection (manual mode), and an in-cab display that provides route information (including movement authority limit) with automatic train protection, when the train is in automatic train control mode. Therefore, based on the documentation provided the northbound operator of Run 123 appeared to proceed based on the in-cab display and unable to check the status of Signal X8 moved Run 123 out of the Osgoode pocket track to the main line.

[redacted].

4. The TSE Team is aware that one of the objectives of implementing an Automatic Train Control (ATC) System that is based on Communications Based Train Control (CBTC) technology, is to minimize the need for wayside signal equipment. [redacted]. All Toronto Transit Commission revenue trains have the vehicles equipped to interface with a wayside tripping device. The distance between Signal X8 and the fouling point for a northbound or a southbound mainline move is relatively short. The use of an equilateral switch at Signal X8 means that any train run operating out of Osgoode Interlocking in manual mode without following the stated rules for the manual mode move will be routed to a fouling condition for a northbound or Southbound move on the main line revenue track.

[redacted].

During the recorded interview with the tower controller, [redacted], on June 15, 2020, he stated that the Geographical Automatic Movement Authorization (GAMA) was always activated at Osgoode interlocking and that normal operation is for a train to enter the pocket track in "Manual," but exit from Osgoode interlocking is normally done in automatic train control mode of operation (i.e., with GAMA protection). Had GAMA been activated during the incident, the northbound Run 123 would have been protected by the automatic train control sub system referred to as automatic train protection. Therefore, the Automatic Train Control operating mode would had prevented the near fouling incident from occurring. The TSE Team was advised that due to the unique southbound geometry of the Osgoode pocket track, the GAMA feature was deactivated at that location. Further, the TSE Team observed that at the time of the incident, the OCC was dealing with at least three revenue trains to minimize the impact on service delivery. There are also comments from the tower controller interview regarding the workload and the number of qualified employees available at the OCC. [redacted].

[redacted]

5. Another factor identified by the TSE Team is based on statements in the Chief Supervisors' report, which states that the northbound motor-person saw the trip stop at the boundary of Osgoode interlocking clear. However, it was reported by Toronto Transit Commission that the trip stop was tied down and out of service. The TSE Team has concluded that the northbound motor person was confused related to the operational status of the trip stop and falsely believed that it cleared after the 5A switch moved to align the northbound move, indicating to him that it is safe to exit the pocket track into the main line. During discussions with TTC representatives, the TSE Team was advised that there are no unique markings or identifications for train operators to distinguish between trip stops that are out of service and trip stops that remain in service. [redacted]

   [redacted]

Conclusions

The TSE Team has analyzed incident data and documents received from TTC and summarized its findings and recommendations in this report. Since the Osgoode interlocking incident, TTC has published several operational notices with the intent to prevent the occurrence of similar incidents in the future. It is understood that the ATC project is placing a significant burden on its staff and that assistance in performing their assigned duties is a factor in the undertaking. Many of the requirements for the manual operation into and out of the interlocking have been documented in the information sources published prior to this incident – the question is how they are transmitted to the TTC staff and enforced on a daily basis. There is evidence from the interviews conducted by TTC that ongoing and rapidly changing operation to support the ATC project implementation, along with putting the new signal system into operation, may be placing difficult burdens and challenges on the TTC operating staff. Conducting service delivery tasks under such additional burdens and challenges could result in hazards to normal operation. The identification of these hazards is difficult due to the ongoing significant physical and operational changes to the signal system. The new ATC system is technically sophisticated and has a different architecture and supporting infrastructure. However, some of the traditional safety functions were not provided by the ATC system and were handled as exported hazards to TTC. The TTC operating staff is now tasked with managing service delivery and ensuring safety for all operating modes and operational scenarios. For these reasons, the TSE Team has recommended a Phase II study that is based on a quantitative fault tree analysis to identify and quantify operational risks. Phase II will focus on performing a functional comparison between the original fixed block wayside signal installation (base case) and the new ATC system based on CBTC Technology (ATC case). Further, Phase II will perform a review of TTC's operating rules and procedures and will recommend changes as appropriate. The main

objective of Phase II is to assess if the implementation of the ATC system has complied with the "Minimum Performance Requirements", i.e., that the new ATC system is as safe or safer than the previous wayside, fixed block signal installation. Once the Phase II analysis is published, the recommendation would be for the Authority to form an operations group to work with the TSE Team. During this collaboration, the operations group would be charged with a systemwide (Line 1) review of changes needed to complete the process of mitigating the identified hazards. It is further recommended that this group have a dedicated and consistent presence to assist in assuring the tasks associated with the Phase II study, as well as existing rules and regulations, are properly implemented.

Reference Information

1. *Rule Book*

   20.5 Manual (MAN) Mode Note: This section also applies to unequipped subway vehicles operating in ATC territory. OPERATOR

   20.5.1 Operate in MAN mode in ATC territory only if you have permission from Transit Control.

   20.5.2 While in MAN mode in ATC territory:

   • Do not proceed until authorized by Transit Control.

   • Operate no faster than 25 km/h.

   • Operate by line of sight, with extreme caution, and in accordance with wayside signals and markers. • Stop at all switches and crossovers. Check each switch to ensure it is set for the intended route.

   20.5.3 In non-ATC territory when operating in MAN mode, operate according to wayside signals and markers.

2. TTC YUS ATC Hazard Log Review

   03-Nov-2020

   A.Kalbasi, S.Cox

   TTCYUS-2.0-D-8-02-19 rev 1AB (draft received 30-Oct-2020).

   Manual Train Over-speed

   SRAC: U400-SRAC-0072 - For non-equipped trains and MAN Driving Mode, the Train operator is responsible of the train operation and shall respect basic signalling rules (including speed limit).

   Clarification: In ATC territory, MAN mode train speed is fully the Train Operator's responsibility. Train/work car can derail or exceed ATP protection. ATC cannot control the speed of a manual train except RMF mode.

Justification: Non-ATC train movement can only be under manual train movement procedures coordinated between Tower Controller and Train Operator.

3. Toronto Transit Commission Nov, 2020

   YUS ATC Project

   System Safety Management Report – Phase 3BE 3CE Passenger Service

   ATC-DOC-00119

   Alstom Hazard Log Rev 1AB (draft) supporting Ph3CE has been reviewed with comments and discussed with Alstom safety team. Resolution of some comments is deferred until after Ph3CE commissioning as they are not specific to Ph3CE. Additionally, a detailed review of the Alstom Hazard Log was undertaken to evaluate the degree of reliance on TTC operations and maintenance activities to mitigate hazards. This review found that the ATC system relies upon procedures and rules for the following types of activities:

   - Selection of train operating mode
   - Manual train operation
   - Entry of restrictions for ATC territory
   - Management of work zones
   - Management of rescues and emergencies
   - Correct installation and maintenance
   - Adherence to rules and procedures.

   One recommendation was raised as a comment in the formal DRF, that non-ATC trains will be detected by the ATC system (through a secondary train detection system) and the ATC system will prevent ATC trains from entering an area of track occupied by a non-ATC train. This change request is in progress and being tracked by CR atvcm01079750 “Additional flanking protections at sidings/pocket tracks”. Enlarged flanking block to enhance protection at Osgoode pocket track and similar locations is in place as an interim measure.