



## STAFF REPORT ACTION REQUIRED

### **Procurement Authorization Change Directive to the Toronto Rocket (TR) Supplier for the Design Provisions for Train Door Monitoring (TDM) System**

<b>Date:</b>	March 26, 2015
<b>To:</b>	TTC Board
<b>From:</b>	Chief Executive Officer

### **Summary**

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The TTC is in the process of modernizing its subway operations. In line with the modernization, the TTC's Five Year Corporate Plan includes the implementation of One Person Train Operation (OPTO). OPTO will be implemented on all subway lines, except Line 3 Scarborough Rapid Transit where this technology is already fully operational.

OPTO will be piloted on Line 4 with four car Toronto Rocket (TR) trains. The subway car operator cabs will require installation of a Train Door Monitoring (TDM) System to allow the operator to have a clear view of the platform and car doors from their seat, and relocation and modification of the door control system to allow the operator to safely open and close the doors. Engineering design is required for modifications to the TR train to facilitate the associated work.

Upon successful completion of the pilot project, the OPTO program will then expand to the remaining TR trains operating on Line 1. Following Line 1 installation, work will begin on Line 2 and the T1 trains.

A Change Directive to Bombardier Transportation Canada Inc. (Bombardier) in the amount of \$2,734,822.98, including taxes is required for the engineering design to facilitate the changes to the TR train.

## **Recommendation**

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### **It is recommended that:**

1. The Board authorize a Change Directive to Bombardier Inc. (Bombardier), in the amount of \$2,734,822.98, including taxes, for the additional engineering design to facilitate installation of TDM equipment and modification/relocation of door control systems on the TR trains for OPTO.

## **Financial Impact**

Sufficient funds for this expenditure are included in the \$2,914,000 approved for 2015 in Capital Project 4.16 – Subway Car Overhaul, under Work Order #6261 – Train Door Monitoring System – T1 and TR as set out in the 2015-2024 Capital Budget as approved by City Council at its meeting on March 10/11, 2015.

Sufficient funds are available for the pilot project on Line 4. Modifications to the remaining TR and all T1 trains for Lines 1 and 2 are unfunded. Sufficient funds will be submitted in the 2016-2025 Capital Program upon successful completion of the prototype TR train on Line 4.

The Chief Financial & Administration Officer has reviewed this report and agrees with the financial impact information.

## **Decision History**

In 2006, the TTC awarded a contract to Bombardier for the purchase of 39 TR train sets to replace the existing H4 and H5 subway vehicles that were approaching the end of their service life. Minutes of the meeting are available on the TTC website. Refer to agenda item 4 in the following link:

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2006/Sept 20 2006/Minutes/index.jsp](http://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2006/Sept_20_2006/Minutes/index.jsp)

Subsequently, the TTC accepted Option 1(B) in the contract for the purchase of 21 TR train sets to replace the H6 subway vehicles, which were also approaching the end of their service life, and Option 1(A) for the purchase of 10 TR train sets to support the Toronto York Spadina Subway Extension (TYSSE) program. Minutes of the meeting are available on the TTC website. Refer to agenda item 5b in the following link:

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2010/June 2 2010/Minutes/index.jsp](http://www.ttc.ca/About_the_TTC/Commission_reports_and_information/Commission_meetings/2010/June_2_2010/Minutes/index.jsp)

Subsequently, the TTC approved a purchase order amendment for the purchase of 10 TR train sets to meet existing service standards and future ridership growth. Minutes of the meeting are available on the TTC website. Refer to agenda item 5a in the following link:

[http://www.ttc.ca/About the TTC/Commission reports and information/Commission meetings/2014/April\\_30/Minutes/index.jsp](http://www.ttc.ca/About%20the%20TTC/Commission%20reports%20and%20information/Commission%20meetings/2014/April_30/Minutes/index.jsp)

Table A shows the Board approved authority for the Toronto Rocket Contract

Table A		
Item		Authorization
Original Contract	Base Order (39 Train Sets – H4/H5 Replacement)	\$ 674,787,602.52
	Option 1(A) (10 Train Sets - TYSSE)	\$ 162,708,071.30
Previous Amendments	Option 1(B) (21 Train Sets – H6 Replacement)	\$ 317,212,249.73
	ATC Integration (70 Train Sets)	\$ 34,784,863.92
	Spares, Special Tools and Test Equipment (Option 1(A) and 1(B) Train Sets)	\$ 28,000,000.00
	All Other Amendments (Design changes, etc.)	\$ 34,115,423.16
	Additional 10 Train Sets	\$ 216,788,870.00
Current Amendment	Design Provisions for Train Door Monitoring System	\$ 2,734,822.98
Total Authorization Amount		\$ 1,471,131,903.61

These amounts include all applicable taxes. Exclusive of base order vehicle price, all other vehicle pricing is prior to a one-time adjustment for foreign currency exchange rate variance and net project costs will include tax recoveries under HST from the contract authorized amounts.

## Issue Background

TTC subway trains presently on Lines 1, 2 and 4 are operated with a crew of two, both an operator and a guard. The operator is responsible for controlling the train's movement, watching for workers, customers, or obstructions at track level, and following the routing and timing of the signal system. The guard is responsible for customer movement while the train is stationary, opening and closing the doors of the train and ensuring that customers are clear of the train as it moves off from the station platform. Both members of the crew assist in resolving customer and/or equipment related incidents.

OPTO removes the need for a guard on the train. The use of OPTO will permit the operator duties to be safely expanded to include monitoring customers boarding and exiting the train, operation of the doors and assisting in resolving customer and/or equipment related incidents.

The safety of OPTO technology has been tested in a vast majority of subway authorities including but not limited to Paris, London, Chicago, Los Angeles, Montreal and Philadelphia. Furthermore, the TTC's own Line 3 SRT is OPTO. The adoption of this new technology on all subway lines at the TTC will not sacrifice the overall safety of the system and will allow the TTC to modernize and grow.

The TDM System permits the operator to have a clear view of all subway car doors while maintaining an unobstructed view of track level and signals ahead of the train. The TDM System is described below.

The TDM System consists of four strategically placed CCTV cameras that are installed on the subway platform to provide live clear video of all 24 train doors while the train is in the station. The video images are collected and transmitted by means of a wireless system to the subway train. Similar equipment is installed on each train to collect, process and feed the video images to a monitor in the operator's cab.

The monitor is installed in the operator's cab in such a manner that it does not obstruct the operator's view of track level and the signal system while considering ergonomics for the operator. The view on the monitor is split in four providing a live view from each CCTV camera on the subway platform.

The TDM System provides the operator with the ability to view the subway car doors from a forward facing position in the cab while the train is in the station and as the train is leaving the station. The operator will have the ability to discern objects or people caught in the doors. The system automatically turns on and off as the train enters the station and does not require any action by the operator to operate.

Engineering design is required for modifications to the TR train to accommodate the TDM System.

For OPTO, the operator must also be able to operate door controls that open and close the doors from the operator's seat. Door control buttons are presently located on both sides of the cab for the guard in a location that requires the guard to stand and look out the window to observe the subway car doors. The door control used by the guard depends on which side of the subway the platform is located. Consequently, the door control system must be modified and relocated in the cab to an ergonomic position that can be easily operated from the operator seat.

Engineering design is also required for modifications to the TR train to accommodate the door control system for OPTO.

Once Bombardier completes the engineering design a proposal will be requested from Bombardier for installation on one prototype TR train for testing.

Line 4 Sheppard Line was selected as the pilot for the OPTO concept because there are only 4 trains operating during customer service hours.

The T1 trains presently operating on Line 4 will require replacement with TR trains that are Automatic Train Control (ATC) equipped prior to implementation of ATC on Line 1 YUS in 2020 because access to Line 4 is from Line 1. The required conversion of a six car TR train to a four car train for the OPTO pilot will be the subject of a future Board report.

To implement the new OPTO technology on all subway lines, a Concept of Operations is being developed to provide a road map for all customer service issues, safety issues, stakeholders and interdependencies to ensure a safe and efficient subway operation. The issues addressed include the management of emergencies, system related delays to service, subway station incidents, emergency alarms, communication by public address with customers on the train, training, live exercises and safety of workers at track level. The Concept of Operation will include evaluation criteria for acceptance of each issue prior to implementation into customer service.

Upon completion of the design for the TDM and door control modifications, approval will be obtained to modify one TR train as a prototype. Upon completion of the modifications, testing of the TDM equipment and door controls will take place followed by evaluation processes as prescribed by the Concept of Operations. It is planned to have one TR train available for service in OPTO by the end of 2015.

The associated cost savings and increases related to OPTO will be available at that time for development of a business case for roll out of OPTO for the remaining 3 trains on Line 4 in 2016 and for submission of the 2016-2025 Capital Program for roll out of OPTO on Lines 1 and 2.

## **Accessibility Issues**

Although the recommendations have no accessibility ramifications, active consultations with the Advisory Committee on Accessible Transit (ACAT) will be continued.

## **Comments**

The TR trains do not have provisions for installation of the TDM System or relocation/modification of the door control system. A significant amount of structural work, electrical work and software changes are required in the TR train.

Specifications for the TDM System were tendered in early 2015. As a result of information received from the potential suppliers, TTC staff has been able to determine the on-board installation requirements for the TDM System equipment. In addition, TTC staff has developed the concept of work for relocation and modification of the door control systems.

Bombardier is the Original Equipment Manufacturer (OEM) for the TR trains. A Request For Quotation (RFQ) was prepared and issued to Bombardier for the engineering design of the necessary provisions on the TR trains to accommodate the OPTO concept. The design will include mounting details, structural modifications, panel and dashboard modifications, wiring systems, and software modifications.

TTC staff evaluated Bombardier's quotation and sought clarification from Bombardier for both technical and commercial issues. Bombardier subsequently responded with a revised quotation in the amount of \$2,734,822.98. TTC staff has evaluated this quotation and consider it both technically and commercially acceptable. The costs for this design have been verified by the TTC as reasonable for the level of effort required in completing the change and all rates have been verified per the contract documents.

Without the design expertise of Bombardier (OEM) of the TR train, it would be very difficult, costly, and time consuming to determine the required space, install the required wiring and mounting facilities, and to make the necessary electrical circuit changes. This engineering design will allow for a simple and expedient installation of the TDM equipment on the pilot TR train and for future fleet rollout. This will also result in reduced costs, increased availability of the TR trains, and minimized disruption during the future TDM installations beyond the pilot.

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# ONE PERSON TRAIN OPERATION

**Mike Palmer**

**Deputy Chief Operating Officer**







- **Definition of one person train operation**
- **Best practice world wide**
- **Benefits**
- **Concept of operations**
- **Impact on people and assets**
- **Timelines and milestones**
- **Current status**
- **Safety concerns**
- **Next steps**
- **Post introduction of OPTO**





**One Person Train Operation (OPTO) is a technological change and modernizing step that removes the need for a guard on the train and permits the driver of the train to become a Train Operator - responsible for the safe driving of the train, operational incidents, operation of the train doors and train door monitoring on departure**



# JUSTIFICATION FOR CHANGE



- Technology has developed so that one crew member can safely drive the train AND operate door controls;
- The vast majority of subway authorities operate trains with a single crew member including
  - Paris, London Underground , Chicago, LA, Montreal, Hong Kong, Berlin, Lisbon, Madrid, Glasgow, Stockholm, Bangkok
  - Recent conversions to OPTO include Philadelphia and London Overground
- Notable exceptions include New York and Toronto
- NO subway has reverted back to two person operation on the grounds of safety





## London

- **First ATC/ OPTO – Victoria line 1968**
- **First manual train/OPTO - Piccadilly Line 1987**
- **Last OPTO line– Northern line completed 2000**

## Chicago

- **Yellow line - OPTO since opening in 1964**
- **Full conversion to OPTO of full system in 1998**

## Boston

- **Started in 1996 (Blue line) and finished in 2012 with the Red line**





## London Overground

- **60% of the network was already OPTO**
- **Conversion of an additional line to OPTO in 2013 prompted a strike by the RMT union claiming customer safety would be compromised**
- **Verified statistics from Transport for London**
  - OPTO lines had one door related incident for every 7m passengers
  - Conventional lines had one door related incident for every 4m passengers
- **OPTO introduced after strike**



# AND CLOSER TO HOME



The SRT (line 3) has operated safely with One Person Train Operation since its opening in March 1985.





- **Huge potential for long term savings**
  - Line 4 pilot facilitates rollout to lines 1 & 2 at a later date
- **Safer Guarding**
  - Clearer and more comprehensive view of platform (3 views)
  - Full benefits realized at ATC introduction when driving workload further decreases
- **Reinvestment into improved efficiency**
  - TTC increasing station staff presence
  - Incidents managed as efficiently with station based support
  - Safety of employees and public not sacrificed
  - Future service improvements require no new hires
  - Crewing of each train is simplified ie only one person needs to be allocated or found in advance or on the day





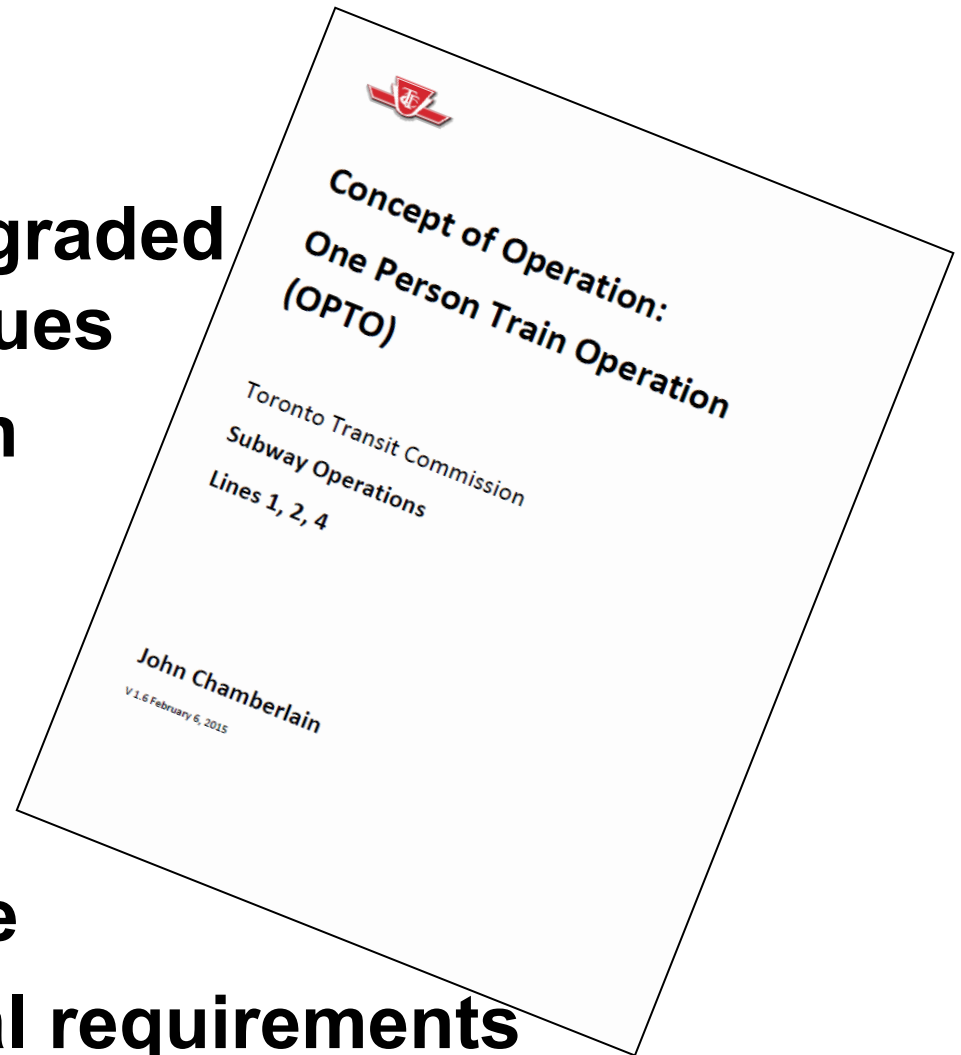
**Train crew reductions from 2 to 1 person operation will be accommodated through**

- **Attrition – retirements and resignations**
- **Transfers and promotions within the TTC**
- **Future service improvements**
- **Increasing station staff presence**





- Roadmap of OPTO
- Identify normal, degraded and emergency issues
- Tabletop simulation OPTO concepts
- Issues and interdependencies identified
- Stakeholder involve
- Driven out technical requirements
- Foundation of rule book changes





- **Safety/Emergencies**

- Train/platform safety interface
- Train evacuation
- Operator rescue
- Fire and smoke exposure
- Defective train

- **Communication**

- Customers
- Transit control

- **Rules & Procedures**

- Subway rule book

- **Station Incidents**

- Stations support
- Emergency alarm/door issues
- Delay management

- **Crewing**

- Turnaround time
- End of line/turnbacks

- **Training**





- **Station Staff**

- Increase in deployment of station staff
- Training
- Delay minimization

- **Wayside Equipment**

- CCTV on platform
- Wireless connection to train

- **Tunnel Ventilation**

- Upgrade
- Repair

- **Track Level Safety**

- Station departure zone
- Track workers present





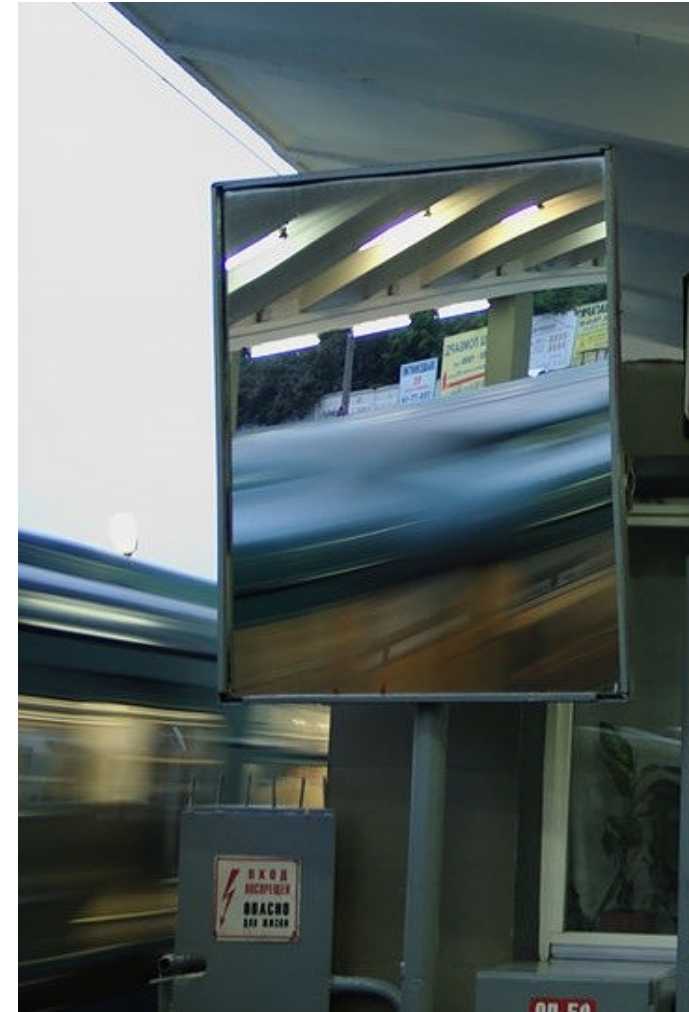
- **Converting an older T1 train which has a smaller cab and is more basic in technology is complex, more expensive and takes longer**
- **4 Car TR Trainsets on Line 4 - Shepherd**
  - Fastest way to introduce OPTO
  - Increases capacity by 5% on the line with no extra trains
  - Cost savings in crew and maintenance training on lines 1 and 4 (1 train type)
  - ATC in 2019 means access to Line 4 from Line 1 will be via ATC signalling. Better to address the issue now and once only
- **Trainborne Upgrades**
  - Operator desk door controls
  - Platform to train CCTV
  - Correct side door enable (prevents wrong side door opening)





## USE OF MIRRORS

- One view
- Train alignment needed
- Early technology
- Not TTC option



# CONVERSION OF AN OLDER TRAIN



- **Less space**
- **No space in cab for CCTV monitors**





## 96TS – Jubilee line

- Purpose built for OPO
- Multiple CCTV views
- Departure monitoring
- Preferred TTC option



# BOMBARDIER LU – OPTO TRAIN







- **Line 4 Rollout 12/31/15**

- CCTV Development
- Wireless Development
- 6 to 4 Car TR Train mods
- Procedures and Rules
- Safety certification
- Safety assurance

- **Line 1 Rollout**

- Lessons learnt on Line 4
- CCTV/Wireless Install
- 6 Car TR Cab Modifications
- Programme to be developed

- **Live Exercises 2015**

- Evacuation from train
- Driver Collapse / Rescue
- Disabled Train Recovery
  - 8 car push out
  - Rear Cab operation
- Smoke Resilience

- **Line 2 Rollout**

- Too soon to determine staging/exploring synergies
  - ATC vs. OPTO vs new rolling stock
  - One joined up solution



# CURRENT STATUS



- **CCTV Wireless design complete - platform to train**
- **CCTV camera installation on Line 4 is complete**
- **TR trainset #61 was delivered as a 6 car train and will be converted to a 4 car train**
  - Subject of future board paper
- **Consultation with union Local 113**





- **No evidence world wide where OPTO is in operation of an increased safety risk**
- **We are working with CoMet for historical and current OPTO safety statistics and performance**
- **We already have OPTO here at the TTC**
- **Training, People or Equipment to mitigate**
  - Customer incidents with the train / platform interface
  - Driver illness / rescue
  - Fire and smoke exposure
  - Detrainment / tunnel evacuation
  - Train recovery due to defect





- **Engineering design to modify TR cabs (this report)**
- **Modify 6 x 4 car TR trains**
- **Install Train Door Monitoring (TDM) equipment**
- **Develop rule book changes and training**
- **OPTO Trial Operations**
  - Normal/Abnormal/Emergencies/Failure Modes
  - Development of SOP's; Contingency Plans
  - Provides validation of SRB and employee training
  - Include live exercises ie evacuation, smoke incident





- **Post Introduction Review of Line 4 pilot**
  - Lessons learnt, SRB validation, technology suitability
- **Development of business plan for Line 1**
- **Line 1 implementation modified as required as the result of the Line 4 pilot**
- **Line 1 technical preparation and employee training**
- **Line 2 – Work through the issues of ATC and T1 replacement alongside OPTO to determine the most cost and time effective means of migration**

