Region of Waterloo
Stage 1 Light Rail Transit Project

Design and Construction Performance Output Specifications
Article 9
Intelligent Transportation Systems

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ARTICLE 9 INTELLIGENT TRANSPORTATION SYSTEMS

9.1 General

(a) The purpose of this Article is to provide design guidelines for Intelligent Transportation Systems to be provided for the Project. Project Co's solution to Intelligent Transportation Systems shall expand on these guidelines. Project Co shall prepare a Basis of Design Report – Intelligent Transportation Systems (ITS) with ITS equipment specifications and concept level drawings and block diagrams, which explain Project Co's approach to ITS design work in greater detail and in a site specific manner. The presentation of specific ITS design requirements within this Article must not be construed to limit or modify in any way Project Co's responsibility to provide a holistic, comprehensive, and fully functional solutions to all ITS configurations. The Basis of Design Report – Intelligent Transportation Systems (ITS) shall address every aspect of the ITS design requirements cited in this Article. The rationale for all deviations or variances from any requirement cited in this Article must be fully described in the Basis of Design Report – Intelligent Transportation Systems (ITS).

(b) ITS uses technology and innovative solutions to provide a safe and efficient surface transportation network for travelers, transit operators and emergency personnel.

(c) The Waterloo Stage 1 LRT Project will utilize ITS solutions to monitor and manage the LRT corridor and Light Rail Vehicles (LRV), and provide additional services to passengers making their trips more reliable, convenient, and secure. In addition, the traffic network surrounding the LRT corridor will be managed with respect to the traffic signal operations at intersections.

(d) The ITS solutions for the LRT system will be integrated with existing and planned Region ITS systems to provide a seamless operation.

9.2 References

(a) The following list of standards, specifications and guidelines shall be referenced during the design and/or construction of the Project as appropriate and relevant. Project Co shall be responsible for ensuring all required designs and construction practices concur with local standards, laws and regulations.

(i) MTO Contract Design, Estimating and Documentation Manual

(ii) Ontario Provincial Standards

(iii) Ontario Electrical Safety Code

(iv) Electrical Engineering Manual, MTO

(v) Ontario Engineering Manual, MTO

(vi) Roadside Safety Manual, MTO

(vii) Ontario Traffic Manual

(viii) Accessibility for Ontarians with Disabilities Act (AODA)

(ix) National Fire Protection Association (NFPA) 731: Standard for the Installation of Electronic Premises Security Systems

(x) US Department of Transportation: Transit Security Design Considerations

(xi) American Public Transportation Association (APTA): Recommended Practices for Security Infrastructure

(xii) Region of Waterloo Grand River Transit Fare Collection Strategy and Policy

(xiii) Region of Waterloo ITS Strategic Plan (2013 – in progress)

(xiv) APTA Technical Recommended Practice for The Selection of Cameras, Digital Recording Systems, Digital High-Speed Networks and Train-lines for Use in New Transit-Related CCTV Systems (APTA IT-RP-001-08)

9.3 Intelligent Transportation Systems Architecture

(a) The Canadian ITS Architecture is defined by Transport Canada. It is intended to provide a common ground for the planning and designing of ITS. The ITS architecture defines the functions, physical entities, subsystems and the communication links between the systems, which come together to form an integrated transportation system.

(b) The Canadian ITS Architecture shall be used as the Basis of Design work for the Project. Exhibit 9.3-1 shows the anticipated ITS architecture and the interconnects for the Stage 1 LRT Project. It represents a high level physical architecture that relates Travellers, Centres, Vehicles, and Wayside.

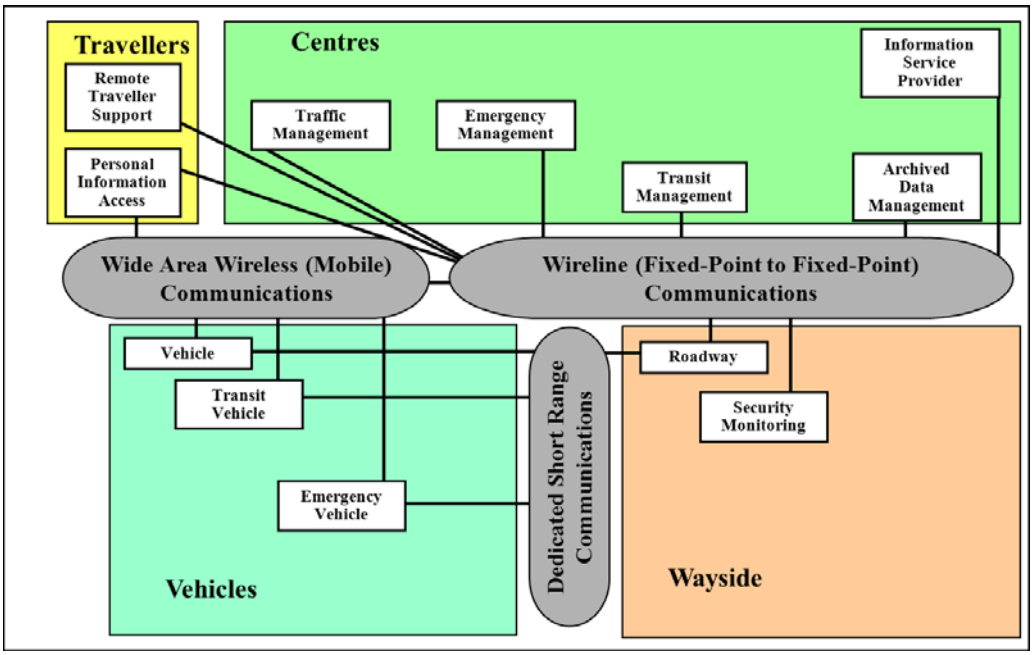


Exhibit 9.3-1 Project ITS Architecture

(c) The ITS system shall follow the Systems Engineering Process. The International Council on Systems Engineering (INCOSE) defines Systems Engineering as "an interdisciplinary approach and means to enable the realization of successful systems." Customer needs and functional requirements shall be identified early in the development cycle with documentation, and then proceeds with design synthesis and system validation while considering the complete problem. A structured development process is formed for all involved disciplines to work together as a team to deliver a system or project from concept to production to operation. The system engineering

process shall consider both the business and technical needs of all customers with the goal of providing a quality product that meets the user needs.

In general, systems engineering is a systematic process that includes reviews and decision points intended to provide visibility into the process and encourages stakeholder involvement. The "V" model, as shown in Exhibit 9.3-2, has been widely adopted as the standard representation for system engineering process and the design of ITS system shall follow this approach. This process is driven by design requirements and testing, and all design elements and testing shall be traceable to the requirements themselves. This process ensures that everything necessary for the design/system is successfully accomplished and shall prove to be cost effective.

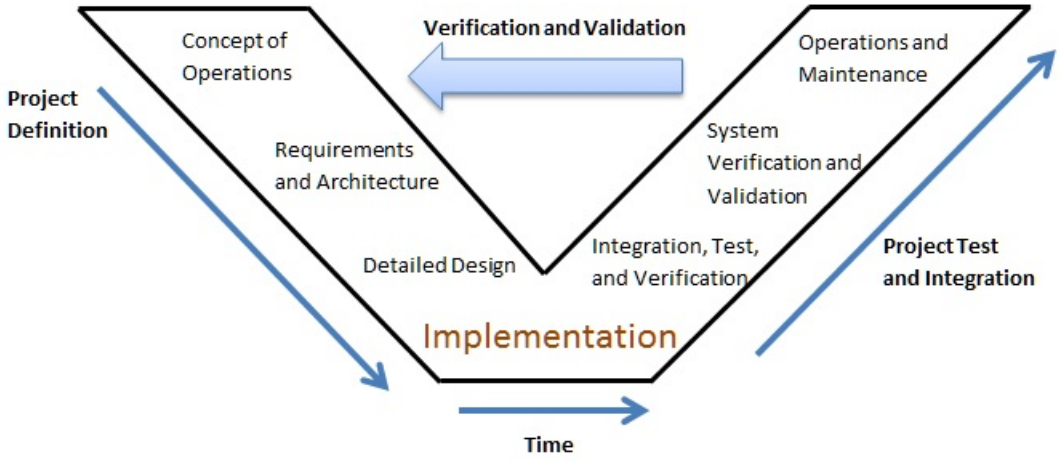


Exhibit 9.3-2 "V" Model for Systems Engineering Process

9.4 ITS Systems for the Project

(a) The Project ITS design shall include the following systems:

(i) Transit Management Systems

(ii) Traffic Signal Control/Transit Signal Priority (TSP) Systems

(iii) Transit Security

(iv) Passenger Assistance Intercom

(v) Fare Collection

(vi) Communication Systems (see Schedule 15-2 Article 10 for additional information)

(vii) Control Centres

(vii) Power Supply System

(ix) Advanced Traveller Information System (ATIS)

(b) Unless otherwise indicated, Project Co shall be responsible for the design, supply, installation, commissioning, operation and maintenance of a fully functional ITS system as outlined in this

Article. Project Co shall be responsible for the supply of all equipment, software licenses, permits, and the initial system configuration and data to enable the operation of the ITS system upon revenue service.

(c) All ITS systems must comply with AODA standards and regulations.

(d) On-board ITS systems mentioned in this Article may require integration into, or interface with, the LRT vehicle systems and close co-ordination with the Region's Light Rail Vehicle (LRV) supplier will be required to successfully implement such systems.

9.5 Transit Management Systems

(a) The main purpose of the LRT Transit Management System (TMS) is to provide operators with visibility and control over the fleet, and provide drivers, passengers, and other systems with vehicle and scheduling information. A typical TMS system consists of subsystems which track vehicle location, inform passengers, manage and control on-board components, and collect passenger and vehicle data.

(b) The on-board Transit Management Systems, unless indicated otherwise in the Articles, will be provisioned with the vehicle to be provided to Project Co for revenue service. For details regarding the systems included and their functionality, please refer to the light rail vehicle performance specifications in Schedule 15-2 Article 5. The following TMS subsystems will be included in the LRV:

(i) Passenger Information Systems – Consisting of Variable Message Sign (VMS) displays and a public address system used for next stop announcements.

(ii) Automated Passenger Counting System - Counts the number of passengers entering and leaving an LRV for schedule and route planners.

(iii) Train-to-Wayside Communications – To provide a data communications link between the on-board systems, wayside equipment, and the control centre facility.

(c) Project Co shall provide an Automatic Vehicle Location system to allow all LRVs to be tracked in real-time at the CCF. This system may be provisioned as a standalone system, or as a function of other systems to be provided by Project Co as part of the Waterloo Stage 1 LRT Project. The system shall be capable of accommodating all additional vehicles envisioned for the LRT fleet without any degradation in vehicle tracking performance.

(d) The off-board TMS components at the LRT platforms shall be provided by Project Co and shall include variable message signs for passenger information. The displays shall inform passengers of next train arrival times per direction of travel. These displays shall also be used by Control Centre Operators to convey messages and emergency management information.

The following are general requirements:

(i) VMS displays shall be placed at every LRT platform.

(ii) VMS displays shall be clearly visible by passengers boarding the vehicle and purchasing tickets

(iii) Signs shall be weather proof, visible and functional in all harsh weather conditions

(iv) Provide real-time transit arrival/departure time information, up to the nearest minute

(v) Allow for user or central system initiated messages to be displayed on the VMS signs.

For Project Co's information, existing GRT variable message signs at select stops and terminals in the Region are provided through the INIT transit management system. These signs display route and next bus arrival/departure times.

(e) At all LRT platforms Project Co shall provide power and communications provisions to support the deployment of GRT's digital information displays. Digital displays have been deployed by GRT at select bus terminals to provide departure times for intersecting bus routes, transit service information, and weather information. At each LRT platform Project Co shall provision for:

(i) Mounting of a 42" digital display

(ii) Connection to 120 volt, 15amp power supply, conduits and cabling

(iii) Ethernet based communication cables and conduit terminated at the communications cabinet at the stop

Digital displays, where required, will be provided by the Region. The design and integration of the digital displays at each stop shall be coordinated with the Region during the design phase.

(f) System Operations

(i) The on-board TMS system will be provided by the vehicle supplier. The off-board TMS subsystems shall be designed and installed by Project Co. Project Co shall operate the entire TMS system. The Project Co's operators shall be located at the Central Control Facility (CCF).

(ii) Project Co shall be responsible for a fully functional TMS integrating the on vehicle systems and the control centre systems.

(iii) The TMS system and its operational relationship between the CCF and the GRT Control Centre (at the Strasburg facility) is discussed in the Transit Control Centre section of this Article.

(iv) Project Co is responsible for the collection, processing (for reporting purposes), and storing of all transit management system related data.

9.6 Traffic Signal Control/Transit Signal Priority Systems

(a) A traffic signal control system involves the efficient operation of traffic signals in a coordinated manner to meet the traffic demands at intersections along a defined corridor. The traffic signal control system shall provide Transit Signal Priority (TSP) operations suitable for the LRT service with a primary objective of optimizing LRT progression through signalized intersections by applying TSP strategies to signal timings in favour of the LRT operation. The Region is currently standardized upon Econolite ACS/3 traffic signal controllers on street. Econolite controllers are the preferred controllers for the LRT corridor. Signal pre-emption for emergency vehicles within the Region is currently established through an EMTRAC priority management system.

(b) Functional Requirements:

(i) Central Traffic Signal Control System

1. Project Co shall supply, install, test, and commission a centralized traffic signal control system in the Region for the purpose of managing traffic signals, and TSP operations, along the LRT corridor. Project Co may also submit an innovation submission to enhance the Region's existing Fortran T2000/Fastracs system in addition to the base proposal. At a minimum the system provided shall:

I. Include all system servers, communications equipment, UPS, one IT rack, and wiring for a fully functioning system.

II. Include two workstations in the control room for system operators.

III. Be capable of monitoring all signalized intersections along the LRT corridor in real-time.

IV. Be interconnected to all traffic signal controllers along the LRT corridor via the fibre optic network.

V. Utilize GPS and Network Time Protocol for time clock synchronization. The Region will specify the preferred method during design.

VI. Be able to manage fully actuated, semi-actuated, and fixed time traffic signal operations

VII. Be NTCIP compliant

2. A centralized traffic signal control system capable of monitoring and managing an advanced network based TSP system is preferred.

3. The traffic signal control system shall be operated by the Region. All central system equipment shall be located at the Region of Waterloo Traffic Control Centre located at 150 Frederick Street.

(ii) Transit Signal Priority (TSP) System

1. Project Co shall provide an advanced network based TSP system. This system shall allow LRVs to be consistently served without significant delay to general traffic at signalized intersections.

2. TSP algorithms and operations may be integrated within the traffic signal controllers located at signalized intersections, or within a centralized management system.

3. TSP requests would be received by traffic signal controllers on the LRT route, or within the central management system, for modeling and preparation of appropriate TSP strategies at approaching and downstream intersections. Downstream traffic signal controllers shall effectively prepare and reallocate green time to the respective phases to allow the LRV to progress through the intersection on a green signal without an unnecessary amount of delay.

4. The key functional objectives of the TSP system are to:

I. Maintain the same green time to general traffic phases over a limited number of cycles

II. Maintain actuated phases and minimum durations

III. Maintain minimum pedestrian walk and clearance times

IV. Maintain emergency vehicle and/or train pre-emption calls

V. Provide when possible, a green band for LRVs in both directions of travel

5. The advanced network based TSP system shall generally feature a series of upstream detection points for each signalized intersection (i.e. detection at two

intersections upstream and/or at midblock points depending on the proximity of adjacent intersections), and a library of TSP strategies of which the appropriate strategy is selected by an advanced algorithm and applied to the signal timings based on the LRV's progression along the approach. Strategies shall include, but not be limited to, the following:

I. Green Extension – the green signal indication is extended beyond its normal termination point, which provides the opportunity for the transit vehicle to advance through the intersection without having to wait the successive cycle;

II. Early Phase Activation/Red Truncation – the opposing phases are reduced to a minimum duration, providing an early return of the green indication to the transit phase;

III. Special Transit Phase – this strategy includes the introduction of a LRT signal phase which will only be called when a transit vehicle is detected;

IV. Phase Rotation – the sequence of signal phases is rotated to provide TSP. For example, a northbound left turn phase could normally be a lagging phase such that it follows the opposing thru signal phase. A transit vehicle that arrives before the start of the green phase for the thru movement could request priority for the left turn phase. For the phase rotation concept, the left turn phase could be served as a leading phase such that it precedes the opposing thru phase.

6. The advanced TSP algorithm shall generally operate as follows:

I. The procedure is activated by a LRV arrival at the first transit detection point for a particular signalized intersection. Within corridors where the signalized intersections are spaced close together, the first detection point may be two intersections in advance. The system conducts an identical procedure, as outlined below, at subsequent detection points. Such upstream detection shall provide the LRT location input necessary for the traffic signal control system to better "ready" the signal operation at the subject downstream intersection in an advanced preliminary manner in order to provide a more optimized response once the LRT vehicle enters the subsequent road section.

II. For each priority strategy plan within the library, and in consideration of the existing traffic signal timing, the prediction model estimates the transit travel time to the stop line at the designated intersection.

III. At locations where the LRV passes through closely spaced signalized intersections, the prediction model may deliver different transit travel times for each priority plan selected at downstream intersections.

IV. At a designated detection point along the approach, the priority plan that is expected to best serve the LRV with minimal delay, and with minimal impact to traffic, is implemented by the traffic signal controller.

V. Subsequent detection points along the approach after the plan is initiated within the traffic signal timing operation are used to verify the expected progress of the LRV. TSP plans are augmented if absolutely necessary based on the LRV's progress.

VI. Once the LRV has cleared the designated signalized intersection, the advanced TSP algorithm returns to standby status as the final step.

VII. In addition to the operation outlined above, the TSP operation shall:

(a) Ensure that signal coordination along the primary corridor is maintained.

(b) Manage the provision of TSP service between competing calls to first serve the prioritized vehicle that is behind schedule.

7. Selective vehicle detection for LRVs shall feature radio based technology capable of predefining detection zones and providing full range tracking coverage if necessary. Project Co shall ensure that the LRVs shall be equipped with the proper on-board devices for transmitting TSP priority requests; which may require further coordination with the vehicle supplier for the seamless integration of the devices. The TSP system design shall be coordinated with the functional requirements provided in Schedule 15-2, Article 8, to provide for a seamless, efficient, and cost effective design.

8. Project Co shall ensure that the TSP system features a fail-safe mode if there is a failure of the radio based selective detection technology. Fail-safe operations may feature local TSP operations operating in a more simplistic manner.

9. In the occurrence of special events and track maintenance, reverse running LRT operations are required. The TSP system shall be functional under these situations, and shall be capable of recognizing the vehicle's direction of travel during these operations. Under these situations, an advanced network based TSP operation, as defined above, is not required.

10. Project Co shall ensure that a client-acceptable microsimulation modeling is conducted to verify that the LRT operations, along with the proposed TSP system, are fluid without adversely impacting off alignment traffic operation. The microsimulation model shall also be used to optimize the configurable parameters of the TSP operation.

(iii) Traffic Signal Control Field Equipment and Provisions

1. All signalized intersections shall be redesigned to suit the new intersection geometric designs and any required temporary intersection designs during construction.

2. MTO and Region traffic signal design standards shall be applied as appropriate.

3. Project Co shall be responsible for the provision of all permanent and temporary PHM-125 drawings and traffic signal timing plans.

4. Traffic signal timing plans shall be reviewed and updated by Project Co after the initial revenue service operation to optimize the signal timing plans for actual traffic conditions. Traffic counts shall be undertaken by Project Co and timing plans adjusted accordingly. The traffic counts shall be undertaken within one year after the initial revenue service operation of the LRT.

5. All traffic signal controllers shall be interconnected with the centralized traffic signal control system.

6. Traffic signal operations shall be integrated with the transit signal priority system.

7. Day-to-day operation of the traffic signals will be undertaken by the Region.

8. All traffic signal control equipment and provisions at signalized intersections shall be new. Equipment to be salvaged and returned to the Region as defined in Schedule 15-2, Article 18, Section 18.16(d).

9. Profile Drawings for the track alignment and intersection geometry are included in the Appendix I for reference. Project Co is responsible for verifying the information and for accounting for any anticipated changes during Design, Construction, Testing and Commissioning, and Revenue Service.

(c) System Operations

(i) The system will be operated by the Region.

(d) System Maintenance

(i) The system will be maintained and serviced by the Region.

9.7 Transit Security

(a) The purpose of the transit security system is to provide a safe environment for transit patrons and transit operators both on-board and off-board the LRT system. The transit security system will also protect transit vehicles and transit properties through surveillance monitoring.

(b) Functional Requirements:

(i) Provide a central management system for security related devices and functions at the OMSF. The Region of Waterloo Security Control Centre at the Strasburg will have a work station, with full user privileges, to access security related information and data from the OMSF.

(ii) Review any existing security analysis/research previously performed to address specific security needs and determine how they can be incorporated into the design.

(iii) For On-board Security Systems, refer to the Vehicle Specification in Schedule 15-2 Article 5. On-board security systems will include the following subsystems:

1. CCTV Monitoring and Recording

2. Passenger Assistance Intercoms

3. On-board Public Address Systems for Emergency Use

4. Passenger Alarm Strips (Distressed Alarm System)

5. Vehicle Operator Covert Emergency Alarm

(iv) Closed Circuit Television (CCTV) cameras are used to provide general monitoring capabilities both on-board LRVs and at LRT platforms. CCTV cameras shall be placed in strategic locations to provide full coverage, specifically concentrating on sensitive areas. Sensitive areas for on-board LRVs may include LRV doors used for boarding/disboarding, LRV operator area, and Priority Seating Areas. For LRT platforms, sensitive areas may include inside shelters, LRV boarding/disboarding areas and Ticket Vending Machine Areas.

1. On-board CCTV monitoring is discussed in Schedule 15-2 Article 5 under Vehicle Specifications.

2. Off-board CCTV cameras at LRT platforms shall provide coverage for the entire platform specifically around Ticket Vending Machine areas and Passenger Assistance Intercoms. LRT platform CCTV cameras shall adhere to the following requirements:

    I. A minimum of 4 CCTV cameras shall be required for off-board monitoring at LRT platforms

    II. 1 CCTV camera shall be dedicated for monitoring the areas around TVMs.

    III. At least 1 additional CCTV shall be required for monitoring inside the transit shelter and Passenger Assistance Intercom area.

    IV. 2 additional CCTVs shall be required for general monitoring of the rest of the platform.

    V. Cameras shall be fixed IP Megapixel cameras with a minimum resolution of HDTV 720p (1280x720) for future auditing purposes if required. Cameras shall be capable of outputting at a frame rate of 30 fps.

    VI. Cameras shall be tamper-proof and have protective covers.

    VII. The resolution and frame rate settings of the cameras shall adhere to the minimum requirements set out in APTA Technical Recommended Practice for The Selection of Cameras, Digital Recording Systems, Digital High-Speed Networks and Train-lines for Use in New Transit-Related CCTV Systems (APTA IT-RP-001-08):

        a. Resolution for color digital video cameras must have an output resolution of at least 4CIF (704x480pixels).

        b. For trackside operations and platform areas, frame rate shall be at least 15FPS.

        c. For ticket office desks and pay machines, frame rate shall be at least 15FPS.

    VIII. Operators at the security control centre and OMSF shall have continuous live streaming capabilities for all footage captured from the off-board CCTV cameras at LRT platforms.

    IX. The footage captured by LRT platform cameras will be recorded on NVRs at the OMSF with H.264 encoding. The recorded CCTV footage shall be retained for a minimum of 72 hours.

    X. Ensure CCTVs used to monitor the TVMs and Passenger Assistance Intercoms have sufficient image resolution to be able to recognize a person standing by the TVMs or intercoms. Likewise, the recorded footage on NVRs shall have sufficient image resolution. In order to reasonably recognize a person, the suggested minimum requirements by APTA IT-RP-001-08 must be followed:

- The figure, when viewed on a monitor without zoom, shall occupy at least 50% of screen height for the viewer to be able to say with a high degree of certainty, whether or not an individual shown is the same as someone they have seen before.
- This requirement shall be demonstrated during playback of a recorded image, rather than via viewing of any direct camera output on a monitor.

(v) Public Address systems are used on-board LRVs and at LRT platforms to ensure transit operators may effectively communicate any emergency situations or transit related issues to multiple transit riders at one time.

I. On-Board PA systems are discussed in Schedule 15-2 Article 5 under Vehicle Specifications.

II. LRT Platform PA systems:

a. PA system speakers shall be located in strategic areas to provide sufficient audio levels to ensure all transit riders on the platform may hear the public announcement clearly.

b. The platform shall be equipped with a microphone in a locked cabinet which will allow mobile security staff to make announcements through the platform PA system.

c. PA system shall be accessible by the Transit Security Control Center (Region) and OMSF for broadcasting emergency information.

d. The priority sequence for PA announcements is listed in the order of higher priority to lower priority as follows: platform announcements, announcements from the Transit Security Control Centre and announcements from the OMSF. The higher priority announcements shall be able override any announcements from a lower priority source.

(vi) Passenger Assistance Intercom systems will allow a customer to speak to an LRV operator or a customer support staff through a two-way voice communication system when the customer is in duress or requires assistance. Passenger Assistance Intercoms shall be provided both on-board the LRVs and at LRT platforms.

I. On-board Passenger Assistance Intercoms is discussed in Schedule 15-2 Article 5 under Vehicle Specifications.

II. LRT platform Passenger Assistance Intercoms will be discussed under Section 9.8.

(vii) Access Control Systems are used to restrict access and ensure only authorized personnel may enter sensitive areas. Access Control Systems shall be installed at the OMSF and any other LRT facilities as required. The following requirements are applicable to Access Control System for the CCF.

I. An assessment of the entire facility and LRT system shall be conducted by qualified security experts to determine which entry points require door Access Control Systems to be put in place.

II. Door Access Control Systems shall include door locks, door status sensors and Access Control devices which will control the opening of the doors.

III. The Access Control device shall utilize proximity card technology. The doors shall only open when presented with an authorized card.

IV. Access Control doors shall adhere to applicable building and fire codes.

V. The Access Control monitoring system shall be operated at the CCF.

(viii) CCTV surveillance technologies shall be installed at the OMSF, and at any other LRT facilities as required, to provide general monitoring capabilities. The following requirements are applicable for the CCTV monitoring system:

I. An assessment of the entire facility and LRT system shall be conducted to determine where CCTV monitoring may be required.

II. Generally, CCTV cameras shall monitor building entry points, building perimeters or where Region of Waterloo assets are being held.

III. Project Co shall determine the appropriate camera type to be used for each location.

IV. The OMSF facility CCTV camera footage shall be capable of viewing in real time through the workstation monitors at the Central Control Facility.

V. The recording of the CCTV camera video will be conducted at the OMSF facility and must be retained for a period of at least 72hours.

(c) System Operations

(i) The primary operation of LRT security systems will be conducted by Project Co at OMSF. These include the operation of:

I. LRT platform CCTV Camera Monitoring and Manipulation

II. Public Address System Control at LRT platforms

III. LRT platform Passenger Assistance Intercom System (Primary Response).

(ii) The Region of Waterloo Transit Security Control Centre at Strasburg will have a work station dedicated to monitoring the LRT security operations. In general, the Region will be capable of performing the following operations:

I. LRT platform CCTV Camera Monitoring

II. Public Address System Control at LRT platforms

III. LRT platform Passenger Assistance Intercom System (Secondary Response).

(iii) The main Public Address System Control will be located at the OMSF, and the Region will have a workstation set up for Public Address System control. However, priority will be given to announcements initiating from the Region site.

(d) System Maintenance

(i) Transit security system maintenance will fall under the responsibility of Project Co.

9.8 Passenger Assistance Intercom at LRT Stops

(a) Passenger Assistance Intercoms allow transit riders to speak to an operator at the OMSF employed by Project Co to resolve any emergency issues or transit related inquiries. It shall be one integrated system which shall handle both emergency calls and customer service calls from transit riders.

(b) Functional Requirements

(i) A minimum of 1 Passenger Assistance Intercom shall be located at every LRT platform.

(ii) The Passenger Assistance Intercom shall be in a location that is easily accessible by transit riders.

(iii) The Passenger Assistance Intercom shall be clearly marked. Instructions shall also be provided on how to operate the intercom system. Instructions must be easy to understand.

(iv) The Passenger Assistance Intercom shall connect a transit rider to an operator 24hours a day and 7 days a week.

(v) Each Passenger Assistance Intercom shall have a hands-free operation once activated.

(vi) The Passenger Assistance Intercom interface shall have two separate activation systems: one for emergency calls and one for customer service calls. The two separate systems will be integrated into one intercom and will share the speakerphone system. They shall be clearly marked so that passengers can easily distinguish which is for emergency and which is for customer service.

(vii) The Passenger Assistance Intercoms shall be activated in a single manoeuvre (either through the press of a button or pulling down of a lever).

(viii) Calls for emergency and customer service will both be initially directed to an operator at the OMSF.

(ix) The Passenger Assistance Intercoms System shall be a network based Voice Over IP (VOIP) System.

(x) Once call has been put through to an operator at the OMSF, the operator shall be able to determine the location where the call was made and whether it was for emergency or customer service.

(xi) The operator shall have a display unit which has the ability to view multiple active calls as well as the ability to select and switch between these calls. The display unit shall clearly show the nature of each call, whether it was for emergency or customer service. Operators shall give priority to emergency calls.

(xii) Passenger Assistance Intercoms shall be closely monitored with CCTV surveillance technology.

(xiii) Operators at the OMSF shall have capabilities to request live CCTV footage of the customer that they are speaking to.

(xiv) Operators at the OMSF will determine the nature of the call and, if necessary, forward the call to the Region's Transit Security Control Centre, the Region's Customer Service Call Centre, or the local police.

(xv) Multiple incoming calls shall automatically be routed to the next available operator.

(xvi) If there are insufficient operators to handle all the incoming calls simultaneously, then any subsequent callers shall be put in a queue system until the next available operator. The caller shall be notified through the speakerphone that he/she has been put into a queue system.

(xvii) Conversation between the caller and the operator will be recorded at the OMSF and archived.

(xviii) Work stations shall be installed at the Region's Transit Security Control Centre and the Customer Service Call Centre to answer any intercom calls forwarded from the OMSF.

(xiv) The Passenger Assistance Intercom System shall have the ability to relocate the main work station from the OMSF to any location outside the OMSF provided that network connectivity exists at the new location.

(c) System Operation

(i) Passenger Assistance Intercom calls will be first received by Project Co's operators, and routed to the Region's Customer Service or Transit Security operations as necessary.

(d) System Maintenance

(i) Maintenance services for the Passenger Assistance Intercoms will be provided by Project Co.

9.9 Fare Collection System

(a) A Fare Collection System will be required to enable the collection of transit fees from riders. The Fare Collection System will include Ticket Vending Machines and Ticket Validators or Platform Fare Transaction Processors (PFTPs). The Stage 1 LRT Project shall adopt the fare collection strategy put forth by the Region's Electronic Fare Management Contractor. The strategy and policy for the System is anticipated to include the implementation of payment off-board in a Proof-of-Payment (POP) system to encourage quick boarding at all LRV doors.

(b) Ticket Vending Machines (TVM) and Ticket Validators (TV) or PFTPs shall be installed at LRT platforms to facilitate off-board payment. The fare collection system also includes a centralized Revenue Management System to effectively monitor and manage fare collection transactions.

(c) Fare enforcement officers will be deployed along the LRT corridor to perform spot-checks and ensure that transit riders have properly paid for the fare. Fare enforcement officers will be supplied with handheld validators to perform this task. The handheld machine shall be supplied by the Region's Electronic Fare Management Contractor.

(d) Functional Requirements:

(i) Project Co must determine the optimal location for TVMs and TVs/PFTPs at LRT platforms.

(ii) Project Co shall design and construct the necessary provisions for the fare collection system at each platform as per the requirements established by the Region. These shall include, but are not limited to equipment mounting pads, ducts, grounding, power connections and communication connections for electronic fare equipment, etc.

(iii) The fare collection system equipment shall be supplied by the Region and the Region's Electronic Fare Management Contractor shall be responsible for the installation and commissioning of the devices.

(iv) Project Co shall coordinate with Region's Electronic Fare Management Contractor to ensure seamless integration of the fare collection equipment with the LRT platform, including integration of the supporting power and communication systems.

(v) The voltage requirement for the TVMs shall be 110 V.

(vi) The communication link shall be provided through fibre optic cables dedicated for fare collection use.

(e) System Operations

(i) Region shall be responsible for the implementation and operation of the Revenue Management System.

(ii) Revenue servicing of the TVMs shall be managed and operated by the Region.

(iii) Region shall be responsible for handling card management tasks if the fare payment technology is based on card media.

(iv) Region shall provide fare enforcement officers.

(f) System Maintenance

(i) Fare collection equipment maintenance and servicing shall be the responsibility of the Region's Electronic Fare Management Contractor.

(ii) Maintenance and servicing for the Fare Collection System provisions shall be the responsibility of Project Co.

9.10 Communications System

(a) A communication infrastructure is required to exchange information between different entities of the ITS system. The purpose of the communications system is to provide the means of transmitting information from remote locations and/or vehicles to the Central Control Facility (CCF) for processing and display as well as the means of transmitting data for control to remote location and/or vehicles. The communication infrastructure shall support the exchange of both voice and data information with the latest feasible technology.

(b) Functional Requirements

(i) Transit Management System Communication requirements:

1. Data communication between the LRV and the Control Centres shall be established via Train-to-Wayside Communication (TWC). This will serve as the primary communication link between the vehicle to the communication backbone.

2. Transit Management System primary data communications will interface with the backbone communication system on a fibre optic Ethernet network.

3. Voice communication between the LRV Operator to OMSF CCF will be established through two-way mobile radio technology.

(ii) Fare Collection System Communication requirements:

1. At each platform, the fare collection equipment will interface with the backbone communications subsystem on a dedicated fibre optic Ethernet network.

2. Two-way voice communication shall be provided for customer assistance with TVMs. These calls shall be routed to the designated customer service agents. These service agents shall be Region of Waterloo staff.

3. Mobile radio systems will be supplied to the ticket inspectors (Region of Waterloo staff) to enable communication between inspectors and control centre operators.

(iii) Transit Signal Priority Communication requirements:

1. Provide communication link between vehicle and the field equipment in order to facilitate transit signal priority controls.

(iv) Transit Security Communication requirements:

1. Platform Public Address systems shall utilize digital Voice over IP (VOIP) technology to broadcast audio.

2. Platform Passenger Assistance Intercom Systems shall utilize digital VOIP technology to enable two-way voice communication.

3. Mobile security staff employed by the Region of Waterloo will communicate with each other, with the Transit Security Control Centre operator, and with CCF operators using the two-way radio system.

4. All platform ITS Security systems that require communication with the Transit Security Control Centre located at both Strasburg site and OMSF shall interface with the communications fibre optic backbone through an Ethernet network set up at each LRT platform. These ITS systems include the Public Address Systems and Passenger Assistance Intercom System.

5. ITS Security systems shall, at a minimum, have a dedicated pair of fibre to interface with the backbone communication system.

(v) Passenger Assistance Intercom Communication requirements:

1. Passenger Assistance Intercom Systems shall utilize digital VOIP technology to enable two way voice communications.

2. Passenger Assistance Intercom Systems located at LRT platforms shall interface with the backbone communication using an Ethernet network. Passenger Assistance Intercom audio data will be transferred to the OMSF on an optical fibre network.

(vi) Central Control Facility Communication requirements:

1. All communication devices at the CCF will interface with the communication backbone using an Ethernet network.

2. Communication links shall be established between the Central Control Facility and LRV vehicles.

3. Communication links shall be established between the Central Control Facility and ITS field devices where required.

4. Data communication between the existing Region of Waterloo Control Centres and the OMSF facility shall be established using existing or newly constructed Intranet service. Project Co shall be responsible for the design, coordination, and

establishment of these centre-to-centre linkages in collaboration with the Region of Waterloo.

5. Voice communication between the existing Region of Waterloo Control Centres and the OMSF facility shall be established using the telephone system.

(vii) Communication system shall be physically protected where applicable and be secured.

(c) System Operation

(i) Backbone Communications System shall be operated by Project Co.

(ii) All ITS communication nodes extending from the backbone Communications System and ITS Ethernet networks will be operated by Project Co.

(iii) Any fibres along the backbone which are to be dedicated for use by the Region will be operated by the Region.

(d) System Maintenance

(i) Maintenance services for the Communications System, including the backbone and all communication nodes, shall be performed by Project Co.

9.11 Control Centres

(a) Control centres, especially the Central Control Facility, are the central hub dedicated to managing, monitoring, analyzing, and evaluating all information collected from the vehicles and field equipment. Control centre systems consist of the software required to interpret the data collected and the hardware required to display the information. There are primarily three types of central control functions envisioned as part of the ITS system of the Project. Each of these central functions manage a different aspect of the ITS system which include the Traffic Control Centre, the Transit Control Centre and the Transit Security Control Centre. These control centres may be functioned and located separately; however, the efficient and instantaneous sharing of data between the three systems is required to enable effective coordination.

(b) This section of the Article establishes the overall requirements for planning and designing the Central Control Facility to support ITS systems. The general design, construction, provisioning and technical requirements for the CCF are defined in Schedule 15-2 Article 16.

(c) Central Control Facility

Functional Requirements for the Central Control Facility

(i) A communication infrastructure shall be established between Central Control Facility and the regional Traffic, Transit, and Transit Security Control Centres to include voice communication, and sharing and managing data of LRT operations.

(ii) The design and layout of the CCF shall include a Control Room for LRT operations and management, boardroom/meeting rooms, ITS equipment storage room, multipurpose room, yard control operations room, washrooms, lunchroom, electrical/mechanical room and site security area. Due consideration shall be given to the overall layout and presentation of the CCF as the facility would be toured by politicians and external groups.

(iii) The CCF shall provide restricted security access for authorized personnel.

(iv) The CCF shall provide data storage capacity for a minimum of 5 years on main servers to retain historical data of LRT subsystems. Historical data older than 5 years shall be archived offline from the main servers.

(v) The CCF shall provide a full HVAC system and power backup capability (i.e. UPS, Generator).

(vi) The CCF shall be sized to house LRT staff (i.e. but not limited to the following personnel: LRT operators, supervisors, management, engineering support, technicians, security staff and administrative staff).

(vii) The Control Room shall provide workstations and consoles for LRT operators to operate, manage, and monitor LRT operations and systems (i.e. computer systems, monitors, keyboard, telephone, camera controllers and office furniture such as ergonomic desks and chairs). See Exhibit 9.11-1 for a conceptual layout of the workstations.

1. Provisions for workstations shall include, but not limited to: Transit management, LRT security management, power system management, SCADA monitoring and control, and other LRT subsystems that are defined in Articles.

(viii) The Control Room shall provide a video wall with at least the following features:

1. Video wall shall utilize industry leading technology.
2. Segment of the video wall is ergonomically visible and viewable to the designated LRT operators and supervisors.
3. The video wall shall be sized to accommodate CCTV images of LRT system, including LRT security and an area map of the LRV locations. The video wall shall be able to display multiple images with screen size of 19" along the diagonal, at minimum. See Exhibit 9.11-2 for a conceptual layout of the video wall.

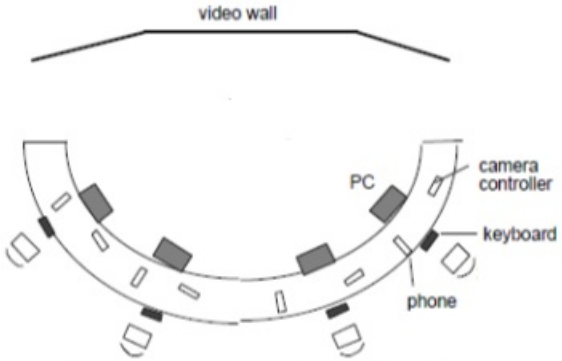


Exhibit 9.11-1. Conceptual Layout of Workstations.

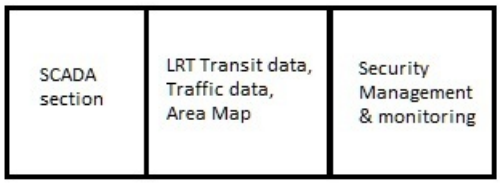


Exhibit 9.11-2. Conceptual Layout of Video Wall Configuration

(ix) The Control Room shall provide console task lighting and proper lighting to avoid glare of the video wall display.

(x) The boardroom shall be served to coordinate any LRT operations, management, planned events, and issues among LRT staff and regional agencies.

(xi) The boardroom shall be designed to provide a glass enclosure to overlook the control room and video display wall.

(xii) The multipurpose room shall serve as a meeting room and/or visitor's area.

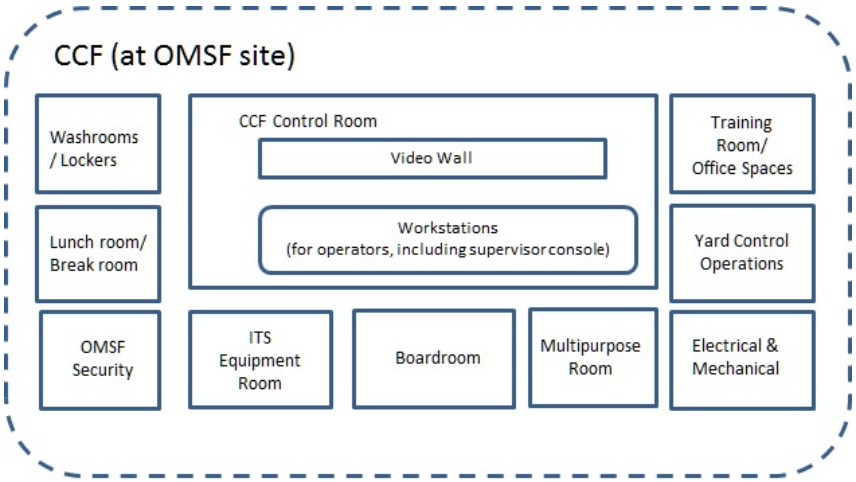
(xiii) The multipurpose room shall be designed to provide a glass enclosure to overlook the control room and video display wall.

(xiv) The ITS equipment room shall accommodate all LRT system servers and associated equipment required to operate and maintain ITS subsystems.

(xv) The ITS equipment room shall be environmentally-controlled and provide a suitable fire suppression system.

(xvi) Security management for OMSF-site may be located in the Control Room or independently in the CCF.

(xvii) Exhibit 9.11-3 is a preliminary functional diagram of the Central Control Facility (CCF). Project Co shall be responsible for the design of the facilities. The design layout shall be carefully evaluated and be part of the overall design of Stage 1 LRT project.



Note: This is a concept diagram that depicts the functions of the Central Control Facility. Not drawn to scale.
**OMSF Security and Yard Control Operations may be located in the control room.*

Exhibit 9.11-3 Preliminary Functional Design of Central Control Facility

(d) Traffic Control Centre (Region of Waterloo)

(i) A Traffic Control Centre shall be provided for the monitoring and coordination of traffic related systems and issues.

(ii) Functional Requirements for Region of Waterloo Traffic Control Centre:

1. Required enhancements to the Region's existing Traffic Control Centre shall be provided by the Project Co. These enhancements shall include the necessary system provisions, furnishings, and equipment for the efficient operation and management of the traffic signal control system (including TSP).

2. Project Co is responsible for the design, supply, installation, testing and commissioning of the system enhancements required at the Region's Traffic Control Centre.

(iii) System Operations

1. The Region of Waterloo will continue to be responsible for the operation of the traffic control systems along the LRT corridor.

(iv) System Maintenance

1. The Region of Waterloo will continue to be responsible for the maintenance and servicing of the Traffic Control Centre and it's systems for the LRT corridor.

(e) Transit Control Centre

(i) Project Co transit control centre, located at the OMSF, shall provide capabilities to monitor and operate LRT related systems. The transit control centre shall include a management system, to provide operators with visibility and control over the LRV fleet.

The Region of Waterloo GRT Control Centre, located in Strasburg, will have real-time LRT fleet monitoring capabilities within their TMS.

(ii) Functional Requirements for Region of Waterloo Transit Control Centre at Strasburg:

1. Retain existing scheduling function, via Hastus, expand to include LRT route and LRV fleet. Send schedules to Project Co, OMSF CCF for their use if needed.

2. Receive real-time LRV location coordinates and identification, for each vehicle in the LRT fleet, from the OMSF CCF, and seamlessly integrate it to the GRT transit system (INIT), allowing operators to view real-time vehicle locations, including schedule adherences, through existing interfaces.

3. Project Co is responsible for the design, supply, installation, testing and commissioning of the INIT system enhancements required at the GRT's Transit Control Centre.

(iii) Functional Requirements for OMSF CCF:

1. Project Co shall provide a Fleet Management System allowing operators to track each LRV vehicle through an interactive graphical display, map or route-line layout, and a tabular interface, from the AVL data received from each LRV.

2. The Fleet Management System shall be able to create vehicle assignments, and calculate schedule adherences. It shall also allow operators to make schedule modifications, delaying or canceling trips due to disruptions.

3. The Fleet Management System shall also have the ability to send real-time LRT location, for each vehicle in the fleet, to the GRT Control Centre. This will require the data to be formatted to allow for integration with the existing GRT INIT system. The real-time data sent to the GRT Control Centre shall include the following for each vehicle:

   I. Vehicle ID – to identify the LRV

   II. Real-time GPS Coordinates – to locate each LRV

   III. Real-time Route/Run information – to adjust for changes to the route/run, in case of a disruptions or cancellations.

   Project Co shall coordinate with the Region for INIT requirements. Project Co shall include all costs associated with developing, integrating, testing and commissioning this functionality within the Region's INIT system in their Submission.

4. Project Co shall provide a Driver Management System, allowing operators to adhere the route scheduling information, provided by the Fleet Management System, to create driver schedules and send update scheduling information to vehicle operators. It shall provide reports to allow operators to assess LRV Operators and performance.

(iv) System Operations

1. The Transit Control Centre will be operated by Project Co for the LRT operations.

(v) System Maintenance

1. The Transit Control Centre equipment will be maintained and serviced by Project Co.

(f) Transit Security Control Centre

(i) A transit security control centre will manage and control the security aspect of the entire LRT system. This includes monitoring of surveillance equipment as well as management and monitoring of access control systems to vulnerable areas of the LRT system.

(ii) The main LRT Security Control Centre will be located at the CCF. The Region of Waterloo Security Control Centre (At Strasburg) will have user access to the surveillance monitoring and Public Address Control and will be the secondary responder to Passenger Assistance Intercom calls.

(iii) Functional Requirements for Region of Waterloo Security Control Centre at Strasburg:

1 Project Co shall expand the Region's video wall to accommodate additional CCTV and system images from the LRT system.

2. CCTV Monitoring System:

I. LRT platform CCTV images shall be streamed and integrated into the CCTV monitoring system to allow operators to select specific CCTV footage to view on the video wall or through a computer monitor at a workstation.

3. Passenger Assistance Intercom System:

I. Project Co shall provide a workstation to receive calls routed from the OMSF.

II. The workstation shall be equipped with a speakerphone system which shall allow the operator to have two-way voice communication with the intercom system located at the LRT platforms.

III. The operator must be provided with an audible and visual alert when a call is being received.

IV. The operator shall have the capability of determining where the call was made.

V. The workstation must have capabilities to record and log incoming calls.

VI. The operator must be able to easily contact and dispatch a mobile security staff using mobile radio technology.

4. Public Address Control

I. Project Co shall provide the system and capabilities to broadcast live messages to the Public Address speakers located at LRT platforms along the corridor.

II. The operator shall be able to select the desired LRT platform the announcement will be broadcasted to.

III. The operator shall be able to broadcast live messages through a microphone or be able to select a pre-recorded announcement from a database.

IV. The operators shall be able to put announcements into a queue system to be broadcasted one after another.

V. This Public Address Control System located at the Transit Security Control Centre must seamlessly be integrated with the Public Address Control System located at the OMSF. When two announcements are simultaneously sent to the same PA system from the two separate sources, priority will be given to the Transit Security Control Centre.

5. Communication with Mobile Security Staff

I. Operators at the Transit Security Control Centre shall be able to communicate with mobile security staff deployed along the LRT corridor through the use of mobile radio technology.

6. Project Co is responsible for the design, supply, installation, testing and commissioning of the system requirements at the Region of Waterloo's Security Control Centre at Strasburg.

(iv) Functional Requirements for OMSF CCF:

1. Project Co shall provide a security system workstation with a dedicated video wall (or display section) in the CCF which will be capable of monitoring the security related systems of the LRT corridor and associated areas.

2. The video wall (or display section) shall initially be sized to accommodate a minimum of 28 CCTV camera images (or one CCTV image for each LRT platform with the ability to cycle between cameras), which are viewable from the security operator workstation. CCTV images on the video shall be a minimum of 19 inches along the diagonal.

3. CCTV Monitoring System:

I. The CCTV monitoring system shall allow operators to select specific CCTV footage to view on the video wall. The operator shall have access to recorded LRV CCTVs, and both live and recorded platform CCTVs, substation CCTVs, and OMSF CCTVs.

4. Provide a system to monitor, manage and modify the access control database for the OMSF complex.

5. Public Address Control

I. Provide capabilities to broadcast live messages to the Public Address speakers located at LRT platforms along the corridor.

II. The operator shall be able to select the desired LRT platform where the announcement will be broadcasted to.

III The operator shall be able to broadcast live messages through a microphone or be able to select a pre-recorded announcement from a database.

IV. The operators shall be able to put announcement into a queue system to be broadcasted one after another.

V. Coordination must be made between Transit Security Control Centre at the Region of Waterloo site and OMSF to manage Public Address Control System at LRT platforms.

VI. Any announcements made from the Region of Waterloo Transit Security Control Centre will override or take precedence over announcements originating from the OMSF security workstation.

6. Passenger Assistance Intercom Workstation

I. The operator shall be able to receive calls initiated from the Passenger Assistance Intercom System located at LRT platforms.

II. The workstation shall be equipped with a speakerphone system which shall allow the operator to have two-way voice communication with the intercom system located at the LRT platforms.

III. The operator shall be provided with an audible and visual alert when a call is being received.

IV. The operator shall have the capability of determining where the call was made.

V. The workstation shall have capabilities to record and log incoming calls.

VI. The operator shall have abilities to route the received call to either the Security Control Centre or the Region of Waterloo Customer Service Call Centre.

VII. The operator shall have capabilities to easily contact emergency personnel or the local police in the case of time critical emergency situations.

(v) System Operation:

1. The Transit Security Control Centre shall be operated by the Region of Waterloo.

2. The CCF Security Control Centre shall be operated by Project Co.

(vi) System Maintenance:

1. The Transit Security Control Centre equipment shall be maintained and serviced by the Region.

2. The CCF security equipment and workstation shall be maintained and serviced by Project Co.

(g) Staff Training

(i) Project Co shall be responsible for training all OMSF staff and field operators and personnel. More specifically, CCF staff and associated field operators shall be trained on all ITS systems. ITS training provisions shall also be made for Region of Waterloo staff that will be involved in LRT operations. Training shall be provided to up to 10 Region of Waterloo staff.

9.12 Power Supply System

(a) The power supply system shall ensure all ITS components along the LRT corridor obtain sufficient electrical power for operation.

(b) Functional Requirements:

(i) The electrical power for LRT stops and other ITS devices will be drawn from the closest local hydro connections and/or substation to the system.

(ii) Power circuits may be established between substations and power supply cabinets at LRT platforms; however, individual circuits shall be provided between the LRT platform power supplies and the various ITS subsystems.

(iii) A separate ITS power panel shall be provided at each substation to isolate power to ITS systems.

(iv) Traffic signals shall be placed on its own dedicated circuit for each signalized intersection. Electrical power shall be coordinated and provided from local hydro connections, or from a nearby substation

(c) System Operation:

(i) The ITS electrical power supply system for the LRT corridor shall be operated by Project Co.

(d) System Maintenance:

(i) The ITS electrical power supply system shall be maintained and serviced by Project Co.

9.13 Advanced Traveler Information System

(a) The future Advanced Traveller Information System (ATIS) will provide a centralized system to allow travelers to gain access to the latest transit, traffic information, and other travel related information. ATIS will include multi-modal trip planning capability for applicable interactive modules.

(b) The traveler information system will be capable of acquiring and storing multimodal traveler information from various transit and traffic systems. Other systems could also connect to the traveler information system, such as weather, emergency (e.g. missing persons) and security systems.

(c) The system may provide website applications, mobile applications, kiosk terminals (at mobility hubs/centers/malls), interactive voice response systems, and other interfaces to allow travelers to request and receive travel related information. Websites, mobile applications, kiosks will have trip planning capabilities, allowing passengers to insert starting and ending addresses, and displaying the best route according to real-time traffic and transit information.

(d) Functional Requirements:

(i) Project Co is not required to provide the ATIS system. However, all ITS systems deployed shall be capable of providing static and real-time information to the ATIS system. At a minimum, Project Co shall develop and publish GTFS (General Transit Feed Specification) real-time feeds, providing transit scheduling info to Google Transit.

9.14 System Design Documentation

(a) Project Co shall prepare documentation detailing the intended design of the subsystems and the overall system in accordance with the provisions of Schedule 15-2 Article 1.

(b) The system design documentation shall be provided by Project Co to the Region of Waterloo for review, coordination, and approval prior to the ordering of materials and construction. As part of

Phase 1 deliverables, Project Co shall provide an ITS Concept Design Report and an ITS Architecture and Functional Requirements.

(c) As part of the detailed design process in Phase 2, Project Co shall include a minimum of two reviews with the Region of Waterloo for the ITS subsystems and microsimulation model.

(d) The drawings shall be updated during construction to produce an "as built" package in AutoCAD and PDF formats. All drawings and design specifications shall be handed over to the Region for archiving and future referencing.

9.15 Software Licenses and Escrow

(a) As part of the Contract, the Project Co must negotiate and sign with the Region of Waterloo the proper software agreements that will warranty that the system is legally protected in terms of intellectual property, patents and uses rights, and that the sufficient information (i.e. source code, manuals, compiling directives) are accessible to the Region in order to warranty the continuing operation of the system in case of a default by Project Co. All contracts and agreements would have to be reviewed and approved by the Region in order to verify that its interests are covered and protected.

(b) The Region and Project Co will have in place at least the following agreements.

(i) Software User License Agreement

(ii) Software Escrow Agreement

(iii) Warranty and Support Agreement

(c) Software User License Agreement

(i) The User License Agreement shall release the Region from any liability to the Project Co, third party or other persons in any dispute regarding patents, intellectual property, etc.; furthermore, Project Co will defend, indemnify and hold harmless based upon an alleged infringement of, or violation of any intellectual property rights, such as trade secrets, trademarks or copyrights and relating to, caused by, or arising out of these agreements.

(ii) The agreements shall include all the necessary clauses that would give the Region the following rights:

1. The access and the rights to use the original software, upgrades and all enhancements made to the software for the duration of the warranty period without the need to pay any additional fees.

2. The access and the rights to use the software, upgrades and all enhancements made to the software, for the duration of the warranty period without need to negotiate any additional agreements.

(d) Software Escrow Agreement

(i) The Region and Project Co shall negotiate the necessary Software Escrow Agreements. Software Escrow Agreement shall at least cover the following scenarios:

1. Project Co's system suppliers has failed to carry out obligations imposed on it pursuant to the Software License Agreement

2. Project Co's system suppliers has ceased to offer support for the Software;

3. Project Co's system suppliers has failed to continue to do business in the ordinary course;
4. Project Co's system suppliers has applied for or consented to the appointment of, or the taking of possession by, a receiver, custodian, trustee, liquidator or the like of itself or all or a substantial portion of its assets;
5. Project Co's system suppliers has made a general assignment for the benefit of, or a composition with, creditors;
6. Project Co's system suppliers has been adjudicated for bankruptcy or insolvency;
7. Project Co's system suppliers has filed a petition seeking to take advantage of any other law relating to bankruptcy, suspension of payments, insolvency, reorganization, liquidation, winding up, composition or adjustment of debts.

(e) The Region and Project Co will be required to sign additional agreements, such as Maintenance and Support and/or Extended Warranty Agreements as required.

9.16 Testing, Acceptance, and Commissioning Requirements

(a) Project Co shall comply with the Verification Testing, Acceptance, and Commissioning (VTAC) requirements as detailed in Schedule 15-2 Article 13.