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SCHEDULE 15-2
DESIGN AND CONSTRUCTION

PART 8
DESIGN AND CONSTRUCTION REQUIREMENTS – VEHICLES

ARTICLE 1 INTRODUCTION

1.1 Definitions

(a) In this Specification, unless the context otherwise requires:

(i) Acceptance Test: Test performed on a Vehicle using production items to determine whether or not the item complies with specified requirements for the purpose of confirming that production items are at least equal to the qualified item.

(ii) Accepted: Found suitable to the City, subject to successful completion of all testing.

(iii) Anticlimber: Fingers at the ends of Vehicles that are designed to engage adjacent Vehicles

(iv) Automatic Coupler: A coupler which when mechanically engaged also engages electrical and pneumatic trainlines between Vehicles.

(v) AW0: Weight of a fully functional, ready to run Vehicle.

(vi) AW1: AW0 plus the weight of Passengers when all seats are occupied

(vii) AW2: AW1 plus the weight of standing Passengers at 4 pass/m^2

(viii) AW3: AW1 plus the weight of standing Passengers at 6 pass/m^2

(ix) Body Section: Portion of a Vehicle that provides Passenger seating and includes articulation points on each end.

(x) Bogie: The assembly containing motors, drive train, Vehicle suspension and brakes which swivels beneath each end of a Vehicle and supports its mass on the rails.

(xi) Braking, Dynamic: Electrical braking in which the power generated by the traction motors, when driven as generators providing retardation effort, is either dissipated as heat by brake resistor grids (Rheostatic) or returned to the Vehicle to power loads.

(xii) Braking, Emergency: Irrevocable braking to a full stop at the maximum design brake rate.

(xiii) Braking, Full Service: A brake application which obtains the maximum controlled, non-emergency brake rate consistent with the design of the propulsion and friction brake systems.

(xiv) Collision Posts: Members of the end structure projecting upward from the underside of the underframe to provide protection to the interior of the Vehicle against penetration during a collision.

(xv) Component: One replaceable part of the Vehicle.

(xvi) Conditional Acceptance: Found suitable to the City, subject to successful completion of all testing. Open items may exist, each of which shall be tracked by a Field Modification Instruction. Open design issues may exist, subject to acceptance by the City on a case-by-case basis

(xvii) Console: Control panel in the Operators cab from which the Operator monitors and controls Train operation.

(xviii) Consist: The quantity and specific identity of Vehicles that make up a Train.

(xix) Contractual Deliverable Requirement List (CDRL): CDRLs identify a portion of the items that are required to be submitted by Project Co, to confirm compliance with Project Agreement obligations. CDRLs will be used by Project Co to show the City how the design achieves compliance with the agreed Technical Requirements.

(xx) Corner Post: Vehicle structural member that extends vertically from the floor structure to the roof structure, located at the end sill surfaces with the side surface of the Vehicle.

(xxi) Coupler: A device for mechanically coupling Transit Vehicles together. This term is also applied to connectors, as in electric coupler and pneumatic coupler which couple electric and pneumatic trainlines together between Transit Vehicles.

(xxii) Deadman Control: A spring loaded device that detects cognizance of the Operator.

(xxiii) Device: An element of a component, consisting of parts and structure, which performs specific functions necessary to the operation of the component (bearings, batteries, connectors, and similar elements).

(xxiv) Draft Gear: The energy absorbing mechanism that attaches the coupler or drawbar to the anchorage.

(xxv) Draft screens: Screens located on either side of doors extending into Passenger compartment to form a vestibule and protect Passengers in adjacent seats.

(xxvi) Failure, Component or System: A state of a component or system that requires replacement or adjustment to return to normal operation.

(xxvii) Fault Monitoring: Automatic monitoring of Train control logic for errors during service from any of the subsystems including brakes, traction, doors, air conditioning, etc.

(xxviii) Floor Height: The vertical distance measured between the upper surfaces of the rail and Vehicle floor including floor covering.

(xxix) FMI (Field Modification Instruction): A formal document, subject to acceptance by the City, which defines/describes modifications and serves as a record of vehicle configuration.

(xxx) Handrails: Safety appliances installed anywhere on the Vehicle, to assist in movement or provide a hand-hold during Train motion.

(xxxi) Leading Cab: The controlling cab in a Train.

(xxxii) Load Weigh: A signal derived from the load on the secondary suspension, used to regulate tractive effort and braking in proportion to Vehicle load.

(xxxiii) Master Controller: The device to control power and braking from an operator's cab.

(xxxiv) Mock-Up: A full scale model used to demonstrate preliminary design and/or specification compliance.

(xxxv) Operator's Cab: The compartment located at the end Vehicle and equipped to provide proper facilities to enable operation of the Train.

(xxxvi) Profile Grade: A straight line representing an established grade line, in relation to the horizontal.

(xxxvii) Prototype: A unit built to test a new design and which performs essentially the same as a production unit.

(xxxviii) Qualification Test: Test performed using a preproduction or production item to determine whether or not the item complies with specified performance requirements.

(xxxix) Roll: Rotational motion of a Transit Vehicle body about a longitudinal axis.

(xl) Slide, Wheel: The condition existing when the rotational speed of the wheel is slower than that for pure rolling contact between the tread and the running rail.

(xli) Speed, Max Operating: The steady state speed attainable by the Vehicle.

(xlii) Spin, Wheel: During positive tractive effort, the condition existing when the rotational speed of the wheel is faster than that for pure rolling contact between the tread and the running rail.

(xliii) Subsystem: A subsystem comprised of elements interconnected within a system to perform a specific function.

(xliv) Systems Safety Management: Program management which ensures the accomplishment of systems safety tasks including identification of the systems safety requirements; planning, organizing, and controlling those efforts which are directed towards achieving the safety goals.

(xlv) Ultimate Strength: The limit of the ability of a structural member to resist fracture or collapse.

(xlvi) Zero Speed: Vehicle velocity of less than 3 km/h.

1.2 Introduction

(a) Project Co shall provide seven Trains of minimum capacity of 420 Passengers per Train for the Trillium Line Extension. Vehicles shall be fully assembled and tested prior to delivery, and delivery shall not take place prior to Conditional Acceptance by Project Co. The City reserves the right to restrict delivery if substantial non-compliances exist in the New Revenue Vehicle design or construction.

(b) Project Co shall ensure that the capacity of each Train is based on the following:

A. A peak standee density of 3.3 Passengers/m^2.

(c) Project Co shall provide a Service Proven Vehicle, with limited redesign required to comply with the requirements of this Part 8. Project Co may propose alternatives to the requirements herein to more closely reflect the proposed New Vehicle, subject to acceptance by the City. Alternatives will be reviewed on a case by case basis, and the City reserves the right to accept or reject any proposed alternative at its sole discretion.

(d) The New Revenue Vehicles need not be fully compatible with the six 40m Alstom Lint vehicles currently in service, but shall be structurally compatible in case of collisions and mechanically compatible for coupling under pushing and towing requirements. For reference, the coupler height of the existing vehicles is 1,060mm above TOR.

(e) Diesel-electric vehicle technology is the preferred solution. Alternative arrangements that are equivalent to diesel-electric in terms of reliability, maintainability and safety may be proposed for consideration by the City. Validation of equivalence shall be required before another arrangement may be considered.

(f) Project Co shall provide level boarding with a Platform height of 574mm with a maximum horizontal gap of 75mm. Level boarding shall be defined as Revenue Vehicle threshold height at ±16mm from Platform height for all wheel diameters and passenger loading, up to and including AW1 with standing Passengers at 3.3/m^2.

(g) Project Co shall ensure that the Revenue Vehicles are designed and constructed to satisfy Transport Canada rules and regulations including but not limited to the CTA Code of Practice, Passenger Rail Car Accessibility and Terms and Conditions of Carriage by Rail of Persons with Disabilities. The Revenue Vehicles shall also comply with the Capital Railway Inspection and Safety Rules.

1.3 General Requirements

(a) Project Co shall satisfy the following high level overview of the general New Revenue Vehicle requirements:

Item	Requirement
Length*	Compatible with 77,000mm Platforms

Max Distance between Centerline of End Doors*	65,000mm
Height (max)	4,310mm (static)
Width(max)	Compatible with a Platform edge 1,574mm from track centre-line
Operational Speed	120km/h
Structural Strength	P-II of EN12663-1:2010
Crash Energy Management	EN15227:2011 or FRA Tier I Alternative Compliance
Coupler Style	Sharfenberg Type 10 Latch, or equivalent
ADA/AODA Compliant Level Boarding	Revenue Vehicle threshold height at ±16mm from Platform height for all wheel diameters and passenger loading, up to and including AW1 with standing Passengers at 3.3/m^2.
Accessibility	Entire low floor section between doors shall be ADA/AODA compliant
Emissions	Euro III-B or Interim Tier 4
Vehicle Life	30 years

1.4 Expanded Trillium Line Alignment

(a) Project Co shall ensure that the New Revenue Vehicle is compatible with and designed to operate safely and reliably over the Expanded Trillium Line alignment. Project Co shall ensure that the Revenue Vehicles are compatible with interfaces of the System, including but not limited to:

(i) Track Gauge: 1435mm;

(ii) Minimum radius curve in workshop: 100m;

(iii) Minimum radius curve on main line: 125m;

(iv) Guideway maintained to Transport Canada Class IV requirements;

(v) AREMA compliant Special Trackwork; and,

(vi) Maximum grade: 4% (5% shall be permitted for lengths less than 250m).

1.5 Environmental Conditions

(a) Project Co shall design and construct the New Revenue Vehicles to operate in -40°C to +40°C.

(b) Project Co shall design and construct the New Revenue Vehicle to be capable of operation at the performance levels stated in this Part 8 under the following environmental conditions:

(i) Thermal shock temperature change 58°C;

(ii) Humidity 10 to 100%;

(iii) Continuous rain fall rate 60mm/hr;

(iv) Continuous snowfall rate 55mm/hr;

(v) Freezing rain accretion 5mm/hr;

(vi) Maximum daily freezing rain accretion 30mm; and

(vii) Fording

A. Water 75mm above TOR; and

B. Snow 40cm above TOR.

(c) Project Co shall design and construct the New Revenue Vehicle to be resistant to water intrusion under any combination of wind, rain or snow and any Vehicle speed. A slope with a grade of no greater than 1:12 may be provided to drain water locally at doorways.

1.6 Performance Requirements

(a) Project Co shall design and construct the New Revenue Vehicles to be capable of operating at a speed of 120 km/h. The maximum Revenue Service speed shall be easily adjustable through the DDU and initially set at 85km/hr. Project Co shall adjust the speed limit as and when requested by the City. The setting scheme shall require a password or similar arrangement to ensure all New Revenue Vehicles are set to the same maximum

(b) Project Co shall design and construct the New Revenue Vehicle for maximum availability, be capable of operating reliably for a minimum of 165,000km per year and provide a minimum service life of 30 years.

(c) The New Revenue Vehicles shall have the following minimum performance with AW2 loading:

(i) Average acceleration rate from 0 to 50 km/h shall be no less than 0.68 m/s^2, and 0.32 m/s^2 from 50 to 80 km/h;

(ii) Service braking shall be no less than 0.95 m/s^2; and,

(iii) New Revenue Vehicles shall have a guaranteed emergency brake rate of no less than 1.1 m/s^2.

1.7 Vehicle Weight Definition

(a) Project Co shall consider options for weight reduction during the design phase to maximize the energy efficiency of the System.

(b) Project Co shall design and construct the New Revenue Vehicles to balance weight per powered axle.

(c) Project Co shall design and construct the New Revenue Vehicle so that the maximum axle load with 500kg/m^2 interior loading shall be no greater than 19 tonnes.

1.8 Noise, Shock and Vibration Requirements

(a) Project Co shall design and construct the New Revenue Vehicle so that the interior noise levels shall be no greater than 70 dBA in the seated area and cab area

(b) Project Co shall conduct all measurements of exterior noise levels with the Train on or operating on level, tangent Track in a free-field environment, such as outdoors, away from any reflecting surfaces. Noise external to the New Revenue Vehicle, shall not exceed:

(i) 75dBA, when measured 25m from a stationary Vehicle; and,

(ii) 79dBA, when measured 25m from a Train traveling at 85 km/h and braking.

(c) Project Co shall design and construct the New Revenue Vehicle so that shock and vibration limits are in accordance with and tested to IEC 61373. In addition, the Vehicle shall be designed to withstand the shock loads imparted by existing and proposed Expanded Trillium Line Special Trackwork, including AREMA design railway crossing diamonds, railbound-manganese bolted turnout frogs and/or bolted heel blocks.

1.9 Electrical Equipment Environmental Conditions

(a) Project Co shall design and construct the New Revenue Vehicle so that all Vehicle electronic equipment shall function reliably under power quality conditions detailed in EN 50155, unless otherwise specified. Documentation of similar Vehicles that comply with these requirements may be proposed for review by the City.

1.10 Clearance Requirements

(a) Project Co shall provide clearance diagrams and dynamic envelopes for the New Revenue Vehicles.

(b) Project Co shall ensure that the dynamic envelopes of the Revenue Vehicles and the infrastructure are fully integrated.

1.11 Towing

(a) Project Co shall design and construct the New Revenue Vehicle so that at AW3, maximum ambient temperature, maximum allowed variation in Bogie wheel diameters any Train shall be able to tow an equal length, equal weight, dead Train between any two Stations. No over temperature shut down shall occur and no part of the propulsion system shall exceed the manufacturer's limits for a 30 year life.

(b) Project Co shall design and construct the New Revenue Vehicle so that at AW0, maximum ambient temperature, maximum allowed variation in Bogie wheel diameters any Train shall be

able to tow an equal length dead Train the entire length of the line. The speed through Stations shall be limited to 16km/h. No over temperature shut down shall occur and no part of the propulsion system shall exceed the manufacturer's limits for a 30 year life.

1.12 Safety

(a) Project Co shall design and construct fire Safety in accordance with the following:

(i) Unless similar documents exist from the New Revenue Vehicle family, Fire Safety shall be achieved through adherence to the following requirements or equivalent specifications:

A. All non-metallic components used on the Vehicle shall be smoke, flame and toxicity tested to NFPA 130, 49 CFR part 238 and BSS 7239, or Bombardier standard SMP 800-C;

B. Project Co shall retain a list of materials (flammability matrix) used in the Vehicles showing location of material, weight (density and total weight), heat value per kg and per Vehicle, flame spread, flashpoint, smoke generation, and toxicity. Project Co shall retain and manage test results for each component for the operating life of the Vehicle;

C. All heat sources on the Vehicle shall be protected with redundant levels of protection so that circuits are open before unsafe temperatures exist;

D. Smoke detectors and fire detectors shall be located throughout the Vehicle, including within the fresh air intake, engine compartments and water heaters (if provided). Upon activation, the detectors shall energize a signal in the fire alarm system. The location of the fire shall be sent to the alarm system. Fire suppression in the diesel engine compartment may be provided in lieu of heat detectors;

E. Fresh air dampers shall automatically close upon detection of smoke;

F. Protection from smoke and fire originating under the Vehicle floor shall be proven through testing documenting successful completion of a 30 minute floor fire test in accordance with ASTM E119, NFPA 130, and 49 CFR part 238; and,

G. An interior and exterior manual door release shall be provided for each side door.

(b) Project Co shall design and construct Safety analyses in accordance with the following:

(i) FMECA

A. Unless a similar document exists from a comparable new Vehicle in service, Project Co shall perform a FMECA to identify weaknesses in system-wide hardware and software design, and to analyze the modes and effects of failures whenever these details are not established by historical records of equipment operation. The FMECA shall provide input to system designs and to the safety analyses for theoretical circuit behaviour, random component failures, electrical

interference, systematic component failures, and software errors in software-based logic. The FMECA shall be updated throughout the system design development and throughout the operational life of the system.

(ii) Hazard Analysis

A. Unless similar documents exist from the new Vehicle family, a preliminary hazard analysis, a systems hazard analysis and a sub-system hazard analysis shall be prepared and submitted for review by the City.

B. Project Co shall identify failure-induced and normal operating (non-failure condition) hazards falling into severity Categories I, II and III (as defined in MIL-STD-882).

(c) Project Co shall design and construct Emergency tools and equipment in accordance with the following:

(i) Emergency tools shall be provided in all New Revenue Vehicles. The Emergency tools shall be located in equipment cabinets that are readily identifiable (visible) and accessible.

(ii) Tool cabinets shall be suitably enclosed, entirely recessed and shall be readily accessible by either Passengers or crew without the use of tools.

(iii) The Emergency tools and equipment shall include:

A. Fire extinguishers shall be located in each Passenger area and each cab. Extinguishers shall meet the requirement of Part XIII, of the On-Board Trains Occupational Safety and Health Regulations; and,

B. Wrecking tools suitable to the vehicle's fabrication.

(d) Project Co shall ensure that first aid supplies and equipment shall be available and accessible to Passengers, Train crew and ESP and shall consist of the following:

(i) A stretcher, first aid supplies and a trauma kit. The trauma kits shall contain twice the first aid supplies prescribed in Part XII of the On-Board Trains Occupational Safety and Health Regulations and shall include four flashlights, one armband, five pairs of latex gloves, five pocket masks, 10 one-way valve resuscitation mouth to mouth protectors, and one megaphone.

(e) Project Co shall design and construct the New Revenue Vehicles so that 16 Emergency egress/Emergency rescue windows shall be provided per Train along with two additional Emergency windows located in each cab area. The number of Emergency egress/Emergency rescue windows may be reduced during design review after consultation with Transport Canada.

(i) Windows shall be compliant to APTA-SS-PS-003-98 – Standard for Emergency Evacuation Units for Passenger Rail Cars.

(ii) Procedures for removal of the glazing in case of Emergency shall be indicated by pictographs mounted in conspicuous and clearly visible locations. Hammers shall not be provided.

(f) Project Co shall design and construct the New Revenue Vehicles so that roof Emergency access shall be provided in accordance with APTA-RP-C&S-001-98 – Recommended Practices for Passenger Equipment Roof Emergency Access. Each body section shall contain such a location, suitably marked.

1.13 Carbody

(a) Project Co shall design and construct the carbody in accordance with the following general requirements:

(i) The New Revenue Vehicle shall meet the structural and crashworthiness requirements of all the related standards and requirements outlined in this Part 8.

(ii) The carbody shall have a 40 year expected life. The carbody material shall have inherent corrosion protection. The proposed material for the body shell, structural beams and underframe shall be submitted for approval by the City.

(iii) The carbody shall be designed to achieve crash energy management per EN 15227 and/or FRA Tier I Alternative Compliance consistent with **[REDACTED]**.

(iv) The structural integrity shall be to EN 12663, P-II, or equivalent and protect the Operator and Passengers.

(v) Carshell Design features

A. A pilot beam shall be mounted onto each head face. The minimum load capability of the pilot beam shall be 300 kN at center and 250 kN laterally.

B. The body sides of New Revenue Vehicle shall be flat or include a designed curve. Deviations shall not exceed 2.5mm over 1m. Alternatively, surface quality may be reviewed visually and approved by the City.

C. Bellows between carbody sections shall be double walled. The outer wall shall be flush with the exterior sidewalls.

D. Roof drainage shall be managed and controlled. Water shall not flow over the sides of the New Revenue Vehicle or onto the Station Platform.

(vi) Thermal and Acoustical Insulation

A. All external surfaces shall have no less than 50mm of thermal insulation. Alternative levels of insulation will only be considered if the heating and cooling requirements can be met with the alternative level of insulation.

B. Condensation shall not occur on any interior or exterior surface under any temperature or humidity level, to the maximum extent possible. Where

condensation is unavoidable, parts where condensation may form shall be equipped with a drain.

C. Acoustical insulation shall be utilized as required to meet the noise requirements outlined in this Part 8.

(vii) Carshell structural features shall include:

A. A coupling speed up to 5km/h with no resulting damage to coupler or anchorage. Replaceable energy absorption components of the coupler shall be excluded from this requirement;

B. Provisions for Vehicle towing;

C. Component mounting to the carshell shall confirm to APTA SS-C&S-006-98, Std for Attachment Strength of Interior Fittings for Passenger Railroad Equipment (or EN12663 class P-II); and,

D. Sufficient jacking pads to allow New Revenue Vehicle jacking during Maintenance and in the case of derailment.

1.14 Crash Energy Management

(a) Project Co shall ensure that all New Revenue Vehicles shall be fitted with CEM systems.

(b) Project Co shall prove compliance with EN 15227 and/or FRA Tier I Alternative Compliance.

(c) Project Co shall conduct and submit a crash energy absorption analysis of the New Revenue Vehicle to assess the energy absorbing properties of the structure and the structural compatibility with the existing Vehicles. The analysis shall be subject to review and comment by the City as well as Transport Canada.

1.15 Fuel Tank Arrangement

(a) Each New Revenue Vehicle shall have a fuel tank that stores no less than 2600 liters of fuel.

1.16 Coupler and Draft Gear

(a) Project Co shall design and construct the coupler and draft gear in accordance with the following requirements:

(i) The New Revenue Vehicle shall include couplers on each end. Couplers shall be arranged to perform automatic coupling and resetting after uncoupling.

(ii) The couplers shall be Type 10 latch, as manufactured by Sharfenberg or equivalent. The centerline of the coupler shall be 1060mm above Top of Rail.

A. The coupler shall provide for mechanical coupling with the existing Vehicles.

(iii) The coupler shall be equipped with an energy absorption device and a shear off device that contains the coupler while allowing front end deformation under crash conditions.

(iv) The coupler shall:

A. Be a service proven design;

B. Use an automatic centering device that allows for coupling on curve;

C. Be equipped with a weather protective device to protect couplers from rain, ice and snow;

D. Include manual coupling/uncoupling lever(s);

E. Be equipped with heaters for coupler faces. Additional heaters shall be provided if they are required to ensure reliable operation in Ottawa climatic conditions; and,

F. Couplers shall be capable of retreating rearward in a crash to allow complete collapse of all 3 crash energy management zones.

1.17 Cab Equipment and Controls

(a) Full width cabs shall provide a spacious, ergonomic, Operator friendly environment. Project Co shall design and construct the cab to be separated from the Passenger area by a full partition and a lockable cab door. The cab shall provide the New Revenue Vehicle with an aesthetically pleasing, modern look. Large windows on all four sides of the cab shall provide excellent visibility to the Operator. Cabs shall be provided on each end of the Vehicle.

(b) Project Co shall design and construct the Operator's seat to be fully adjustable, heated and shall accommodate 5th percentile females and 95th percentile males. A foot rest shall be provided.

(c) Project Co shall ensure that all controls necessary to operate the New Revenue Vehicle, including low voltage circuit breakers, cut-out and bypass switches, are located in the cab. All controls shall be proposed by Project Co for review by the City.

(d) Project Co shall provide a mock-up of the proposed cab arrangement and layout.

(i) The arrangement and accessibility of the controls and comfort/visibility provided by the Operator's seat shall be reviewed and approved by the City during the mock up review. Ease of entering and exiting the cab as well as seating comfort behind the console shall be demonstrated.

(ii) Alternative approaches to mock ups, such as a review of existing models of the proposed Vehicle, may be proposed for consideration by the City, however, the City reserves the right to customize the cab layout as necessary to improve the interface and provide a seamless Operator experience with the existing and New Vehicles.

(e) Project Co shall design and construct the cab to be provided with:

(i) A Hinged cab door, arranged to allow quick emergency egress into the Passenger compartment (panic bar);

A. The cab door glazing shall be "one-way" or transparent to the Operator and opaque on the passenger side.

B. The door shall be fitted with a keyed lock. The tumbler shall match the Existing Vehicle Fleet so that a single key opens all cars in the fleet.

(ii) A full width contoured front windshield;

A. Designed to minimize glare and interior reflection.

B. Laminated safety glass, FRA Type 1 or UIC 651, clear.

C. Windshield shall be electrically heated with a watt density of no less than 0.08 watts/cm^2. The entire windscreen shall be heated.

(iii) Cab side windows;

A. Horizontal sliding or hinged panel on both sides of cab. Open adjustment shall be incremental

B. Tint visible light transmission shall be proposed by Project Co for approval by the City.

C. Latch easily operated by Operator.

D. Glazing to be dual-pane laminated safety glass.

(iv) Side windows; and

A. Fixed horizontal panels on both sides.

B. Maximized in size to contribute to the modern feel of the New Revenue Vehicle.

C. Glazing to be dual-pane laminated safety glass.

(f) Project Co shall design and construct cab controls in accordance with the following:

(i) Cab controls shall include all of the following at a minimum.

A. Clock configured such that all Revenue Vehicles show the same time;

B. Door status of the entire Train, as well as the status of each individual door shall be provided, either on the DDU or alternate location;

C. Sander switch shall be a momentary push button, not an on/off switch;

D. The indicator panel shall be provided with a backlight or alternative approach to provide clear visibility in bright sunlight;

E. Gooseneck for interior and exterior announcements;

F. Push to talk microphone for voice radio functions;

G. The headlight dimmer shall utilize a pushbutton;

H. Seals on all safety-critical cutout and bypass switches;

I. Coupler controls;

J. Silent alarm pushbutton;

K. Master controller;

L. Transfer switch/direction switch;

M. Alerter pushbutton;

N. Cab video display screens;

O. Dimming adjustment for all displays and LED indicators;

P. Communication control panel;

Q. Passenger door controls shall:

i. Be a momentary recessed push buttons that preclude accidental activation. (collar type pushbutton); and

ii. Illuminated when activated (Color coded as follows: open =green, close = red, enable = yellow);

R. A low voltage voltmeter with a range as applicable for battery voltage;

S. An odometer;

T. Ventilation, cooling and heating controls;

U. Cab heater, with direction adjustability and an outlet for the Operator's feet and cab side windows; and,

V. A recessed folding coat hook.

(g) Project Co shall include the following additional cab features:

(i) Emergency tool cabinets and fixtures as described in the Safety section of this Specification;

(ii) Full width (no less than 450mm) permanently fixed jump seat shall be provided in the cab. The arrangement shall provide back and bottom cushions;

(iii) A cup holder and storage locker shall be provided for the Operator. Arrangement of these components subject to agreement by the City. The locker shall provide a volume of no less than 7,000cc;

(iv) Cab video display screen(s);

(v) A DDU display screen;

(vi) Full width Sun visors that provide UV protection; and,

(vii) Irretrievable Emergency brake switch.

(h) Project Co shall design and construct vigilance device/alerter in accordance with the following:

(i) An alerter system shall be provided in the cab which shall ensure the continuous attentiveness of the Operator by monitoring selected cab activities. Activities may be proposed by Project Co for review and approval by the City.

A. The system shall initiate a penalty brake application if the Operator fails to institute a change of state in a monitored input or depress the alerter push button within a set time period.

i. Prior to a penalty application the system shall first illuminate a visual display for four seconds, then sound an audible alarm and illuminate a visual display for six seconds.

ii. The light alarm shall be perceivable from the Operator's seat at all times. Once activated, the alarm shall remain on until one of the monitored inputs has changed state. If no change of state occurs in any monitored input within 10 seconds, the alerter system shall initiate a penalty brake application.

iii. Foot pedals may be also be included as a vigilance device, provided that a change of state of the pushbutton is required and a constant force on the pedal is not an indication of Operator alertness.

B. The alerter timer shall be made inactive and the timing reset to zero whenever any of the following conditions occur:

i. Train speed less than 10 km/h

ii. The brakes are applied

iii. The cab is inactive.

(i) Project Co shall ensure that cab exterior appointments shall include, but not be limited to the following:

(i) Windshield wipers:

A. Windshield wipers shall be full width and arranged to park outside of the Operator's field of view.

B. Wiper blade shall be heated, or an alternative method shall be proposed to prevent freezing of blades.

C. Electrically operated (operable in the Lead cab only);

D. Speed control which includes off, low, high and adjustable Intermittent

(ii) Windshield washers with no less than 15 litres of washer fluid capacity.

(iii) 100dBA Horn with snow deflecting cone.

(iv) 85dBA Bell – type EBE, or alternative proposed for acceptance by the City

(v) Lighting in accordance with this Part 8.

1.18 Passenger Doors and Controls

(a) Project Co shall design and construct each Passenger body section to include no less than two dual-leaf doorways per side. Doorways shall provide a clear opening width of no less than 1300 mm and height of no less than 2150 mm.

(b) Project Co shall design and construct the New Revenue Vehicle to be equipped with threshold extensions (if required) to achieve ADA/AODA compliance as required in Clause 1.2(f) of this Part 8.

(c) Project Co shall design and construct the door system to be the bi-parting sliding leaf type using high reliability Overhead electric operators. Doors shall be arranged to ensure that the Platform may not be fouled under any circumstances.

(d) Project Co shall design and construct the following door operator design features

(i) The operator shall be a service proven design with a history of reliability without the need for Maintenance and adjustment. The door mechanism shall be suitable for operation in cold temperatures as well as snow and ice storms. The operator shall be sufficiently powered to open with 3mm of freezing rain developed on the door panels and seals.

(ii) The door operator shall be a simple, safe design employing interlocking relay logic to prevent unintended operation. The door operator shall also be interlocked with the no-motion relay.

(iii) Door panels shall be closed and locked out of service with a mechanical lock which is independent from the motor and mechanically prevents panel movement. The lock shall cut out door motion, provide a close and locked indication to the door summary loop and energize a door out of service sign on both interior and exterior locations.

(iv) Door control operators shall provide the ability to adjust open and close time intervals using the PTU. Timing shall be set to match the existing Vehicles.

(v) The door closing force shall not exceed the limits specified in APTA SS-M-18-10 or equivalent specification. Pressure sensitive obstruction detection or motor current monitoring shall automatically open the doors when an obstruction is encountered. The obstruction detection system shall stop the affected panel from closing when an obstruction is detected, fully reopen and recycle.

(vi) The maximum force needed to open the doors manually shall not exceed 75N.

(e) Project Co shall design and construct the following door panel design features

(i) The door panels shall be designed to blend seamlessly with the New Revenue Vehicle exterior. Panel design shall meet the following requirements:

A. Be fitted with dual-pane laminated safety glass windows. Window to be aligned with Passenger side windows and tinted to match; and

B. Be provided with interior and exterior Passenger pushbuttons in compliance with AODA and ADA to allow individual door control when enabled.

(f) Project Co shall design and construct door controls in accordance with the following:

(i) Doors shall be operable via pushbuttons in the cab (open, close, door release enable, door release disable), trainline signals and local door open pushbuttons, depending on the mode set up within the consist.

(ii) A Door release feature shall release door control and illuminate a “Door Open” LED pushbutton at each active door, in the interior and exterior of the New Revenue Vehicle allowing Passengers to open individual doors by pressing the “Door Open” button. A pictogram shall indicate the function of the pushbutton switch. Pushbuttons out of service will not display energized LEDs.

A. Light barriers shall be fitted on each doorway. Six seconds after the last Passenger has passed the light barrier, the door shall commence closing. The timing of the device shall be adjustable.

(iii) Crew switches shall have the capability to cycle the doors. Interior and exterior crew switches shall be installed on the inside and outside of all doors.

A. Crew switches shall be housed behind a lockable door.

(g) Project Co shall include the following Passenger door safety features:

(i) Door control on each car shall be interlocked with the no motion detection system on that car.

(ii) Door operator design shall include a safety device to ensure doors recycle after contact with a 19mm round object or 9.5mm thick by 75mm wide object inserted at any height.

(iii) Doors closed and locked status shall be interlocked with propulsion to prevent movement when a door is open.

(iv) All doors shall have a mechanical Emergency release mechanism inside and outside the Vehicle. Actuation of any door release shall activate the nearest PEI.

(v) Door operators shall have a cut-out that locks the door and completes the door closed summary loop.

(vi) Each doorway system shall have an audio and interior/exterior visual warning while open and during closing. The City will provide the sound requirements for the opening, closing and obstacle detection sounds.

(vii) Marker lights and brake lights shall flash whenever doors are open.

1.19 Heating, Ventilation and Air Conditioning

(a) Project Co shall design and construct the HVAC equipment to provide safe, reliable climate control in accordance with the climatic and environmental conditions outlined in this Part 8. The system shall utilize microprocessor controls to automatically control interior temperatures (both in the cab and Passenger area) and prevent snow or ice or water from accumulating on the New Revenue Vehicle floor or the thresholds. The system shall incorporate a layover mode to maintain moderate interior temperatures when New Revenue Vehicles are not in Revenue Service.

(b) Project Co shall design and construction the HVAC system in accordance with the following:

(i) The system shall be designed to prevent condensation forming on the windows at any time during Revenue Service when cooling is available. A reheat mode shall be incorporated to achieve this requirement.

(ii) The HVAC units shall be roof-mounted, fully unitized packages with a height that meets the roof equipment height limits.

(iii) Watertight and leak-proof seals shall be provided between carbody and HVAC unit return and supply air interfaces.

(iv) The refrigerant circuit shall be hermetically sealed system charged with non-ozone depleting refrigerant. Refrigerant shall comply with all applicable Canadian standards and laws.

(v) 12 m^3/hr of fresh air per Passenger at AW2 shall be provided. Fresh air dampers, or equivalent, shall allow a quicker warm-up or cool down during initial start-up by limiting fresh air.

(vi) The HVAC heating system shall be arranged to operate in stages. The system shall use duct sensors to keep supply air within 8°C of return air temperature.

(vii) Temperature stratification shall be limited to 3°C within any vertical or horizontal plane.

(viii) Over-temperature safety protection shall be:

A. Self-resettable thermostats that disable control voltage to the heater contactors; and,

B. Fusible link(s), or equivalent, to protect the system in the event of a failure of the over-temperature thermostat.

(ix) The system shall be designed to maintain interior conditions between 19°C and 22°C with 1% design conditions for cooling and 99% design conditions for heating as defined in ASHRAE fundamentals handbook. Design conditions include AW2 passenger loads and worst case solar loads and fresh air loads, as well as all equipment heat loads.

(c) Project Co shall design and construct the HVAC controls in accordance with the following:

(i) The HVAC controller shall allow software adjustments and modification to settings, including a ±2°C setpoint adjustment for all switching points. Setpoint accuracy shall be ±1.0°C.

(ii) Setpoints shall be easily adjustable. Project Co shall adjust the setpoint as directed by the City

(d) Project Co shall design and construct the following additional HVAC features:

(i) Emergency shutdown switch for HVAC system (per car and consist control) shall be located in the cab.

(ii) Emergency fresh air damper close switch (per car and consist control) shall be located in the cab.

(iii) A layover mode to maintain interior temperatures between 4°C and 8°C. (Dampers shall be closed during layover).

(iv) A positive interior pressure shall be maintained at all times and at all New Revenue Vehicle speeds.

(e) Project Co shall design and construct the floor heat system in accordance with the following:

(i) No less than 15 kW of floor heat shall be provided per body section. The heat shall enter the New Revenue Vehicle through baseboard heat registers throughout the Vehicle.

(ii) The entire heater shall be fabricated from stainless steel or anodized aluminum, including enclosure and grilles.

(iii) The grilles/heater guards shall be designed to prevent Passenger exposure to unsafe surface temperatures (greater than 52°C) and electrical connections.

(iv) Threshold heaters shall also be provided as part of the floor heat system. These heaters shall be sized to keep snow and ice from accumulating at the doorway or affecting the

operation of the door system. Thresholds shall be arranged to allow drainage of melted snow and ice.

(f) Project Co shall design and construct the cab system in accordance with the following:

(i) The HVAC equipment within the Operator's cab shall consist of:

A. An electrically heated windshield;

B. Overhead air diffusers with volume and directional adjustability; and

C. Thermostatically controlled cab heater(s) with the following features:

i. OFF-LOW-HIGH rotary switch for air speed/volume control of both cab heaters;

ii. Manual adjustment to direct airflow to floor, cab side windows, or both;

iii. Heater noise level in HIGH speed not to exceed 72dBA;

iv. Cab heater surface temperatures shall not exceed 52°C; and,

v. Over-temperature protection shall include:

1 An over-temperature thermostat which shall automatically cycle the heater contactors upon excessive temperatures; and

2 Failure of the over-temp thermostat shall cause a manually resettable shunt trip breaker to open power to the heaters. Manual reset switch shall be easily accessible to the Operator.

1.20 Lighting

(a) Project Co shall design and construct the lighting system to consist of all interior lighting, exterior lighting, and indicators. The design shall provide lighting with a minimal degradation of color or luminosity over time. Safe levels of lighting shall be provided in the event of Emergency conditions.

(b) Project Co shall design and construct the Lighting system to:

(i) Be LED based, operating entirely from the New Revenue Vehicle low voltage system;

(ii) Have two luminosity levels for the main interior lighting: normal and Emergency;

(iii) Be configured so that lighting throughout the Train can be controlled from the lead Vehicle; and,

(iv) Provide lighting levels in Passenger compartments and at doors compatible with AODA/ADA requirements.

(c) Project Co shall design and construct the interior lighting in accordance with the following:

(i) The main lighting fixtures shall use LED cluster modules operating from the low voltage distribution network.

(ii) The interior Emergency lighting shall use LED modules operating from the New Revenue Vehicle battery.

(iii) LLEPM shall be provided along the aisle and vestibules leading to the doorways (for wayfinding in case of an Emergency), utilizing a HPPL material strip embedded into the floor (or LED lighting).

(iv) An interior LED indicator light shall be provided over each door to indicate that the door is not closed and locked.

(v) An LED backlit sign shall be provided over each side door to indicate when the door is locked out of service.

(d) Project Co shall design and construct the cab area lighting in accordance with the following:

(i) LED indicator and instrument lighting shall be provided.

(ii) Overhead lighting shall be provided using dimmable and directionally adjustable lights.

(iii) LED cab equipment compartment lighting shall be provided.

(iv) Overhead and equipment compartment lighting shall be included in the Emergency lighting system.

(e) Project Co shall design and construct the cab exterior lighting in accordance with the following:

(i) The following exterior lighting shall be LED type, visible in all natural and artificial lighting conditions:

A. marker lights;

B. tail lights;

C. Brake cutout lights;

D. Exterior fault lights;

E. Door open LED indicator light at each door; and,

F. Additional indicator lights as necessary.

(ii) Headlights shall have high and low beam functionality.

(iii) A third, forward facing headlight shall be provided at the center line of the New Revenue Vehicle, above the cab to distinguish the Vehicle from other types of vehicles.

(iv) Headlights shall conform to Transport Canada requirements (200,000 candela) and shall be aligned to centreline in the horizontal plane and adjusted to strike the rail at 244m.

(v) Headlights, tail lights and brake lights intensity shall meet all requirements of Canadian Motor Vehicle Safety Regulations, Technical Standard 108.

(f) Project Co shall design and construct the lighting controls in accordance with the following:

(i) All lighting controls switches and circuit breakers shall be located in the cab area. Alternative locations may be acceptable provided that the Operator can access breakers with a key turn without the need for any other tools.

(ii) Passenger compartment lighting control shall be a trainline control function from the control panel on the lead car.

(iii) Cab lighting shall be controlled through a switch with dimmer control.

(iv) Equipment locker lighting shall be controlled by a switch on the control panel and a limit switch actuated by the locker door.

(v) A dimmer switch shall be provided to control the intensity of indicator panel back lighting.

(vi) Control of headlights, tail lights, brake lights, and marker lights shall be interlocked with the direction trainlines and coupler loop switches so that head lights, tail lights, brake lights and marker lights shall only be active at ends of the Train in accordance with Train direction.

(g) Project Co shall ensure the following performance is achieved:

(i) The cab and Passenger area lighting intensity shall meet as a minimum, the requirements of EN 13272 or equivalent.

A. Lighting levels shall be proposed by the Project Co and shall provide adequate lighting levels for day time and night time conditions while minimizing glare.

(ii) Emergency lighting shall be available for 60 minutes after loss of the low voltage power supply and shall meet or exceed the minimum illumination requirements of APTA SS-E-013-99, Rev. 1.

(iii) LLEPM shall meet APTA standard SS-PS-004-99 Rev. 2.

(iv) Amber marker lights shall be activated on the front of the lead car when the master controller is in the forward position.

(v) Marker Lights, tail lights and brake lights shall operate as follows:

A. Red marker lights and tail lights shall be activated on the last car at all times;

B. Brake lights shall be active on the last car when the Train brakes are applied;

C. Red marker lights and red tail lights shall be active on the front of the Train when no direction is selected; and,

D. Marker lights and brake lights shall flash when the Train is stopped and the doors are open. Marker and brake lights shall also flash when the Master Controller is in the reverse position.

(vi) Interior Passenger and cab lighting shall time out in 20 minutes after the New Revenue Vehicle is turned off.

(vii) Exterior New Revenue Vehicle door status lights shall be visible from both the longitudinal and transverse directions.

(h) Project Co shall design and construct the auxiliary power in accordance with the following:

(i) Auxiliary power units shall include:

A. 3 phase 60Hz AC power units to supply power for HVAC, blower motors, compressors, fans, etc.; and.

B. LVPS to provide low voltage DC power for control systems, and battery charging, lighting, etc.

(i) Project Co shall design and construct the battery in accordance with the following:

(i) No less than two battery sets shall be provided per New Revenue Vehicle.

(ii) Batteries shall be rated at a minimum of 80 Ah at 110V.

(iii) The battery shall be protected by a fuse and a positive and negative side disconnect switch and over voltage protection.

(iv) The batteries shall be heated.

(v) The battery compartment shall be ventilated sufficiently to prevent build-up of explosive levels of hydrogen gas.

(vi) The batteries shall be sized to power the following loads for 90 minutes:

A. Train radio;

B. Interior Emergency and interior cab lighting;

C. Exterior marker lighting; and,

D. PEI, PA, speakers and announcement signs.

(vii) The batteries shall be sized to power the following loads for 30 minutes:

A. Passenger doors (single cycle);

B. CCTV;

C. TCMS;

D. Windshield wipers;

E. Fire protection systems; and,

F. Instrument lighting.

(j) Project Co shall design and construct the AC and low voltage distribution in accordance with the following:

(i) All AC and low voltage DC circuits shall be circuit breaker protected.

(ii) Low Voltage DC and AC Circuit breakers shall be located in locked enclosures in the cab. Alternative locations may be acceptable provided that the Operator can access breakers with a key turn without the need for any other tools.

(iii) All AC and DC circuit breakers shall meet the requirements of IEEE Std C37-13 and IEEE Std C37-14 respectively. Alternate arrangements that comply with the following IEC standards will be accepted: IEC 61373, IEC 60898-1, IEC 60898-2, IEC 60947-2 and IEC 61009.

(iv) The low voltage DC system shall be grounded in a manner which prevents differences in potential between cars caused by traction return currents from interfering with trainline signals.

(v) Galvanically isolated, ground fault protected single phase 120VAC 60Hz power shall be provided to cab and Passenger compartment outlets as needed for cleaning and for New Revenue Vehicle Maintenance Activity.

1.21 Propulsion Control

(a) Project Co shall design and construct the propulsion control to:

(i) Be based upon networked and trainlined tractive effort and braking effort commands with load-weigh compensation to provide consistent acceleration and braking rates regardless of Passenger loading;

(ii) Detect and correct spins and slides in coordination with the friction brake and traction control system;

(iii) Request sanding control to apply sand in front of both wheels of the leading axle when wheel spin or slide exceeds a pre-set level;

(iv) Monitor direction, propulsion and braking control and friction brake status trainlines and inhibit or shutdown propulsion in case of conflicts;

(v) Provide fault recording and diagnostics for system troubleshooting and report faults to the DDU.

1.22 Bogies

(a) Project Co shall design and construct each New Revenue Vehicle to be supported by four wheeled Bogies.

(b) Project Co shall design and construct the Bogie components in accordance with the following:

(i) Shall be either cast steel or fabricated/welded steel construction. Components may be made from cast iron if service proven components have a record of satisfactory operation in climates similar to Ottawa. Cast iron, if proposed shall be:

A. Ductile spheroidal graphite cast iron EN-GJS-400-18LT-LT

B. Designed for temperatures to as low as -40°C.

(ii) The secondary suspension shall be controlled by a levelling valve to fulfill AODA/ADA level boarding requirements.

(iii) Secondary suspension shall include dual check valves to ensure even deflation in case of a failure.

(iv) Secondary lateral and vertical dampers shall be used.

(v) Wheel profiles shall be identical to those provided on the existing Vehicles. Alternative proposals may be considered by the City, so long as rail wear is consistent between the New and Existing Vehicle Fleets.

(vi) Allowable wheel wear shall be no more than 30mm on the radius. A location for shimming shall be provided.

A. Project Co shall provide a description of the method used to shim the Revenue Vehicles and the expected time required to perform the task.

(vii) A flange lubrication system shall be provided.

(viii) Axles shall be designed in accordance with AAR M-101, APTA RP-M-001-98, or UIC 515-3, or equivalent.

(c) Project Co shall design and construct the Bogie motion control in accordance with the following

(i) Primary suspension strokes shall never be exhausted under any condition of dynamic operation, New Revenue Vehicle weight, weight variation and suspension creep.

(ii) Primary and secondary vertical and lateral stops shall be fabricated from replaceable elastomeric bumpers.

(iii) Equalization shall be such that with the car on level Track under an AW0 load, lifting or dropping any wheel up to 38mm shall not change the load on any other wheel of the car by more than 60%.

(iv) Raising or lowering any wheel up to 50mm shall not result in loss of contact between any of the other wheels on the car and the rail.

(d) Project Co shall conduct stress analysis in accordance with the following:

(i) For the service proven New Revenue Vehicle, stress analysis and FEA results from a previous contract shall be submitted for review and consideration by the City.

(e) Project Co shall ensure the following design ride quality:

(i) A ride quality test shall be performed. The ride quality provided shall be equivalent to or superior to the City's existing vehicles.

(ii) The methodology used to evaluate ride quality shall be ISO 2631 (latest edition), in the frequency range of 0.5 to 80Hz. Limits are valid for three axes.

1.23 Brakes

(a) Project Co shall design and construct the brakes in accordance with the following

(i) The New Revenue Vehicle shall be equipped with a dynamic brake system as well as a friction brake system.

(ii) The braking system shall be designed to operate on the Expanded Trillium Line alignment, which includes 11 stations and a round trip time of 62 minutes. Project Co shall provide proof that the system has the capacity to manage this duty cycle under all conditions.

(iii) Brake cycle design compliance shall be based on the head way and dwell times as described in Schedule 15-2, Part 1, Article 3 – Operational Performance Requirements, with AW3 passenger loading

(iv) Alternative solutions may be proposed for consideration by the City.

(v) Disc Brakes and Calipers

A. A disc brake system shall be provided for all axles of all Bogies.

B. Disc rotors shall have a wear limit indicator.

(vi) Friction Brake Control Unit

A. The disc brakes of each Bogie shall be controlled by a FBCU for that Bogie.

B. The FBCU shall be physically independent or integrated with propulsion logic provided that the level of Safety, Reliability and Availability is the same as with an independent unit.

C. The FBCU shall:

i. Read and interpret trainline requests and load-weigh transducers;

ii. Communicate over a direct link with the propulsion system for that Bogie;

iii. Read the dynamic braking effort signal from the propulsion system and command the friction brakes to provide the difference between braking request and the braking effort supplied by propulsion;

iv. Take over if the TCU cannot control a New Revenue Vehicle slide within a pre-set time;

v. Request the sanding system to apply sand during low adhesion;

vi. Include a means to initiate safety self-checks of the brake system and default to a restrictive state in case of failure;

vii. provide roll back protection when the New Revenue Vehicle is starting from a dead stop, in coordination with the propulsion system;

1 The roll back prevention function of the FBCU shall be coordinated with propulsion to prevent any rollback on the absolute maximum grade for the Expanded Trillium Line, or 4%, whichever is greater.

viii. Provide fault recording and diagnostics for system troubleshooting;

ix. Provide a brake application and inhibit Train propulsion when air pressure falls below a level required to provide a friction only AW3 Emergency brake stop;

x. Control braking to provide the total trainline braking request in case of failure of the propulsion system to provide electric braking or in case of communications failure with the propulsion system;

xi. Default to safe operating mode if a failure of the load weigh sensor occurs on the Bogie; and,

xii. Distinguish between speed sensor failures and New Revenue Vehicle slides.

(vii) Sanding System

A. A sanding system shall be provided that shall deposit sand at the wheel rail interface of the lead axle of each New Revenue Vehicle in the Train.

B. The air system powering the sander shall store sufficient compressed air that it is capable of 20 seconds of sand application without running the air compressor.

C. Sand boxes and nozzles shall be heated and have a volume of no less than 20 litres.

D. Sanders shall be activated during spinning or sliding events and continuously down to zero speed during any emergency brake application.

E. A momentary switch shall be provided on the console to manually activate sanding.

1.24 Communications and Passenger Information System

(a) Project Co shall design and construct all equipment needed for wireless communication between Revenue Vehicles and TOCC. Project Co shall arrange interfaces for this data to facilitate the communication by Project Co's equipment.

(b) Project Co shall design and construct the system in accordance with the following system functional requirements

(i) Provide synchronized audio and visual Passenger information announcements and shall include, at a minimum destination, Station stops, time, Emergency announcements.

(ii) Coordinate Emergency announcements on the New Revenue Vehicle with station announcements so that station and Vehicle announcements do not compete.

(iii) Provide a Passenger Emergency intercom system.

(iv) Provide reliable voice communications with the TOCC.

(v) Provide a CCTV video monitoring and recording system.

(vi) Provide fault recording and diagnostics for system troubleshooting.

(vii) Include a silent alarm reporting function.

(viii) Train Voice Radio

A. The Revenue Vehicle's PA system shall provide, as required, power, analog and digital interfaces and connections to the P25 radio system.

B. The radio, antenna and any other equipment needed to integrate the radio into the Revenue Vehicles shall be provided, installed and tested by Project Co.

C. The radio system shall be as detailed in Clause 5.4(b) of Schedule 15-2, Part 3 - Systems.

(ix) Public Address System

A. The PA system shall accept input from the Operator's cab microphone, patched through TOCC announcements, and the automatic announcement system.

i. TOCC and cab input shall take priority over automatic announcements.

B. The PA system shall automatically compensate for ambient noise.

C. The PA control shall emit an activation chime different from the door chime before any announcement.

D. The PA system shall have both internal and external speakers. External speakers will not be active unless selected.

E. Automatic selection of the correct side for external speaker activation based on location of the Station Platform shall be provided.

(x) Cab to Cab and Passenger Emergency Intercoms

A. PEI units shall be installed at all accessible areas in the car and at the cab walls.

B. PEI and cab-to-cab intercom systems shall have a session hold function with ability to transfer between PEI and cab-to-cab sessions.

C. Once activated, the PEI stations shall require no further intervention by the Passenger to communicate with the Train. PEI stations shall meet ADA and AODA requirements and be provided in each accessible area in the New Revenue Vehicle

D. A view from the CCTV camera with the best view of the first PEI activated and a longitudinal view of that car shall be automatically transmitted to the CCTV display in the active cab once zero speed is reached. Queuing of multiple PEI or cab-to-cab intercom calls shall be possible.

E. The PEI system shall permit a Passenger speaking at a distance of 50cm from the PEI unit in a normal tone of voice with ambient noise levels up to 85dBA to be heard. Total harmonic distortion through the system from microphone to cab handset shall be less than 2%.

F. The Passenger interface and functionality of the PEI shall be consistent with the City's LRV fleet.

(xi) Radio and Intercom Control Panel

A. The Communications System control panel radio handset shall by default connect to the Train voice radio.

B. Pushbuttons shall be provided to connect the handset to the cab-to-cab intercom and PEI systems.

C. Controls shall be provided to adjust the volume of the radio, and intercom speakers and handset volume above a pre-set minimum level.

(xii) Automatic Announcement System

A. The automatic announcements shall provide pre-recorded simultaneous voice and visual announcements over the Train PA system and the transverse announcement signs located in each body section of all Revenue Vehicles.

B. Station and connection announcements shall be provided as the Train enters each Station. Pre-recorded announcements shall be determined during design review.

C. Pre-recorded special announcements may be selected from the Communications Systems control panel at any time and override any other messages.

D. The cab system may make direct announcements at any time over the PA system using the gooseneck microphone and a control switch.

E. The system shall have the capability of transmitting TOCC announcements.

F. Station announcements shall be triggered based on Revenue Vehicle's location.

G. All automatic announcements shall be made in English and French.

H. Project Co shall provide the equipment and software necessary to create content for use on the system.

I. Project Co shall propose a design that provides integration of the Confederation Line and Expanded Trillium Line announcement systems, for approval by the City.

J. The current Existing Trillium Line fleet uses a Passenger information system provided by **[REDACTED]**. If an alternate system is proposed that meets these functional requirements, Project Co shall supply a hardware and software package to enable editing and updates to the onboard messages. City approval shall be required on alternative solutions.

(xiii) Announcement Signs

A. LED Passenger announcement signs shall be visible throughout all of the Revenue Vehicles, so that Passengers may read a sign from any seated or standing location.

B. The announcement signs shall be controlled by the automatic announcement system from the lead Revenue Vehicle in the Train over the Train communications network.

C. Signs shall display longer messages by sequencing rather than scrolling.

D. The system shall have the ability to display 30 characters with a character height compliant to ADA/AODA for all Passengers on the Revenue Vehicle.

E. Signs shall display time of day (military time) when not displaying a message.

(xiv) LCD Displays:

A. One LCD display shall be provided per vestibule in New Revenue Vehicles. The display shall be used to indicate each Station stop, highlighting current station and upcoming stations.

B. The LCD display system shall also display information about connections, service delays, elevators out of service, indicate and highlight next stop, and provide the time of day.

C. The LCD display system shall display time countdown messages for upcoming Stations and provide time countdown messages for the destination Station.

D. The LCD display system shall only be powered when the interior lighting trainline control is active and the Passenger area temperature is above 10 °C.

E. The LCD display system shall have a minimum of 16GB of solid state drive data storage.

F. Project Co shall provide a software editing package to enable the City to make changes to the system as required.

G. The LCD displays shall:

i. Be housed in tamper proof enclosures;

ii. Be equipped with an Ethernet port to receive content from the media controller;

iii. Be ruggedized to withstand the shock and vibration of a rail transit environment;

iv. Be no more than 88mm deep;

v. Have a viewing area diagonal of 17 inches or greater;

vi. Have a high reliability, long service life, LED back light;

vii. Have intensity sensing and compensation for brightness and contrast;

viii. Have adjustable resolution up to minimum of 1280/720 pixels; and,

ix. Be capable of operating between -20 °C and + 70 °C.

H. The size and layout of the display shall be proposed by Project Co for review and approval by the City.

I. Thin film transistor displays may also be proposed for acceptance by the City.

(xv) Passenger information control panel

A. An Operator's Passenger information control panel shall be provided to allow the Operator to select pre-recorded announcements over the PA and to select destinations in case of the automatic system's failure.

B. The Operator's Passenger information control panel shall also display failure of PA sign or PEI equipment in any New Revenue Vehicles in a Train.

C. The Passenger information control panel shall be either an independent unit or a sub-screen of the DDU.

(xvi) Destination Signs

A. One external electronic destination sign shall be provided and installed at the cab end of each New Revenue Vehicle and one on each side of each body section of the Vehicle.

B. The destination sign control shall automatically display the correct destination of the Train based on Train travel direction and location.

C. When a Train enters a terminal location the destination signs shall reverse direction as soon as the Train comes to a stop unless this action is overridden. The "Out of Service" message shall also be able to be selected.

D. Destination signs shall only display English.

(xvii) Security Alarm System

A. A pushbutton switch shall be provided in the cab compartment of Revenue Vehicles to activate the silent alarm.

B. Pushbutton location shall be determined during review of the cab mock-up.

C. Activation of the silent alarm shall:

i. Cause an alarm message to be sent over the Train radio system to the TOCC. This alarm message shall include the Revenue Vehicle number where the alarm was activated; and,

ii. Cause a tag message to be sent to the NVR of the Revenue Vehicle where the alarm was initiated to prevent overwriting of the video data.

(xviii) CCTV and Network Video Recorder System

A. Interior cameras within the Passenger compartment shall provide full coverage of the interior areas of the Revenue Vehicles. Cameras views shall cover the entire Passenger area such that there are no blind spots.

B. Cab forward facing and cab interior facing (Operator's seat and console) cameras shall be provided.

C. The network cameras shall be directly networked to the NVR.

D. The system shall be arranged to comply with Ottawa's Transit Network Access and Privacy Policy.

E. The Platform mounted cameras that capture the Platform edge view of all doors shall be displayed on the cab monitor(s). The views shall display in the cab when the cab is active and the Revenue Vehicle is stationary.

i. Alternatively, Revenue Vehicle side mounted cameras may be used to monitor all doors on the trainset. One camera per body section shall be provided.

F. When the Revenue Vehicle comes to a stop, the display shall show the views from the Platform cameras that capture the doorways of the Revenue Vehicle or consist of vehicles. When a Passenger intercom button is pushed, the camera that captures the particular PEI shall be displayed.

G. The Operator shall have the ability to toggle between camera views or display all views when the Train is stopped. The PEI call shall take precedence over any other views.

H. Cameras shall stream video adjustable up to 30 frames per second. Triggering the silent alarm shall set recording to 30 frames per second for an amount of time defined by the City.

I. Cameras and NVR shall be powered from the low voltage DC power with necessary DC to DC isolation converters.

J. A means shall be provided to determine if the camera has been tampered with or vandalized, or if the camera has failed.

K. Means shall be provided for the City to access real time video data in the event of an emergency.

L. Project Co shall provide a CCTV system that communicates and downloads all images to the wayside system. Project Co shall provide the on-board equipment required for communication to the wayside.

(xix) NVR

A. The Revenue Vehicles NVR shall be networked into the communications network to provide video feeds to the Operator, displayed on the CCTV cab video display.

B. Each NVR shall have storage capacity sufficient to store 30 days of video data from the attached cameras without overwriting. The storage device shall be shock and vibration hardened for rail transit duty.

C. The NVR system shall safeguard and maintain authenticity of the video images using security techniques such as digital image watermarking or encryption and shall be able to demonstrate a chain of custody for data that will be used as evidence in a court of law. When a tag is activated, the NVR shall prevent the video data from being overwritten for 60 days.

D. Activation of the silent alarm shall insert a tag in the files of all recording units in the Train.

E. Activation of any PEI shall activate the camera that captures the PEI location and initiate recording of the communication.

F. Data collected by the NVR shall be automatically downloaded each time the Revenue Vehicle enters the New Walkley Yard.

G. The NVR system shall be coordinated with the wayside system for communication and downloading. Project Co shall provide and install the equipment required for wireless communication.

(xx) Cab Video Display

A. The cab video display shall be energized only in the active cab of Revenue Vehicles.

B. The cab video display shall not display any images until the Train reaches zero speed. The video shall remain active for 10 seconds after departure.

C. Upon Station arrival, the cab video shall automatically activate a view of the Platform doors in order to enable the Operator to monitor Platform edge safety. The monitor shall be independent of other cab displays.

(xxi) APC System

A. The APC system provided by Project Co shall be an Infodev EDI solution in order to match the Existing Vehicle Fleet and provide seamless data integration.

i. It shall be capable of counting Passengers at each doorway with a minimum accuracy of Alstom Lint % as tested by the City, together with precise stop activity location/time points.

ii. Door dimensions shall be confirmed with the APC supplier during design review in order to provide correct sensor sizing.

iii. Project Co shall ensure that the APC sensors are mounted at all Passenger doorways at the precise location for maximum accuracy, with the assistance of the APC system supplier.

iv. Sensor bars shall be painted according to interior paint code.

v. The Current installed equipment includes Infodev GW-400B computer module and DA-400 sensors. Project Co's proposed solution shall be provided to the City for review and approval.

vi. Project Co shall supply the required power, I/O signals (door switch activity), and direct Ethernet connections from each APC unit to a provided cellular router unit (Digi WR44RR).

vii. The APC system shall have non-volatile memory capacity to store Passenger data for all doors for eight days assuming 20 round trips per day.

viii. The data collected by the APC shall be recorded and remotely available in real-time, or at each Station, as a minimum.

ix. Data collected by the APC shall be automatically downloaded each time the Vehicle enters the New Walkley Yard.

x. The APC system shall have a diagnostic and fault recording system and shall report failures to the DDU.

xi. Diagnostics shall be remotely available over the communications network.

(xxii) Onboard Cellular Modem

A. An onboard cellular modem shall be provided to provide GPS locations to the onboard NVR and onboard APC equipment and to enable remote access to the NVR and APC.

B. For information, the existing Vehicles are provided with a Digi Transport LTE modem with antennas for GPS and cellular connections.

1.25 Interior Appointments

(a) Project Co shall design and construct the interior appointments in accordance with the following:

(i) Seats

A. The seating shall be arranged with a combination of transverse and longitudinal seating throughout the length of the New Revenue Vehicle and to accommodate ADA/AODA required floor space.

B. Flip seats shall be provided adjacent to all vestibules to provide clear floor space to accommodate wheelchairs, baby carriages, bicycles and the other Passenger requirements. Flip seats shall be arranged to revert to the stowed position with less than 20N of force. Lowering the flip seats into position shall require not more than 40N.

C. All seats adjacent to windscreens as well as accessible areas shall be designated "Priority seating" and shall be fitted with signage depicting the International Symbol for Accessibility (ISA), along with language indicating priority seating for elderly/persons with disabilities. Signage shall be located on the side wall above all seats designated for this purpose as well as at the accessible areas.

D. Seats shall be contoured with rail transit grade cushion and a vandal resistant material.

E. Seats shall have a minimum width of 420mm.

F. Fabric, cushioning and all aesthetics shall be subject to review and approval by the city

G. Seats shall be arranged knee to back transverse with a minimum pitch of 750mm. Face to face seats shall only be utilized at Emergency windows and with the approval of the City.

H. An Accessible location shall be provided directly adjacent to each vestibule.

(ii) Stanchions, Handrails and Grab Bars

A. Hand holds, grab bars and stanchions shall be arranged such that all standees have an accessible support.

B. Stanchions shall be placed to not interfere with Passenger flow during boarding / alighting. Stanchions shall be powder coated yellow RAL Classic 1023.

C. Handholds shall be provided in the accessibility seating areas.

(iii) Miscellaneous Interior Equipment

A. Draft screens shall be fitted on each side of each doorway. Design of screen shall be subject to approval by the City

B. The floor panels shall be of phenolic composite construction. They shall be at least 19mm thick and comprised of upper and lower fiberglass fabric reinforced skins, impregnated with a phenolic thermosetting resin.

i. Alternative arrangements may be proposed for consideration by the City.

C. The floor covering shall include the following:

i. High friction material in both wet and dry conditions; and,

ii. Smooth surface (non-ribbed or dotted).

D. Miscellaneous interior appointments shall include:

i. Advertising card frames for ceiling corners, side walls, and end walls;

ii. Locked convenience outlets for car Maintenance (110 VAC);

iii. Signage placed adjacent to the accessible space and denote priority seating for persons with disabilities;

iv. Additional interior graphics/signs/instructions in Canadian English and French in consultation with the City; and,

v. Emergency and car number information in Braille. General interior signage shall be submitted for review by the City.

1.26 Exterior Design

(a) Project Co shall design and construct the exterior of the New Revenue Vehicle to be sleek, modern and attractive. All electrical and mechanical equipment shall be concealed behind easily replaceable roof shrouds, Bogie skirts or cab side skirts.

(b) Project Co shall design and construct the exterior of the car in accordance with the following:

(i) Exterior

A. Exterior Appointments shall include:

i. Tinted, dual-pane, laminated safety glass Passenger side windows;

ii. Exterior speakers next to each Passenger side door;

iii. Sand filling provisions; and,

iv. General exterior signage shall be submitted for review by the City.

B. Exterior Painting

i. The underframe and the roof shall be dark gray (RAL 7012) and the Bogies black (RAL 7021).

ii. The exterior base color shall be traffic red (RAL 3020).

iii. The painting scheme and branding details shall be subject to review and approval by the City.

(ii) Snowplough

A. A removable, body mounted snowplough with vertical height adjustment shall be provided at each cab end. The plough shall be subject to review and approval by the City.

i. It shall be at least 75mm and not more than 150mm above TOR.

ii. It shall be properly coated for corrosion resistance.

iii. The plough shall be fitted with easily replaceable, sacrificial blade. The blade shall extend 50mm below the plough structure. The blade shall be constructed with a durable fibre reinforced elastomeric material.

1.27 Train Control

(a) Project Co shall select a Train Control System that meets the Headway and system capacity as described elsewhere in this Project Agreement.

(b) Project Co shall provide, install and test the on board Train Control equipment and ensure it is properly integrated into the Revenue Vehicle controls.

(c) The Train Control system requirements are detailed in Article 10 of Schedule 15-2, Part 3 - Systems.

1.28 Event Recorder

(a) Project Co shall design and construct the event recorder in accordance with the following general objectives:

(i) The event recorder shall be crashworthy, meeting the construction requirements of IEEE 1482-1999.

(ii) Project Co shall propose a list of signals in compliance with IEEE 1482-1999 to be recorded for review and approval by the City. At a minimum, the following signals shall be included:

A. Train speed;

B. Direction of motion;

C. Time;

D. Distance (GPS);

E. Throttle position;

F. Automatic air brakes/ emergency brakes;

G. Operation of dynamic/independent brake;

H. Position on/off Switch for headlights;

I. Position on/off Switch for auxiliary lights;

J. Horn control handle activation;

K. Magnetic track brake, if applicable.

L. Status of vigilance device;

M. Slip/ slide Control;

N. All Train Control signaling; and,

O. Operation of the hydraulic retarder, if applicable.

(iii) The event recorder shall record all Safety Critical data and allow retrieval after accidents or unsafe events.

(iv) Project Co shall propose the data retrieval protocol and the health check process.

(v) Project Co shall propose the size of the data storage and detail the level of data that can be saved before any over-writing occurs, for review and acceptance by the City.

(b) The event recorder shall be powered from the battery backed up low voltage bus through a dedicated magnetic push to reset circuit breaker which cannot be turned off.

(c) The event recorder shall have voice recording capability. PEI communication shall also be recorded. Voice recording requirement applies to Revenue Vehicles.

(i) Alternatively, the PEI recordings may be stored on the NVR.

1.29 Drawings and Documentation

(a) Project Co shall provide all documentation that is required to confirm compliance with this Part 8 for review to the City in accordance with Schedule 10 – Review Procedure. This shall include vendor submittals and the following as a minimum:

(i) Passenger capacity calculations/approach;

(ii) Applicability of design for climatic conditions (such as heating capacity, snow plow, threshold heaters, temperature rating of components);

(iii) Overall New Revenue Vehicle dimensions and Vehicle dynamic envelope;

(iv) Basic design parameters – acceleration, deceleration, top speed;

(v) ADA/AODA compliance details, including level boarding;

(vi) Carbody details;

(vii) Diesel engine details – cooling, exhaust, emissions;

(viii) Propulsion details;

(ix) Bogie details;

(x) RAMS data for proposed New Revenue Vehicle;

(xi) Communication system details;

(xii) Brake system details;

(xiii) Passenger door system details;

(xiv) Auxiliary/LVPS/battery system details;

(xv) HVAC and heating system details;

(xvi) HVAC heating and cooling calculations;

(xvii) Friction brake and propulsion thermal calculations;

(xviii) Wheel profile and interface with rail;

(xix) New Revenue Vehicle dynamics modeling results;

(xx) New Revenue Vehicle electrical modeling results;

(xxi) Cab layout/ergonomics;

(xxii) Passenger seating/stanchions/level of comfort;

(xxiii) Provisions for on-board equipment (Train Control, Radio, Wireless Link);

(xxiv) Emergency lighting and signage;

(xxv) Waiver requests;

(xxvi) FEA results & stress analyses;

(xxvii) Crashworthiness analyses;

(xxviii) Climate room test results;

(xxix) Noise test results;

(xxx) Flange lubrication/wayside squeal suppression;

(xxxi) Load leveling functional description;

(xxxii) Diagnostics and monitoring functional description;

(xxxiii) Operator's display functional description;

(xxxiv) Spin/Slide control functional description;

(xxxv) Cab mock up, or alternative proposal to demonstrate layout, functionality and ergonomic performance of the cab;

(xxxvi) New Revenue Vehicle electrical schematics;

(xxxvii) Qualification test procedures and reports

(xxxviii) Train to Wayside Emissions Safety Analysis;

(xxxix) FEA models and load cases;

(xl) Battery load calculations; and,

(xli) Battery load Shed Schedule.

(b) All test procedures shall be provided to the City with the Final Design Review. Test reports shall be submitted as available. This shall include vendor testing.

(c) Project Co shall notify the City of all tests taking place. The City reserves the right to witness testing.

(d) An electronic copy of all assembly and installation drawings shall be provided to the City. The package shall include vendor drawings required to convey the design.

(e) All documentation shall be provided as required to certify that the New Revenue Vehicles comply with Transport Canada requirements, such as smoke, flame and toxicity test certificates, EMI limitations, etc. Project Co shall support the city in gaining compliance with all Transport Canada rules and regulations.

(f) All Operations and Maintenance Manuals shall be provided in English.

1.30 Special Tools

(a) Project Co shall submit their standard list of special tools for review by the City.

1.31 Materials and Workmanship

(a) Project Co shall ensure the following standards are follows in the design and construction of the New Revenue Vehicle:

(i) All materials shall conform to APTA, AISI, ANSI ASTM, ASME, IEEE, CEC, CAN/CSA and other specifications as stated herein or as otherwise applicable.

(b) Project Co shall ensure the following prohibited materials are considered:

(i) The New Revenue Vehicle shall comply with the Toxic Reductions Act of 2009, Ontario Regulation 455/09.

(ii) In addition, the following materials shall not be permitted for use on the New Revenue Vehicles:

A. PVC except in limited quantities, as approved on a case by case basis;

B. Asbestos;

C. Cadmium (except for battery);

D. Lead (except in solder used for electrical purposes and engine starter batteries);

E. PCBs;

F. Carcinogenic materials as listed by current Publication of TLV and BEIs guidelines published by the ACGIH;

G. Materials that, in their normal installed state, emit products that are known to be toxic or irritants as per materials listed in 29 CFR 1910.19;

H. All CFC and HCFC compounds classified as ozone depleting substances per 40 CFR 82; and

I. Urethane Foam.

(c) Project Co shall design and construct fasteners in accordance with the following:

(i) Fasteners – General

A. No protruding screws, rivets, mounting bolts, or similar items shall be permitted on the exterior of the New Revenue Vehicle. Interior fasteners shall not protrude enough to become a tripping or snagging hazard.

B. Fasteners exposed to Passengers shall be tamperproof.

C. All carbon steel fasteners shall be zinc plated.

(ii) Fasteners – Locking Requirements

A. Threaded fasteners shall be self-locking or provided with locking devices. Project Co may propose a list of fasteners without locking devices for review/acceptance of the City. The list shall be risk based and shall detail the results of each fastener's loosening.

(d) Project Co shall design and construct elastomers in accordance with the following:

(i) Elastomers – General

A. Elastomeric parts shall be designed for the temperature extremes listed in this Part 8.

B. Elastomeric parts used for interior decorative trim shall be coloured to harmonize with adjacent surfaces. All colors shall be as approved by the City.

C. Elastomers shall meet the combustibility requirements of this Part 8.

(ii) Elastomers – Floor Covering

A. Project Co shall submit color and material samples and material friction tests in wet and dry conditions to demonstrate safety of Passengers in accordance with Schedule 10 – Review Procedure.

(e) Project Co shall design and construct laminated safety glass in accordance with the following:

(i) Laminated safety glass shall be used exclusively and shall conform to the following general, manufacturing, and finish requirements:

A. Float glass quality shall conform to ASTM C1036, Type 1, Class 1, quality Q3.

B. Tinted assemblies shall use a tinted PVB layer with clear glass laminate. Tinting shall be applied to the perimeter of the glass to mitigate UV damage of the elastomer surround or bonding agent.

C. Manufacturers stamp shall be positioned in lower right hand corner as viewed from inside the New Revenue Vehicle.

(ii) Forward facing glazing shall:

A. Be clear laminated safety glass;

B. Meet the requirements of 49 CFR 223, FRA Type I rating, having a minimum thickness of 14 mm; and

C. Be certified to comply with the requirements of ANSI Z26.1.

(f) Project Co shall design and construct tempered safety glass in accordance with the following:

(i) Tempered safety glass that may be used for internal glazing and partitions, shall be manufactured to ASTM C1048, Kind FT, Condition A, Type 1 clear, Class 1 clear, quality Q3 (or Class 3, tinted, light reducing).

(g) Project Co shall design and construct piping and fittings in accordance with the following:

(i) Piping and Fittings – General

A. Project Co shall perform a leak test on the final air and coolant piping system, with all components installed, on each New Revenue Vehicle in accordance with IEC 61133. A copy of the test report for each Vehicle, including retest reports if appropriate, shall be included with each Vehicle history book.

(ii) Piping and Tubing

A. Piping and tubing shall be fastened with insulated clamps.

B. Inside surfaces of Piping shall be cleaned after fabrication and ends shall be capped.

(h) Project Co shall design and construct wire and cable in accordance with the following:

(i) Wire and Cable – General

A. All wire and cable shall be in accordance with AAR RP-585 and the recommendations of APTA RP-E-009-98 section 6.0 (or latest version).

i. Alternatively, all wire and cable shall be in accordance with EN 50343, EN 50355, and EN 50153.

B. New wire and cable shall be soft annealed copper, tinned, stranded, and jacketed with radiation cross linked polyolefin (Exane), or City accepted equal, in accordance with ASTM B33 and AAR Standard S 501.

C. The use of aluminum wire and/or cable shall not be permitted.

D. The insulation system for all internal wires and cables shall be flame retardant and be specifically formulated to minimize smoke, noxious emissions or corrosive fumes in the event of severe overheating or fire. Materials used for the insulation shall be free of halogens.

E. All wires and cables shall be protected against movement, chafing and contact with other components that might cause damage to the insulation.

(ii) Wire and Cable – High Temperature

A. High temperature wire and cable shall be used in locations where the operating temperatures shall exceed the limits of the other indicated insulations.

B. High temperature wire insulated with PTFE shall not be used in conduit or raceways. This type of wire and cable shall not be bundled together or run with any other type of cable.

(i) Project Co shall design and construct wiring in accordance with the following:

(i) Wiring – General

A. Wiring which is used for the transmission of signals and the control of vehicle functions shall not be placed in the same conduits, raceways, or ducts as wiring used for the transfer of power.

B. Wiring shall be in conduit, raceways or ducts.

C. Safety grounds shall utilize dedicated grounding bosses or grounding pads.

D. Power train line cables shall be supported by insulated cable cleats with sufficient spacing between individual conductors to permit adequate ventilation.

E. Wire markers shall be used on all cable ends, to the maximum extent practicable.

F. Low and high voltage cables shall have separate individual raceways.

G. Splicing of conductors shall not be permitted.

(ii) Wiring – Terminals

A. All wiring shall be fitted with pre-insulated diamond grip terminals.

i. Alternate terminals may be proposed for consideration by the City.

(iii) Wiring – Grounding

A. Battery (low voltage DC) circuits shall not be individually grounded.

B. All equipment enclosures and frames of all resiliently mounted electrical apparatus, with the exception of the battery box, shall be suitably grounded to the car body.

C. The New Revenue Vehicle grounding system shall meet all technical requirements of IEEE Std 16-2004 and APTA SS-E-005-98 (or latest version). Alternatively, the system may be designed in accordance with EN 50153.

D. A guaranteed shunt value of 0.06 Ohms shall be provided.

(iv) Wiring – Conduits and Fittings

A. Wires shall not occupy more than 50% of the free cross-sectional area of any conduit.

B. Where necessary to facilitate component removal and replacement, minimum lengths of flexible liquid tight conduit may be used.

C. Insulated bushings shall be used in all conduit and conduit fittings.

(j) Project Co shall include the following flammability, toxicity and smoke emission requirements in the design and construction:

(i) Materials shall comply with the flammability, smoke emission, toxic gas and fire retardation requirements specified herein.

(ii) Materials shall be low halogen in addition to meeting the low-smoke requirements specified herein.

(iii) As a minimum, all materials used in the construction of the New Revenue Vehicle shall meet the requirements of the 49 CFR 238.103, and Appendix B to Part 238 – Test Methods and Performance Criteria for the Flammability and Smoke Emission Characteristics of Materials Used in Passenger Cars and Locomotive Cabs. Unless otherwise specified, all materials and construction shall meet the requirements of NFPA 130-2017.

(iv) Should a conflict exist between the NFPA requirements, federal requirements and requirements listed elsewhere in these provisions, the more restrictive requirement shall govern.

(v) Project Co shall retain a list of materials (flammability matrix) used in the New Revenue Vehicles showing location of material, weight (density and total weight), heat value per pound and per Vehicle, flame spread, flashpoint, smoke generation and toxicity.

(vi) Project Co shall retain laboratory test results for each test, including a technical data sheet.

(vii) Test report documentation shall specifically identify the tested material by the same description that appears on the technical data sheet and other related references. This documentation shall be directly traceable to the applicable Contractor drawings.

(viii) Flammability and Smoke Generation Criteria, Flammability and Smoke Generation Criteria requirements are outlined in Table 8-1.1.

Table 8-1.1

Function of Material	Test Procedure	Performance Criteria
All Vehicle materials and components except as otherwise noted.	ASTM E162 ASTM E662	$I_s \leq 35$ D_s (1.5) ≤ 100, Ds (4.0) ≤ 165
HVAC Ducting	ASTM E162 ASTM E662	$I_s \leq 35$ D_s (4.0) ≤ 100
Lighting Diffusers / Plastic Glazing	ASTM E162 ASTM E662	$I_s \leq 100$ D_s (1.5) ≤ 100, D_s (4.0) ≤ 200
Thermal and Acoustical Insulation	ASTM E162 ASTM E662	Is ≤ 25 D_s (4.0) ≤ 100
Flexible Cellular Foams	ASTM D3675 ASTM E662	Is ≤ 25 D_s (1.5) ≤ 100, Ds (4.0) ≤ 175
Elastomers – Lock strip gaskets	ASTM C542 ASTM E662	D_s (1.5) ≤ 100, D_s (4.0) ≤ 200
Elastomers – Other gaskets or seals	ASTM C1166 ASTM E662	100mm (4.0in), maximum flame propagation (15) D_s (1.5) ≤ 100, D_s (4.0) ≤ 200
Structural – Floor, Roof	ASTM E119	Pass (30 minutes minimum endurance at AW3 loading)
Floor Covering	ASTM E648 ASTM E662	CRF ≥ 0.5W/cm^2 D_s (1.5) ≤100, D_s (4.0) ≤ 200
Seat Cushion, Mattresses	ASTM D3675 ASTM E662	$I_s \leq 25$ D_s (1.5) ≤ 100, D_s (4.0) ≤ 175
Seat Frame, Seat Shroud	ASTM E162 ASTM E662	$I_s \leq 35$ D_s (1.5) ≤ 100, D_s (4.0) ≤ 200
Upholstery	14 CFR (FAR) 25.853 (Appendix F, vertical, textiles) ASTM E662	Flame Time ≤ 10s Burn Length ≤ 150mm (6in) D_s (4.0) ≤ 200
Wire Insulation	IEEE Std 383 – Flammability ASTM E662	Pass D_s (4.0) ≤ 50

(ix) Toxic Content Limits In Combustion Products

A. The maximum toxic gas concentration in the combustion products of any materials used in the construction of the New Revenue Vehicle shall not exceed the values outlined in Table 8-1.2:

Table 8-1.2

Toxic Gas – BSS-7239	Maximum Concentration
CO	3500ppm
Hydrogen Fluoride (HF)	200ppm
Nitrogen dioxide (NO2)	100ppm
Hydrogen Chloride (HCL)	500ppm
Hydrogen cyanide (HCN)	150ppm
Sulphur dioxide (SO2)	100ppm

(k) Project Co shall design and construct films and graphics in accordance with the following:

(i) Films and Graphics – General

A. All graphic materials shall be transportation grade materials. Signage graphics shall have an opaque background with clear, vandal resistant overlayment. Printed signage graphics shall be either reverse printed on the back of the clear overlayment, or printed on opaque background and covered by the clear overlayment.

B. Films and graphics shall withstand effects of detergents and brushes used in washing procedures for removal of multiple applications of graffiti.

C. Films shall use a removable grade adhesive that upon removal does not require use of solvents, or secondary operations to remove adhesive or graphic residue.

(ii) Films and Graphics – Emergency Exit Signage

A. Emergency exit signage shall comply with APTA SS-PS-004-99, Standard for LLEPM and 49 CFR, Part 238.

B. LLEPM material shall be provided to illuminate the path to each Emergency exit.

C. The LLEPM and Emergency exit signage shall be passive and independent of the car's normal and Emergency lighting systems.

i. HPPL material shall be used in the fabrication of the exit signage and the LLEPM.

(iii) Films and Graphics – Emergency Access Signage

A. Each door intended for use by Emergency responders for rescue access shall be identified with Emergency access signs and instructions consisting of retro-reflective materials.

(l) Project Co shall design and construct electrical devices and hardware in accordance with the following:

(i) Electrical Devices and Hardware – Contactors, Relays and Switches

A. All devices shall be readily identifiable by means of a permanent, durable marking strip giving the device circuit designation.

B. Switches shall be provided with a "keying" feature that prevents the body of the switch from rotating.

(ii) Electrical Devices and Hardware – Circuit Breakers

A. The "on" and "off" positions of all circuit breakers shall be permanently marked.

B. All circuit breakers shall be sized by current rating and tripping time to protect both the associated equipment and the minimum size wire.

C. All circuit breakers shall be of a high shock-resistant design.

(iii) Electrical Devices and Hardware – Fuses

A. Fuses shall be used only where the use of a circuit breaker is not technically feasible.

B. Each fuse shall be permanently identified and readily accessible.

i. The rating of each fuse shall be clearly and permanently marked on the fuse and holder.

C. The fuse holder shall have fuse retention devices at both ends.

D. Blown fuse indication shall be provided.

(iv) Electrical Devices and Hardware – Bus Bars

A. Bus bars shall conform to the requirements of IEEE Std 16-2004.

(v) Electrical Devices and Hardware – Switch, Circuit Breaker, and Fuse Panels

A. All live portions of the protected circuitry shall be completely concealed so that no danger of electrocution or shock exists from the touching of the panel or any appurtenances or devices mounted thereto.

B. All switches, circuit breakers, fuses, and indicating lights shall be provided with a nameplate.

(vi) Electrical Devices and Hardware – Illuminated Status Indicators and Annunciators

A. All illuminated status indicators, annunciators or similar devices shall be long-life LED type lamps.

(vii) Electrical Devices and Hardware – Rotating Equipment

A. Rotating machinery shall be suitable for continuous duty, and the continuous duty shall be confirmed in accordance with IEEE Std 11-2000 or IEC 60349-2.

1.32 Vehicle Testing

(a) Project Co shall conduct New Revenue Vehicle testing in accordance with the following:

(i) General

A. Project Co shall be responsible for testing the vehicles.

B. Vehicle testing or operation on the mainline shall be coordinated between Project Co and the City. City Operators will operate all Trains on the mainline.

C. Project Co may provide test results from a similar Vehicle and submit to the City with a request for a waiver. Tests may be waived, at the sole discretion of the City.

D. Project Co shall notify the City of the planned test date no less than 30 calendar days prior to the planned start of the test.

E. Additional tests shall be performed by Project Co as required to ensure complete compliance, as well as all Applicable Laws, regulations and standards.

F. Production tests shall take place on all Vehicles.

G. All tests shall be submitted for review by the City

(ii) Test Documentation

A. Test Plan

i. Project Co shall prepare and submit a Master Test Plan. The Master Test Plan shall include all tests required to prove complete compliance to this Part 8.

ii. Test order shall be arranged, to the maximum extent possible, such that failures resulting in re-design do not nullify the results of successfully completed tests.

iii. Subsystem performance requirements may be addressed in one or more comprehensive tests, as elected by Project Co.

(iii) Test Procedures

A. All test procedures shall be submitted to the City during the Final Design Review.

(iv) Test Reports

A. Test reports shall be produced by Project Co and be available for review by the City. Reports shall be submitted after each test is completed.

(v) Test Protocol

A. Labs shall be certified to perform tests, if required by applicable agency or administration.

B. All equipment used in the performance of tests shall be calibrated by an independent test laboratory on an annual basis, or more often, if required by the specific test.

(vi) Test Notification

A. The City reserves the right to witness any test or portion of a test required on any New Revenue Vehicle delivered under this contract. Project Co shall notify the City of any planned tests a minimum of 30 calendar days prior to the test taking place.

(vii) Types of tests

A. Component Qualification Tests

i. Components shall be Qualification tested before they are presented for review and approval at the FAI. FAI approval shall be required prior to sub-system installation on the first production car.

ii. Component qualification testing is documented in the previous sections of this Article.

B. Component Production Tests

i. Components shall be production tested at the New Revenue Vehicle supplier factory before shipment to the Project Site.

ii. Test reports shall be shipped with each component. Copies of the test reports shall be included in each car history book.

C. New Revenue Vehicle Qualification Testing

i. Qualification tests are one-time tests on the first production Vehicles produced by Project Co. The tests shall be performed to prove that the Vehicle performs as required by the specification and to Transport Canada requirements.

ii. Vehicles other than the first production car may be used to complete tests, such as carbody compression and HVAC climate room, as deemed appropriate by the City.

iii. Testing shall be performed on the completed Vehicles with production components.

D. New Revenue Vehicle Production Tests

i. Vehicle production tests shall be completed before Project Co requests permission to ship each car.

ii. Test reports shall be shipped with each New Revenue Vehicle. Copies of the test report shall be included in the Car history Book.

iii. Production Tests shall include:

1 All of the tests necessary to prove proper functionality of the New Revenue Vehicle;

2 Verification that water shall not enter the Vehicle during Revenue Service operation; and

3 Vehicle weighing.

E. On-Site Commissioning Tests

i. New Revenue Vehicles arriving on City property shall be Commissioned to ensure they are ready to run in Revenue Service.

ii. Testing shall include all tests required to ensure the Vehicle is safe to operate.

iii. Testing shall also include all production tests required to verify complete functionality of all equipment.

F. Integration Testing

i. Project Co shall perform integration testing to ensure the New Revenue Vehicle is fully compatible with the System Infrastructure.

ii. The number of burn-in hours shall be selected by Project Co. Burn-in shall take place with Vehicles out of service, without Passengers. Burn-in shall be performed by Project Co and shall be coordinated with the City.

1.33 System Safety and Security Certification

(a) Project Co shall prepare a complete assessment of risk following the requirements of Schedule 15-2, Part 1, Article 7 – System Safety Certification, using the CENELEC standards and shall

form part of Project Co's safety case to the City. Any statements as to the safety hazards associated with the proposed equipment are to be substantiated by means of a risk assessment, including identification of safety issues and measures proposed to control and mitigate the risks.

(b) Project Co shall prepare, with Vehicle Supplier input, an SSAP that encompasses system RAM in accordance with the requirements of Schedule 15-2, Part 1, Clause 7.8. The RAM requirements shall apply to all of the System.

1.34 Rail Regulatory Obligations

(a) Project Co shall be responsible for providing Revenue Vehicle information to support regulatory filings by the City including all relevant technical, O&M, and supporting documentation, in accordance with the requirements of Schedule 15-2, Part 1, Article 6 – Rail Regulatory Structure and Obligations.

(i) Project Co shall prepare a compliance and homologation package to assist the City in demonstrating to Transport Canada, with verifiable documentation, that the equipment meets all applicable legislation, regulation, rules and standards under the Railway Safety Act including a standards compliance verification matrix demonstrating how the Revenue Vehicles comply with APTA standards directly. Where compliance to the APTA standards are demonstrated through equivalent standards, Project Co must thoroughly document how equivalency is achieved. The full compliance and homologation package shall be made available to Transport Canada.

(ii) Project Co shall prepare a complete assessment of risk for the City to share with Transport Canada.

(iii) Project Co shall assist the City with submission of amendments to existing rules that require modification to allow the Revenue Vehicles to operate in Canada. For changes to existing rules and regulations, Project Co shall work with the City to detail risk scenarios that the proposed rule change intends to address in order to facilitate Transport Canada's determination as to whether the proposal would be conducive to safe railway operations.

1.35 Revenue Vehicle Supply Contract Technical Documents

(a) Project Co shall provide Trains in accordance with the Revenue Vehicle Supply Contract and the technical documents that comprise Appendices 2 to 7 of that contract.