

THE CITY OF EDMONTON
PROJECT AGREEMENT
VALLEY LINE LRT – STAGE 1

Schedule 5 – D&C Performance Requirements

Part 7: LRV

VALLEY LINE PROJECT
SCHEDULE 5
D&C PERFORMANCE REQUIREMENTS

PART 7: LRV

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PART 7: LRV

SECTION 7-1– LRV PERFORMANCE REQUIREMENTS

7-1.1 PURPOSE

A. This Part 7 [LRV] sets out the performance requirements for the Light Rail Vehicles.

7-1.2 APPLICABLE CODES, STANDARDS AND REGULATIONS

A. Without limiting Section 1-1.7 [Reference Documents] of this Schedule, the LRVs shall comply with the codes, standards and regulations specified herein.

7-1.3 LRV GENERAL REQUIREMENTS AND DESIGN PARAMETERS

7-1.3.1 Vehicle General

A. Each LRV shall:

1. be capable of meeting the service requirements set out in Section 5 [Service Requirements] of Schedule 7 [O&M Performance Requirements];
2. meet the requirements for Operational Availability;
3. have a maximum service speed of not less than 70kph;
4. be a service proven make, model and version, with a minimum cumulative number of 25 LRVs having operated in low floor, in-street passenger revenue service for a minimum of 2 years prior to the Technical Submission Date, (the “**Service Proven LRV**”);
5. be winter service proven, whereby:
 - a. at least 1 full winter season prior to the Technical Submission Date, a minimum cumulative number of 10 Service Proven LRVs shall have operated in low floor, in-street passenger revenue service in a city with:
 - i. a climate designated as Koppen classification Dfa or Dfb; and
 - ii. at least three calendar months per year of ice and snow cover; or
 - b. the Service Proven LRV shall be winter certified in accordance with *prEN 16251:2011(E) Railway application – Environmental conditions – Design and test of rolling stock under severe conditions*, for operation to at least:
 - i. -20°C on the Technical Submission Date; and
 - ii. -35°C, and for snow and ice conditions which typically prevail in the City of Edmonton during winter months (either by simulating these conditions or conducting winter field testing), at least 1 year prior to the Target Service Commencement Date;
6. be fully integrated, such that substitution of major systems and sub-systems on the Service Proven LRV shall only be considered where these are necessary to suit the winter climatic challenges present in Edmonton. Major systems and sub-systems that are so substituted shall be winter service proven, whereby they shall have met the following conditions:
 - a. each of these major systems or sub-systems shall have either:

- i. been fully winter certified in accordance with *prEN 16251:2011(E) Railway application – Environmental conditions – Design and test of rolling stock under severe conditions*, to at least -20°C on the Technical Submission Date; or
 - ii. performed in a minimum cumulative number of 10 LRVs operated in low floor, in-street passenger revenue service with temperatures of at least -20°C at least 1 year prior to the Technical Submission Date; and
- b. each of these major systems or sub-systems shall have been fully winter certified in accordance with *prEN 16251:2011(E) Railway application – Environmental conditions – Design and test of rolling stock under severe conditions*, to at least -35°C, and for snow and ice conditions which typically prevail in the City of Edmonton during winter months (either by simulating these conditions or conducting winter field testing), at least 1 year prior to the Target Service Commencement Date, and

for clarity, major systems and sub-systems shall include:

- i. auxiliary systems – including auxiliary converter, batteries, battery charger, internal and external lighting;
 - ii. heating, ventilation and air conditioning (HVAC) system – including main HVAC modules, air ducts/channels, control electronics;
 - iii. bodyshell – including underframe, wall sections, module end portal sections, roof structures and all associated joining methods;
 - iv. running gear – including bogies, brake equipment, traction motors, gearboxes, primary suspension, secondary suspension, wheels, levelling system (if applicable), axles (if applicable);
 - v. door system – including door header assemblies, door leaves (including seals), interlocks and control equipment;
 - vi. braking system – including Driver's traction/brake controller, load control detection system, Dynamic Brakes, Friction Brakes; Track Brakes, and Wheel Slide Protection;
 - vii. vehicle control system – including control electronics, event recorder;
 - viii. coupling system – including mechanical, electrical and pneumatic connections;
 - ix. LRV wiring and cabling system – including connectors and associated sockets;
 - x. pneumatic systems (if applicable) – including compressor, reservoirs, air dryer and associated pipework; and
 - xi. hydraulic systems (if applicable) – including accumulators, actuators and associated pipework;
7. be of a Low Floor design, meaning that at least 70% of the total floor area of each LRV:
- a. is at the same nominal elevation as the LRV floor at the Passenger door threshold; and
 - b. can be accessed from all Passenger doors without any step or any slope exceeding the gradients permitted by Section 7-1.3.6O.2 [*Wheelchair Spaces*] of this Schedule;
8. be operable by a single Driver;

9. be capable of providing bi-directional operation, in Trains comprised of single or multiple coupled LRVs; and
 10. permit operation of all relevant control systems from any Driver's Cab, while prohibiting simultaneous operation of control systems from multiple Driver's Cabs.
- B. Without limiting the requirements of Part 2 [*Sustainable Urban Integration*] of this Schedule, the LRV, including the LRV body, livery and Passenger areas, shall be consistent with the themes, colours, imagery and aesthetics as illustrated in the Design Guide, a copy of which is included in the Disclosed Data.
- C. All LRVs delivered to the City prior to the Service Commencement Date shall be substantively and functionally identical.

7-1.3.2 LRV Loading Requirements

- A. The LRV shall be designed based upon the AW Loadings, as defined in ASME RT-1, but with the mass of each Passenger, crew member and Driver being 75kg.
- B. The LRV loading design shall take account of:
1. Passenger loading levels up to and including AW3;
 2. maximum suspension deflections;
 3. most adverse combination of wheel wear in relation to all Infrastructure interfaces, including the Platform to LRV horizontal and vertical stepping distances, as defined in Section 7-1.6.3 [*Platform/LRV Interface*] of this Schedule; and
 4. minimum ground clearances.

7-1.3.3 Fire and Life Safety

- A. Except as otherwise specified, LRVs, including all materials and components, shall comply with either:
1. NFPA130, Chapter 8, Vehicles;
 2. EN 45545; or
 3. DIN 5510 (2009 version).
- B. Except as otherwise stated herein, vehicle category OC1/N/HL1 shall apply where standard EN 45545 is referenced, and DIN 5510-1 Fire Protection Level 1 shall apply where standard DIN 5510 is referenced.
- C. Where EN 45545 is used, the seat fire performance shall comply with the requirements for vehicle category HL2.
- D. Evacuation time for emergency evacuation due to fire or other incident shall comply with NFPA130.
- E. Submit a comprehensive fire report with the Final Design of the LRVs, detailing the compliance of the LRV, including all materials and components, with the fire and life safety requirements of NFPA130, Chapter 8, Vehicles, EN 45545, or DIN 5510 (2009 version) as applicable.

7-1.3.4 Overall Passenger Capacity

- A. Each LRV shall provide a minimum of 25% seated capacity based on AW2 loading, with all wheelchair spaces occupied by wheelchairs, and with no additional calculated seated capacity allowances made for oversized seats.

7-1.3.5 LRV Seating

- A. LRV seating shall:

1. be covered with a durable, rip and stain resistant, fabric with a Design Service Life of at least 15 years;
2. have interior seating upholstery that is secured in position to prevent unauthorized removal, but which can be easily replaced by authorized personnel;
3. have seat shells that are:
 - a. contoured for Passenger comfort;
 - b. corrosion and vandalism resistant; and
 - c. concaved to optimize legroom for the Passenger seated in the row behind the seat, based on guidance provided in section the "*Human Properties for 5th Percentile Female and 95th Percentile Male*", as referenced in "*Human Factors and Ergonomics Design Handbook*", second edition 1992, or ISO 9241;
4. be provided with handholds as detailed in Section 7-1.9.6 [*Handholds*] of this Schedule; and
5. have no pockets or voids behind or between seat backs in which baggage, litter or other items can be left behind by Passengers.

- B. At least 20% of the total number of Passenger seats in each LRV shall be designated as priority seating for mobility challenged persons. Each designated seat shall be identified by signs and shall:

1. include a handhold at any point where a vertical pole or handrail is not within arm's reach;
2. provide space adjacent to each priority seat, without obstructing the aisle, for use by a service animal or for the storage of a walking aid;
3. not be of a fold-up/fold-down type; and
4. be designated as the seats positioned closest to the Passenger doors.

- C. Priority seat signage shall be as illustrated in Figure 7-1.3.5.1 [*Priority Seat Decal Appearance*], printed in reverse on clear 10% white mounted on exterior of glass window. Decals shall be applied to the glass prior to the application of any protective films. Exact position is as follows.

1. Horizontal Position:

Decal is positioned such that the vertical centerline of the decal is aligned with the vertical centerline of the window.

2. Vertical Position:

Decal is positioned such that the top edge of the decal is 180 mm below the top edge of the glass, where the glass meets the window sealing.

Figure 7-1.3.5.1 Priority Seat Decal Appearance

Dimensions:
9.2"x 3.3"
Typeface:
Futura EF Heavy
Purple
PMS 255 C
CMYK: 51/100/0/25
Black
PMS Black 6 C
CMYK: 0/0/0/100



7-1.3.6 Wheelchair Spaces

- A. Provide a minimum of two wheelchair spaces per LRV, based on the Reference Wheelchair size in accordance with the "*Design Guidelines for pedestrian accessibility, FOR ACCESSIBLE PEDESTRIAN ENVIRONMENTS*", published by Alberta Transportation and Utilities.
- B. Each of the wheelchair spaces shall have a minimum clear floor space of 1300mm by 750mm, with the wheelchair facing in the longitudinal direction of the LRV against a transverse back panel. These spaces shall not protrude into any Passengers movement corridors, including those for entering, exiting or movements within the LRV.
- C. Position wheelchair spaces adjacent to the wheelchair compatible access doors described in Section 7-1.10.3 [*Wheelchair Compatible Access Doors*] of this Schedule.
- D. Devices to fix or secure a wheelchair to the LRV are not permitted.
- E. Wheelchair spaces shall also be designed for storage of walking aids, strollers and bicycles.
- F. Wheelchair space signage shall be as illustrated in Figure 7-1.3.6.1 [*Wheelchair Space Decal Appearance*].
- G. Decals shall be applied to the glass prior to the application of any protective films. Exact position of decal on the back of the glass divider adjacent to wheelchair compatible access doors is as follows:
 1. Horizontal Position:

Decal is positioned such that the left or right edge, depending on the window, of the decal is 10 mm from the edge of the glass, as shown in Figure 7-1.3.6.2 [*Wheelchair Space Decal Position (1)*].
 2. Vertical Position:

Decal is positioned such that the bottom edge of the decal is 10 mm from the edge of the glass, as shown in Figure 7-1.3.6.2 [*Wheelchair Space Decal Position (1)*].
- H. Exact position of decal on the back of the seats adjacent to wheelchair compatible access doors is as follows:
 1. Horizontal Position:

Decal is positioned such that the top left corner of the decal is 17mm from the side of the seat back, as shown in Figure 7-1.3.6.3 [*Wheelchair Space Decal Position (2)*].
 2. Vertical Position:

Decal is positioned such that the top edge of the decal is 14 mm from the top of the seat back, as shown in Figure 7-1.3.6.3 [Wheelchair Space Decal Position (2)].

Figure 7-1.3.6.1 Wheelchair Space Decal Appearance



130mm x 100mm

Figure 7-1.3.6.2 Wheelchair Space Decal Position (1)



Figure 7-1.3.6.3 Wheelchair Space Decal Position (2)



- I. Notwithstanding the decal positions indicated in Sections 7-1.3.6 G and H [Wheelchair Spaces] of this Schedule, should these decal placement positions not provide an acceptable viewing position or angle for Passengers, Project Co shall provide drawings/illustrations with the applicable Final Design to demonstrate the suitability of alternative positioning.
- J. Within the wheelchair spaces provide fold-up/fold-down type, or similar compact seating (e.g. perch). When flipped up, this seating shall not protrude into the minimum clear floor space requirements specified in Section 7-1.3.6B [Wheelchair Spaces] above.

- K. At each wheelchair space, provide:
1. a control device to allow Passengers to request the Driver to extend the door closing time; and
 2. a pushbutton activated emergency intercom device, as described in Section 7-1.15 [*Passenger Emergency Devices*] of this Schedule,
- each of which shall:
3. be placed to be within reach of a person using a Reference Wheelchair; and
 4. be operable by the palm of the hand, with a force of 30 Newton's necessary to activate the device, so as to reduce the potential for accidental operation.
- L. Provide a 180° turning space adjacent to, or partly adjacent to and partly within, each wheelchair space to turn a Reference Wheelchair.
- M. If the wheelchair space includes a horizontal handrail, the handrail shall:
1. be fitted onto, and parallel with, the side of the LRV;
 2. be mounted at a height of not less than 650mm and not more than 1000mm, as measured vertically from the floor;
 3. not protrude into the minimum clear floor space requirements specified in Section 7-1.3.6B [*Wheelchair Spaces*] above; and
 4. be capable of withstanding an applied force of 1.5 kN at any point in any direction without causing permanent deformation to the handrail, its fixings or the LRV body.
- N. The Passenger area shall:
1. have no obstructions that prevent a Reference Wheelchair from being manoeuvred through any designated wheelchair compatible doors and to/from the associated wheelchair space; and
 2. provide a minimum turning circle sufficient to allow a Reference Wheelchair to complete a full 360 degree turn adjacent to the wheelchair space. The minimum turning circle for a Reference Wheelchair within the LRV shall be 1500mm.
- O. The route between a wheelchair compatible access door and the nearest wheelchair space shall:
1. not have any step;
 2. not have any slope with a gradient exceeding:
 - a. 5%; or
 - b. 8% provided the slope does not exceed 2000mm in length;as measured when the LRV is on a straight and level Track; and
 3. be not less than 800mm wide at any point.
- P. Provide full scale and dimensionally accurate mock-ups of each proposed LRV wheelchair space, to include actual placements of:
1. space signage;
 2. decals;

3. control devices and pushbuttons;
4. handrails; and
5. adjacent seats, hand holds, and other elements that the wheelchair user may interact with between the wheelchair space and the nearest wheelchair compatible access door.

Delivery of the mock-ups to the City shall be part of the Interim Design review required in accordance with Section 6.8(a)(v)(K) [Interim Design Reviews] of Schedule 4 [Design and Construction Protocols].

7-1.3.7 Safety Critical Systems and Interfaces

- A. The LRV shall employ a Vital control system philosophy for all safety critical systems and interfaces in accordance with IEEE 1475.

7-1.4 LRV ENVIRONMENTAL REQUIREMENTS

7-1.4.1 Internal Noise Levels

- A. The method of measurement for internal noise levels within the Driver’s Cab and Passenger compartment shall comply with the procedure described within ISO 3381.
- B. Internal noise levels within the Driver’s Cab shall not exceed the values given for “Tramcar (low floor)” in Table 4.3 of VDV Recommendation 154 “Noise Caused by Urban Rail Vehicles 10/2011” and as stated in Table 7-1.4.1.1 [Requirements for Noise Levels Within the Driver’s Cab].

Table 7-1.4.1.1 - Requirements for Noise Levels Within the Driver’s Cab

Operating Condition of Vehicle and HVAC System	$L_{pAeq,T}$ where $T \geq 10$ seconds
LRV at standstill, ready for operation and HVAC in ventilation or air conditioning mode at: full-load operation part-load operation	63 dB(A) 55 dB(A)
LRV operating at 60 km/h and HVAC in cooling mode at part-load operation	65 dB(A)

- C. Internal noise levels within the Passenger areas shall not exceed the values given for “Tramcar (low floor)” in Table 4.2 of VDV Recommendation 154 “Noise Caused by Urban Rail Vehicles 10/2011” and as stated in Table 7-1.4.1.2 [Requirements for Noise Levels Within the Passenger Area].

Table 7-1.4.1.2 - Requirements for Noise Levels Within the Passenger Area

Operating Condition of Vehicle and HVAC System	$L_{pAeq,T}$ where $T \geq 10$ seconds
LRV at standstill, ready for operation and HVAC at maximum heating	62 dB(A)
LRV at standstill, ready for operation and HVAC in cooling mode at: full-load operation part-load operation	65 dB(A) 57 dB(A)

LRV operating at 60 km/h, HVAC in cooling mode at part-load operation:	
(i) at transition, door and running gear areas	70 dB(A) ^{Note1}
(ii) at areas other than (i) for areas directly adjacent to (i), that are sufficiently far away and minimally influence the acoustic results, such as the area between two doors or between a door and a transition	68 dB(A) ^{Note 2}

Note 1: This value may be relaxed to 75 dB(A) if the design requirements of the LRV do not allow realization of the necessary sound insulation for observance of the stated maximum noise levels, such as at the sound insulation in the running gear zone of the car body of 100% low floor LRVs.

Note 2: This value may be relaxed to 72 dB(A) if the design requirements of the LRV do not allow realization of the necessary sound insulation for observance of the stated maximum noise levels.

7-1.5 LRV OPERATIONAL REQUIREMENTS

7-1.5.1 Operational Capability

A. LRV traction and braking systems shall:

1. be capable of meeting the service requirements set out in Section 5 [*Service Requirements*] of Schedule 7 [*O&M Performance Requirements*] under all operating conditions, and in any event with not less than 6 standees per m² at an AW3 Loading; and
2. meet the requirements for Operational Availability.

7-1.5.2 Automatic Passenger Counting System

A. Provide an automatic means of counting and recording the following information, with a minimum 95% level of accuracy:

1. the number of Passengers boarding and alighting each LRV at each Stop/Station;
2. Stop/Station identification; and
3. date and time of each counting activity.

B. Provide all equipment to permit automatic downloading of the stored data for interrogation and analysis, with stored data capable of being interrogated remotely in accordance with Section 8 [*Remote Data Queries*] of Schedule 7 [*O&M Performance Requirements*].

7-1.5.3 Train Length

A. The maximum Train length of the longest Train operating at the Maximum Service Level shall be such that while the Train is stopped at any Platform:

1. the entire length of the Train is within the boundaries of the adjacent Roadways and crosswalks;
2. the Driver has a clear and unobstructed view of the entire length of the Platforms; and
3. safe and unobstructed Passenger access to all doors is provided from the Platforms.

7-1.6 LRV INTERFACE REQUIREMENT

7-1.6.1 Wheel / Rail Interface

- A. Provide a wheel/rail interface that provides protection against derailment, and minimizes wear, damage, noise and vibration under all operating and environmental conditions for all Track forms, including switches and crossings, in accordance with EN 13232-3.
- B. Submit a comprehensive wheel/rail interface report along with the Final Design of the LRV, demonstrating the analysis, testing and design undertaken to confirm the requirements of Section 7-1.6.1A above.

7-1.6.2 Vehicle Envelopes

- A. Determine all necessary LRV envelopes to ensure that there are no operational conflicts between the operation of On-track Vehicles and the fixed Infrastructure.

7-1.6.3 Platform/LRV Interface

- A. The Platform to LRV interface at each Stop and Station shall comply with the following tolerances under any combination of maintenance/construction tolerances, suspension deflections, wheel/rail wear and AW Loadings, up to and including AW3 loading:
 - 1. vertical height differences between the LRV floor at the door threshold and the Platform shall not exceed 50mm at any door position;
 - 2. horizontal clearance between the Platform and the door threshold shall not exceed 75mm at any door position; and
 - 3. horizontal and vertical clearances between the LRV door threshold and the Platform shall be such that no infringements can occur between the LRV body (including the doors when opening/closing) and any part of the Platform.

7-1.7 BODY SHELL

7-1.7.1 Structural Design

- A. The structural design of the LRV shall comply with EN 12663-1 categories P – V or ASME RT-1.
- B. The structural design of the LRV body shell shall be based on an AW4 loading and shall be capable of supporting such load over the Design Service Life of the LRV.

7-1.7.2 Lifting and Jacking for OMF and Emergency Use

- A. The design of the LRV shall include provision for lifting and jacking the body modules, articulation assemblies and bogies for both Maintenance and emergency recovery purposes in accordance with EN 12663-1 or ASME RT-1. This provision shall include the necessary lifting points, body support points and jacking points on all LRVs for use in all Track form areas and within the Gerry Wright OMF.
- B. The location of all lifting points shall be clearly identified on each LRV.

7-1.7.3 Crashworthiness

- A. The crashworthiness of the LRV shall comply with EN 15227:2008 category C-IV or ASME RT-1.

7-1.7.4 Under-run protection

- A. Provide under-run protection to prevent persons, animals and objects from passing underneath the LRV. Under-run protection shall:
 - 1. interact with all Track forms and alignment without damaging the LRV or Trackway; and
 - 2. not interfere with the safe Operation of the System.

7-1.7.5 Anti-Surfing

- A. Incorporate features to deter, and minimize the possibility of, persons riding on the external surfaces of an LRV.

7-1.7.6 Water Tightness and Drainage

- A. Provide means of preventing corrosion in the LRV, including the:
 - 1. roof structure;
 - 2. body structure (including windows);
 - 3. articulations;
 - 4. under-frame structure;
 - 5. bogies; and
 - 6. electrical and electronic equipment including wiring and connectors.
- B. Drainage of water from the roof shall be directed away from doorways.
- C. Prevent ponding of water within all Passenger areas, including doorways.

7-1.7.7 Articulations

- A. Where an LRV is comprised of modules, provide articulations between each module to allow Passenger movements throughout the length of Passenger area of the LRV.
- B. For all operating conditions, the articulations shall be free of pinch points that can trap objects or cause injury to persons.

7-1.7.8 Windows

- A. The windows in the Driver's Cab and Passenger areas shall be sealed to prevent drafts and water ingress and to maintain the environmental conditions set out in Section 7-1.11 [*Temperature and Climate Control*] of this Schedule.
- B. Provide protection for windows and internal glass panels from vandalism, including etching of the glass.
- C. Apply window mounted information labels, including "Priority Seat" decals in accordance with Section 7-1.3.5 [*LRV Seating*] of this Schedule prior to applying any window protection measures.

7-1.7.9 Body Exterior

- A. All roof mounted external equipment shall be located out of view when viewed from street/Platform level.

- B. LRV exterior bodywork shall have no:
 - 1. gaps, sharp corners, sharp edges or finger traps;
 - 2. side protrusions that could pose a danger to pedestrians, cyclists or motor vehicles; and
 - 3. no visible fixings or fastenings.
- C. All coupling devices shall be concealed when not in use in accordance with Section 7-1.19B [*Coupling*] of this Schedule.

7-1.7.10 Livery

- A. The exterior surface of each LRV shall:
 - 1. be painted;
 - 2. not be adversely affected by cleaning or removal of graffiti;
 - 3. have a graffiti resistant finish; and
 - 4. be suitable for the frequent application and removal of vinyl's and decals, including full body wraps, without damage or deterioration to the exterior surface/paint finish and decals.
- B. All exterior surface finishes shall have a minimum Design Service Life of fifteen (15) years.

7-1.8 WINDSHIELD, WIPERS AND WASHERS

7-1.8.1 Windshield and Side Windows

- A. Each Driver's Cab windshield and side windows shall comply with:
 - 1. the FRA Type I impact and ballistics requirements per 49 CFR 223;
 - 2. ECE R43 or ANSI Z26.1 for light or colour distortion; and
 - 3. the requirements of Section 7-1.7.8 [*Windows*] of this Schedule.

7-1.8.2 Wipers and Washers

- A. Each Driver's Cab shall be fitted with a windshield wiper system, covering the Driver's full viewable windshield area, with variable speed for both continuous and intermittent operation.
- B. The windshield wiper system shall include an automatic wash system that effectively cleans the swept path of the windshield wiper assembly under all operating and environmental conditions.

7-1.9 PASSENGER AREA LAYOUT AND APPEARANCE

7-1.9.1 Layout Design/Aesthetic Requirements/Ergonomics

- A. The Passenger areas of the LRVs shall have an open interior layout:
 - 1. with good visibility between all areas throughout the length of the LRV; and
 - 2. which affords ease of access and egress from all areas of the LRV under all operating conditions.
- B. For Passengers who are seated / standing adjacent to each side of a doorway, provision shall be made to shield the Passengers against the elements such as wind, rain and snow while the doors are open.

7-1.9.2 Internal Advertising

- A. Provide a digital multimedia system to allow advertising and other multimedia information to be displayed throughout all Passenger areas.
- B. Multimedia displays shall be located so as to ensure that they can be viewed from at least 51% of the seats.
- C. Multimedia displays shall be positioned so that they do not present a Hazard to Passengers.
- D. The multimedia system and all displays shall comply with the following requirements:
 - 1. 16:9 display aspect ratio;
 - 2. 17" minimum display size. Alternatively, the multimedia display may be integrated with the interior Variable Message Sign using two 15" displays arranged side-by-side. Passenger height clearance from floor level to the bottom of display shall not be less than 1950mm;
 - 3. 1280 x 720 minimum display resolution;
 - 4. display content in HTML format; and
 - 5. permit uploading of multimedia content via WiFi at the Gerry Wright OMF.

7-1.9.3 Bicycles

- A. Provide bicycle facilities in compliance with City of Edmonton By-law no. 8353.
- B. Bicycle facilities shall provide for safe storage of bicycles. Any restraining devices shall not present tripping or other Hazards to Passengers.
- C. The wheelchair spaces may be used for bicycle storage in accordance with Section 7-1.3.6 [*Wheelchair Spaces*] of this Schedule. Where the wheelchair space is used for bicycle storage it shall include signage stating:
 - 1. that wheelchairs have priority over bicycles; and
 - 2. the maximum number of bicycles that can be stored in each space.
- D. Bicycle storage shall not be provided by the hanging of bicycles.

7-1.9.4 Internal Lighting

- A. Internal lighting shall be provided in accordance with EN 13272:2012 for mass transit vehicles and shall include:
 - 1. general lighting in the Passenger areas and both Driver's Cabs;
 - 2. emergency lighting in the Passenger areas and both Driver's Cabs; and
 - 3. at least one (1) hour of emergency lighting operating time in the Passenger areas and both Driver's Cabs.
- B. Internal lighting levels shall be appropriate for the LRV Surveillance Subsystem, so as to maintain the evidential quality of the recorded images.
- C. Internal lighting fixtures shall be resistant to vandalism.
- D. Internal lighting shall incorporate low energy and energy saving devices.

- E. Reflection and glare from windows and other reflective surfaces shall comply with EN 13272:2012.
- F. Provide a manual switch for the Driver to turn on/off the internal lights in the Driver's Cab and the Passenger areas.

7-1.9.5 Flooring

- A. All LRV flooring surfaces shall comply with ASTM D2047 and:
 - 1. have a static coefficient of friction of 0.55 or greater, as measured in accordance with ASTM D2047, with a standard deviation of less than 0.05, under both dry and wet conditions; and
 - 2. produce minimal glare.
- B. At each Passenger doorway inside the LRV, the floor shall have a band of single contrasting colour running parallel with the full width of the entrance, not less than 50mm and not more than 100mm wide.
- C. LRV flooring inside and adjacent to each Passenger doorway, shall be of a colour that contrasts with the colour of the band referred to in Section 7-1.9.5B [*Flooring*] of this Schedule, and the rest of the flooring. The colour contrast shall be sufficient to assist Passengers with visual impairment to identify and distinguish the entry/exit from the rest of the LRV.
- D. In static conditions, LRV flooring colour contrasts shall provide a minimum difference of 30%.
- E. The floor structure and covering shall be designed to prevent water/moisture ingress between the floor structure and any covering surface and to prevent intrusion of water/moisture from outside of the LRV.

7-1.9.6 Handholds and Handrails

- A. Provide handholds or handrails at intervals of not more than 1050mm along the length of the Passenger area and on all Passenger seats facing toward an end of the LRV which are located next to an articulation between modules.
- B. All handholds shall:
 - 1. be fitted to the top of the seat backrest;
 - 2. contrast in colour with the seat to which it is attached. In static conditions, the contrast shall provide a minimum difference of 30%;
 - 3. have a slip-resistant surface;
 - 4. have rounded edges and corners, including those in its mountings with the seat;
 - 5. provide a minimum of 45mm clearance on all sides, including any gap between the handhold and the seat to which it is attached; and
 - 6. have a cross section, excluding any mountings, of between 20mm and 40mm in thickness.
- C. Handholds shall not be provided on any seat:
 - 1. where the back of the seat touches a partition;
 - 2. where the back of the seat touches the back of another seat fitted with a handhold and facing the opposite direction;
 - 3. to which a handrail is attached; or

4. which is situated within 50mm from a handrail, handhold or partition measured from the top of the back of that seat.
- D. In addition to Section 7-1.9.6A [*Handhold and Handrails*] of this Schedule, vertical handrails shall be fitted on either side of each Passenger doorway.
- E. Handrails shall:
1. have a circular cross section with a diameter of between 30mm and 40mm;
 2. have a minimum 45mm clearance between any part of the handrail and any other part, excluding the mountings of the handrail to the LRV;
 3. have a slip-resistant surface; and
 4. contrast in colour with adjacent parts. In static conditions, the contrast shall provide a minimum difference of 30%.
- F. Vertical handrails shall extend from a point not more than 700mm above the floor to a point not less than 1200mm above the floor.

7-1.10 PASSENGER DOORS

7-1.10.1 Layout and Operation

- A. LRV Passenger doors shall comply with EN 14752:2005 or APTA SS-C&S-012-02, "Door Systems for New and Rebuilt Passenger Cars."
- B. Provide a sufficient number of Passenger doors on each LRV to meet the boarding and alighting performance requirements of the Operating Concept Plan, through modelling of the waiting queues for sequential boardings and alightings at each Stop and Station.
- C. The minimum width of Passenger doors shall be:
1. Double width doors - 1200mm; and
 2. Single width doors, if provided - 800mm.
- D. The exterior of each Passenger door shall be clearly identified, by a colour that contrasts with the exterior of the LRV, excluding any contrast resulting from a window or door mounted Passenger control device. In static conditions, the contrast shall provide a minimum difference of 30%.
- E. The floor along each Passenger door entrance shall be illuminated, when doors are enabled/opened, by a light placed within or immediately adjacent to that edge.
- F. The Passenger doors shall be operated by a Passenger activated control device. The Passenger activated control device shall:
1. only operate the doors once activated by the Driver and when the LRV is stationary; and
 2. only operate the doors on the Platform side of the LRV;
 3. only operate the individual door to which it is attached.
- G. The Driver shall be able to operate all LRV doors simultaneously from within the Active Driver's Cab.
- H. The Driver's Cab mounted controls for Passenger door enable/open functions shall:

1. have a logical layout and sequence that prevents unintended operation of non-Platform side doors and shall require a two stage confirmation process; and
 2. only be operable when the LRV is stationary.
- I. When the Passenger doors have been enabled by the Driver for Passenger use, the doors shall:
1. remain closed until such time that a Passenger operates the applicable Passenger Door Control Device;
 2. once opened via the Passenger Door Control Device, automatically close after a user-configurable time interval of not less than 5 seconds;
 3. remain available for Passenger operation until such time that the Driver operates the “all-doors close” function , which shall remove the door open function from the Passenger Door Control Devices; and
 4. upon operation of the “all-doors close” function , all open doors shall close and automatically lock until such time the Driver reinitiates the door enable function.
- J. Controls for closing Passenger doors shall be located in the Driver’s Cab.
- K. The Passenger doors shall only be capable of being enabled, by the Driver’s controls when the Train is stationary.
- L. The Passenger door system shall automatically detect obstacles and prevent closure in accordance with EN 14752. When an obstacle is detected the Passenger door system shall do the following, until all the doors successfully close and lock or the Driver overrides the system:
1. automatically re-open the affected door(s);
 2. attempt to automatically re-close the affected door(s); and
 3. automatically inform the Driver by both audible and visual means which door(s) have been affected.
- M. No part of the door or operating mechanism shall intrude into the Passenger area.
- N. Provide an isolation device to lock individual defective doors out of service. The isolation device shall be located such that its operation is restricted to authorized personnel only and, when activated, shall cause a visual message to be displayed to the Driver indicating which door has been isolated.
- O. Provide an externally located, tamper resistant, emergency release device on each side of the LRV at an external door location to allow the associated door to be manually opened from the outside of the LRV. The emergency release device shall only operate when the LRV is stationary.
- P. Each Passenger door shall be equipped with an audible warning device which shall:
1. emit a distinct sound for a period of three (3) seconds commencing when the door becomes operable by Passengers; and
 2. emit a different distinct sound for a period of three (3) seconds before the door starts to close.
- The audible warnings shall be emitted both inside and outside the LRV in the proximity of the Passenger control device for each door. The sound level of the door audible warning devices shall be user adjustable within a reasonable range.

- Q. Each Passenger doorway shall incorporate a flashing light, with a flash rate of 2Hz, centred above the doorway to indicate that doors are opening or closing.
- R. When stationary in a Station or Stop, all LRV doors shall be aligned alongside the Platform and have level access in accordance with the tolerances in Section 7-1.6.3 [*Platform/LRV Interface*] of this Schedule.

7-1.10.2 Passenger Door Controls

- A. Provide a door control device on the exterior and interior sides of each door to allow Passengers to request the door to open once the LRV is stationary and the devices have been enabled by the Driver (each, a "**Passenger Door Control Device**").
- B. Passenger Door Control Devices shall be located not less than 890mm and not more than 1200mm vertically above an imaginary horizontal line extended from the door threshold of the relevant doorway.
- C. Passenger Door Control Devices shall be operable by the palm of the hand and shall not require a force greater than 15 Newtons.
- D. When enabled by the Driver, all Passenger Door Control Devices, or their immediate surround, shall either be illuminated continuously or flash at a frequency of 2Hz.
- E. The illumination or flashing of each Passenger Door Control Device shall cease not less than 3 seconds before the doors start to close.
- F. Passenger Door Control Devices shall contrast in colour with the surface on which they are mounted and shall have a raised tactile surface and shall provide visual feedback when pressed.

7-1.10.3 Wheelchair Compatible Access Doors

- A. At least two of the Passenger doors on each side of the LRV shall be designed for wheelchair compatible access and shall:
 - 1. be not less than 1250mm width;
 - 2. comply with the Platform interface tolerances set out in Section 7-1.6.3 [*Platform / LRV Interface*] of this Schedule, without the use of boarding plates or similar devices that rest on the Platform surface when deployed;
 - 3. be positioned near the wheelchair spaces within the LRV; and
 - 4. be provided with labels which shall be visible from the Platform both before and after the doors have opened.
- B. For doors that do not comply with the requirements of Section 7-1.10.3A [*Wheelchair Compatible Access Doors*], and any other doors that do not allow direct access to at least one wheelchair space within the LRV (e.g. those where the aisle through the vehicle interior is less than 800mm wide), provide signage that indicates no through access for wheelchairs.

7-1.10.4 Door Interlock

- A. Each individual Passenger door leaf shall be interlocked with the traction and braking systems, such that:
 - 1. when stationary the Traction Power cannot be obtained and the brakes cannot be released unless every door leaf is electrically proved to be closed; and

2. the Traction Power shall be automatically removed and the Service Brakes automatically applied if electrical proof of closure is interrupted for any reason while the LRV is in motion.

7-1.10.5 Passenger Emergency Door Release

- A. Provide a device located on the interior of the Passenger area, in proximity to each Passenger door, to permit the manual release of the Passenger door lock in the event of an emergency.
- B. Design the Passenger emergency door release device such that it:
 1. does not allow the door to be released or opened when the LRV is in motion;
 2. does not result in an automatic brake application when operated while the LRV is not stationary;
 3. includes a tamper resistant cover that does not require replacement after the Passenger emergency door release device has been activated; and
 4. overrides any prior isolation or lockout of the applicable Passenger door, when the LRV is stationary.
- C. On operation of the Passenger emergency door release device, an audible and visual alarm shall be indicated to the Driver and shall remain active until the affected Passenger door(s) have been closed and locked and the Passenger emergency door release device has been reset by the Driver. Following operation of the Passenger emergency door release device, when the LRV is stationary, the door interlock system shall prevent LRV movement.

7-1.10.6 Authorized Personnel Controlled Access

- A. Provide designated access doors on both sides, at each end, of each LRV for use by Drivers and other authorized personnel. The designated access doors shall:
 1. be a Passenger door or a separate door, operated independently of all other doors;
 2. provide a means of electrically opening and closing from both inside and outside the LRV;
 3. be capable of manual operation, using external and internal release devices, when no power is available; and
 4. be protected from unauthorized operation.

7-1.11 TEMPERATURE AND CLIMATE CONTROL

- A. Provide a temperature and climate control system in compliance with the following:
 1. Passenger area - EN 14750-1;
 2. Driver's Cab - EN 14813-1;
 3. Category B for urban type applications;
 4. Winter Zone category 3 (-40°C); and
 5. Summer Zone category 2 (+35°C).
- B. The method of measurement of temperature and climate shall comply with:
 1. Passenger area - EN 14750-2; and

2. Driver's Cab - EN 14813-2.
- C. No exposed parts or surfaces shall be at a temperature that could cause harm to any persons.
- D. The temperature and climate control system shall prevent the build-up of moisture, condensation, frost and ice on the windshield in the Driver's Cab or on the side windows or any internal surfaces of the Driver's Cab and Passenger areas.

7-1.12 DRIVER'S CAB

- A. The Driver's Cab is the designated space on each end of the LRV that contains all necessary controls and equipment required to safely and efficiently operate the Train in each direction.
- B. The design of the Driver's Cab and its layout shall employ human factors and industrial design principles, including good forward and sideward vision for the Driver, based on guidance provided in section "Human Properties for 5th Percentile Female and 95th Percentile Male", as referenced in the "Human Factors Design Handbook", second edition 1992, or ISO 9241.

7-1.12.1 General

- A. The door into each Driver's Cab shall be lockable and designed to prevent access to the Driver's Cab by unauthorized persons.
- B. Provide a partition window, with anti-glare treatment, between the Driver's Cab and Passenger areas for night time operation.
- C. The Driver's controls and instruments shall be designed to prevent glare under all lighting conditions.
- D. Provide sun visors or similar devices, operable by one hand, for the windshield and each side facing window in the Driver's Cabs.
- E. Provide at least two means of exit from each Driver's Cab, including one emergency escape route that does not require the occupants of the Driver's Cab to enter the Passenger area.
- F. Each Driver's Cab shall include a Driver's seat and a control console as set out in Section 7-1.12 [*Driver's Cab*] of this Schedule, arranged:
 1. such that the position of the Driver's seat optimizes the Driver's forward, sideward and rearward views, as required for operating on both street running and segregated environments;
 2. with controls positioned, for both street running and segregated environments; and
 3. to allow the Driver to see into the Passenger area to observe Passenger movements.
- G. Each Driver's Cab shall include a fixed or portable instructor's seat, located:
 1. to allow access, and emergency egress, to and from the Driver's Cab;
 2. such that the door to the Driver's Cab can be securely closed with the Driver's seat and the instructor's seat both occupied; and
 3. to provide a means to remotely stop the LRV, from the instructor's seat.

7-1.12.2 Cab Controls

- A. Provide controls within each Driver's Cab to allow the LRV or Train to be safely driven by one Driver, as set out in Section 7-1.12 [*Driver's Cab*] of this Schedule.

- B. All human machine interfaces in the Driver's Cab shall have a demonstrably logical, and user friendly layout, based on Driver task frequency and priority.
- C. Each Driver's Cab shall include the following key controls:
 - 1. a combined Traction Propulsion and braking controller, in accordance with IEEE STD 1475, designed for operation with the left hand. The controller shall follow the convention of demanding Traction Power when the controller handle is pushed forward and away from the Driver, and Service Braking when pulled towards the Driver, and shall include a Hazard Brake position that, when engaged, activates a revocable emergency 3 brake function in accordance with Section 7-1.13.5.2 [*Hazard Brake*] of this Schedule;
 - 2. an Emergency Stop Mushroom Button coloured red, which when depressed provides an irrevocable emergency 4 brake application in accordance with Section 7-1.13.5.3 [*Emergency Braking*] of this Schedule;
 - 3. if a pantograph is provided, an emergency pantograph 'down' mushroom button, coloured other than red, which when depressed will lower the pantograph into the down position;
 - 4. Passenger door controls designed to minimize the risk of wrong side door open operation; and
 - 5. all other control systems required to safely and efficiently operate the Train in each direction.
- D. All controls, indications, alarms, lights and desk panels shall be clearly visible under all operating conditions.

7-1.12.3 Cab Equipment

- A. Each Driver's Cab shall be fitted with the following safety equipment:
 - 1. break glass hammer including wall fixing;
 - 2. warning triangle;
 - 3. an portable fire extinguisher in accordance with NFPA 10, including dedicated mounting bracket;
 - 4. hand lamp, including dedicated bracket for hand lamp storage;
 - 5. first aid kit, mounted;
 - 6. needle disposable container; and
 - 7. all other equipment determined to be necessary pursuant to the Safety and Security Certification Program.

7-1.13 BRAKING SYSTEMS

- A. LRV braking, performance and testing shall comply with the following standards:
 - 1. EN 13452-1 Railway Applications – Braking – Mass Transit Brake Systems, Part 1 Performance Requirements; and
 - 2. EN-13452-2 Railway Applications – Braking – Mass Transit Brake Systems, Part 2 Method of Tests.
- B. The deceleration and jerk rates for all braking modes shall comply with EN 13452 Table 4 — Deceleration and Jerk levels.

- C. The LRV braking shall include all necessary equipment and control systems to provide the following braking modes:
1. Service Brake: controlled braking mode used to reduce LRV speed, in accordance with the requirements of Section 7-1.13.3 [*Service Braking*] of this Schedule;
 2. Stationary Brake: braking mode used to hold the LRV in place when stationary on any gradient, in accordance with the requirements of Section 7-1.13.4 [*Stationary Braking*] of this Schedule;
 3. Emergency Brake: emergency and automatic braking modes as defined in EN 13452, and in accordance with the requirements of Section 7-1.13.5 [*Emergency Braking*] of this Schedule; and
 4. Security Brake: high integrity braking mode used in the event of failure of critical LRV control system(s), in accordance with the requirements of Section 7-1.13.6 [*Security Brake*] of this Schedule.
- D. Provide the braking rates required pursuant to EN 13452-1 and EN 13452-2 under AW3 loading.
- E. Passenger loads up to and including AW3 shall not detrimentally affect the braking performance of the LRV.

7-1.13.1 Braking Elements

7-1.13.1.1 Dynamic Brakes

- A. Provide primary braking by means of Dynamic Braking in accordance with EN 13452.
- B. The LRV regenerative braking function shall be designed in conjunction with the Traction Power System in order to maximize energy savings.
- C. The Dynamic Braking system shall provide full braking rates under all conditions, including when:
1. the Traction Power supply is not receptive; and
 2. no Traction Power supply voltage is present.

7-1.13.1.2 Friction Brakes

- A. Provide Friction Braking equipment, including the appropriate number of brake actuators and disc brakes necessary to comply with the braking requirements of EN 13452.
- B. Brake discs shall comply with EN 14535-1 or IEC 61373

7-1.13.1.3 Electromagnetic Track Brakes

- A. Provide electromagnetic Track Brakes on all bogies to apply Track Brakes directly to the rail surface in accordance with the braking requirements of EN 13452.
- B. The Track Brakes shall operate with all Track forms and under all conditions.

7-1.13.1.4 Wheel Slide Protection

- A. Provide a Wheel Slide Protection system in accordance with EN 15595, EN 13452-1 and EN 13452-2.
- B. The WSP system shall minimize any reduction in braking force.
- C. On its application, the WSP control system shall include an automatic application of sand on the rail surface from the Automatic Sanding System.

- D. Any failure of the WSP system shall not adversely affect the integrity of the braking systems under any braking mode.

7-1.13.1.5 Automatic Sanding System

- A. Provide a system to automatically apply sand to each leading wheelset of each powered bogie, for any direction of travel:
 - 1. under low adhesion conditions;
 - 2. in conjunction with the WSP, in accordance with Section 7-1.13.1.4 [*Wheel Slide Protection*] of this Schedule;
 - 3. upon the occurrence of wheel spin, in accordance with Section 7-1.17.2A.2 [*Wheel Spin*] of this Schedule;
 - 4. upon activation of the Service Brake, Emergency Brake and Security Brake,

(the "**Automatic Sanding System**").
- B. The Automatic Sanding System shall comply with EN 15595, EN 13452-1 and EN 13452-2.
- C. Provide cab mounted, Driver operated, controls to permit manual operation of the Automatic Sanding System during pre-service inspection/maintenance tests. The manual controls shall only operate when the LRV is stationary.
- D. Provide an automatic means of determining the level of sand remaining in all on-board storage hoppers/units.

7-1.13.1.6 Load Control

- A. Provide a load control detection system in accordance with EN 13452 to detect the LRV load and to automatically adjust acceleration and braking (excluding Security Brake) operations accordingly.

7-1.13.2 Braking Modes

7-1.13.3 Service Brake

- A. Provide a Service Brake in accordance with EN 13452.
- B. The Service Brake shall use the Dynamic Braking system as the primary braking system and may be supplemented by Friction Braking when required.
- C. Application of the Service Brake shall invoke the following braking elements:
 - 1. Dynamic Braking;
 - 2. Friction Braking, to the extent required for desired deceleration rate;
 - 3. Wheel Slide Protection, including automatic sanding in accordance with Section 7-1.13.1.5 [*Automatic Sanding System*] of this Schedule; and
 - 4. load control.

7-1.13.4 Stationary Brake

7-1.13.4.1 Parking Brake

- A. Provide a Parking Brake system in accordance with EN 13452, which shall be capable of being applied without assistance of any electric, hydraulic, pneumatic, or other form of non-mechanical energy.
- B. The Parking Brake shall automatically engage and maintain the Train in a stationary position indefinitely:
 - 1. with an AW0 empty load; and
 - 2. on the maximum System gradient
- C. Application of the Parking Brake shall invoke the Friction Braking.

7-1.13.4.2 Holding Brake

- A. Provide a Holding Brake system in accordance with EN 13452, which shall maintain the Train in position under the following conditions:
 - 1. with an AW3 Passenger loading requirement; and
 - 2. on the maximum System gradient.
- B. Application of the Holding Brake shall invoke the Friction Braking.

7-1.13.5 Emergency Braking

- A. Provide the following principal means of Emergency Brake initiation, in accordance with EN 13452 Table 3 — Theoretical operational performances:
 - 1. **Emergency 1**: initiated by the Driver's Safety Device;
 - 2. **Emergency 3**: initiated by the Driver, via dedicated "Hazard" position on the brake controller; and
 - 3. **Emergency 4**: initiated by the Driver, via the Emergency Stop Mushroom Button.

7-1.13.5.1 Driver's Safety Device (Emergency 1)

- A. Provide a Driver's Safety Device which complies with EN 13452 (Emergency 1) and which requires the Driver to apply continuous pressure or activity to remain activated.
- B. The Driver's Safety Device shall:
 - 1. be interconnected with the Traction Power and emergency braking systems in such a manner that upon failure to detect a level of activity or pressure exerted by the Driver, the Train shall be brought to a stop, by:
 - a. interrupting the Traction Power supply; and
 - b. automatically initiating an irrevocable emergency 1 brake performance as defined in EN 13452;
 - 2. activate a warning buzzer in the Active Driver's Cab immediately upon deactivation of the Driver's Safety Device;
 - 3. only be resettable once the Train is stationary;

4. be designed to minimize strain for the Driver;
5. be of a tamper resistant design; and
6. have a manual override function to by-pass the system. Operation of the by-pass function shall only allow the Train to operate at a maximum speed of 15kph.

C. Application of emergency 1 braking shall invoke the following braking elements:

1. Dynamic Braking;
2. Friction Braking, to the extent required for desired deceleration rate;
3. Wheel Slide Protection, including automatic sanding, in accordance with Section 7-1.13.1.5 [*Automatic Sanding System*] of this Schedule;
4. load control; and
5. electromagnetic Track Brakes.

7-1.13.5.2 Hazard Brake (Emergency 3)

A. Provide a revocable Hazard Brake function in accordance with EN-13452 (Emergency 3).

B. The Hazard Brake function shall be controlled from the Driver's traction/brake controller.

C. Application of Hazard Braking shall invoke the following braking elements:

1. Dynamic Braking;
2. Friction Braking, to the extent required for desired deceleration rate;
3. Wheel Slide Protection, including automatic sanding, in accordance with Section 7-1.13.1.5 [*Automatic Sanding System*] of this Schedule;
4. load control; and
5. electromagnetic Track Brakes.

7-1.13.5.3 Emergency Braking (Emergency 4)

A. Provide a high integrity Emergency Brake function in accordance with EN 13452 (Emergency 4).

B. The Emergency Brake function shall:

1. be activated by the Driver's Emergency Stop Mushroom Button;
2. only be resettable once the Train is stationary;
3. apply a deceleration rate in accordance with the performance requirements in EN-13452 Table 3; and
4. shall not be capable of degradation by loss of any control systems.

C. Application of Emergency Braking shall invoke the following braking elements:

1. Dynamic Braking;
2. Friction Braking;

3. load control;
4. Automatic Sanding System; and
5. electromagnetic Track Brakes.

7-1.13.6 Security Brake

- A. Provide a Security Brake function in accordance with EN 13452.
- B. No load compensation/control when the security brake is activated.
- C. The Security Brake shall achieve a higher level of system integrity than the Service Brake and Emergency Brake; however the braking performance can be at a lower level than that achieved in either Emergency Brake or Service Brake application.
- D. The Security Brake shall automatically engage when a failure of one or more critical LRV control system(s) has compromised the integrity of either Emergency Brake or Service Brake application
- E. Application of the Security Brake shall invoke the following braking elements:
 1. Friction Braking, as the primary braking system;
 2. Wheel Slide Protection in accordance with Section 7-1.13.1.5 [*Automatic Sanding System*] of this Schedule, including automatic sanding, are optional requirements for the Security Brake function. If these are required to ensure the Security Brake performance operates in accordance with the standard EN 13452, then no single failure shall prevent the attainment of the specified performance for the Security Brakes.

7-1.14 LRV PA/VMS SYSTEM

- A. The LRV PA/VMS system provides:
 1. automated announcements and Driver initiated Passenger announcements in both audible and visual forms; and
 2. a means for the Driver to respond to emergencies and other requests for assistance by Passengers.
- B. Prepare and submit a comprehensive study with the Final Design of the LRV to demonstrate that the LRV-PA subsystem complies with the acoustic coverage and intelligibility requirements of Section 7-1.14.1 [*LRV-Public Address*] and that the LRV-VMS subsystem complies with the requirements of Section 7-1.14.2 [*LRV Variable Message Signs*], (the "**LRV Coverage Study**").
- C. Related audible (LRV PA) and text (LRV VMS) messages shall be coordinated so that playback to the Passengers occurs simultaneously. Unrelated audible and text messages shall be capable of being transmitted independently of each other.

7-1.14.1 LRV Public Address

- A. Provide an LRV PA subsystem which permits the Driver to make ad-hoc audible announcements throughout the Passenger area of the Train, and which provides predetermined automatic Stop/Station audible announcements that include the name of the next Stop/Station and Train destination.
- B. PA volume shall be set to the configured parameter during vehicle start up. The interior volume shall be equipped with automatic gain control (AGC) with local sound sensing devices to maintain a clear and pleasing audio within the LRV considering interior noises.

- C. The LRV-PA system shall allow authorized personnel to load and update automatic announcements.
- D. The maximum noise levels of the LRV-PA system, when the Train, is stationary at a Stop or Station with all doors open, shall not exceed the requirements set within Section 1-2.1.3 [*Noise Control*] of this Schedule.
- E. The LRV-PA announcement volume shall automatically adjust based on time of day pre-sets. The system shall allow authorized personnel to adjust the pre-set volume and time parameters.

7-1.14.2 LRV Variable Message Signs

7-1.14.2.1 General

- A. Provide interior and external Variable Message Signs on each LRV.
- B. The LRV-VMS shall include provision for preloading and displaying information in accordance with Section 7.8.2 [*Information on LRVs*] of Schedule 7 [*O&M Performance Requirements*].
- C. The information displayed by the LRV-VMS subsystem shall be capable of being changed by authorized personnel at the Gerry Wright OMF.
- D. Horizontal scrolling displays shall be provided and have a scrolling speed not exceeding 6 characters per second.
- E. The LRV-VMS system shall display predetermined, ad-hoc (from typed input), and automated (pre-programmed inputs) text messages.
- F. Related audible and text messages shall be coordinated so that playback to the Passengers occurs simultaneously. Unrelated audible and text messages shall be capable of being transmitted independently of each other.
- G. Based on the minimum character height requirements as stated in this Section 7-1.14.2 [*LRV Variable Message Signs*], maximize the number of characters that can be displayed on the LRV-VMS. If horizontal or vertical scrolling displays are used, any Stop/Station names (which may be abbreviated) and any other complete words or messages shall be displayed for a minimum of 2 seconds.
- H. The LRV-VMS characters shall be displayed in lower case with capitalization, with ascender and descender characters having a minimum size ratio of 20% to upper case characters. Words shall not be displayed on LRV-VMS written in capital letters only.
- I. The LRV-VMS shall include an optical function that automatically adjusts intensity based on ambient light levels.
- J. Each LRV-VMS shall be visible and legible under all lighting conditions.
- K. Words and numbers displayed on LRV-VMS shall:
 1. contrast with their background; and
 2. not be red in colour.

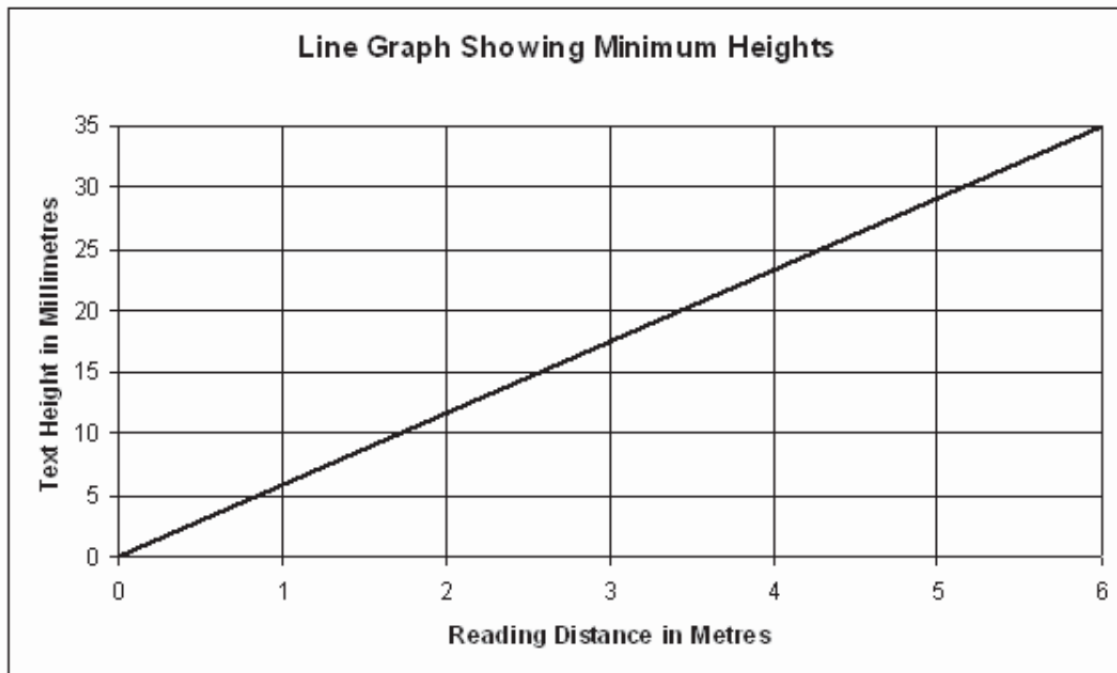
7-1.14.2.2 External LRV-VMS

- A. Provide external LRV-Variable Message Signs at both ends of each LRV and a minimum of two LRV-VMS along each side of each LRV, located such that they can be seen by Passengers when the LRV is entering a Stop or Station and from anywhere on the Platform when the LRV is stationary.

- B. Capitalized letters and numbers displayed on external LRV-VMS shall be not less than:
 1. 100mm high on front/rear mounted LRV-VMS; and
 2. 70mm high on side mounted LRV-VMS.
- C. The external LRV-VMS shall be integrated into the overall LRV form and flush with the bodywork so as not to detract from the clean lines and shape of the LRV.
- D. The external LRV-VMS shall display the Destination Stop or an out of service message, as applicable.

7-1.14.2.3 Internal LRV-VMS

- A. Provide internal LRV-VMS capable of being viewed from:
 1. a minimum of 51% of all combined seating;
 2. a minimum of 51% of the priority seats; and
 3. at least one wheelchair space.
- B. The minimum character height on the LRV-VMS shall be equal or greater than the “Text Height in Millimetres” as shown on the following graph for the applicable reading distance, provided that for a reading distance of more than 6 metres, the minimum character height shall be 35mm. For the purpose of this Section 7-1.14.2.3 [*Internal LRV-VMS*], “reading distance” shall mean the greatest distance between any Passenger space in the LRV and the nearest readable LRV-VMS.



- C. All internal LRV-VMS shall have the same minimum character height.
- D. The internal LRV-VMS shall display the next Stop or Station once the Train has left the preceding Stop or Station.

7-1.15 PASSENGER EMERGENCY DEVICES

7-1.15.1.1 Passenger Emergency Alarm

- A. Provide clearly labelled, two-way devices for communication with the Driver in the in the event of an emergency (each, a "***Passenger Emergency Alarm***").
- B. Activation of the PEA shall not apply any LRV brakes.
- C. The PEA shall consist of a touch sensitive strip, coloured yellow and located throughout the length of the Passenger area, including within the vicinity of each wheelchair space.
- D. The touch sensitive strip shall be located so as to prevent accidental use, but remain within access to all Passengers, including a person using a Reference Wheelchair.
- E. When the PEA strip is operated in any Passenger area, an audible and visual alarm shall be provided in the Active Driver's Cab, along with a video image of the area within which the PEA has been activated, in accordance with Section 6-1.12.1.F [*General Surveillance Requirements and Coverage*] of this Schedule. The Driver shall be able to hear and communicate via the LRV-PA system and the microphone nearest to the point of activation.

7-1.15.1.2 Passenger Emergency Intercom

- A. Provide at least 4 pushbutton activated emergency intercom devices evenly spaced throughout the LRV.
- B. In addition to Section 7-1.15.1.2 [*Passenger Emergency Intercom*] of this Schedule, provide one pushbutton activated emergency intercom device in each wheelchair space.
- C. When a Passenger emergency intercom is activated, an audible and visual alarm shall be provided in the Active Driver's Cab, along with a video image of the area within which the Passenger emergency intercom has been activated, in accordance with Section 6-1.12.1.F [*General Surveillance Requirements and Coverage*] of this Schedule. The Driver and Passenger shall be able to hear and communicate with one another via a two-way intercom device. The intercom device shall be handsfree, once activated.
- D. The Passenger emergency intercom devices shall include an LED to indicate activation.

7-1.16 AUXILIARY SYSTEMS

7-1.16.1 Auxiliaries

- A. Provide an auxiliary power supply system to energize equipment on-board the LRV and to charge the LRV batteries described in Section 7-1.16.2 of this Schedule. The auxiliary power supply system shall comply with IEEE STD 16-2004.

7-1.16.2 Batteries

- A. Provide batteries which comply with IEC 60077 Railway Applications – Electric equipment for rolling stock, in each LRV, with sufficient capacity to supply power to all auxiliary systems required for safe operation, including the following, for a minimum of 60 minutes without charging current:
 - 1. internal emergency lights;
 - 2. LRV Surveillance Subsystem;
 - 3. external lighting, including hazard warning lights;

4. radio system;
 5. Passenger Emergency Devices;
 6. pantograph raising/lowering operation (if applicable);
 7. Service Brake release/apply;
 8. Automatic Sanding System;
 9. Wheel Slide Protection;
 10. windshield wipers;
 11. warning devices (e.g. horn/bell); and
 12. all other systems determined to be necessary pursuant to the Safety and Security Certification Program.
- B. If a pantograph is provided as the means for Traction Power current collection, provide a means:
1. of manually raising and lowering the pantograph without any power source (e.g. in the event of full battery discharge); and
 2. to re-energize and charge the batteries using only the supply from the pantograph.
- C. Provide battery isolation switches on each side of the LRV, which shall be:
1. accessible from ground level;
 2. located behind a lockable cover that is clearly identified for maintenance and Emergency Services access; and
 3. positioned to protect the switch against accidental operation and against damage as a result of collisions.

7-1.17 TRACTION PROPULSION SYSTEM

7-1.17.1 General

- A. Provide a Traction Propulsion System on each LRV that encompasses all equipment necessary to receive LRV propulsion energy from the Traction Power System. The Traction Propulsion System shall comply with the following standards:
1. EN 50153 - Rolling stock - Protective provisions relating to electrical hazards or NFPA 70 – Chapter 3 and Chapter 2, article 240;
 2. EN 50155 - Electronic equipment used on rolling stock;
 3. EN 50163 - Supply voltages of traction systems or IEC 60850;
 4. IEC 60077 - Electric equipment for rolling stock - Part 1: General service conditions and general rules;
 5. IEC 60077 - Electric equipment for rolling stock Part 2: Electrotechnical components - General rules – contactors;
 6. IEC 60077 - Electric equipment for rolling stock Part 3: Electrotechnical components - Rules for d.c. circuit-breakers;

7. IEC 60077 - Electric equipment for rolling stock Part 5: Electrotechnical components - Rules for HV fuses;
 8. IEEE STD 16-2004 - Standard for Electrical and Electrical Control Apparatus for Rail Vehicles; and
 9. IEC 60310 Railway applications - Traction transformers and inductors on board rolling stock - Filter inductors.
- B. The Traction Propulsion System and the LRV braking systems shall provide a seamless interface between Dynamic Braking and Friction Braking system commands.
 - C. The Traction Propulsion System shall operate at any power level (in motoring), or any braking effort level (in braking) for as long as is necessary to maintain a selected speed, acceleration and deceleration rates required to meet the Project Requirements.
 - D. In addition to the duty cycle rating required to meet the Operational Availability requirements and the LRV recovery requirements, the Traction Propulsion system shall be designed for:
 1. low speed operation; and
 2. frequent starts and stops.
 - E. The tractive effort, motor current and line current versus acceleration and time for various input voltages shall be provided with the Final Design of the LRV to demonstrate that the line current limits are in accordance with the Project Requirements for the Traction Power System.
 - F. The traction motor design shall comply with IEC 60349-2.
 - G. The traction inverter design shall comply with IEC 61287-1.
 - H. The control system for the Traction Propulsion System shall include an event log to capture and record Traction Propulsion System operating parameters for troubleshooting.
 - I. Where the traction motor speed provides less than the duty cycle average ventilation of the Propulsion System, provide thermal protection sufficient to protect the Propulsion System equipment against damage or degradation.
 - J. If a speed restriction is required due to Propulsion System equipment failure, the speed restriction shall be automatically applied and controlled, without Driver intervention, to prevent an over-speed occurrence.
 - K. Passenger loads up to and including AW3 shall not detrimentally affect the acceleration performance of the LRV.
 - L. To prevent LRV rollback, the LRV shall automatically detect and coordinate the release of the brakes and the application of tractive effort, for any load up to AW3 on any gradient on the System. Where, for any reason, application of tractive effort is not successful, any LRV rollback shall be automatically detected and the Friction Brake shall be automatically applied such that LRV rollback does not exceed 500mm.

7-1.17.2 Wheel Spin

- A. The Traction Propulsion System shall include an anti-Wheel Spin function to perform the following:
 1. detect individual wheel set spin, including synchronous slide of all bogies;

2. maximize adhesion by automatic application of sand in accordance with Section 7-1.13.1.5 [*Automatic Sanding System*] of this Schedule;
3. detect wheel spin and react before reaching an uncontrolled spin condition; and
4. remove and then restore Traction Power from the affected wheel set or bogie, without reducing the applied torque to any other wheel sets or bogies.

7-1.17.3 Traction Power Source

- A. If a pantograph is provided, it shall comply with EN 50206-2 or IEC 60494-2 and shall be:
 1. capable of operating in either direction at all speeds up to and including the Maximum Design Speed with the pantograph raised;
 2. provided with a manual means of raising, lowering and isolating the pantograph;
 3. provided with over voltage protection, including protection from lightning strikes;
 4. provided with clearly marked externally mounted switches and devices for emergency external isolation and lowering.

7-1.17.4 Degraded Operation

- A. The LRV shall have provision to operate in a Degraded Traction Mode.
- B. Provide a mode of operation that restricts the Train to a Restricted Speed.

7-1.17.5 Power Interruptions – Performance

- A. The Traction Propulsion System performance shall not be adversely affected by intermittent interruptions in the supply of Traction Power.

7-1.18 BOGIES AND RUNNING GEAR

7-1.18.1 Bogies

- A. Bogie frames shall comply with EN 13749.
- B. The running gear shall comply with EN 13232-3, EN 13260, EN 13261, and EN 13262, include protection against derailment and be compatible with all Track forms, including all:
 1. combinations of Track geometry;
 2. switches and crossings;
 3. guard rails; and
 4. other Track mounted equipment and systems.
- C. Where the standards required by Sections 7-1.18.1A [*Bogies*] and 7-1.18.1B [*Bogies*] of this Schedule are not suitable, either in part or full for the proposed type of bogie, submit alternative recognized industry standards / guidance including system assurance documentation that demonstrates equivalent functionality and performance for the actual service environment to be encountered.

7-1.18.2 Suspension

- A. All bogies shall include both primary and secondary suspension systems, which shall allow for movement of the LRV in the lateral, vertical and roll axes.
- B. The suspension systems shall comply with EN 13298 and EN 13802 or AAR 114, *Helical Springs, Heat-treated, steel*.
- C. The suspension systems shall:
 - 1. maintain all Passenger door entrance heights and horizontal gaps within the tolerances specified in Section 7-1.6.3 [*Platform / LRV Interface*] of this Schedule;
 - 2. comply with the ride performance requirements, in accordance with Section 7-1.18.5 [*Ride Performance*] of this Schedule, with all components at their maximum allowable state of wear;
 - 3. be designed to perform under all Track and wheel wear conditions, without the risk of derailment; and
 - 4. minimize the dynamic forces on both the LRV and the Track.

7-1.18.3 Wheels and Axles

- A. Wheels and axles shall comply with EN 13103 and EN 13104 and shall:
 - 1. comply with the Project Requirements for noise and vibration as set out in Section 1-2.1.3 [*Noise Control*] of this Schedule;
 - 2. comply with the ride performance requirements in accordance with Section 7-1.18.5 [*Ride Performance*] of this Schedule; and
 - 3. have a tread and flange profile compatible with all Track forms, in accordance with EN 13232-3.

7-1.18.4 Wheel Flange Lubrication

- A. Provide a wheel flange lubrication system in accordance with EN 15427.
- B. The wheel flange lubrication system shall:
 - 1. be compatible with all Track forms, without contamination of the running rail surface, adjacent Roadways, pedestrian crossings or the environment;
 - 2. automatically detect where the LRV is, in order to restrict the application of the lubricant to only those areas where rail wear and wheel noise is most likely to occur;
 - 3. provide lubricant coverage to minimize wheel/rail wear; and
 - 4. reduce wheel squeal associated with the wheel/rail interface in compliance with Section 1-2.1.3 [*Noise Control*] of this Schedule.

7-1.18.5 Ride Performance

- A. Each LRV shall have a mean Ride Comfort Index value of less than 3 and more than 1, where the ride quality indices are measured in accordance with EN 12299.
- B. All LRVs shall comply with ISO 2631 for Mechanical Vibration and Shock - Evaluation of Human Exposure to whole Body Vibration.

7-1.18.6 Shunt Performance

- A. If the TCS uses Track Circuits pursuant to Section 6-1.3 [*Train Control System (TCS)*] of this Schedule, the design of the LRV vehicle shall be co-ordinated with the design of the Track Circuits, such that the maximum allowable rail to rail LRV shunt resistance shall be constrained to a known maximum value under all environmental and Track conditions, whether the LRV is in motion or stationary.

7-1.19 COUPLING

- A. Provide coupling devices on both ends of each LRV, which shall operate safely and reliably:
 - 1. under all AW Loadings;
 - 2. when coupling and uncoupling LRVs;
 - 3. during all LRV recovery situations;
 - 4. under all Track conditions and on all Track forms; and
 - 5. on all gradients, including combined horizontal and vertical curvatures;
- B. When not in use, the coupling devices shall be concealed behind manually operated or automatically operated covers that are flush with the body of the LRV. If automatically operated covers are provided, they shall be capable of being manually operated in the case of failure of the automatic feature.
- C. The coupling system shall permit changes to Train configurations as required to meet all applicable Service Levels.
- D. The coupling devices shall withstand coupling forces up to a speed of at least 4kph without damage or deformation to the couplers or associated equipment and mountings.

7-1.20 EXTERNAL LIGHTING

- A. Provide external lighting on all LRVs in compliance with the requirements of the *Traffic Safety Act* (Alberta) and the *Vehicle Equipment Regulations* (Alberta), applicable to operation of the LRVs on the roadway, tunnels, elevated guideways and segregated alignments of the System. The LRV external lighting requirements include the following:
 - 1. headlights, with high and low beam functions;
 - 2. side lights;
 - 3. tail lights;
 - 4. brake lights;
 - 5. rear fog lights;
 - 6. hazard lights;
 - 7. outline marker lights;
 - 8. individual direction indicator lights at each end of the LRV and also equally spaced along each side such that they are visible to other road users;

9. side marker lights equally spaced (at a maximum spacing of 10m) along each side of the LRV such that they are visible to other road users. Note that side marker lights may also be combined with direction indicator lights as specified in 7-1.20A.8 [*External Lighting*]; and
 10. reflectors, along each side of the LRV, which are mounted 1m above road level. Note that reflectors may also be combined with direction indicator lights as specified in 7-1.20A.8 [*External Lighting*].
- B. External lighting on each LRV shall auto-switch as required for bi-directional operation.
 - C. The headlights, direction indicator lights (not flashing), tail lights and outline marker lights shall remain on at all times whenever a Driver's Cab within the Train is switched on and active.
 - D. When direction indicator lights on one side on an LRV are activated/flashing to indicate a turning manoeuvre, the direction indicator lights on the other side of the LRV shall remain illuminated, i.e. not flashing.
 - E. The hazard warning lights shall remain operable at all times, including with an Active Driver's Cab, with the control key switch in the 'off' position, or with the control key removed.
 - F. The tail lights shall remain on at all times whenever a Train is stationary, for any reason, on the Mainline Track including with an Active Driver's Cab, with the control key switch in the 'off' position, or with the control key removed.
 - G. External lighting shall be provided by LEDs.

7-1.21 AUDIBLE WARNING DEVICES

- A. Provide each LRV with audible warning devices that emit distinct but different types of warning sounds for the following areas:
 1. residential areas;
 2. low Posted Speed (≤ 30 kph), pedestrian areas; and
 3. high Posted Speed (> 30 kph) areas .
- B. Submit sound samples, in an electronic format, concurrently with submission of the LRV Final Design package to demonstrate the effectiveness of the sounds to be provided in accordance with 7-1.21A [*Audible Warning Devices*].
- C. The sound levels produced by the audible warning devices shall comply with the requirements of Section 1-2.1.3 [*Noise Control*] of this Schedule.

7-1.22 ONBOARD LRV ACCIDENT/INCIDENT EVENT LOGGING AND RECORDER

- A. Provide an on-board LRV accident/incident event logging and recording system on each LRV (the "**Accident/Incident Event Recorder**"). The Accident/Incident Event Recorder shall comply with IEEE STD 1482.1 and shall:
 1. log and record all changes (actions and inactions) in Driver action, LRV function, safety critical system operation and LRV interface;
 2. have sufficient capacity to provide at least 48 hours of operational service recording time; and
 3. include a condition status indicator suitably located in the Driver's Cab.

- B. Provide all software and hardware interface devices necessary to allow data to be readily retrieved by Project Co and the City, for interrogation and analysis via a COTS operating system.

7-1.23 RADIO SYSTEM

- A. Provide a radio in each Driver's Cab, that enables clear and dependable two-way voice and data radio communication between Drivers, OCC and other Project Co personnel at all points along the LRT Corridor. The Driver's Cab radios shall comply with Section 6-1.13 [*Radio Systems*] of this Schedule, and shall include necessary:
 - 1. receivers;
 - 2. transmitters;
 - 3. antennas; and
 - 4. intermediate devices.

7-1.24 LRV SURVEILLANCE SUBSYSTEM

- A. Provide an LRV Surveillance Subsystem in accordance with Section 6-1.12 [*Surveillance System*] of this Schedule.

7-1.25 TRPS SYSTEM

- A. Provide all on-board equipment required for the Train Routing and Priority System, including on-board equipment required to initiate routing requests and Transit Signal Priority requests in accordance with Section 6-1.4 [*Train Routing and Priority System*] of this Schedule.

7-1.26 GROUNDING

- A. The design of the LRV grounding and bounding system shall not permit the vehicle carbody to present any electrical Hazards to Passengers under any electrical fault condition.
- B. The carbody potential shall not exceed 50V in the case of fault or lose of safety ground.
- C. The ground system shall provide safe separation of DC and AC ground connections.
- D. Provide an insulated negative return system for traction power DC circuits.