spouts and automatic dispensing equipment. All lubricant sumps shall be fitted with magnetic-type drain plugs or magnets in the reservoir pan.

9.6.1. Transmission Test Port

The transmission shall be equipped with an oil sample port of the push button type and located to ensure easy access on a line with adequate circulation. The oil sampler port shall have a sampling pressure range of 5 psi to 750 psi, max operating pressure of 6,000 psi, maximum burst pressure of 24,000 psi, and nitrile seal temperature of -40°F to +240°F. The oil sampling port proposed will be subject to approval by the Authority.

10. Hydraulic Systems

Hydraulic system(s) service tasks shall be minimized and scheduled at the same frequency as those of other major coach systems or in accordance with the maintenance requirement in section 5.7. All elements of the hydraulic system(s) shall be easily accessible for service or unit replacement. Critical points in the hydraulic system(s) shall be fitted with service ports so that portable diagnostic equipment may be connected or sensors for an off-board diagnostic system permanently attached to monitor system operation when applicable. A tamperproof priority system shall prevent the loss of power steering during operation of the bus if other devices are also powered by the hydraulic system(s).

The hydraulic system(s) shall operate within the allowable temperature range as specified by the component and hydraulic lubricant manufacturer.

10.1. Hydraulic System Sensors

Sensors in the main hydraulic system shall indicate out of range conditions on the driver's onboard diagnostic panel/ dash. Out of range conditions include but not limited to low hydraulic fluid level, temperature overlimit, electric overcurrent, etc.

The hydraulic system specifications shall apply to a wheelchair ramp should the ramp be hydraulically driven.

10.2. Hydraulic Fluid Lines

All lines shall be rigidly supported to prevent chafing damage, fatigue failures, degradation, and tension strain. Lines should be sufficiently flexible to minimize mechanical loads on the components. Lines passing through a panel, frame or bulkhead shall be protected by grommets (or similar devices) that fit snugly to both the line and the perimeter of the hole that the line passes through to prevent chafing and wear. Pipes and fluid hoses should not be bundled with or used to support electrical wire harnesses.

Lines shall be as short as practicable and shall be routed or shielded so that failure of a line shall not allow the contents to spray or drain onto any component operable above the auto-ignition temperature of the fluid.

10.3. Hydraulic Fittings and Clamps

All clamps shall always maintain a constant tension, expanding and contracting with the line in response to temperature changes and aging of the line material. The lines shall be designed for use in the environment where they are installed (for example, high-temperature resistant in the rear compartment, resistant to road salts near the road surface, and so on).

Compression fittings shall be standardized to prevent the intermixing of components. Compression fitting components from more than one manufacturer shall not be mixed, even if the components are known to be interchangeable.

10.4. Hydraulic System Radiator/Heat Exchanger

If liquid cooling is used, the radiator and/or heat exchanger shall be a heavy-duty metal unit, preferably constructed with a copper core. It is preferred to be of the tube type with bolted-on upper and lower tanks and with no solder-to-coolant contact. The radiator/heat exchanger shall be accessible for cleaning. Any radiator/heat exchanger shall be easily removable from the bus. Aluminum brazed/soldered radiator and/or heat exchanger may be used for low-temperature coolant systems only.

Radiator piping shall be stainless steel, brass tubing, or painted steel rated at 1000 hours of salt spray according to ASTM B117. Where practicable, hoses shall be eliminated. Necessary hoses shall be impervious to all bus fluids. All hoses shall be secured with stainless steel clamps that provide a complete 360-degree seal. The clamps shall always maintain a constant tension, expanding and contracting with the hose in response to temperature changes and aging of the hose material.

10.5. Hydraulic System Heat Exchanger Fluid Transfer Lines

All systems lubrication shall meet or exceed component manufacturer’s recommendation for installation, operation, and maintenance. The fluid transfer lines shall be designed and intended for use in the environment where they are installed (for example, high-temperature resistant in the rear compartment, resistant to road salts near the road surface and so on). Fluid lines shall not be the lowest point of the bus undercarriage.

11. Fuel- Diesel

11.1. Fuel Lines

Fuel lines shall be capable of carrying the type of fuel specified by the Agency (i.e., up to B20 type fuel).

Fuel lines shall be securely mounted, braced and supported as designed by the bus manufacturer to minimize vibration and chafing and shall be protected against damage, corrosion or breakage due to strain or wear.

Manifolds connecting fuel containers shall be designed and fabricated to minimize vibration and shall be installed in protected locations to prevent line or manifold damage from unsecured objects or road debris.

Fuel hose and hose connections, where permitted, shall be made from materials resistant to corrosion and fuel and protected from fretting and high heat. Fuel hoses shall be accessible for ease of serviceability.

11.2. Tank- Design and Construction- Diesel and Diesel Exhaust Fluid-

The diesel fuel tank(s) shall be made of stainless steel. Maximum fuel tank capacity available shall be installed. The maximum fuel tank capacity available shall have the most usable gallon capacity so as to obtain the highest range possible from the vehicle.

The Diesel Exhaust Fluid tank shall be the largest tank available and made of high-density polyethylene. The largest tank available shall have the most usable gallon capacity so as to obtain the highest range possible from the vehicle.

11.2.1. Diesel Fuel Tank Installation

The fuel tank(s) shall be securely mounted to the bus to prevent movement during bus maneuvers.

The fuel tank(s) shall be equipped with an external, hex head, drain plug. It shall be at least a ⅜-inch size and shall be located at the lowest point of the tank(s). The fuel tank(s) shall have an inspection plate or easily removable filler neck to permit cleaning and inspection of the tank(s) without removal from the bus. The tank(s) shall be baffled internally to prevent fuel-sloshing noise regardless of fill level. The baffles or fuel pickup location shall assure continuous full power operation on a 6 percent upgrade for 15 minutes starting with no more than 25 gallons of fuel over the unusable amount in the tank(s). The bus shall operate at idle on a 6 percent downgrade for 30 minutes starting with no more than 10 gallons of fuel over the unusable amount in the tank(s).

The materials used in mounting shall withstand the adverse effects of road salts, fuel oils, and accumulation of ice and snow for the life of the bus.

11.2.2. Diesel Exhaust Fluid (DEF) Tank Installation

The diesel exhaust fluid tank shall be securely mounted to the bus to prevent movement during bus maneuvers. The DEF tank shall be installed on the curbside rear of the bus.

The fill port and cap shall be so that the DEF tank can be filled using a standard “gun” style fuel fill nozzle.

The DEF fill port shall be easily distinguishable and marked so as not to be confused with any other fluid fill port. The Vehicle Manufacturer shall work with the Authority to identify/label the DEF fill port.

11.2.3. Labeling

The capacity, date of manufacture, manufacturer name, location of manufacture, and certification of compliance to Federal Motor Carrier Safety Regulation shall be permanently marked on the fuel tank(s). The markings shall be readily visible and shall not be covered with an undercoating material.

11.2.4. Diesel Fuel Fill

The fuel filler shall be located 7 to 25 feet behind the centerline of the front door on the curbside of the bus. The filler cap shall be retained to prevent loss and shall be recessed into the body so that spilled fuel will not run onto the outside surface of the bus.

The fuel lines forward of the engine bulkhead shall be in conformance to SAE Standards.

The vehicle fuel filling system shall be equipped with a break fueling system that has the same salient features as the Emco Wheaton Posi/Lock-105 Automatic Dry-Break Fueling System - Adapter with PosiSnap Cap, Fill Neck, Level Control Valve, Whistle and Pressure Relief Valve. The fuel filler shall accommodate a nozzle that forms a locked and sealed connection during the refueling process to eliminate spills. Fuel shall not be allowed to flow into the tank unless the nozzle has been properly coupled, locked and sealed to the filler. With the nozzle open, fuel shall enter the tank at a fill rate of not less than 40 gallons per minute of foam-free fuel without causing the nozzle to shut off before the tank is full. The nozzle shall automatically shut off when the tank is essentially full. Once disconnected, fuel shall not be allowed to flow through the nozzle at any time. Any pressure over 3 psi shall be relieved from the fuel tank automatically. An audible signal shall indicate when the tank is essentially full.

STRUCTURE

12. Chassis General

12.1. Design

The structure of the bus shall be designed to withstand the transit service conditions typical of an urban or intercity duty cycle throughout its service life. The vehicle structural frame shall be designed to operate with minimal maintenance throughout the 12-year design life.

12.1.1. Design and Technical Drawings and Schematics

Upon completion of the first pilot bus(es), the Contractor shall provide the Authority with a hard copy set of the production shop floor drawings of the bus for the Configuration Audit, as required in Exhibit F-2 Quality Assurance.

The Vehicle Manufacturer shall furnish complete electrical schematics for the bus prior to production. Reproducible wiring schematics in hard copy and PDF format shall be provided in the quantities specified.

Final drawings reflecting any modifications made during the production cycle shall be provided in PDF or DXF format within 120 days after the delivery of the final production bus.

These drawings shall, at a minimum, include:

- The complete structural design of the bus
- Interior body layout with dimensions
- Exterior body layout with dimensions
- Floor plan
- Glazing and frame details
- Propulsion system mounting details
- Passenger assistance layout
- Seat placement and dimensions
- Passenger door and window dimensions
- Wiring schematics and diagrams
- Wiring harness and cable drawings
- Plumbing schematics (pneumatic/hydraulic) and drawings
- Suspension system details
- Operator cab layout/configuration
- Paint scheme
- Interior decal placement
- Exterior decal placement
- Destination sign drawings and schematics
- Frame drainage plan
- Fire Suppression System (FSS) installation and routing

12.1.2. Design and Sub-System Qualification Testing

The Vehicle Manufacturer shall demonstrate that each sub-system supplied meets the requirements of these specifications. This conformance may be accomplished by means of acceptable previously conducted testing reports. These tests shall be run on production equipment that has passed production acceptance testing. These tests shall stress the equipment under environmental conditions at least as severe as those expected in the Authority's operating environment. While stressed in this manner, it shall be demonstrated that the equipment performs its intended function without failure.

Major sub-systems shall be assembled separate from the vehicle or on a test vehicle and shall be tested to verify compliance with these specifications. Related sub-systems may be integrated and tested together to verify compliance of the individual sub-systems and to verify the design of the interface between them.

These qualification tests shall be in accordance with industry standards or equivalent such as:

SAE USCAR (United States Council for Automotive Research) 21 – Performance Specification for Cable to terminal Electrical Crimps

SAE J1455 – Joint SAE/TMC Recommended Environmental Practices For Electronic Equipment Design (Heavy-Duty Trucks)

Thermal Shock and Vibration Testing (Applicable SAE standards)

12.1.3. Design Test Reports

Within fifteen (15) days after completion of each test, a report shall be provided that summarizes results, analyses, and corrective actions, if necessary. Reports shall include photographs, charts, and additional data to support the test results. Reports shall include a statement that certifies conformance to specifications and specifically note any deficiencies.

All reports shall be submitted and reviewed by the Authority.

12.1.4. Test Procedures

Vehicle Manufacturer shall submit an overall test procedure for each design qualification and conformance tests and each acceptance tests for approval 30 days prior to the scheduled date of the test. The Vehicle Manufacturer shall provide all equipment and instrumentation required to conduct tests. The test procedures shall contain at least the following:

- Test objective
- Success / failure criteria
- Sequence of testing
- Equipment and instrumentation required
- Test setup, description and diagrams
- Test methodology
- Data evaluation procedure
- Type of report or data to be submitted to the Authority with associated time frame after completion of tests (Not to exceed 30 days).

12.1.5. Test Submittals

The following items shall be submitted to the Authority for review and approval:

- Draft Test Program
- Draft Test Procedures
- Sample Test Reports
- First Article Inspections

A production order with all of the major components listed along with manufacturers, model numbers, serial numbers, and specifications for each. – Request that the parts book contain the model and serial numbers for each major subcomponent. Enter language that the parts be delivered with the bus a “final local copy (thumb drive)” (required), revisions allowable via shared site. Have access to the latest parts catalog. Have access to production files as the vehicles as they are being built.

12.1.6. First Article Inspections (FAI) and Application Approval Certificates

The intention is to have performed and witnessed, those tests conducted by the sub-component manufacturer that would constitute an FAI. Essentially, a form, fit and limited functionality check would be made of the assembly against detailed technical drawings. The Contractor and sub-component manufacturer shall provide a complete assembly for these inspections. Additionally, the sub-component manufacturer should ensure acceptable performance prior to shipment to the bus manufacturer will perform acceptance testing of all production units.

At a minimum the following sub-systems of the bus shall be subjected to First Article Inspections:

- Operator Seat
- Door Systems
- ESS System
- Fire Suppression System
- Event Data Recorder
- Closed Circuit Security Camera System
- Intelligent Transportation Systems (ITS)- Computer Aided Dispatch (CAD)/Automatic Vehicle Locator (AVL)

The Authority may participate in such FAI’s. OEM shall provide a schedule for completing the required FAI’s.

At a minimum, the Vehicle Manufacturer shall provide documentation, Application Approval Certificates, stating they are qualified to install the required sub-components either from the sub-component supplier, preferred, or from their internal engineering department on the following sub-components:

- Windows
- Floor covering
- Passenger Seating
- HVAC
- Exterior vinyl wrap
- Diesel Engine
- Hybrid Transmission Drive

12.1.7. Reporting and Information Storage and Sharing

All reports shall be provided, at a minimum, on a shared drive between the Vehicle Manufacturer and the Authority. The reports shall be backed up on thumb drive type media and provided to the Authority for record keeping.

The storage site and media shall also be used for all lists and information.

12.2. Altoona Testing

Prior to submitting the proposal, the vehicle must have completed and passed the FTA-required Altoona testing. A copy of the Altoona Test Report shall be provided to the Authority as part of the proposal.

Any items that required repeated repairs or replacement during the Altoona testing must have undergone corrective action with supporting test and analysis. A report that clearly describes and explains the failures and corrective actions taken to ensure that any and all such failures will not recur, shall be submitted to the Authority.

The report shall include the following:

Failure Mode and Effects Analysis (FMEA)-

The Altoona test report shall include a complete Failure Mode and Effects Analysis (FMEA) on all safety related systems of the bus. The analysis shall conform to generally accepted industry standards (SAE J1739, DOT-FTA-MA-26-5005-00-01/DOT-VNTSC-FTA-00-01, or equivalent) and be the product of a person or persons with demonstrated expertise in FMEA analysis. At a minimum these systems would include:

- Brake system and all air related components
- Steering system
- Passenger door operation
- Electrical
- Fire suppression

The Vehicle Manufacturer shall notify the Authority at the Pre-Production meeting of the schedule and details of these reports. Complete reports shall be provided to the Authority.

12.3. Structural Validation

The structure of the bus shall have undergone appropriate structural testing and/or analysis. At minimum, appropriate structural testing and analysis shall include Altoona testing or finite element analysis (FEA).

12.4. Distortion

The bus, loaded to GVWR and under static conditions, shall not exhibit deflection or deformation that impairs the operation of the steering mechanism, doors, windows, passenger escape mechanisms or service doors. Static conditions shall include the vehicle at rest with any one wheel or dual set of wheels on a six (6)-inch curb or in a six (6)-inch deep hole.

12.5. Resonance and Vibration

All structure, body, and panel-bending mode frequencies, including vertical, lateral and torsional modes, shall be sufficiently removed from all primary excitation frequencies to eliminate audible, visible or sensible resonant vibrations during normal service.

12.6. Propulsion Compartment Bulkheads

The passenger and propulsion system compartments shall be separated by a fire-resistant bulkhead. This bulkhead shall preclude or retard propagation of a compartment fire into the passenger compartment and shall be in accordance with the Recommended Fire Safety Practices defined in FTA Docket 90A, dated Oct. 20, 1993. Only necessary openings shall be allowed in the bulkhead, and these shall be fire-resistant. Any passageways for the climate control system air shall be separated from the rear compartment by fire-resistant material. Piping through the bulkhead shall have fire-resistant fittings sealed at the bulkhead. Wiring may pass through the bulkhead only if connectors or other means are provided to prevent or retard fire propagation through the bulkhead. Rear compartment access panels in the bulkhead shall be fabricated of fire-resistant material and secured with fire-resistant fasteners. These panels, their fasteners and the bulkhead shall be constructed and reinforced to minimize warping of the panels during a fire that will compromise the integrity of the bulkhead.

12.7. Crashworthiness

The bus body and roof structure shall withstand a static load equal to 150 percent of the curb weight evenly distributed on the roof with no more than a six (6) inch reduction in any interior dimension. Windows shall remain in place and shall not open under such a load. These requirements must be met without the roof-mounted equipment installed.

The bus shall withstand a 25-mph impact by a 4000-pound automobile at any side, excluding doorways, along either side of the bus and the articulated joint, if applicable, with no more than three (3) inches of permanent structural deformation at seated passenger hip height. This impact shall not result in sharp edges or protrusions in the bus interior.

Exterior panels below 35 inches from ground level shall withstand a static load of 2000 pounds applied perpendicular to the bus by a pad no larger than five (5) square inches. This load shall not result in deformation that prevents installation of new exterior panels to restore the original appearance of the bus.

12.8. Corrosion

The bus flooring, sides, roof, understructure, and axle suspension components shall be designed to resist corrosion or deterioration from atmospheric conditions and deicing materials for a period of 12 years or 500,000 miles, whichever comes first. It shall maintain structural integrity and nearly maintain original appearance throughout its service life, with the Authority's use of proper cleaning and neutralizing agents.

All materials that are not inherently corrosion resistant shall be protected with corrosion-resistant coatings. All joints and connections of dissimilar metals shall be corrosion resistant and shall be protected from galvanic corrosion. Representative samples of all materials and connections shall withstand a two-week (336-hour) salt spray test in accordance with ASTM Procedure B-117 with no structural detrimental effects to normally visible surfaces and no weight loss of over 1 percent.

12.9. Towing

Towing devices shall be provided on each end of the vehicle. Towing devices should accommodate flat-bedding or flat-towing. Each towing device shall withstand, without permanent deformation, tension loads up to 1.2 times the curb weight of the bus within 20 degrees of the longitudinal axis of the bus. The rear towing device(s) shall not provide a toehold for unauthorized riders. The method of attaching the towing device shall not require the removal or disconnection of front suspension or steering components. Removal of the bike rack is permitted for attachment of towing devices. The OEM shall provide the towing procedure.

Shop air connectors shall be provided at the front and rear of the bus and shall be capable of supplying all pneumatic systems of the bus with externally sourced compressed air. Shop air connectors shall match the air fittings described in section 21.4. The location of these shop air connectors shall facilitate towing operations.

A plug connector, if standard, should be permanently mounted at the front of the bus and shall provide for bus tail lamp, marker, stop and turn signal lamp operation as controlled from the towing vehicle. The connector shall include a spring-loaded dust- and water-resistant cap. Manufacturer/ proposer shall propose the plug connector style and installation location subject to approval by the Authority.

12.9.1. Lifted (Supported) Front Axle and Flat Towing Capability

The front towing devices shall allow attachment of adapters for a rigid tow bar and shall permit the lifting of the bus until the front wheels are clear off the ground in order to position the bus on the towing equipment by the front wheels. These devices shall also permit common flat towing.

Two rear recovery devices/tie-downs shall permit lifting and towing of the bus for a short distance, such as in cases of an emergency, to allow access to provisions for front towing of the bus. The method of attaching the tow bar or adapter shall require the specific approval of the Authority. Any tow bar or adapter exceeding 50 pounds should have means to maneuver or allow for ease of use and application. Each towing device shall accommodate a crane hook.

12.10. Jacking

It shall be possible to safely jack up the bus, at curb weight, with a common 10-ton floor jack with or without special adapter, when a tire or dual set is completely flat and the bus is on a level, hard surface, without crawling under any portion of the bus. Jacking from a single point shall permit raising the bus sufficiently high to remove and reinstall a wheel and tire assembly. Jacking pads located on the axle or suspension near the wheels shall permit easy and safe jacking with the flat tire or dual set on a 6 inch high run-up block not wider than a single tire. The bus shall withstand such jacking at any one or any combination of wheel locations without permanent deformation or damage.

12.10.1. Jacking Pad Requirements

Jacking pads shall be painted safety yellow.

Decals for jacking pads not required. The Authority reserves the right of final approval should jacking pad decals be provided.

12.11. Hoisting 40 -foot

The bus axles or jacking plates shall accommodate the lifting pads of the Authority’s current hoist systems. A set of adapters shall be supplied for each bay if required. Jacking plates, if used as hoisting pads, shall be designed to prevent the bus from falling off the hoist. Other pads or the bus structure shall support the bus on jack stands independent of the hoist.

The vehicle shall be capable of lifting by the wheels and, as necessary to meet tire load requirements, the proper number for wheel lifts and/or adapters must be used.

13. Floor

The floor shall be essentially a continuous plane, except at the wheel housings and platforms. Where the floor meets the walls of the bus, as well as other vertical surfaces such as platform risers, the surface edges shall be blended with a circular section of radius or coving not less than ¼ inch. Similarly, a molding or cover shall prevent debris accumulation between the floor and wheel housings. The vehicle floor in the area of the doors shall have a lateral slope not exceeding 2 degrees to allow for drainage.

The floor design may consist two levels (bi-level construction). Aft of the rear-most door extending to the rear settee riser, the floor height may be raised to a height no more than 21-inches above the lower level, with equally spaced steps. An increased slope will be allowed on the upper level, not to exceed 3.5 degrees off of the horizontal plane.

A floor drain is not required. However, if a floor drain is installed it should be of noncorrosive materials on the bus behind the front, curbside wheelhouse near the wall to help drain any water that may accumulate due to ice, snow, rain, etc. The drainpipe shall be approximately 1½ inches in diameter and shall extend no more than five (5)- inches below the floor. The drainpipe shall be fitted with a rubber drain spout to minimize or prevent air drafts to the interior of the bus. The strainer shall be firmly retained but also removable to allow flushing of any accumulated debris.

13.1. Strength

The floor deck may be integral with the basic structure or mounted on the structure securely to prevent chafing or horizontal movement and designed to last the life of the bus. Sheet metal screws shall not be used to retain the floor, and all floor fasteners shall be serviceable from one side only. Any adhesives, bolts or screws used to secure the floor to the structure shall last and remain effective throughout the life of the coach. Tapping plates, if used for the floor fasteners, shall be no less than the same thickness as a standard nut, and all floor fasteners shall be secured and protected from corrosion for the service life of the bus.

The floor deck shall be reinforced as needed to support passenger loads. At GVWR, the floor shall have an elastic deflection of no more than 0.60-inches from the normal plane. The floor shall withstand the application of 2.5 times gross load weight without permanent detrimental deformation. The floor, with coverings applied, shall withstand a static load of at least 150 pounds (lb.) applied through the flat end of a ½-inch diameter rod, with 1/32-inch radius, without permanent visible deformation.

13.2. Construction

The floor shall consist of the subfloor and the floor covering that will last the life of the bus. The floor as assembled, including the sealer, attachments and covering, shall be waterproof, non-hygroscopic, and resistant to mold growth. The subfloor shall be resistant to the effects of moisture, including decay (dry rot). Flooring throughout the vehicle at a minimum shall offer some level of noise reduction characteristics. The subfloor on the upper level shall also offer some level of sound deadening.

Composite material for sub-flooring may be used, if used it shall provide all the salient characteristics as listed below:

- unitized molded assembly
- consist of two glass-reinforced polyester resin face sheets encapsulating a core of honeycomb
- filled with closed-cell polyurethane or polyisocyanurate foam

The manufacturer may propose other sub-flooring material subject to approval by the Authority.

Reference the following sections for relevant flooring requirements:

- 31.11 Floor Covering specifications.
- 31.12.3 Floor Access Panels

13.3. Platforms

13.3.1. Driver's Area

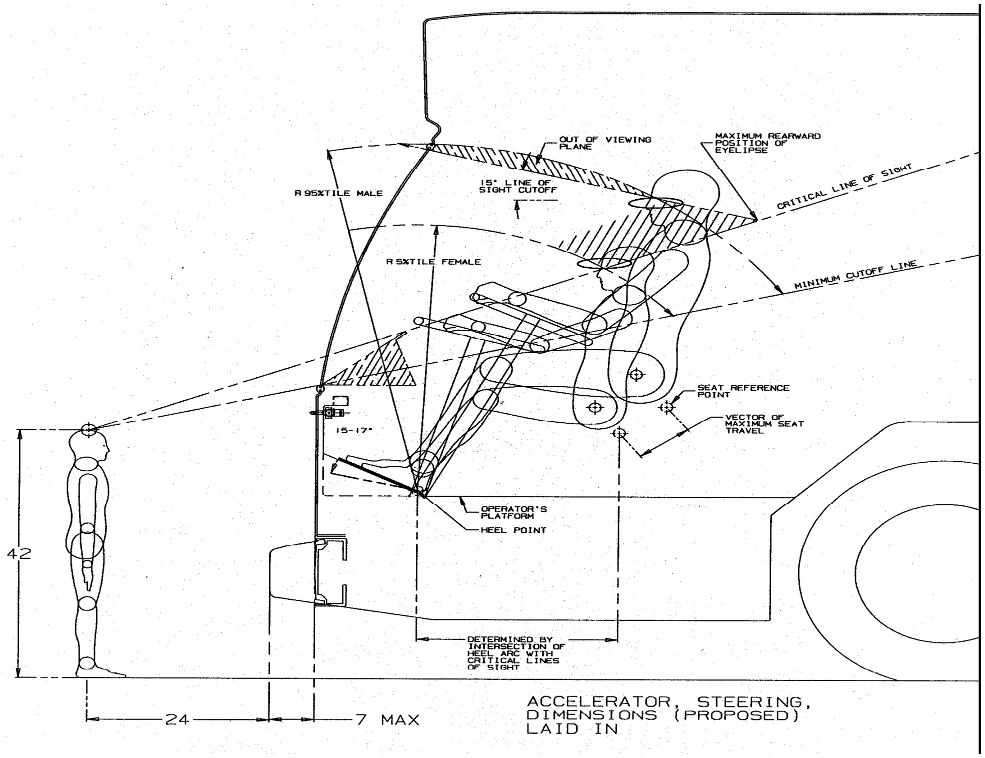
The covering of platform surfaces and risers, except where otherwise indicated, shall be the same material as specified for floor covering. Trim shall be provided along top edges of platforms unless integral nosing is provided. Trim installed along edges of platforms shall be constructed of stainless steel or aluminum. Other raised areas such as for providing for space for under-floor installation of components shall be limited. Such raised areas shall be constructed in accordance with these specifications.

13.3.2. Driver's Platform

The driver's platform shall be of a height such that, in a seated position, the driver can see an object located at an elevation of 42-inches above the road surface, 24-inches from the leading edge of the bumper or bike rack. Notwithstanding this requirement, the platform height shall not position the driver such that the driver's vertical upward view is less than 15 degrees. A warning decal or sign shall be provided to alert the driver to the change in floor level. Figure 4 illustrates a means by which the platform height can be determined, using the critical line of sight.

FIGURE 4

Determining Platform Height



13.3.3. Farebox Platform

The farebox will be mounted at floor level in order to minimize impact to passenger access and minimize interference with the driver's line of sight. The position of the farebox shall be so that there are no dirt traps on the sides and behind the farebox that are inaccessible for cleaning.

13.3.4. Rear Step Area to Rear Area

If the vehicle is of a bi-level floor design, then a rear step area shall be provided along the center aisle of the bus to facilitate passenger traffic between the upper and lower floor levels. This step area shall be cut into the rear platform and shall be approximately the aisle width, a minimum 12 inches deep and approximately half the height of the upper level relative to the lower level. The horizontal surface of this platform shall be covered with the same material as the floor covering with a visually contrasting nosing and shall be sloped slightly for drainage. A warning decal or sign shall be provided at the immediate platform area to alert passengers to the change in floor level, reference Exhibit F-1A – Typical Capital Metro Interior Decal Requirements.

14. Wheel Housing

14.1. Design and Construction

Sufficient clearance and air circulation shall be provided around the tires, wheels, and brakes to preclude overheating. Wheel housings shall be constructed of corrosion-resistant and fire-resistant material. Wheel housings, as installed and trimmed, shall withstand impacts of a 2-inch steel ball with at least 200 ft-lb of energy without penetration.

Interference between the tires and any portion of the bus shall not be possible in maneuvers up to the limit of tire adhesion with weights from curb weight to GVWR. Wheel housings shall be adequately reinforced where seat pedestals are installed. Wheel housings shall have sufficient sound insulation to minimize tire and road noise and meet all noise requirements of this specification.

Design and construction of front wheel housings shall allow for the installation of a radio or electronic equipment storage compartment on the interior top surface, or its use as a luggage rack.

The finish of the front wheel housings shall be scratch-resistant and complement interior finishes of the bus to minimize the visual impact of the wheel housing. If fiberglass wheel housings are provided, then they shall be colored to compliment the interior finishes or approved equivalent. The lower portion extending to approximately 12 inches above the floor shall be equipped with stainless-steel trim to protect the area from damage.

Wheel housings not equipped with seats or equipment enclosure shall have a horizontal assist mounted on the top portion of the housing no more than 4 in. higher than the wheel well housing.

Where wheel housings are equipped with seats or equipment enclosures, all fasteners passing through to the outside of the coach shall be fully sealed to prevent the intrusion of water into the coach.

CHASSIS

15. Suspension

15.1. General Requirements

The front, rear and mid (if articulated) suspensions shall be pneumatic type. The basic suspension system shall last the service life of the bus without major overhaul or replacement. Adjustment points shall be minimized and shall not be subject to a loss of adjustment in service. Routine adjustments shall be easily accomplished by limiting the removal or disconnecting the components.

15.2. Alignment

All axles shall be properly aligned so the vehicle tracks accurately within the size and geometry of the vehicle.

15.3. Springs and Shock Absorbers

15.3.1. Suspension Travel

The suspension system shall permit a minimum wheel travel of 2.75-inch jounce-upward travel of a wheel when the bus hits a bump (higher than street surface), and 2.75-inch rebound-downward travel when the bus comes off a bump and the wheels fall relative to the body. Elastomeric bumpers shall be provided at the limit of jounce travel. Rebound travel may be limited by elastomeric bumpers or hydraulically within the shock absorbers. Suspensions shall incorporate appropriate devices for automatic height control so that regardless of load the bus height relative to the centerline of the wheels does not change more than ½ inch at any point from the height required. The safe operation of a bus cannot be impacted by ride height up to 1 inch from design normal ride height.

15.3.2. Damping

Vertical damping of the suspension system shall be accomplished by hydraulic shock absorbers mounted to the suspension arms or axles and attached to an appropriate location on the chassis. Damping shall be sufficient to control coach motion to three cycles or fewer after hitting road debris/other influences. The shock absorber bushing shall be made of elastomeric material that will last the life of the shock absorber. The damper shall incorporate a secondary hydraulic rebound stop.

15.4. Lubrication

All elements of steering, suspension and drive systems requiring scheduled lubrication shall be provided with grease fittings conforming to SAE J534. These fittings shall be located for ease of inspection and shall be accessible with a standard grease gun from a pit or with the bus on a hoist. Each element requiring lubrication shall have its own grease fitting with a relief path. The lubricant specified shall be standard for all elements on the bus serviced by standard fittings and shall be required no fewer than every 6,000 miles.

15.5. Kneeling

A kneeling system shall lower the entrance(s) of the bus a minimum of 2 inches during loading or unloading operations regardless of load up to GVWR, measured at the longitudinal centerline of the entrance door(s) by the driver. The kneeling control shall provide the following functions:

- Downward control must be held to allow downward kneeling movement.
- Release of the control during downward movement must completely stop the lowering motion and hold the height of the bus at that position.
- Upward control actuation must allow the bus to return to normal floor height without the driver having to hold the control.

The brake and throttle interlock shall prevent movement when the bus is kneeled. The bus shall kneel at a maximum rate of 1.25 inches per second at essentially a constant rate. After kneeling, the bus shall rise within 4 seconds to a height permitting the bus to resume service and shall rise to the correct operating height within 7 seconds regardless of load up to GVWR. During the lowering and raising operation, the maximum vertical acceleration shall not exceed 0.2g's, and the jerk shall not exceed 0.3g's per second.

An indicator visible to the driver shall be illuminated until the bus is raised to a height adequate for safe street travel. An audible warning alarm will sound simultaneously with the operation of the kneeler to alert passengers and bystanders. The audible alarm shall sound only while the vehicle is executing the kneeling or rise function. The audible warning alarm shall be adjustable via an attenuation adjustment. A warning light mounted near the curbside of the front door, a minimum 2.5 inches diameter amber lens, shall be provided that will blink when the kneel feature is activated. Kneeling shall not be operational while the wheelchair ramp is deployed or in operation. The kneeling valve air exhaust, if equipped, shall be routed away from the curbside of the bus and the noise level reduced via a muffler.

The four-way flashers should automatically turn on when the bus is in the kneeling motion (up or down) and when in the knelt position.

15.6. Near Level Boarding

The Vehicle Manufacturer should design a bus where the “normal ride height” is within 1.5 inches of a 9-inch curb height, so that the bus will not have raise for the entrance floor heights to be even with the curb. Nominal curb height on the Austin area BRT route is 9 inches +/- 1.0 inches. The vehicle may lower to achieve a “near level boarding” height to the curb but should not raise to achieve the nominal curb height level. The vehicle shall have a door threshold height level and curb height difference of within 3 inches between the two horizontal planes when the vehicle is sitting at its “normal” ride height.

16. Wheels and Tires

16.1. Wheels

All wheels shall be interchangeable and shall be removable without a puller. Wheels shall be compatible with tires in size and load-carrying capacity. Front wheels and tires shall be balanced as an assembly per SAE J1986.

The wheels shall have the following salient features or approved equivalent:

- Brushed aluminum on both sides
- The surface of the wheels shall be treated so as to keep them “durable and bright”
- A durable flange wear protection
- No tire-pressure monitoring system
- Two-piece (minimum) captive locking lug nut system

16.2. Tires

Tires shall be suitable for the conditions of transit service and sustained operation at the maximum speed capability of the bus. Load on any tire at GVWR shall not exceed the tire supplier’s rating.

The tires shall be provided under agreement from the Authority’s tire supplier. The tires shall be the appropriate size and load range for the vehicle.

17. Steering

Electrically assisted or electrically driven hydraulic pump power steering shall be provided to reduce steering effort. The manufacturer shall endeavor to provide a power steering system that is virtually problem free.

The steering system controller (if applicable) shall report any and all diagnostic codes on the J1939 Communication Area Network (CAN) so that the vehicle can warn the operator of a steering system condition.

The codes shall be able to be read via the operator interface or a laptop that is connected to the J1939 diagnostic port. All programs necessary to read and clear the steering system diagnostic codes shall be provided by the Vehicle Manufacturer.

17.1. Steering Axle

The front axle may be a solid beam or independent design suspension. Either configuration shall have the following characteristics:

Solid Beam Axle and Grease or Oil Type Front Bearings and Seals

The front axle may be solid beam, non-driving with a load rating sufficient for the bus loaded to GVWR and may be equipped with grease or oiled-type front wheel bearings and seals.

Independent Suspension Axle

The front axle may be of an independent suspension design, non-driving, with a load rating sufficient for the bus loaded to GVWR and may be equipped with grease or oiled-type front wheel bearings and seals.

All friction points on the front axle shall be equipped with replaceable bushings or inserts and, if needed, lubrication fittings easily accessible from a pit or hoist.

The steering geometry of the outside (front lock) wheel shall be within 2 degrees of true Ackerman up to 50 percent lock measured at the inside (back lock) wheel. The steering geometry shall be within 3 degrees of true Ackerman for the remaining 100 percent lock measured at the inside (back lock) wheel.

17.2. Steering Wheel

17.2.1. Turning Effort

Steering effort shall be measured with the bus at GVWR, stopped with the brakes released, propulsion system running, with vehicle on clean, dry, level, commercial asphalt pavement and the tires inflated to recommended pressure.

Under these conditions, the torque required to turn the steering wheel 10 degrees shall be no less than 5 ft-lb and no more than 10 ft-lb. Steering torque may increase to 70 ft-lb when the wheels are approaching the steering stops, as the relief valve activates.

Power steering failure shall not result in loss of steering control. With the bus in operation, the steering effort shall not exceed 55 pounds at the steering wheel rim, and perceived free play in the steering system shall not materially increase as a result of power assist failure. Gearing shall require no more than seven turns of the steering wheel lock-to-lock.

Caster angle shall be selected to provide a tendency for the return of the front wheels to the straight position with minimal assistance from the driver.

17.2.2. Steering Wheel, General

The steering wheel diameter should be approximately 18 to 20 inches; the rim diameter shall be ⅞ to 1¼ inches and shaped for firm grip with comfort for long periods of time or approved equivalent. The Authority has a preference for an 18-inch diameter steering wheel.

Steering wheel spokes and wheel thickness shall ensure visibility of the dashboard so that vital instrumentation is clearly visible at center neutral position (within the range of a 95th-percentile male and 5th percentile female, as described in ANSUR II). Placement of steering column must be as far forward as possible, but either in line with or behind the instrument cluster.

17.2.3. Steering Column Tilt

The steering column shall have full tilt capability with an adjustment range of no less than 40 degrees from the vertical and easily adjustable by the driver and shall be accessible by a 5th percentile female and 95th percentile male. Driver’s knees shall not contact wheel spokes at any adjustment.

17.2.4. Steering Wheel Telescopic Adjustment

The steering wheel shall have full telescoping capability and have a minimum telescopic range of 2 inches and a minimum low-end adjustment of 29 inches, measured from the top of the steering wheel rim in the horizontal position to the cab floor at the heel point.

TABLE 4

Steering Wheel Height Relative to Angle of Slope

At Minimum Telescopic Height Adjustment (29 in.)		At Maximum Telescopic Height Adjustment (5 in.)	
Angle of Slope	**Height**	**Angle of Slope**	**Height**
0 d□□	2□ □n□	0 d□□	□□ □n□
15 d□□	2□2 □n□	15 d□□	□1□2 □n□
25 d□□	2□□□ □n□	25 d□□	2□□□ □n□
□5 d□□	22□5 □n□	□5 d□□	27□5 □n□

1. Measured from bottom portion closest to driver.

18. Axles

18.1. Drive Axle

If the bus is driven by a heavy-duty axle then the axle shall have a load rating sufficient for the bus loaded to GVWR. The drive axle shall have a design life to operate for not less than 300,000 miles on the operating profile without replacement or major repairs. The lubricant drain plug shall be magnetic type. If a planetary gear design is employed, then the oil level in the planetary gears shall be easily checked through the plug or sight gauge. The axle and driveshaft components shall be rated for both propulsion and retardation modes with respect to duty cycle. If a planetary gear design is employed, then the planetary gear drain plugs shall also be magnetic.

The drive shaft shall be guarded to prevent hitting any critical systems, including brake lines, coach floor or the ground, in the event of a tube or universal joint failure.

18.1.1. Hubodometer

The Authority requires the installation of a hubodometer on each vehicle with the following salient features:

- Programmable to the exact dimensions of over 2,500 tire models
- Preprogrammed for the specified tire requirements
- Compact in size allowing for mounting and dismounting tires without the removal of the meter from the wheel
- No moving parts
- Large, easy-to-read LCD display that automatically positions numbers upright

The hubodometer shall be installed on the curbside rear dual wheel assembly in a manner that allows the meter to track mileage.

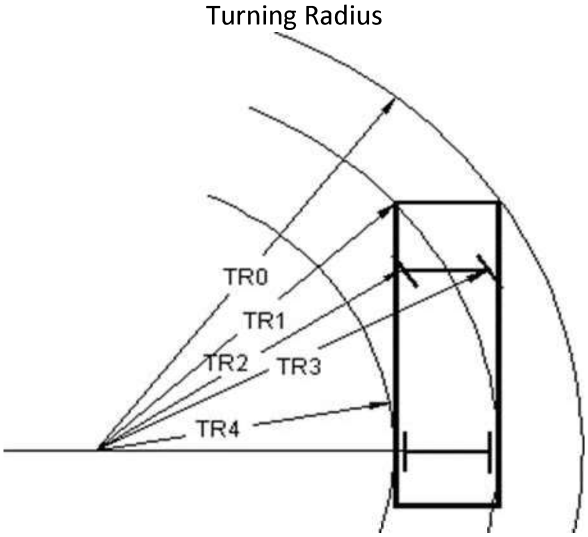
18.2. Turning Radius

TABLE 5

Maximum Turning Radius

Bus Length (approximate)	Maximum Turning Radius (see Figure 5)	Authority Requirement
□0 □□	□□ □□□R0□	□□□□ □□an □5 □□

FIGURE 5



19. Brakes

19.1. Service Brake

Brakes shall be self-adjusting. Brake wear indicators (visible brake indicators) should be provided on exposed push rods.

19.2. Regenerative Braking

In addition to traditional mechanical friction service braking, the bus should be equipped with regenerative braking designed to improve energy efficiency and extend brake lining service life. The application of regenerative braking shall cause a smooth blending of both regenerative and service brake function. Actuation of Anti-lock Braking System (ABS) and/or Automatic Traction Control (ATC) shall override the operation of the regenerative brake.

19.3. Actuation

Service brakes shall be controlled and actuated by a compressed air system. Force to activate the brake pedal control shall be an essentially linear function of the bus deceleration rate and shall not exceed 75 pounds at a point 7 inches above the heel point of the pedal to achieve maximum braking. The heel point is the location of the driver’s heel when his or her foot is rested flat on the pedal and the heel is touching the floor or heel pad of the pedal. The Electronic Control Unit (ECU)for the Anti-lock Braking System (ABS) system shall be protected, yet in an accessible location to allow for ease of service.

The total braking effort shall be distributed among all wheels in such a ratio as to ensure equal friction material wear rate at all wheel locations. The Vehicle Manufacturer shall demonstrate compliance by providing a copy of a thermodynamic brake balance test upon request.

19.4. Friction Material

The brake linings shall be made of non-asbestos material. In order to aid maintenance personnel in determining extent of wear, a provision such as a scribe line or a chamfer indicating the thickness at which replacement becomes necessary shall be provided on each brake lining. The complete brake lining wear indicator shall be clearly visible from the hoist or pit without removing backing plates.

No remote brake wear indicator required.

19.5. Hubs and Discs

Replaceable wheel bearing seals shall run on replaceable wear surfaces or be of an integral wear surface sealed design. Wheel bearing and hub seals and unitized hub assemblies shall not leak or weep lubricant when operating on the operating profile for the duration of the initial Vehicle Manufacturer’s warranty.

The bus shall be equipped with disc brakes on all axles, and the brake discs shall allow machining of each side of the disc to obtain smooth surfaces per manufacturer’s specifications.

The brake system material and design shall be selected to absorb and dissipate heat quickly so that the heat generated during braking operation does not glaze the brake linings.

19.6. Parking/Emergency Brake

19.6.1. Parking Brakes

The parking brake shall be a spring-operated system, actuated by a valve that exhausts compressed air to apply the brakes. The parking brake may be manually enabled when the air pressure is at the operating level per FMVSS 121. The parking brake valve button shall apply/ “pop out” when air pressure drops below the required range per FMVSS 121. The parking brake control valve knob shall be yellow in color and installed in a location that is ergonomic to the operator i.e. in the effort to mitigate the potential harm to an operator when the brake is applied and released repetitively.

19.6.2. Parking Brake Activation Switch

The Vehicle Manufacturer should install a toggle switch that when activated shall apply the parking brake. The switch shall be “momentary” type, with a switch guard, installed on the side dash panel that engages the parking brake when activated. The Authority reserves the right of final switch installation location approval.

19.6.3. Parking Brake Alarms

An audible alarm shall sound if the vehicle’s “master switch” is turned to the “off” position and the parking brake is not applied.

19.6.4. Operator - Empty Seat Alarm

As part of the Authority’s safety initiative, the bus shall be equipped with an Empty-Seat Alarm system. The Empty Seat alarm system shall activate when the operator is not occupying the operator seat and the master switch is on the position with the vehicle is placed in gear. Once activated the system shall sound a unique alarm and display a prominent warning message on the dash. The Authority reserves the right of final configuration approval.

19.6.5. Emergency Brake Release

Not a requirement.

20. Interlocks

20.1. Passenger Door Interlocks

To prevent opening mid and rear passenger doors while the bus is in motion, a speed sensor shall be integrated with the door controls to prevent the mid/rear doors from being enabled or opened unless the bus speed is less than 2-mph.

To preclude movement of the bus, an accelerator interlock shall lock the accelerator in the closed position, and a brake interlock shall engage the service brake system to stop movement of the bus when the driver's door control is moved to a mid/rear door enable or open position, or a mid or rear door panel is opened more than 3 inches from the fully closed position (as measured at the leading edge of the door panel). The interlock engagement shall bring the bus to a smooth stop and shall be capable of holding a fully loaded bus on a 6 percent grade with the transmission in gear until the interlocks are released. These interlock functions shall be active whenever the vehicle master run switch is in any run position.

All door systems employing brake and accelerator interlocks shall be supplied with supporting failure mode effects analysis (FMEA) documentation, which demonstrates that failure modes are of a failsafe type, thereby never allowing the possibility of release of interlock while an interlocked door is in an unsecured condition, unless the door master switch has been actuated to intentionally release the interlocks, upon request by the Authority.

A Non-adjustable brake interlock regulator shall be installed.

Accelerator Interlock shall engage when front or rear doors are open and interlock override switch not engaged.

An accelerator interlock shall lock the accelerator in the closed position, and a brake interlock shall engage the service brake system to stop movement of the bus whenever the doors are open.

21. Pneumatic System

21.1. General

The bus air system shall operate the air-powered accessories and the braking system with reserve capacity. New buses shall not leak down more than 5 psi over a 15-minute period of time as indicated on the dash gauge.

Provision shall be made to apply shop air to the bus air systems. A quick disconnect fitting shall be easily accessible and located in the engine/ rear compartment and near the front bumper area for towing. Quick disconnect fittings shall be as described in section 21.4. Retained caps should be installed to protect fittings against dirt and moisture when not in use. Air for the compressor shall be filtered. The air system shall be protected per FMVSS 121.

21.2. Air Compressor

The electrically or engine driven air compressor shall be sized to charge the air system from 40 psi to the governor cut-off pressure in less than 4 minutes. The compressor shall be mounted in a way to isolate vibration from carrying into the passenger compartment.

The air compressor shall have a system for filtering the incoming atmosphere before it enters the air compressor assembly. The filtering system at a minimum shall consist of a durable housing that contains a replaceable filter element, that is easily accessible for maintenance. The air filter maintenance shall fall in line with the 6,000-mile PM inspection as described in section 5.5 Maintenance and Inspection. The air filter assembly shall not be installed in a position where it will ingest debris at a faster rate than the recommended service interval, i.e. directly behind the rear dual wheels.

21.3. Air Lines and Fittings

Air lines, except necessary flexible lines, shall conform to the installation and material requirements of SAE J1149 for copper tubing with standard, brass, flared or ball sleeve fittings, or SAE J844 for nylon tubing if not subject to temperatures over 200 °F. The air on the delivery side of the compressor where it enters nylon housing shall not be above the maximum limits as stated in SAE J844. Nylon tubing shall be installed in accordance with the following color-coding standards or as approved by the Authority:

- Green: Indicates primary brakes and supply.
- Red: Indicates secondary brakes.
- Brown: Indicates parking brake.
- Yellow: Indicates controller feed (compressor governor, transmission, and/ or ride height).
- Black: Indicates accessories

Airline supports/securements shall prevent movement, flexing, tension, strain and vibration. Copper lines shall be supported to prevent the lines from touching one another or any component of the bus. To the extent practicable and before installation, the lines shall be pre-bent on a fixture that prevents tube flattening or excessive local strain. Copper lines shall be bent only once at any point, including pre-bending and installation. Rigid lines shall be supported at no less than 2-foot intervals. Nylon lines may be grouped and shall be supported at 30-inch intervals or less.

The compressor discharge line between power plant and body-mounted equipment shall be flexible convoluted copper, stainless steel line, or may be flexible Teflon hose with a braided stainless-steel jacket. Other lines necessary to maintain system reliability shall be flexible Teflon hose with a braided stainless-steel jacket. End fittings shall be standard SAE or JIC brass or steel, flanged, swivel-type fittings. Flexible hoses shall be as short as practicable and individually supported. They shall not touch one another or any part of the bus except for the supporting grommets. Flexible lines shall be supported at 2-foot intervals or less.

Air lines shall be clean before installation and shall be installed to minimize air leaks. All air lines shall be routed to prevent water traps to the extent possible. Grommets or insulated clamps shall protect the air lines at all points where they pass through understructure components.

21.4. Air Reservoirs

All air reservoirs shall meet the requirements of FMVSS 121 and SAE J10 and shall be equipped with drain plugs and guarded or flush type drain valves. Major structural members shall protect these valves from road hazards. Reservoirs shall be sloped toward the drain valve. All air reservoirs shall have drain valves that discharge below floor level with lines routed to eliminate the possibility of water traps and/or freezing in the drain line.

No automatic moisture ejector valves shall be installed on the air reservoirs. All air reservoirs shall have brass drain valves which discharge below floor level. The drain valves shall have quick disconnect fittings to connect hose ends for manifold gauge assembly when performing air system test on vehicle.

The Authority has developed an air system testing manifold which requires quick connection of a test manifold to individual tanks within the air system. The quick disconnect fittings shall be a Nipple – ¼" National Pipe Thread, Series 10 couplers, Male, of a "Tru-Flate Design". The shut off valves shall be manual ¼-turn valve, ¼ NPT, ¼-turn in clockwise direction to close.

The quick disconnect fittings shall have the following salient characteristics:

- Tubular valve delivers high air flow with minimal pressure drop
- Brass body option with stainless steel springs and locking balls is available for added corrosion resistance
- Standard seal is Nitrile

21.5. Air System Dryer

An air dryer shall prevent accumulation of moisture and oil in the air system. The air dryer system shall include one or more replaceable desiccant cartridges. The air dryer shall have the following requirements or approved equivalent.

21.5.1. Additional Oil Separator Provision

Capital Metro has a preference for a provision to be included to collect/remove oil from the air system to prevent affecting function and/or damaging pneumatic system components.

The air system shall be equipped with an air dryer located before the Number 1 air tank and as far from the compressor as possible to allow air to cool prior to entering the air dryer. The air dryer shall have the following salient features or approved equivalent:

- Weight, lb.- 53lbs. w/mounting bracket
- Envelope, in.- 20" W x 15" H x 12" D
- Inlet/outlet ports- ¾" – 14 NPT
- Control port ¼" – 18 NPT
- Purge port- ¼" – 18 NPT
- Maximum working pressure, PSIG- 150
- Safety valve, PSIG- 160
- Ambient temp., °F- -40° – 176°
- Maximum inlet air temp., °F- 176°
- Recommended inlet air temp., °F- +40° – 150°
- Air flow capacity, SCFM- 70
- Minimum purge volume, (in. cubed)- 600
- Electrical power- 24 VDC / 5.0A • 12 VDC / 10.0 A
- Drain capacity- 1.3cc per ADV / Operation
- Drain options- Swivel on the pre-treatment portion and open Muffler tube on the dryer portion

ELECTRICAL, ELECTRONIC AND DATA COMMUNICATION SYSTEMS

22. Electrical, Electronic and Data Communication Systems

22.1. Overview of Electrical, Electronic and Data Communication Systems

The electrical system will consist of vehicle battery systems and components that generate, distribute and store power throughout the vehicle (e.g., generator, voltage regulator, wiring, relays and connectors).

Electronic devices are individual systems and components that process and store data, integrate electronic information or perform other specific functions.

The data communication system consists of the bi-directional communications networks that electronic devices use to share data with other electronic devices and systems. Communication networks are essential to integrating electronic functions, both onboard the vehicle and off.

Information level systems that require vehicle information for their operations or provide information shall adhere to J1939 data standard.

Data communications systems are divided into three level store the use of multiple data networks (see Figure 6):

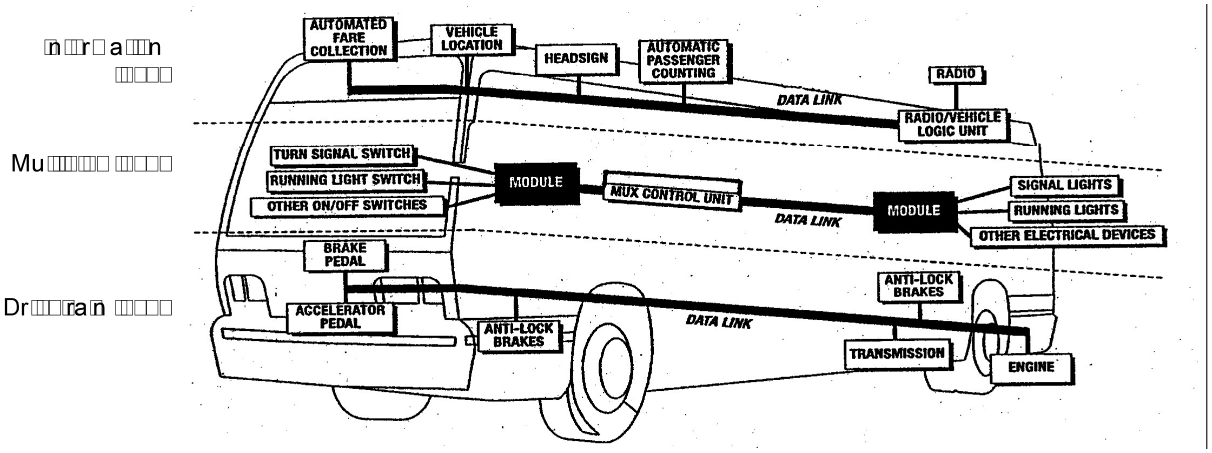
- Powertrain level: Components related to the powertrain, including the propulsion system components (traction motor(s), transmission, and hybrid units) and anti-lock braking system (ABS), which may include traction control. At a minimum, powertrain components consisting of the propulsion system, transmission, retarder, ASR and anti-lock braking systems shall be powered by a dedicated and isolated ignition supply voltage to ensure data communication between components exists when the vehicle ignition is switched to the “on” position.

- Information level: Components whose primary function is the collection, control or display of data that is not necessary to the safe drivability of the vehicle (i.e., the vehicle will continue to operate when those functions are inoperable). These components typically consist of those required for automatic vehicle location (AVL) systems, destination signs, fareboxes, passenger counters, radio systems, automated voice and signage systems, video surveillance and similar components.

- Multiplex level: Electrical or electronic devices controlled through input/output signals such as discrete, analog and serial data information (i.e., on/off switch inputs, relay or relay control outputs). Multiplexing is used to control components not typically found on the drivetrain or information levels, such as lights; wheelchair lifts; doors; heating, ventilation and air conditioning (HVAC) systems (if applicable); and gateway devices.

FIGURE 6

Data Communications Systems Levels



22.2. Modular Design

Design of the electrical, electronic and data communication systems shall be modular so that each electronic device, apparatus panel or wiring bundle is easily separable from its interconnect by means of connectors. Reference section 22.6. Multiplexing for description of multiplexing requirements.

22.3. Environmental and Mounting Requirements

The electrical system and its electronic components shall be capable of operating in the area of the vehicle in which they will be installed, as recommended in SAE J1455.

Electrical and electronic equipment shall not be located in an environment that will reduce the performance or shorten the life of the component or electrical system when operating within the operating profile.

The Authority will follow recommendations from bus manufacturers and subsystem suppliers regarding methods to prevent damage from voltage spikes generated from welding, jump-starts, shorts, etc.

All electrical/electronic hardware mounted on the interior and exterior of the vehicle that is not designed to be installed in an exposed environment shall be protected.

All electrical/electronic hardware and its mounting shall comply with the shock and vibration requirements of published industry standards (SAE, ISO, etc.).

22.4. General Electrical Requirements

22.4.1. Low-Voltage Batteries

Selected or specified batteries shall have a sufficient capacity to execute start after the as-delivered bus has been parked and off for a minimum of 48 hours.

22.4.2. Low-Voltage Batteries (24 Volt)

Two appropriately sized, deep-cycling, and maintainable batteries shall be provided. The batteries shall be designed and installed to withstand the operating environment. Each battery shall have a purchase date no more than one year from the date of release for shipment to the Authority.

22.4.3. Starting Aid Device

The Vehicle Manufacturer shall install a 24Volt DC starting aid device that has the following salient features:

- Quick recharge- charges in approximately 30 seconds.
- Long-lasting energy retention- the charge lasts for several months.
- Relatively Maintenance Free- should be ready to use after installation and readily available for use over and over.
- Long life expectancy- should last over 1 Million cycles, up to 20 years.

The Vehicle Manufacturer shall install the appropriate size starting aid device so that the vehicle starts should the 24Volt system not have enough stored energy to start the vehicle.

22.4.4. Low-Voltage (LV) Battery Cables

The battery terminal ends and cable ends shall be color-coded with red for the primary positive, black for negative and another color for any intermediate voltage cables. Positive and negative battery cables shall not cross each other, if at all possible, shall be flexible, shall be sufficiently long to reach the batteries with the tray in the extended position without stretching or pulling on any connection, and shall not lie directly on top of the batteries. Except as interrupted by required components such as the master battery switch, and LV battery switch, all cables shall be continuous with connections secured by bolted terminals and shall conform to specification requirements of SAE J1127–Type SGR, SGT, SGX or GXL, and SAE J541 as applicable.

22.4.5. Low Voltage “Jump-Start” Connector

A jump-start connector, red for 24 Volt and blue or yellow for 12 Volt, shall be provided in the rear compartment or near the low voltage batteries, equipped with dust cap and adequately protected from moisture, dirt and debris.

22.4.6. Battery Compartment

The battery compartment shall prevent accumulation of snow, ice and debris on top of the batteries and shall be vented and self-draining. It shall be accessible only from the outside of the vehicle. All components within the battery compartment, and the compartment itself, shall be protected from damage or corrosion from the electrolyte. The inside surface of the battery compartment’s access door shall be electrically insulated, as required, to prevent the battery terminals from shorting on the door if the door is damaged in an accident or if a battery comes loose. The battery compartment temperature should not exceed manufacturer’s specification. It is highly preferable that the battery tray be made of stainless steel.

The vehicle shall be equipped with a 12 Volts DC and 24 Volts DC quick disconnect switch. The switch shall disconnect both the 12 Volts DC and 24 Volts DC circuits simultaneously. The battery compartment door shall conveniently accommodate operation of 12 Volts DC and 24 Volts DC quick disconnect switch.

The battery quick disconnect access door shall be identified with a decal. The decal design shall be as noted on Exhibit F-1A – Typical Capital Metro Paint and Decal Scheme.

The battery quick disconnect access door shall be flush-fitting and incorporate a spring tensioner or equal to retain the door in a closed position when not in use. The access door shall open toward the front of the vehicle with the hinge on the forward side of the door.

22.4.6.1. Non-Locking Access Battery and Battery Quick-Disconnect Doors

The battery quick-disconnect access door shall not require any special locking devices to gain access to the switch, and it shall be accessible without removing or lifting the panel. The battery quick-disconnect access door shall open toward the front of the vehicle with the hinge on the forward side of the door. The low voltage battery access door shall not require any special locking devices to gain access to the batteries and shall open to an angle greater than 130 degrees.

The batteries shall be securely mounted on a stainless steel or equivalent tray that can accommodate the size and weight of the batteries. The battery tray, if applicable, shall pull out easily and properly support the batteries while they are being serviced. The tray shall allow each battery cell to be easily serviced. A locking device shall retain the battery tray to the stowed position.

The batteries shall be located in the “engine compartment area” (rear curbside of the bus), the same fire-resistant properties shall apply to the battery compartment. No sparking devices shall be located within the battery box.

22.4.7. Auxiliary Electronic Power Supply

If an auxiliary electronic power supply is required to be mounted in the interior of the vehicle then a gel-pack, or any form of sealed (non-venting) batteries shall be used. The non-venting power supply should be contained in an enclosed, non-airtight compartment, and accessible only to maintenance personnel.

22.4.8. Master Battery Switch

The location of the master battery switch shall be clearly identified on the exterior access panel, be accessible in less than 10 seconds for deactivation, and free of corrosion from battery acid and fumes.

The master switch shall be capable of carrying and interrupting the total circuit load.

The master switch shall be a single switch for disconnecting both 12 Volts and 24 Volts power sources.

22.4.9. Low-Voltage Generation and Distribution

The low voltage generating systems shall maintain the charge on the low voltage batteries. The low-voltage batteries shall be maintained through a DC/DC converter by the high-voltage batteries, alternator driven by the diesel engine, or approved equivalent.

Voltage monitoring and over-voltage output protection (recommended at 32 V) should be provided. Charging profile shall be maintained within battery manufacturer’s guidelines or specifications.

Dedicated power and ground shall be provided as specified by the component or system manufacturer. Cabling to the equipment must be sized to supply the current requirements with no greater than a 5 percent volt drop across the length of the cable.

22.4.10. Circuit Protection

All branch circuits shall be protected by current-limiting devices such as circuit breakers, fuses or solid-state devices sized to the requirements of the circuit. The circuit breaker fuses shall be easily accessible for authorized personnel. Fuses should be used only where circuit breakers are not practicable. The circuit breaker requirement applies to inline fuses supplied by either the vehicle manufacturer or a component supplier. All manual reset circuit breakers critical to the operation of the bus shall be mounted in a location accessible to maintenance technicians with visible indication of open circuits. The vehicle manufacturer shall illustrate all in-line fuses in the final electrical drawings. Any manually resettable circuit breakers shall provide a visible indication of open circuits.

The current rating for the wire and circuit protection used for each circuit shall be capable of carrying fifteen (15) percent greater than the load for the component(s) in the circuit.

22.4.11. Grounds

The low voltage battery(s) shall be grounded to the vehicle chassis/frame at one location only, as close to the batteries as possible. When using a chassis ground system, the chassis shall be grounded to the frame in multiple locations, evenly distributed throughout the vehicle to eliminate ground loops. No more than three ring terminal connections should be made per ground stud with spacing between studs ensuring conductivity and serviceability. Electronic equipment requiring an isolated ground of the battery (i.e., electronic ground) shall not be grounded through the chassis.

22.4.12. Low-Voltage and High-Voltage Wiring and Terminals

All power and ground wiring shall conform to specification requirements of SAE J1127, J1128 and J1292. All high-voltage power and ground wiring shall conform to specification requirements of SAE J1654 and J2910. In the case of conflicts with the requirements below, SAE standards shall apply. Double insulations should be maintained as close to the junction box, electrical compartment or terminals as possible. The requirement for double insulations shall be met by wrapping the harness with plastic electrical tape or by sheathing all wires and harnesses with nonconductive, rigid or flexible conduit.

The bus shall be manufactured so that high-voltage systems and cabling do not interfere with the operation of low-voltage control systems. To this end, high-voltage cabling and low-voltage control wiring must be separated as far as practicable. Cabling and wiring must be installed damage-free. Additionally, parallel runs of high-voltage cabling and low-voltage control wiring shall be minimized.

Wiring shall be grouped, numbered and/or color-coded. Wiring harnesses shall not contain wires of different voltage classes unless all wires within the harness are insulated for the highest voltage carried within the harness. Wire kinking, grounding at multiple points, stretching, and exceeding minimum bend radius shall be prevented.

Strain-relief fittings shall be provided at all points where wiring enters electrical compartments. Grommets or other protective material shall be installed at points where wiring penetrates metal structures outside of electrical enclosures. Wiring supports shall be protective and nonconductive at areas of wire contact and shall not be damaged by heat, water, solvents, or chafing.

To the extent practicable, wiring shall not be located in environmentally exposed locations under the vehicle. Wiring and electrical equipment located under the vehicle shall be insulated from water, heat, corrosion, and mechanical damage.

All wiring harnesses over 5 feet in length and containing at least five wires shall include a 10 percent (minimum one wire) of additional wires for spares. The requirement for spare wires does not apply to datalinks and communication cables. Wiring harness length shall allow end terminals to be replaced without pulling, stretching, or replacing the wire. Terminals shall be crimped to the wiring according to the terminal connector manufacturer’s recommendations for techniques and tools. All cable connectors shall be locking type, keyed and sealed, unless enclosed in watertight cabinets or vehicle interior. Pins shall be removable, crimp contact type, of the correct size and rating for the wire being terminated. Unused pin positions shall be sealed with sealing plugs. Adjacent connectors shall use either different inserts or different insert orientations to prevent incorrect connections.

Terminals shall be crimped, corrosion-resistant and full ring type or interlocking lugs with insulating ferrules. When using pressure type screw terminal strips, only stranded wire shall be used. Insulation clearance shall ensure that wires have a minimum of “visible clearance” and a maximum of two times the conductor diameter or 1/16 in., whichever is less. When using shielded or coaxial cable, upon stripping of the insulation, the metallic braid shall be free from frayed strands that can penetrate the insulation of the inner wires.

Ultra-sonic and T-splices may be used with 8 AWG (American Wire Gauge) or smaller wire. When a T-splice is used, it shall meet these additional requirements:

- It shall include a mechanical clamp in addition to solder on the splice.
- The wire shall support no mechanical load in the area of the splice.
- The wire shall be supported to prevent flexing.

All splicing shall be staggered in the harness so that no two splices are positioned in the same location within the harness.

The instrument panel and wiring should be easily accessible for service from the driver’s seat area or top of the panel. The instrument panel shall be separately removable and replaceable without damaging the instrument panel or gauges. Wiring shall have sufficient length and be routed to permit service without stretching or chafing the wires.

22.4.13. Electrical Components

All electrical components, including switches, relays, flashers, and circuit breakers, shall be heavy-duty designs with either a successful history of application in heavy-duty vehicles or design specifications for an equivalent environment.

All electric motors shall be heavy-duty brushless type where practical and have a continuous duty rating of no fewer than 40,000 hours (except cranking motors, washer pumps, auxiliary heater pumps, defroster and wiper motors). All electric motors shall be easily accessible for servicing.

22.4.14. Electrical Compartments

All relays, controllers, flashers, circuit breakers and other electrical components shall be mounted in easily accessible electrical compartments. Easily accessible compartments means access doors with square key locks as opposed to large panels that are fastened. All compartments exposed to the outside environment shall be corrosion-resistant and sealed. The components in each electrical compartment should be identified and their location permanently recorded on a drawing attached to the inside of the access panel or door. The drawing, when provided, shall be protected from oil, grease, and abrasion.

The front compartment, that contains the front destination sign, shall be completely serviceable from the driver’s seat, via an access door that opens to the interior of the vehicle, preferably the up position, large enough to service the front destination sign, secured with quarter turn locks, preferably “square key” that can be turned by hand.

22.5. General Electronic Requirements

If an electronic component has an internal real-time clock, it shall provide its own battery backup to monitor time when battery power is disconnected, and/or it may be updated by a network component. If an electronic component has an hour meter, it shall record accumulated service time without relying on battery backup.

The Vehicle Manufacturer shall ensure that all electronic components are self-protecting in the event of shorts in the cabling, and also in over-voltage (over 32 VDC on a 24 VDC nominal voltage rating with a maximum of 50 VDC) and reverse polarity conditions. If an electronic component is required to interface with other components, it shall not require external pull-up and/or pull-down resistors. Where this is not possible, the use of a pull-up or pull-down resistor shall be limited as much as possible and easily accessible and labeled.

22.5.1. Wiring and Terminals

Wire kinking, grounding at multiple points, stretching and reducing the bend radius below the manufacturer’s recommended minimum shall not be permitted.

22.5.2. Discrete I/O (Inputs/Outputs)

All wiring to I/O devices, either at the harness level or individual wires, shall be labeled or color-coded in a fashion that allows unique identification at a spacing not exceeding 4 in. Wiring for each I/O device shall be bundled together. If the I/O terminals are the same voltages, then jumpers may be used to connect the common nodes of each I/O terminal.

22.5.3. Shielding

All wiring that requires shielding shall meet the following minimum requirements. A shield shall be generated by connecting to a ground, which is sourced from a power distribution bus bar or chassis. A shield shall be connected at one location only, typically at one end of the cable. However, certain standards or special requirements, such as SAE J1939 or Radio Frequency/electromagnetic applications, have separate shielding techniques that also shall be used where applicable.

When using shielded or coaxial cable, upon stripping of the insulation, the metallic braid shall be free from frayed strands, which can penetrate the insulation of the inner wires. To prevent the introduction of noise, the shield shall not be connected to the common side of a logic circuit.

22.5.4. Communications

The data network cabling shall be selected and installed according to the selected protocol requirements. The physical layer of all network communications systems shall not be used for any purpose other than communication among the system components, unless provided for in the network specifications.

Communications networks that use power line carriers (e.g., data modulated on a 24 V power line) shall meet the most stringent applicable wiring and terminal specifications.

22.5.5. Radio Frequency (RF)

RF components, such as radios, video devices, cameras, global positioning systems (GPS), etc., shall use coaxial cable to carry the signal. All RF systems require special design consideration for losses along the cable. Cabling should allow for the removal of antennas or attached electronics without removing the installed cable between them. If this cannot be done, then a conduit of sufficient size shall be provided for ease of attachment of antenna and cable assembly. The corresponding component vendors shall be consulted for proper application of equipment, including installation of cables

22.5.6. Audio

Cabling used for microphone level and line level signals shall be 22 AWG (American Wire Gauge) minimum with shielded twisted pair. Cabling used for amplifier level signals shall be 18 AWG minimum.

22.5.7. Electrical Magnetic Interference (EMI), Radio Frequency Interference (RFI), and Electromagnetic Field (EMF)

The Vehicle Manufacturer shall take into consideration potential EMI, RFI, and EMF interference in the vehicles design. EMI, RFI, and EMF shall not be allowed to reduce or degrade the performance or communication between or from the required electronic components. This requirement shall include the performance of all antennas needed for communication/information sent from the vehicle's required electronic components.

22.6. Multiplexing

22.6.1. General

Versatility and future expansion shall be provided for by an expandable system architecture. The multiplex system shall be capable of accepting new inputs and outputs through the addition of new modules or the utilization of existing spare inputs and outputs. All like components in the multiplex system shall be modular, interchangeable, with self-diagnostic capabilities. The modules shall be easily accessible for troubleshooting electrical failures and performing system maintenance. Multiplex input/output modules shall use solid-state devices to provide extended service life and individual circuit protection.

Ten percent of the total number of inputs and outputs, or at least one each for each voltage type utilized (0 V, 12 V, 24 V) at each module location shall be designated as spares. The components of the multiplex system shall be of modular design, thereby providing for ease of replacement by maintenance personnel. The modules shall be easily accessible for troubleshooting electrical failures and performing system maintenance. Each module shall be shielded to prevent interference by EMI (Electromagnetic Interference) and RFI (Radio Frequency Interference); and shall have an installed system to indicate circuit integrity and assist in rapid circuit diagnostics and verification of the load and wiring integrity. In conjunction with relays if necessary, each circuit shall be capable of providing a current load of up to 10 Amperes. The internal controls shall be a solid-state device, providing an extended service life. Wiring for data bus and node module power shall consist of three, 22 gage or larger, UL approved, shielded, twisted pairs.

The multiplex system should have self-diagnostics which monitor and display communication fault codes, program errors, etc. The system shall be accessible by a personal computer (laptop) as well as the MFD (Multi-Function Display, reference section 23.5.1.). A maintenance technician shall be able to use either method to check bus wire function. The system shall revert to a "sleep mode" shutting off all electrical components, except as noted, after 20+ minutes of inactivity. All systems directly wired to the battery, such as the Event Data Recorder (EDR), etc. shall not be shut down during this sleep mode. The hazard lights shall not be affected.

Preference: In order to minimize training for the operation, functionality, and maintenance of the vehicle and its various components shall be standardized to be same as those on the Authority 's existing vehicles.

22.6.2. System Configuration

Multiplexing may either be distributed or centralized. A distributed system shall process information on multiple control modules within the network. A centralized system shall process the information on a single control module. Either system shall consist of several modules connected to form a control network.

22.6.3. Input Output - I/O Signals

The input/output for the multiplex system may contain four types of electrical signals: discrete, modulating, analog, or serial data.

Discrete signals shall reflect the on/off status of switches, levers, limit switches, lights, etc. Analog signals shall reflect numerical data as represented by a voltage signal (0–12 V, 10–24 V, etc.) or current signal (4 to 20 mA). Both types of analog signals shall represent the status of variable devices such as rheostats, potentiometers, temperature probes, etc. Serial data signals shall reflect ASCII or alphanumeric data used in the communication between other onboard components.

22.7. Data Communications

22.7.1. General

All data communication networks shall be either in accordance with a nationally recognized interface standard, such as those published by SAE (Society of Automotive Engineers), IEEE (Institute of Electrical and Electronics Engineers), or ISO (International Organization for Standardization), or shall be published to the Authority with the following minimum information:

- Protocol requirements for all timing issues (bit, byte, packet, inter-packet timing, idle line timing, etc.) packet sizes, error checking and transport (bulk transfer of data to/from the device).
- Data definition requirements that ensure access to diagnostic information and performance characteristics.
- The capability and procedures for uploading new application or configuration data.
- Access to revision level of data, application software and firmware.
- The capability and procedures for uploading new firmware or application software.
- Evidence that applicable data shall be broadcast to the network in an efficient manner such that the overall network integrity is not compromised.

Any electronic vehicle components used on a network shall be conformance tested to the corresponding network standard.

22.7.2. Drivetrain Level

Drivetrain components, consisting of the traction motor(s), motor inverter(s), regenerative braking system, antilock braking system and all other related components, shall be integrated and communicate fully with respect to vehicle operation with data using SAE Recommended Communications Protocols such as J1939, with forward and backward compatibilities or other open protocols. At a minimum, drivetrain components shall be powered by a dedicated and isolated ignition supply voltage to ensure that data communication among components exists when the vehicle ignition is switched to the "on" position.

22.7.3. Diagnostics, Fault Detection and Data Access

Drivetrain performance, maintenance and diagnostic data, and other electronic messages shall be formatted and transmitted on the communications networks.

The drivetrain level shall have the ability to record abnormal events in memory and provide diagnostic codes and other information to service personnel. At a minimum, this network level shall provide live/fail status, current hardware serial number, software/data revisions and uninterrupted timing functions. These codes should be able to be read from the driver's digital display (MFD, Multi-Function

Display) or the “Service Tool” (laptop/PC). The minimum amount of J1939 communication/diagnostic ports shall be located at the following locations:

- front of the vehicle, within 4 feet of the operator seat
- Radio/electronics box located above the front driver side wheel well
- rear interior of the vehicle behind an access panel with quarter turn square key locks

The Authority reserves the right of final configuration and location.

22.7.4. Programmability (Software)

The drivetrain-level components shall be programmable by the Authority with limitations as specified by the Vehicle Manufacturer and subcomponent supplier.

22.7.5. Multiplex Level

22.7.5.1. Data Access

At a minimum, information shall be made available via a communication port on the multiplex system. The location of the communication port shall be easily accessible behind a hinged accessible panel that shall follow the requirements in section 31.12. A hardware gateway and/or wireless communications system are options if requested by the Authority. The communication port(s) CAN J1939 ports shall be located at a minimum in three locations as described in section 22.7.3.

22.7.5.2. Diagnostics and Fault Detection

The multiplex system shall have a proven method of determining its status (system health and input/output status) and detecting either active (online) or inactive (offline) faults through the use of onboard visual/audible indicators.

In addition to the indicators, the system shall employ an advanced diagnostic and fault detection system, which shall be accessible via either a personal computer, handheld unit or interface on the dash from the operator seat “driver’s instrument cluster”. Either unit shall have the ability to check logic function.

No requirement for mock-up board.

22.7.5.3. Programmability (Software)

The multiplex system shall have security provisions to protect its software from unwanted changes. This shall be achieved through any or all of the following procedures:

- Password protection
- Limited distribution of the configuration software
- Limited access to the programming tools required to change the software
- Hardware protection that prevents undesired changes to the software

Provisions for programming the multiplex system shall be possible through a PC or laptop. The multiplex system shall have proper revision control to ensure that the hardware and software are identical on each vehicle equipped with the system. Revision control shall be provided by all of the following:

- Hardware component identification where labels are included on all multiplex hardware to identify components
- Hardware series identification where all multiplex hardware displays the current hardware serial number and firmware revision employed by the module

- Software revision identification where all copies of the software in service display the most recent revision number
- A method of determining which version of the software is currently in use in the multiplex system

Revision control labels shall be electronic.

22.8. Electromagnetic Compatibility (EMC)

Electrical and electronic subsystems and components on all buses shall not emit electromagnetic radiation that will interfere with onboard systems, components or equipment, telephone service, radio or TV reception, or violate regulations of the Federal Communications Commission.

Electrical and electronic subsystems on the coaches shall not be affected by external sources of RFI/EMI. This includes, but is not limited to, radio and TV transmission, portable electronic devices including computers in the vicinity of or onboard the buses, AC or DC power lines, and RFI/EMI emissions from other vehicles.

As a recommendation, no vehicle component shall generate or be affected by RFI/EMI that can disturb the performance of electrical/electronic equipment as defined in CAN/CSA-CISPR 12-10, SAE J1113, SAE J1455 or UNECE Council Directive 95/54(R10). Reference section 22.5.7 Electrical Magnetic Interference (EMI), Radio Frequency Interference (RFI), and Electromagnetic Field (EMF).

DRIVER PROVISIONS, CONTROLS, AND INSTRUMENTATION

23. Operator’s Area Controls

23.1. General

In general, when designing the driver’s area, it is recommended that SAE J833, “Human Physical Dimensions,” be used.

Switches and controls shall be divided into basic groups and assigned to specific areas, in conformance with SAE J680, “Location and Operation of Instruments and Controls in Motor Truck Cabs,” and be essentially within the hand reach envelope described in SAE J287, “Driver Hand Control Reach.”

23.2. Glare

The driver’s work area shall be designed to eliminate glare. Objects within and adjacent to this area shall be matte black or dark gray in color wherever possible to reduce the reflection of light onto the windshield. The use of polished metal and light-colored surfaces within and adjacent to the driver’s area shall be avoided, unless otherwise directed by the Authority.

23.3. Visors/ Sunshades

Driver’s Window Sunscreens

An adjustable roller type solid sunscreen shall be provided over the driver’s windshield and the driver’s side window or approved equivalent. The sunscreen shall be capable of being lowered, at a minimum, to the midpoint of the driver’s side window. When deployed, the screen shall be secure, stable, and shall not rattle, or sway. Once lowered, the screen shall remain in the lowered position until returned to the stowed position by the driver. Sunscreen shall be shaped to minimize light leakage between the visor and windshield pillars to the greatest extent possible.

23.4. Driver’s Controls

Frequently used controls must be in easily accessible locations. These include the door control, kneel control, windshield wiper/washer controls, ramp, and lift and “master” run switch. Any switches and controls necessary for the safe operation of the bus shall be conveniently located and shall provide for ease of operation. They shall be identifiable by shape, touch, and permanent markings. Controls shall be located so that passengers may not easily tamper with control settings.

All panel-mounted switches and controls shall be marked with easily read identifiers. Graphic symbols shall conform to SAE J2402, “Road Vehicles – Symbols for Controls, Indicators, and Tell Tales”, where available and applicable. The color of switches and controls shall be dark with contrasting typography or symbols. Verbiage or terms used to describe the functionality of each shall be consistent with the functionality of each switch i.e. not confusing to the operator. Verbiage shall be intuitive in meaning so that an operator can easily understand the functionality of the switch.

Mechanical switches and controls shall be replaceable, and the wiring at these controls shall be serviceable from a convenient location. Switches, controls, and instruments shall be dust- and water-resistant. At the direction of the Authority, specified driver control toggle switches shall have a protective cover so that accidental activation is prevented.

All switches/controls in the driver’s control area shall be mounted in an angled panel steep enough to discourage drivers from using it as a personal storage area for items like food, drinks, cell phones, etc.

The layout, verbiage, and functionality of all driver’s controls are subject to review and acceptance by the Authority. The driver control layout shall be presented to the Authority as soon as possible for approval and before any element of the production process begins to include procurement of parts for the driver controls.

23.5. Normal Bus Operation Instrumentation and Controls

The following list identifies bus controls used to operate the bus. These controls are either frequently used or critical to the operation of the bus. They shall be located within easy reach of the operator. The operator shall not be required to stand or turn to view or actuate these controls unless otherwise specified by the Authority.

Systems or components monitored by onboard diagnostics system shall be displayed in clear view of the operator and provide visual and/or audible indicators. The intensity of indicators shall permit easy determination of on/off status in bright sunlight but shall not cause a distraction or visibility problem at night. All indicators should be illuminated using backlighting.

The indicator panel shall be located within easy view of the operator instrument panel. All indicators shall have a method of momentarily testing their operation. The audible alarm shall be tamper-resistant and should have an outlet level between 80 and 83 dBA when measured at the location of the center of the operator’s seat.

Onboard displays visible to the operator shall be limited to indicating the status of those functions described herein that are necessary for the operation of the bus. All other indicators needed for diagnostics and their related interface hardware shall be concealed and protected from unauthorized access. Table 6, below, represents instruments and alarms. The intent of the overall physical layout of the indicators shall be in a logical grouping of systems and severity nature of the fault.

Provisions for future additions of indicators shall be taken into consideration of the display design as the capability of onboard diagnostic systems improves.

The Four-Way flashers should automatically engage with the doors opening and when the bus is kneeling. Activation of the Four-Way Flasher shall be achieved by the dash switch.

The vehicle shall be equipped with a Light Test functionality that when activated, turns on all exterior lights, including headlights, ramp warning light, turn signals, marker lights, and engages the back-up alarm, with the exception that the reverse lights shall flash when in test mode. The Authority highly prefers the test mode be activated by simultaneously pressing the left and right foot turn signal switches. The test mode shall be active for a minimum of 1 minute unless deactivated by simultaneously pressing the left and right foot turn signal switches.

All devices indicated in Table 6 shall be configured and installed described unless an alternative arrangement is authorized by the Authority.

TABLE 6

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Device	Description	Location	Function	Visual/Audible
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TABLE 6

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TABLE 6

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Device	Description	Location	Function	Visual/Audible
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TABLE 6

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Device	Description	Location	Function	Visual/Audible
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23.5.1. Multi-Function Display (MFD)

In addition to, and in place of some meters, gauges, controls, indicator lights, and other instruments on the instrument panel, the proposer shall include a Multi-Function Display (MFD). The Multi-Function Display shall have complete on-board computer system with a definite purpose, color LCD screen that displays safety related information in large, easy to read graphics, programmable LED warning lights designed to comply with FMVSS for critical information such as Stop Propulsion system, Check Transmission, and Directional Signal indicators; both driving mode and maintenance mode with the driving mode intended to provide useful information during vehicle operation, and the maintenance mode used for vehicle troubleshooting or service. The gauges may display information such as coolant temperature, oil temperature, oil pressure, air pressure, etc., which come directly from the power train J1939 interface. In maintenance mode, the MFD can test certain outputs in real time and the results are shown on the screen. The MFD shall be an integral component of the Input/Output (I/O) system.

23.5.2. Operator Efficiency Feedback

The Authority is requesting instrumentation that reports driving efficiency so that an operator may change driving behavior to optimize vehicle range. The manufacturer should offer an option for Operator Efficiency Feedback.

23.6. Operator Foot Controls

Accelerator and brake pedals shall be designed for ankle motion. Foot surfaces of the pedals shall be faced with wear-resistant, nonskid, replaceable material.

23.6.1. Pedal Angle

The vertical angle of the accelerator and brake pedals shall be determined from a horizontal plane regardless of the slope of the cab floor. The accelerator and brake pedals shall be positioned at an angle of 37 to 50 degrees at the point of initiation of contact and extend downward to a maximum angle of 10 to 18 degrees at full application.

The location of the brake and accelerator pedals shall be determined by the manufacturer, based on space needs, visibility, lower edge of windshield and vertical H-point.

23.6.2. Pedal Dimensions and Position

The floor-mounted accelerator pedal shall be 10 to 12 inches long and 3 to 4 inches wide. Clearance around the pedal must not allow for interference precluding operation.

The accelerator and brake pedals shall be positioned such that the spacing between them, measured at the heel of the pedals, is between 1 and 2 inches. Both pedals should be located approximately on the same plane coincident to the surface of the pedals.

23.6.3. Brake and Accelerator Pedals

Brake Pedal shall be installed in a fixed location and non-adjustable.

23.6.4. Driver Foot Switches

23.6.4.1. Turn Signal Controls

Turn signal controls shall be floor-mounted, foot-controlled, water-resistant, heavy-duty, momentary, latching contact switches.

The Four-Way flashers should automatically engage with the doors opening. Activation of the Four-Way Flasher shall also be achieved by activation of the dash switch.

23.6.4.2. Foot Switch Control

The control switches for the turn signals shall be mounted on an inclined, floor-mounted stainless-steel enclosure mounted to an incline integrated into the driver’s platform, located to the left of the steering column. The angle of the turn signal platform shall be determined from a horizontal plane, regardless of the slope of the cab floor. The turn signal platform shall be angled at a minimum of 10 degrees and a maximum of 37 degrees. It should be located no closer to the seat front than the heel point of the accelerator pedal.

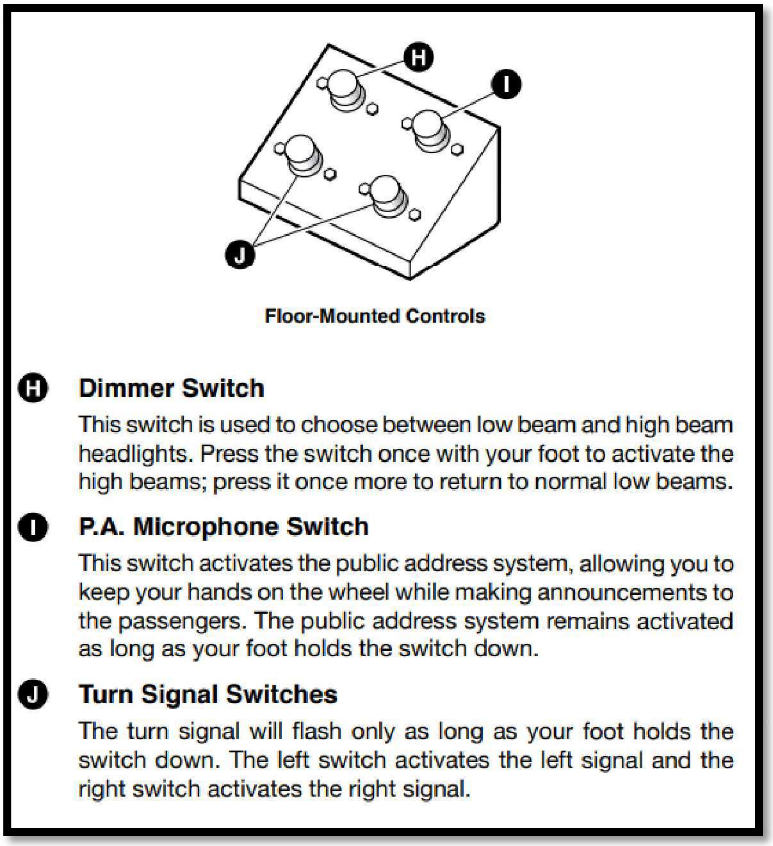
The location and design of this enclosure shall be such that foot room for the operator is not impeded. The Authority prefers to have the inclined mounting surface be skid resistant. All other signals, including high beam and public address system, shall be in approved locations, reference drawing at the end of this section.

The foot switches shall be UL-listed, heavy-duty type, of a rugged, corrosion-resistant metal construction. The foot switches for the directional signals and Public Address (PA) system shall be momentary type, while the switch for the high beam shall be latching type. The spacing of the switches shall be such that inadvertent simultaneous deflection of switches is prevented.

23.6.4.3. Other Floor-Mounted Controls

The Public Address (PA) system control switch shall be floor mounted near the foot signal turn switches, same style as the turn signal foot switches, momentary “on” (normally open circuit), UL-listed, heavy-duty type, of a rugged, corrosion-resistant metal construction.

The following drawing depicts the desired location of the foot switches:



Floor-Mounted Controls

H **Dimmer Switch**

This switch is used to choose between low beam and high beam headlights. Press the switch once with your foot to activate the high beams; press it once more to return to normal low beams.

I **P.A. Microphone Switch**

This switch activates the public address system, allowing you to keep your hands on the wheel while making announcements to the passengers. The public address system remains activated as long as your foot holds the switch down.

J **Turn Signal Switches**

The turn signal will flash only as long as your foot holds the switch down. The left switch activates the left signal and the right switch activates the right signal.

24. Operator’s Amenities

24.1. Coat Hanger

Coat Hanger

A suitable hanger shall be installed in a convenient, approved location for the operator’s coat. The coat hanger should be installed close to the operator seat.

24.2. Drink Holder

A device shall be provided to securely hold the operator’s drink container, which may vary widely in diameter. It must be mounted within easy reach of the driver and must have sufficient vertical clearance for easy removal of the container. When the container is in the device, the driver’s view of the road must not be obstructed, and leakage from the container must not fall on any switches, gauges or controls.

24.3. Operator Storage Box

An enclosed driver storage area should be provided with a positive latching door but shall not lock. The minimum size should be approximately 2,750 cubic inches or approved equivalent. The Authority reserves the right to review and approve the installation location.

25. Windshield Wipers and Washers

25.1. Windshield Wipers

The bus shall be equipped with a windshield wiper for each half of the windshield. At 60 mph, no more than 10 percent of the wiped area shall be lost due to windshield wiper lift. For two-piece windshields, both wipers shall park along the center edges of the windshield glass. For single-piece windshields, wipers shall park along the bottom edge of the windshield. Windshield wiper motors and mechanisms shall be easily accessible for repairs or service. The fastener that secures the wiper arm to the drive mechanism shall be corrosion resistant.

Single-control, electric two-speed (high/low) with intermittent variable wiper is highly preferred.

Intermittent Wiper with Variable Control

A variable-speed feature shall be provided to allow adjustment of wiper speed for each side of the windshield between approximately five and 25 cycles per minute.

Non-Synchronized Wipers- not a requirement, wipers may be either synchronized or non-synchronized.

For non-synchronized wipers, separate controls for each side shall be supplied.

25.2. Windshield Washer System

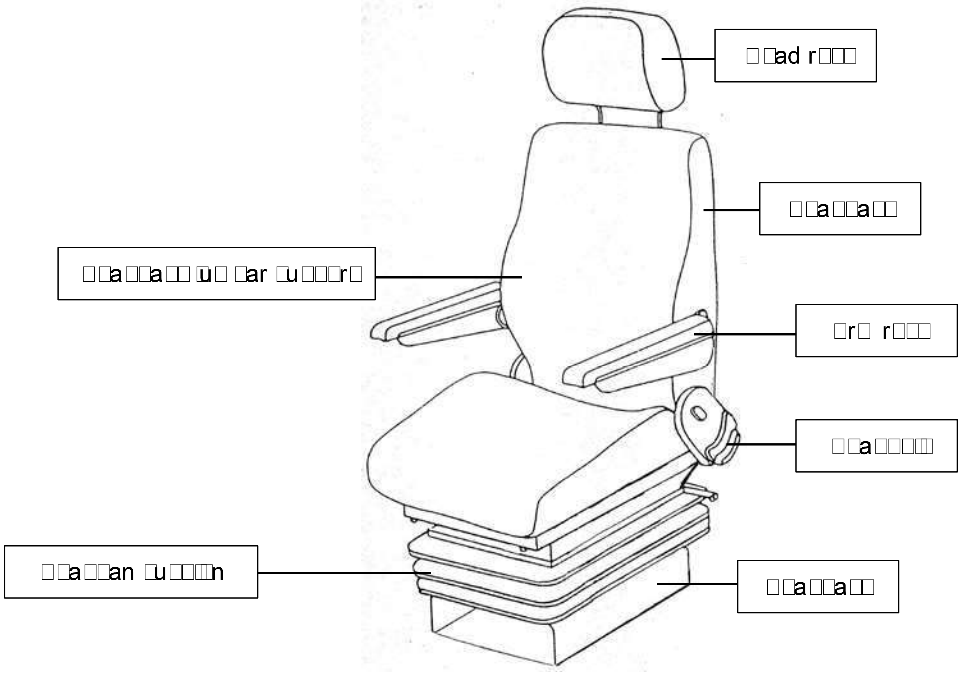
The windshield washer system shall have a washing fluid reservoir fill from the exterior of the vehicle, The application of the washer fluid shall be applied evenly and completely over the entire wiped area.

The windshield washer system should have a minimum 3-gallon reservoir, located for easy refilling from outside the bus. Reservoir pumps, lines and fittings shall be corrosion-resistant and should include a means to determine fluid level.

26. Operator’s Seat

FIGURE 7

Driver’s Seat



26.1. Dimensions

The operator’s seat shall be comfortable and adjustable so that people ranging in size from a 95th-percentile male to a 5th-percentile female may operate the bus.

26.1.1. Seat Pan Cushion Length

Measurement shall be from the front edge of the seat pan to the rear at its intersection with the seat back. The adjustment of the seat pan length shall be no less than 16.5 inches at its minimum length and no more than 20.5 inches at its maximum length.

26.1.2. Seat Pan Cushion Height

Dimensions

Measurement shall be from the cab floor to the top of the level seat at its center midpoint. The seat shall adjust in height from a minimum of 14 inches to a maximum of 20 inches, with a minimum 6 inches vertical range of adjustment or approved equivalent.

26.1.3. Seat Pan Cushion Slope

Measurement is the slope of the plane created by connecting the two high points of the seat, one at the rear of the seat at its intersection with the seat back and the other at the front of the seat just before it waterfalls downward at the edge. The slope can be measured using an inclinometer and shall be stated in degrees of incline relative to the horizontal plane (0 degrees). The seat pan shall adjust in its slope from no less than plus 12 degrees (rearward “bucket seat” incline) to no less than minus 5 degrees (forward slope).

26.1.4. Seat Base Fore/Aft Adjustment

Measurement is the horizontal distance from the heel point to the front edge of the seat. The minimum and maximum distances shall be measured from the front edge of the seat when it is adjusted to its minimum seat pan depth (approximately 15 inches). On all low-floor buses, the seat base shall travel horizontally a minimum of 9 inches. It shall adjust no closer to the heel point than 6 inches. On all high-floor buses, the seat base shall travel a minimum of 9 inches and adjust no closer to the heel point than 6 inches.

All parts of the driver's seat shall be prevented from making physical contact with the driver barrier or any other part of the bus behind and beside the driver regardless of the wide range of adjustment available in the driver's seat design.

26.1.5. Seat Pan Cushion Width

Measurement is the horizontal distance across the seat cushion. The seat pan cushion shall be 17 to 21 inches across at the front edge of the seat cushion and 20 to 23 inches across at the side bolsters.

26.1.6. Seat Suspension

The operator's seat shall be appropriately dampened to support a minimum weight of 650 pounds. The suspension shall be capable of dampening adjustment in both directions.

Rubber bumpers shall be provided to prevent metal-to-metal contact.

26.1.7. Operator Area Depth

The measurement is the horizontal distance from the heel-point to the barrier at the height at which the top of the seat back reclines. For all low-floor buses, the operator area depth shall be a minimum of 45 inches and be able to accommodate the full range of seat adjustment and travel (for a seat with the specifications as described in these guidelines).

26.1.8. Seat Back

Width-
Measurement is the distance between the outermost points of the front of the seat back, at or near its midpoint in height. The seat back width shall be no less than 19 inches. Seat back should include dual recliner gears on both sides of the seat.
Height-
Standard height seat back.

26.1.9. Headrests

Adjustable headrest.

26.1.10. Seat Back Lumbar Support

Measurement is from the bottom of the seat back at its intersection with the seat pan to the top of the lumbar cushioning. The seat back shall provide adjustable-depth lumbar back support with three individual operating lumbar cells within a minimum range of 7 to 11 inches.

26.1.11. Seat Back Angle Adjustment

The seat back angle shall be measured relative to a level seat pan, where 90 degrees is the upright position and 90 degrees-plus represents the amount of recline.

The seat back shall adjust in angle from a minimum of no more than 90 degrees (upright) to at least 105 degrees (reclined), with infinite adjustment in between.

26.2. Seat Belt

The belt assembly should be an emergency-locking retractor (ELR). All seat belts should be stored in automatic retractors. The belts shall be mounted to the seat frame so that the driver may adjust the seat without resetting the seat belt.

The seat and seatbelt assemblies as installed in the bus shall withstand static horizontal forces as required in FMVSS 207 and 210.

26.2.1. Lap and Shoulder (Three-Point) Seat Belt

The driver seat shall be equipped with a three-point lap and shoulder belt. The shoulder belt shall be non-detachable from the lap belt. The seatbelt shall be Emergency Locking Retractor (ELR) in design. The Shoulder Belt shall have an adjustable height D-ring (“comfort latch”). The seatbelt webbing shall be hi-vis Orange.

The seatbelt, buckle and driver seat shall be integrated into the bus to provide an audible and visual dash warning to the operator if the seatbelt is not buckled.

The lap belt assembly should be a minimum of approximately 56 inches in length preferably with an optional use 8-inch extension. If the use of an extension is available, then each bus shall be supplied with one 8-inch extension.

Preferably, the lap and shoulder belt be installed so that the buckle or receiving end of the seat belt is next to the operator side panel or “left side”. The goal for the design configuration is so that damage to the operator side panel is reduced when an operator releases the seat belt.

26.3. Adjustable Armrest

No armrests.

26.4. Seat Control Locations

While seated, the driver shall be able to make seat adjustments by hand without complexity, excessive effort or being pinched. Adjustment mechanisms shall hold the adjustments and shall not be subject to inadvertent changes.

26.5. Seat Structure and Materials

Cushions
Cushions shall be fully padded with approximately 3 inches of padding materials in the seating areas at the bottom and back.
Cushion Materials
Foam and fabric that meets FTA Docket 90A.

26.6. Pedestal

Shall be powder-coated steel, at a minimum, to prevent corrosion and black in color. Unpainted stainless steel or aluminum is allowed.

26.7. Operator Seat Salient Features

The operator seat should have the following salient features:

- Standard back frame with injection-molded back shell
- Quick-release cushion
- 4-way adjustable headrest
- Wide back and cushion (22 inches)
- Continuous dual-sided recline (minimum 15 degrees)
- Air suspension
- Air slide release
- Sliders below suspension
- Pneumatic dual pendulum, scissor-style suspension
- Bilateral dampers
- Secondary bumpers
- 3-chamber air lumbar support
- Fore/aft slide adjustment (9.45 approximate inches of travel)
- Adjustable height (6 inches of travel)
- Adjustable seat pan rake (10 degrees of range)
- 400 pound deadlift (minimum), 650 pound seat rating
- Black fabric and vinyl combination panel offerings
- Complies with international ISO and ANSI vibration standards

26.8. Seat Options

Manufacturers shall provide driver seat to include the following choices to be determined during vehicle configuration:

- seat occupied sensor/ “empty seat alarm”, reference section 19.6.4.
- seat belt sensor
- fabric and vinyl upholstery options and combinations, the Authority reserves the right of the final upholstery configuration. The Authority has a high preference for a combination of fabric and vinyl panels that make up the seat covering to improve the comfort of the operator while trying to maintain durability.
- side bolsters adjustments
- Install provisions for a semi-active operator seat to include a power circuit, a power on circuit, and a vehicle ground circuit. Location and circuit protection to be determined during the vehicle configuration process.

27. Mirrors

27.1. Exterior Mirrors

The bus shall be equipped with corrosion-resistant, outside rearview mirrors mounted with stable supports to minimize vibration. Mirrors shall be firmly attached to the bus to minimize vibration and to prevent loss of adjustment. Mirrors shall permit the driver to view the roadway along the sides of the bus, including the rear wheels. Mirrors should be positioned to prevent blind spots.

Mirrors shall retract or fold sufficiently to allow bus washing operations but avoid contact with windshield.

Exterior mirrors shall be installed without a breakaway mounting system.

The exterior mirror assemblies shall have a combination of flat and convex mirrors referred to as transit specific.

The exterior mirrors shall be aesthetically pleasing, having form as a design factor as well as function.

Turn signals are not required on the exterior mirrors.

27.1.1. Curbside Mirrors

The curbside rearview mirror shall be mounted so that its lower edge is 80 inches (+/- 3 inches) above the street surface.

27.1.1.1. Remote Adjustment of Curbside Mirror

The driver shall be able to adjust both the flat and convex mirror glass in the curbside mirror remotely while seated in the driving position. The control for remote positioning of the mirror shall be a single switch or device.

27.1.1.2. Heated Mirrors Curbside

The heaters shall be energized for a minimum of 15 minutes whenever the driver's heater or defroster is activated or activated independently via a momentary switch on the dash. The heater shall heat both flat and convex mirrors.

27.1.2. Street-Side Mirrors

The street-side mirror shall be the same style and configuration and mounted the same height as the curbside mirror to enhance aesthetic appearance and eliminate low-mounted mirror accidents.

27.1.2.1. Remote Adjustment of Street-Side Mirror

The operator shall be able to adjust both the flat and convex mirror glass in the street-side mirror remotely while seated in the driving position. The control for remote positioning of the mirror shall be a single switch or device.

27.1.2.2. Heated Mirrors Street-Side

The heaters shall be energized for a minimum of 15 minutes whenever the driver's heater or defroster is activated or activated independently via a momentary switch on the dash. The heater shall heat both flat and convex mirrors.

27.1.3. Exterior Mirror Turn Signals

Not required. If turn signals are provided then they shall have amber colored lamps.

27.2. Interior Mirrors

Interior mirrors shall be provided for the driver to observe passengers throughout the bus without leaving the operator seat and without shoulder movement. The operator should be able to observe passengers in forward areas of the bus, including all seats and aisles in the lower section, including directly behind the driver, as well as the steps leading to upper level (on 40-ft bus). The Authority reserves the right to approve interior mirror configuration.

The Authority requires the installation of a relay mirror to view the exit door area. A large "flat" mirror should be installed on the front header so that an operator may see the passenger area. Large "flat" mirror dimensions should be approximately 8.25 inches by 16 inches. The Vehicle Manufacturer may offer an integrated monitor within the mirror assembly mounted on the front header. The monitor shall show the rear camera view of the vehicle when in reverse and the exit door when opened. The monitor screen size should be a minimum of seven (7) inches.

The Authority reserves the right of final mirror installation locations and configurations.

WINDOWS

28. Vehicle Glass

28.1. General Requirement

Use with 40 ft length: Approximately 10,000 square inches of window area, including operator and door windows, shall be required on each side of the standard configuration bus.

28.2. Windshield

The windshield shall permit an operator’s field of view as referenced in SAE J1050. The vertically upward view shall be a minimum of 14 degrees, measured above the horizontal and excluding any shaded band. The vertically downward view shall permit detection of an object 3.5 feet high no more than 2 feet in front of the bus. The horizontal view shall be a minimum of 90 degree above the line of sight. Any binocular obscuration due to a center divider may be ignored when determining the 90-degree requirement, provided that the divider does not exceed a 3-degree angle in the operator’s field of view. Windshield pillars shall not exceed 10 degrees of binocular obscuration. The windshield shall be designed and installed to minimize external glare as well as reflections from inside the bus.

The windshield shall be easily replaceable by removing zip-locks from the windshield retaining moldings. Bonded-in-place windshields shall not be used. Winglets may be bonded.

28.2.1. Glazing

The windshield glazing material shall have a ¼ inch nominal thickness laminated safety glass conforming to the requirements of ANSI Z26.1 Test Grouping AS-1 and the recommended practices defined in SAE J673.

28.2.2. Shaded Band

The upper portion of the windshield above the driver’s field of view shall have a dark, shaded band and marked AS-3, with a minimum luminous transmittance of 5 percent when tested in accordance to ASTM D1003.

One or two-piece windshield will be allowed.

28.3. Operator’s Side Window

The operator’s side window shall be the sliding type, allowing a minimum of half of the sash to latch upon closing, and shall open sufficiently to permit the seated operator to easily extend their hand out of the window for hand signaling. When in an open position, the window shall not rattle or close during accelerating or braking. This window section shall slide in tracks or channels designed to last the service life of the bus. The operator’s side window shall not be bonded in place and shall be easily replaceable. The window shall be non-egress.

The operator's view, perpendicular through the operator's side window glazing, should extend a minimum of 33 inches (840 mm) to the rear of the heel point on the accelerator, and in any case must accommodate a 95th percentile male operator. The view through the glazing at the front of the assembly should begin not more than 26 inches (560 mm) above the operator's floor to ensure visibility of an under-mounted convex mirror. Operator's window construction shall maximize ability for full opening of the window.

The operator's side window glazing material shall have a ¼ inch nominal thickness laminated safety glass conforming to the requirements of ANSI Z26.1-1996 Test Grouping AS-2 and the recommended practices defined in SAE J673.

The design shall prevent sections from freezing closed in the winter.

28.3.1. UV Blocking Operator Window

~~The Authority has a preference for the operator's side window to have a clear window film installed with a highest level of UV blocking and infrared reflecting properties to minimize energy transmittance from the sun onto the driver. The Vehicle Manufacturer should offer an option for installation of window film installation, with the salient features of "3M" products.~~

28.4. Side Windows and Passenger Doors

28.4.1. Configuration

All side windows shall be framed (also referred to as standard frame windows) and fixed in position, except as necessary to meet the emergency escape requirements. Side windows shall not be bonded in place but shall be easily replaceable without disturbing adjacent windows and shall be mounted so that flexing or vibration from power plant operation or normal road excitation is not apparent. All aluminum and steel material will be treated to prevent corrosion.

28.4.2. Emergency Exit (Egress) Configuration

All Emergency Exit Windows shall be, when viewed from the outside, similar in appearance to non-egress windows.

28.4.3. Fixed Side Windows Configuration

All side windows shall be fixed in position, except as necessary to meet the emergency escape requirements.

28.4.4. Materials

28.4.4.1. Safety Glass Glazing Panels

Side windows glazing material shall have a minimum of 3/16 inches nominal thickness tempered safety glass. The material shall conform to the requirements of ANSI Z26.1-1996 Test Grouping 2 and the recommended practices defined in SAE J673.

28.4.4.2. Laminated- Tempered Safety Glazing with integrated tint, and Anti-Vandalism Polyester Sacrificial Film

Sacrificial Film-

All glazing material that is aft of the standee line shall be equipped with 6 mm laminated polyester film. Film material shall be easily installed and removed without the use of specialized tools. Polyester film shall adhere to the window and be resistant to peeling, curling and discoloration by ultraviolet rays. The film shall withstand normal cleaning operations. There shall be at least 2 pieces of sacrificial film.

Tint-

Windows on the bus sides and in the rear door shall be tinted a gray color. The maximum solar energy transmittance shall be 13 percent, +/- 2 percent, as measured by ASTM E424. Luminous transmittance shall be measured by ASTM D1003. Windows over the destination signs shall not be tinted.

Each passenger door assembly glazing light transmittance (“tint”) should be 50 percent as measured by ASTM D1003 and gray in color. The light transmittance shall not impede the ability of passengers to view the passenger door opening system.

NOTE: All glass treatments, with the exception of the operator’s side window, must be permanent, within the glass and/or in the center membrane. Surface films with the exception of the driver’s side window, shall not permitted.

SHGC (Solar Heat Gain Coefficient) and light transmission performance shall be defined by the National Fenestration Rating Council.

28.5. Rear Window

A rear window is not required. However, if a rear-view window is installed the rear window shall be glazed with the same material (including anti-vandalism provision) and tint the same fashion, color, and light transmittance as side windows or approved equivalent. The glazing shall be set in rubber channels or be push-out type to meet FMVSS 217. If push-out type, it shall be one-piece, rugged sash design, meeting specifications for side windows.

29. HVAC, Heating Ventilation Air Conditioning

29.1. HVAC Capacity and Performance

The HVAC unit(s) may either be AC or DC electrically driven and should have hermetic compressor(s), condenser fan(s), and evaporator blower motor(s). The units shall use either R134a or R407C and may be roof or rear mounted.

The HVAC system shall be able to pass the “Houston Pull Down Test” as described in APTA document BTS-HVAC-RP-003-04. The driver control shall be set so that the operator may only select a temperature range from 68- and 78-degrees Fahrenheit. The HVAC system shall be capacity and capability to maintain a relative humidity value of 50 percent or less.

The system shall maintain these conditions while subjected to any outside ambient temperatures within a range of 10 to 110 °F and at any ambient relative humidity levels between 5 and 100 percent.

When the bus is operated outside ambient temperatures of 95 to 115 degrees Fahrenheit, the interior temperature of the bus shall be permitted to rise 0.5 degrees Fahrenheit for each degree of exterior temperature in excess of 95 degrees Fahrenheit.

29.2. Controls and Temperature Uniformity

The bus shall be equipped with two HVAC systems and separate controls for each. Each HVAC system shall be capable of working independently of one another: one dedicated to the passenger area and one dedicated to the operator area. The interior climate control systems shall switch automatically to the ventilating mode if the refrigerant compressor or condenser fan fails.

29.3. Passenger HVAC System

The passenger HVAC system shall be centrally controlled with an advanced electronic/diagnostic control system compliant with J1939 Communication Protocol for receiving and broadcasting of data for extracting/reading.

After manual selection and/or activation of climate control system operation mode, all interior climate control system requirements for the selected mode shall be attained automatically to within ±2 degrees Fahrenheit of the specified temperature control set-point.

The climate control system shall be programmed to allow the operator to adjust the temperature control set-point only between 68 and 78 degrees Fahrenheit.

Interior temperature distribution shall be uniform to prevent hot and/or cold spots. After stabilization with doors closed, the temperatures between any two points in the passenger compartment in the same vertical plane, and 6 to 72 inches above the floor, shall not vary by more than 5 degrees Fahrenheit with doors closed. The interior temperatures, measured at the same height above the floor, shall not vary more than ±5 degrees Fahrenheit from the front to the rear from the average temperature determined in accordance with APTA's "Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System." Variations of greater than ±5 degrees Fahrenheit will be allowed for limited, localized areas provided that the majority of the measured temperatures fall within the specified requirement.

29.4. Operator HVAC System

The Authority desires a dedicated operator climate control system that mimics as much as possible a standard automotive heating, ventilation, and air conditioning system. The system may be integrated into the existing standard design for heating, ventilation and defroster system. The driver HVAC should be separated as much as possible from the passenger HVAC system, meaning the operator can set the operator area at a different temperature, via separate controls, than that of the passenger HVAC system.

The operator air conditioning system should have dash mounted controls that allow the operator to control air speed, temperature, direction, and fresh air mix. Cool air shall flow from vents in the dash that cool the operator's head and torso. Cool air may also be supplied by overhead vents, but these vents shall not be considered to strictly satisfy the requirements for an operator's air conditioning system. The operator's air conditioning system shall be independently controlled from the passenger HVAC system and shall include a separate and dedicated evaporator, heater core, fan speed and system controls.

The heater and defroster system may be electric grid type and provide heating for the driver and heated air to completely defrost and defog the windshield, driver's side window and the front door glasses in all operating conditions. Fan(s) shall be able to draw air from the bus body interior and/or exterior through a control device and pass it through the heater core to the defroster system and over the driver's feet. A minimum capacity of 100 cfm (cubic feet per minute) shall be provided. The operator shall have complete control of the heat and fresh airflow for the operator's area.

The defroster supply outlets shall be located at the lower edge of the windshield. These outlets shall be durable and shall be free of sharp edges that can catch clothes during normal daily cleaning. The system shall be such that foreign objects such as coins or tickets cannot fall into the defroster air outlets. Adjustable ball vents or louvers shall be provided at the left of the driver's position to allow direction of air onto the side windows.

The ventilation system shall be capable of providing fresh (exterior) air in both the foot and head areas. Vents shall be controllable by the operator from the normal driving position. Decals shall be provided, indicating "operating instructions" and "open" and "closed" positions. When closed, vents shall be sealed to prevent the migration of water or air into the bus.

HVAC systems that use coolant pumps for the operator's defroster/heat shall be sized for the required flow and be brushless, having a minimum maintenance-free service life for both the brushless motor and the pump of at least 40,000 hours at full power.

Operator controls for all cooling, heating, ventilation, and defroster systems are subject to the approval of the Authority.

29.5. Auxiliary Heater- HVAC

Auxiliary heating system may consist of electric grid type heaters if needed.

29.6. Load Shedding and Derating

HVAC control must include a method to provide multistage load shedding when required to conserve battery power, if needed. The HVAC system may be operated with reduced performance to allow the bus to operate when the high-voltage batteries are below critical levels.

29.7. Air Flow

29.7.1. Passenger Area

The cooling mode of the interior climate control system shall introduce air into the bus at or near the ceiling height at a minimum rate of 25 cubic feet per minute (cfm) per passenger based on the standard configuration bus carrying passengers equal to 150 percent of the seated load. Airflow shall be evenly distributed throughout the bus, with air velocity not exceeding 100 feet per minute on any passenger. The ventilating mode shall provide air at a minimum flow rate of 20 cfm per passenger.

Airflow may be reduced to 15 cfm per passenger (at 150 percent of seated load) when operating in the heating mode. The fans shall not activate until the heating element (if used) has warmed sufficiently to ensure at least 70 degrees Fahrenheit air outlet temperature. The heating air outlet temperature shall not exceed 120 degrees Fahrenheit under any normal operating conditions.

The climate control blower motors and fan shall be designed such that their operation complies with the interior noise level requirements.

The vehicle does not require "Fresh Air" to be mixed into the HVAC airflow as regular door opening cycle results in effectively providing an adequate "fresh air" mixture.

29.7.2. Operator's Area

The bus interior climate control system shall deliver at least 100 cubic feet per minute (cfm) of air to the operator's area when operating in the ventilating and cooling modes. Adjustable nozzles shall permit variable distribution or shutdown of the airflow. Airflow in the heating mode shall be reduced proportionally to the reduction of airflow into the passenger area. The windshield defroster unit shall meet the requirements of SAE J382, “Windshield Defrosting Systems Performance Requirements,” and shall have the capability of diverting heated air to the operator’s feet and legs. The defroster or interior climate control system shall maintain visibility through the operator’s side window.

The Vehicle Manufacturer shall install only one (1) dashboard fan, aimed at the operator, without interference by driver security barrier or other components.

29.7.3. Air Filtration

Air shall be filtered before entering the HVAC system and then discharged to the passenger and operator compartments. The filtration shall be a mesh style filter. Air filters shall be easily removable for service. The Authority has a high preference for filters with a MERV rating of 13.

Air filters shall be of a disposable type.

29.7.4. Roof Ventilators

Each ventilator shall be easily opened and closed manually. When open with the bus in motion, this ventilator shall provide fresh air inside the bus. The ventilator shall cover an opening area no less than 425 square inches and shall be capable of being positioned as a scoop with either the leading or trailing edge open no less than 4 inches, or with all four edges raised simultaneously to a height of no less than 3.5 inches. An escape hatch shall be incorporated into the roof ventilator. Roof ventilator(s) shall be sealed to prevent entry of water when closed.

For 40-foot bus, a minimum of one ventilator (two preferred) shall be installed in the roof of the bus, one approximately over or just forward of the front axle and the other approximately over the rear axle.

The Authority reserves the right of final configuration approval.

29.8. HVAC Maintainability

Manually controlled shutoff valves in the refrigerant lines shall allow for isolation of the compressor and dehydrator filter for service. Self-sealing couplings using O-ring seals shall be used to break and seal the refrigerant lines during removal of major components, such as the refrigerant compressor. Shutoff valves may be provided in lieu of self-sealing couplings. The condenser shall be located to efficiently transfer heat to the atmosphere and shall not ingest air warmed above the ambient temperature by the vehicle’s mechanical equipment, or to discharge air into any other system of the bus. The location of the condenser shall preclude its obstruction by wheel splash, road dirt or debris. HVAC components located within 6 inches of floor level shall be constructed to resist damage and corrosion. Driver HVAC components should be maintainable independent of the passenger HVAC. For example the driver evaporator shall be capable of being isolated from the passenger HVAC system, to prevent from having to evacuate the entire HVAC system, for maintenance.

29.9. Entrance/Exit Area Heating and Floor Heating

The vehicle does not require special door area heating.

The vehicle does not require special floor-level heating.

EXTERIOR PANELS, FINISHES AND EXTERIOR LIGHTING

30. Exterior Panels, Finishes, and Exterior Lighting

30.1. Exterior Design

The bus shall have a clean, smooth, simple design, primarily derived from bus performance requirements and passenger service criteria. The exterior and body features, including grilles and louvers, shall be shaped to facilitate cleaning by automatic bus washers without snagging washer brushes. Water and dirt shall not be retained in or on body features to freeze or bleed out onto the bus after leaving the washer. The body and windows shall be sealed to prevent leaking of air, dust or water under normal operating conditions and during cleaning in automatic bus washers for the service life of the bus.

Exterior panels shall be sufficiently stiff to minimize vibration, drumming or flexing while the bus is in service. When panels are lapped, the upper and forward panels shall act as a watershed. However, if entry of moisture into the interior of the vehicle is prevented by other means, then rear cap panels may be lapped otherwise. The windows, hatches and doors shall be able to be sealed. Accumulation of spray and splash generated by the bus's wheels shall be minimized on windows and mirrors.

Exterior access panels shall be designed so that they open to the "up" position, with the exception of quick access doors (fuel fill, DEF fill, and windshield washer for example). The exterior access doors shall open up to a minimum of 130 degrees from the 0-degree starting point formed from side the bus body, in an effort to facilitate maintenance access and eliminate maintenance access related injuries. The exterior access door handles and hand grips shall have a minimum of 1.5 inches knuckle clearance.

30.2. Body Materials

Body materials shall be selected and the body fabricated to reduce maintenance, extend durability and provide consistency of appearance throughout the service life of the bus. Detailing shall be kept simple, and add-on devices and trim shall be minimized and integrated into the basic design.

No requirement for protection against graffiti/vandalism for exterior body material surfaces.

30.3. Pedestrian Safety

Exterior protrusions along the side and front of the bus greater than ½ inch and within 80 inches of the ground shall have a radius no less than the amount of the protrusion. The exterior rearview mirrors, cameras and required lights and reflectors are exempt from the protrusion requirement. Grilles, doors, bumpers and other features on the sides and rear of the bus shall be designed to minimize toe holds or handholds.

Exterior protrusions shall not cause a line-of-sight blockage for the operator.

30.4. Side Body Panel Repair

Structural elements supporting exterior body panels should allow side body panels below the windows to be repaired in lengths not greater than 12.5 feet and side panels shall be attached using standard attachment methods.

30.5. Rain Gutters

Rain gutters shall be provided to prevent water flowing from the roof onto the passenger doors and driver’s side window. When the bus is decelerated, the gutters shall not drain onto the windshield, driver’s side window or door boarding area. Cross-sections of the gutters shall be adequate for proper operation.

30.6. License Plate Provisions

Provisions shall be made to mount standard-size U.S. license plates per SAE J686 on the front and rear of the bus. These provisions shall direct-mount or recess the license plates so that they can be cleaned by automatic bus-washing equipment without being caught by the brushes. The rear license plate provision shall be illuminated per SAE J587.

Final location of license plates is subject to review and acceptance by the Authority.

30.7. Rub Rails

No requirement for rub rails.

30.8. Fender Skirts

Features to minimize water spray from the bus in wet conditions shall be included in wheel housing design. Any fender skirts shall be easily replaceable. They shall be flexible if they extend beyond the allowable body width. Wheels and tires shall be removable with the fender skirts in place.

30.9. Wheel Covers

Not required.

30.10. Splash Aprons

Splash aprons, composed of ¼ inch minimum composition or rubberized fabric, shall be installed behind and/or in front of wheels as needed to reduce road splash and to protect underfloor components. The splash aprons shall extend downward to within 6 inches off the road surface at static conditions. Apron widths shall be no less than tire widths. Splash aprons shall be bolted to the bus understructure. Splash aprons and their attachments shall be inherently weaker than the structure to which they are attached. The flexible portions of the splash aprons shall not be included in the road clearance measurements. Splash apron shall be installed as necessary to protect the wheelchair loading device from road splash. Other splash aprons shall be installed where necessary to protect bus equipment.

30.11. Access Doors to Exterior Service Compartments

30.11.1. Access Doors

Access openings shall be sized for easy performance of tasks within the compartment, including tool operating space. Access doors shall be of rugged construction and shall maintain mechanical integrity and function under normal operations throughout the service life of the bus. They shall close flush with the body surface. All doors shall be hinged at the top or on the forward edge and shall be prevented from coming loose or opening during transit service or in bus washing operations. All access doors shall be retained in the open position by props or counterbalancing with over center or gas-filled springs with safety props and shall be easily operable by one person. Springs and hinges shall be corrosion resistant. Latch handles shall be flush with, or recessed behind, the body contour and shall be sized to provide an adequate grip for opening. Access doors, when opened, shall not restrict access for servicing other components or systems.

If precluded by design, the manufacturer shall provide door design information specifying how the requirements are met.

30.11.2. Access Door Latch/Locks

Access doors larger than 100 square inches in area shall be equipped with corrosion-resistant flush-mounted latches or locks except for coolant and fuel fill access doors. All such access doors that require a tool to open shall be standardized throughout the vehicle and will require a nominal 5/16-inch square male tool to open or lock or approved equivalent.

30.12. Bumpers

30.12.1. Location

Bumpers shall provide impact protection for the front and rear of the bus with the top of the bumper being 27 inches, ±2 inches, above the ground. Bumper height shall be such that when one bus is parked behind another, a portion of the bumper faces will contact each other.

30.12.2. Front Bumper

No part of the bus, including the front bumper, shall be damaged as a result of a 5-mph impact of the bus at curb weight with a fixed, flat barrier perpendicular to the bus's longitudinal centerline. The bumper shall return to its pre-impact shape within 10 minutes of the impact. The bumper shall protect the bus from damage as a result of 6.5 mph impacts at any point by the common carriage with contoured impact surface defined in Figure 2 of FMVSS 301 loaded to 4000 pounds parallel to the longitudinal centerline of the bus. It shall protect the bus from damage as a result of 5.5 mph impacts into the corners at a 30-degree angle to the longitudinal centerline of the bus. The energy absorption system of the bumper shall be independent of every power system of the bus and shall not require service or maintenance in normal operation during the service life of the bus. The bumper may increase the overall bus length specified by no more than 7 inches.

30.12.3. Rear Bumper

No part of the bus, including the rear bumper, shall be damaged as a result of a 2-mph impact with a fixed, flat barrier perpendicular to the longitudinal centerline of the bus. The bumper shall return to its pre-impact shape within 10 minutes of the impact. When using a yard tug with a smooth, flat plate bumper 2 foot wide contacting the horizontal centerline of the rear bumper, the bumper shall provide protection at speeds up to 5-mph, over pavement discontinuities up to 1 inch high, and at accelerations up to 2-mph per second. The rear bumper shall protect the bus when impacted anywhere along its width by the common carriage with contoured impact surface defined in Figure 2 of FMVSS 301 loaded to 4000 pounds, at 4 mph parallel to or up to a 30-degree angle to the longitudinal centerline of the bus. The rear bumper shall be shaped to prevent unauthorized riders standing on the bumper. The bumper shall not require service or maintenance in normal operation during the service life of the bus. The bumper may increase the overall bus length specified by no more than 7 inches. Any part of the rear bumper which exceeds any distance beyond the side of the bus must be designed to prevent catching on lane delineators.

30.12.4. Bumper Material

Bumper material shall be corrosion-resistant and shall withstand repeated impacts of the specified loads without sustaining damage. These bumper qualities shall be sustained throughout the service life of the bus. Bumpers (front and rear) shall not be painted.

30.13. Bicycle Rack

The vehicle manufacturer shall provide and install a bicycle rack. The bike racks shall be finished in brushed stainless steel.

For 40-foot bus, the vehicle shall have mounting provisions for a bicycle rack capable of carrying three bicycles on the front bumper area, centered on the front of the vehicle. Each bicycle securement or locking arm on the rack shall remain fully functional regardless of kneeling position of the bus.

The bike rack shall feature a single universal, molded tray. The single tray shall accommodate all types of bicycles (ranging from children’s bikes to large 51inch wheelbase bikes, fat tire bikes, and e-bikes weighing up to 75 pounds each). The bicycle rack shall be mil-spec rated for shock and vibration to include the locking arm mechanism.

The Authority reserves the right of final configuration acceptance for all bike racks.

30.14. Exterior Finish and Color

30.14.1. Surface Appearance

All exterior surfaces shall be smooth and free of wrinkles and dents. Exterior surfaces to be painted shall be properly prepared as required by the paint system Supplier prior to application of paint to ensure a proper bond between the basic surface and successive coats of original paint for the service life of the bus. Drilled holes and cutouts in exterior surfaces shall be made prior to cleaning, priming, and painting, where possible, to prevent corrosion. The bus shall be painted prior to installation of exterior lights, windows, mirrors, and other items that are applied to the exterior of the bus. Body filler materials may be used for surface dressing, but not for repair of damaged or improperly fitted panels. Any joint or seam filler shall be of a color that provides for a uniform appearance of the exterior, such as use of color matched or color compatible filler. Joint color and appearance shall last the life of the bus without fading, cracking, or deterioration.

Paint shall be applied smoothly and evenly with the finished surface free of visible dirt and the following other imperfections:

- blisters or bubbles appearing in the topcoat film
- chips, scratches, or gouges of the surface finish
- cracks in the paint film
- craters where paint failed to cover due to surface contamination
- overspray
- peeling
- runs or sags from excessive flow and failure to adhere uniformly to the surface
- chemical stains and water spots
- dry patches due to incorrect mixing of paint activators
- buffing swirls

All exterior finished surfaces shall be impervious to diesel fuel, gasoline, and commercial cleaning agents. Finished surfaces shall resist damage by controlled applications of commonly used graffiti-removing chemicals.

Proper adhesion between the basic surface and successive coats of the original paint shall be measured using an Elcometer (coating thickness gauge) tester as outlined in ASTM D4541-85. Adhesion shall be a minimum 300 ft-lb. The bus manufacturer shall supply test samples of the exterior surface for each step of the painting process that may be subject to adhesion testing per ASTM G4541-87 and ASTM D4145-85. ASTM D4541-93 may be used for inspection testing during assembly of the vehicle. Reference paint scheme in Exhibit F-1A Typical Capital Metro Paint and Decal Scheme. The Exhibit F-1A shall serve as a guide as the Authority reserves the right of final approval.

30.14.2. Paint Strategy

The paint strategy shall be a two-stage system of base coat/clear coat automotive grade paint.

30.14.3. High Gloss External Paint Finish Quality

Painted surfaces shall have a minimum 95 gloss and an orange peel rating of 7 or more on the Advanced Coating Technologies Inc., orange peel standard panels set #APR 14941 or Authority -accepted wave scan equipment. Paint shall last a minimum of six years with a minimum gloss of 90 as measured in ASTM E97 92, “Standard Test Method For Directional Reflectance.”

30.14.4. Paint Design

The vehicle shall be ~~white~~ blue in color. Reference paint scheme in Exhibit F-1A Typical Capital Metro Paint and Decal Scheme. The Exhibit F-1A shall serve as a guide as the Authority reserves the right of final approval.

30.14.5. Vinyl Material and Application “Bus Wrap”

The Vehicle Manufacturer shall follow standards set forth by the vinyl film manufacturer for proper installation of the vinyl film. The Vehicle Manufacturer’s installers shall be certified by the vinyl film manufacturer. The Vehicle Manufacturer shall provide proof of certification for each installer upon the Authority’s request.

The Vehicle Manufacturer shall provide, for the Authority’s preliminary review and approval, Color Production Proofs (printed on the materials being used) and Elevated Vector Files prior to installation. Part numbers for each segment shall be assigned after final approval of the elevated vector files.

Vinyl “Wrap” film to be used shall have the salient features of 3M Vinyl Anti-Graffiti or an approved equal, with a warranty ensuring that the material will not fade, buckle or peel for seven (7) years. The salient characteristics of a 3M Anti-Graffiti material are:

- Cast vinyl material
- Resistant to mild alkalis, mild acids, salt, water, occasional fuel spills, UV rays, fading, abrasions, chipping, and peeling.
- Adhesion on paint of 17.5 ± 4 N/25 mm;
- Luster overlaminate

The vinyl film shall be warranted to endure bus washing with an automatic brush three (3) times a week during the warranty period. The vinyl film shall be designed to withstand temporary advertisement as a second application. The vinyl film shall withstand heat radiated from the engine aftertreatment system (i.e., around the exhaust pipe outlet, around and on the diesel particulate filter access compartment door, etc.).

The vinyl wrap design can be found on Exhibit F-1A Typical Capital Metro Paint and Decal Scheme. The Exhibit shall serve as a guide as the Authority reserves the right of final approval. The approval will be given after the Vehicle Manufacturer submits the required Production Proofs and elevated vector files of the Authority's branding as it applies to the vehicle's design/shape.

30.15. Decals, Numbering and Signing

Decals for energy storage and delivery systems shall be identified in accordance with federal, state, and local requirements, codes, and standards.

Monograms, numbers, and other special signing shall be applied to the inside and outside of the bus as required. All decals shall be installed per the decal Supplier recommendations. Signs shall be provided in compliance with the ADA requirements defined in 49 CFR Part 38, Subpart B, 38.27.

Reference paint scheme in Exhibit F-1A Typical Capital Metro Paint and Decal Scheme. The Exhibit F-1A shall serve as a guide as the Authority reserves the right of final approval.

The Authority reserves the right to review and approve all decals and signage on the bus, including media, language, translations, font, color, sizing, and location.

30.15.1. Passenger Information

ADA priority seating signs as required and defined by 49 CFR shall be provided to identify the seats designated for passengers with disabilities.

The public information system provided shall be in accordance with 49 CFR.

Capital Metro-Specified: Reference paint scheme in Exhibit F-1A Typical Capital Metro Paint and Decal Scheme. The Exhibit F-1A shall serve as a guide as the Authority reserves the right of final approval.

30.15.2. Braille Bus Number Plates

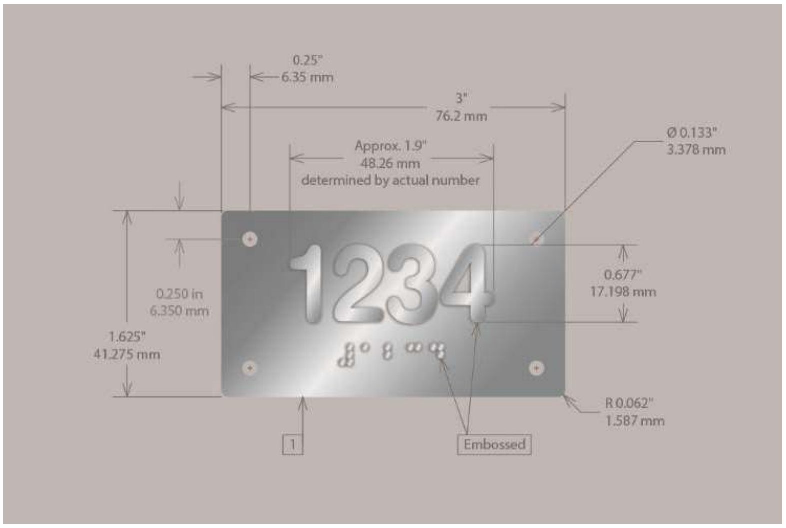
The vehicle manufacturer shall provide and install Braille Bus Number Plate Signs, three (3) braille plates in a 40-foot bus, on the interior of each vehicle. Two (2) plates shall be installed in the front of the vehicle near the forward most seats on both sides of vehicle, so that the plates are accessible to a person sitting in those seats. The third plate on the 40-foot bus shall be installed in the rear door area. The number on the Braille Plates shall display (numerals and braille numerals) the same as the number of the bus designated by the Authority.

The Braille Bus Number Plates shall be embossed stainless steel, permanently mounted, and vandal resistant.

The Authority reserves the right of final configuration approval.

Reference figure 8 below for dimensions:

FIGURE 8



30.16. Exterior Lighting

All exterior lights shall be designed to prevent entry and accumulation of moisture or dust. Lamps, lenses, and fixtures shall be interchangeable to the extent practicable. Light lenses shall be designed and located to prevent damage when running the vehicle through an automatic bus washer.

Commercially available LED-type lamps shall be used at all exterior lamp locations.

LED lamps shall be potted type with the exception of the head lamps and designed to last the life of the bus or approved equivalent.

Size of LED lamps used for tail, brake and turn signal lamps should be 7-inch LED and standard installation of OEM. The Authority prefers larger signals on rear of bus.

Front marker (clearance) lights along with lights located on the roof and sides of the bus shall have protective shields or be of the flush mount type to protect the lens against minor impacts or approved equivalent.

30.16.1. Backup Lights/Alarm

Visible and audible warnings shall inform following vehicles or pedestrians of reverse operation. Visible reverse operation warning shall conform to SAE J593. Audible reverse operation warning shall conform to SAE J994 Type C or D.

30.16.2. Doorway Lighting

Lamps at the front and rear passenger doorways (if applicable to the design of the bus) shall comply with ADA requirements and shall activate only when the doors open. These lamps shall illuminate the street surface to a level of no less than 1-foot candle (fc) for a distance of 3 feet outward from the outboard edge of the door threshold. The lights may be positioned above or below the lower daylight opening of the windows and shall be shielded to protect passengers' eyes from glare.

30.16.2.1. Porch Lamp

The Authority is requesting the installation of a lamp above each passenger door of the vehicle. The lamps are referred to as "porch lamps".

30.16.3. Turn Signals

Turn-signal lights shall be provided on the front, rear, curb, and street sides of the bus in accordance with federal regulations.

All turn signal lights shall be amber, including any associated with exterior rear-view mirrors.

Rear high mounted amber LED turn signals shall be installed. Design elements of style and installation location shall be the right of final configuration approval by the Authority.

30.16.4. Headlamps

Headlamps shall be LED (Light Emitting Diode) sealed beam and designed for ease of replacement.

Daytime Running Lights

Headlamps shall incorporate a daytime running light feature.

30.16.5. Brake Lamps

Brake lamps shall be provided in accordance with federal regulations.

High and Center Mount Red Brake Lamp

Bus shall include red, high and center mounted brake lamp(s) along the backside of the bus in addition to the lower brake lamps required under FMVSS. The high and center mounted brake lamp(s) shall illuminate steadily with brake application. The Authority reserves the right of final approval for rear lamp configuration.

30.16.6. Cornering Lamp

The Authority requires the installation of a lamp to be installed in front of and near the curb side rear duals on the body of the 40-foot vehicle. The purpose is to cast light so that the vehicle operator can see objects that may be in the path of the curb side rear wheels during low light conditions. The lamp shall be directed and cast enough light so that the area of the ground in front of the curb side rear dual can be seen by the operator as right-hand turns are negotiated.

The lamp should illuminate under the following conditions:

- Master run switch is in the “night run” position
- Right-hand turn signal is activated
- Vehicle speed is in the range of 1 to 15 mph, at 0 speed the lamp should be off.

30.17. Service Area Lighting (Interior and Exterior)

LED (Light Emitting Diode) lamps shall be provided in the rear most compartment or “engine bay” and all other compartments where service may be required to generally illuminate the area for night emergency repairs or adjustments. These service areas shall include, but not be limited to, the “engine bay” compartment, the communication box, junction/apparatus panels, fuel/de-fuel port compartments, and passenger door operator compartments. Lighting shall be adequate to light the space of the service areas to levels needed to complete typical emergency repairs and adjustments. The service area lamps shall be suitable for the environment in which they are mounted.

Rear compartment lamps shall be controlled by a switch mounted near the rear controls or in an approved location. All other service area lamps shall be controlled by switches mounted on or convenient to the lamp assemblies. Power to the service area lighting shall be programmable. Power shall latch on with activation of the switch and shall be automatically discontinued (timed out) after approximately 30 minutes to prevent damage caused by inadvertently leaving the service area lighting switch in the “on” position after repairs are made.

LED lamps for the rear mounted fueling ports shall be provided. The lamps shall be lit when the fuel access door is opened and remain on for a minimum of 5 minutes after the “master run switch” is switched to the “off” position. LED lamps shall remain on while the bus is being fueled.

INTERIOR PANELS AND FINISHES

31. Interior Panels and Finishes

31.1. General Requirements

Materials shall be selected on the basis of maintenance, durability, appearance, safety, noise reduction, flammability and tactile qualities. Materials shall be strong enough to resist everyday abuse and be vandalism and corrosion resistant. Trim and attachment details shall be kept simple and unobtrusive. Interior trim shall be secured to avoid resonant vibrations under normal operational conditions.

Interior surfaces more than 10 inches below the lower edge of the side windows or windshield shall be shaped so that objects placed on them fall to the floor when the coach is parked on a level surface. Any components and other electrical components within close proximity to these surfaces shall also be resistant to this cleaning method.

Internal surfaces, as possible, to be stainless steel or other resistant material. The Authority reserves the right of final approval.

The design and layout of the interior shall facilitate easy cleaning and disinfecting of the vehicle. The layout and installation of interior hardware, seats, panels, stanchions, and other supports shall avoid configurations that result in floor areas that cannot be easily and readily swept and mopped, nor result in spaces or cavities that allow accumulation of dirt and trash without falling to the open floor where they can be easily swept.

31.1.1. Fire Resistance

It is the Authority’s preference that all materials shall comply with the Recommended Fire Safety Practices defined in FTA Docket 90-A, dated Oct. 20,1993. At a minimum, all materials shall comply with the requirements of FMVSS 302.

31.2. Interior Panels

Panels shall be easily replaceable and tamper resistant. They shall be reinforced, as necessary, to resist vandalism and other rigors of transit bus service. Individual trim panels and parts shall be interchangeable to the extent practicable. Panels may be fabricated from textured stainless steel, composite, scratch resistant plastic, melamine-type material, or approved equivalent. The Authority to approve materials/ fasteners used, patterns, designs, and installation locations for stainless steel.

31.3. Operator Area Barrier

A barrier or bulkhead between the driver and the street-side front passenger seat shall be provided. The barrier shall minimize glare and reflections in the windshield directly in front of the barrier from interior lighting during night operation. Location and shape must permit full seat travel and reclining possibilities that can accommodate the shoulders of a 95th-percentile male. The partition shall have a side return and stanchion to prevent passengers from reaching the driver by standing behind the driver’s seat. The lower area between the seat and panel must be accessible to the driver. The partition must be strong enough in conjunction with the entire partition assembly for mounting of such equipment as flare kits, fire extinguishers, microcomputer, public address amplifier, etc. The panel should be properly attached to eliminate noise and rattles.

The driver’s barrier should be full-Height (floor-to-ceiling) configuration of Operator’s Barrier, extending continuously from the floor area to the ceiling and from the bus wall to the first stanchion immediately behind the driver to provide security to the driver and to limit passenger conversation.

NOTE: The Manufacturer shall take into account when designing and installing the driver barrier that the Farebox OCU (Operator Control Unit) will be mounted on the farebox and both must be considered with respect to potential interference.

31.4. Operator Area Enclosure/Door

The Vehicle Manufacturer shall install a heavy-duty operator enclosure or door. The door shall have the following salient features:

- The barrier shall be designed for heavy duty transit service use
- Glazing material shall comply with ANSI/SAE Z26.1-1996, FMVSS 571.205, and SAE J673
- Pyrolytic anti-glare coating
- Comply with ADA requirements and AS-2 regulations
- Rattle-free
- Largest sliding upper glass available with rocker latch
- Does not impede foot traffic
- Does not interfere with access to the farebox by passenger or operator
- Glazing shall permit unobstructed view of the curb-side mirrors and to the bottom of the entrance door

The Authority reserves the right to review and approve the door installation design, door, and door configuration.

31.5. Modesty Panels

Sturdy divider panels constructed of durable, unpainted, corrosion-resistant material complementing the interior shall be provided to act as both a physical and visual barrier for seated passengers.

Design and installation of modesty panels located in front of forward-facing seats shall include a handhold or grab handle along their top edge. These dividers shall be mounted on the sidewall and shall project toward the aisle no farther than passenger knee projection in longitudinal seats or the aisle side of the transverse seats. Modesty panels shall extend from at least the window opening of the side windows, and those forward of transverse seats shall extend downward to approximately 8.5 inches above the floor. Panels forward of longitudinal seats shall extend to below the level of the seat cushion. Dividers positioned at the doorways, where applicable, shall provide no less than a 2½ inches clearance between the modesty panel and a fully open, inward opening door, or the path of a deploying flip-out ramp to protect passengers from being pinched. Modesty panels installed at doorways shall be equipped with grab rails if passenger assists are not provided by other means. Panels shall not interfere with access to emergency door exit systems. Panels shall accommodate the Authority's On-board Validator System.

The modesty panel and its mounting shall withstand a static force of 250 pounds applied to a 4-inch × 4-inch area in the center of the panel without permanent visible deformation.

Modesty panels shall be installed as described.

Clear non-glass panel from above the modesty panel to the top of the daylight opening and attached to the stanchion on all modesty panels near the rear door(s) of the bus.

31.6. Front End

The entire front end of the bus shall be sealed to prevent debris accumulation behind the dash and to prevent the driver's feet from kicking or fouling wiring and other equipment. The front end shall be free of protrusions that are hazardous to passengers standing at the front of the standee line area of the bus during rapid decelerations. Paneling across the front of the bus and any trim around the driver's compartment shall be formed metal or composite material. Composite dash panels shall be reinforced as necessary, vandal-resistant and replaceable. All colored, painted and plated parts forward of the driver's barrier shall be finished with a surface that reduces glare. Any mounted equipment must have provision to support the weight of equipment.

31.7. Rear Bulkhead

The rear bulkhead and rear interior surfaces shall be material suitable for exterior skin; painted and finished to exterior quality; or paneled with melamine-type material, composite, scratch-resistant plastic, and trimmed with stainless steel, aluminum or composite.

The rear bulkhead paneling shall be contoured to fit the ceiling, sidewalls, and seat backs so that any litter or trash will tend to fall to the floor or seating surface when the bus is on a level surface. Any air vents in this area shall be louvered to reduce airflow noise and to reduce the probability of trash or litter being thrown or drawn through the grille. If it is necessary to remove the panel to service components located on the rear bulkhead, then the panel shall be hinged or shall be able to be easily removed and replaced. Grilles where access to or adjustment of equipment is required shall be heavy duty and designed to minimize damage and limit unauthorized access.

31.8. Headlining

Ceiling panels shall be made of durable, corrosion resistant, easily cleanable material. Headlining shall be supported to prevent buckling, drumming, or flexing and shall be secured without loose edges. Headlining materials shall be treated or insulated to prevent marks due to condensation where panels are in contact with metal members. Moldings and trim strips, as required to make the edges tamperproof, shall be stainless steel, aluminum or plastic, colored to complement the ceiling material. Headlining panels covering operational equipment that is mounted above the ceiling shall be on hinges for ease of service but retained to prevent inadvertent opening.

31.9. Panel Fastening

Interior panels shall be attached so that there are no exposed unfinished, rough edges or rough surfaces. Fasteners should be corrosion resistant. Panels and fasteners shall not be easily removable by passengers. Exposed interior fasteners should be minimized and shall be tamper resistant.

31.10. Insulation

Any insulation material used between the inner and outer panels shall minimize the entry and/or retention of moisture. Insulation properties shall be unimpaired during the service life of the bus. Any insulation material used inside the engine compartment shall not absorb or retain oils or water and shall be designed to prevent casual damage that may occur during maintenance operations.

The combination of inner and outer panels on the sides, roof, wheel wells and ends of the bus, and any material used between these panels, shall provide a thermal insulation sufficient to meet the interior temperature requirements. The bus body shall be thoroughly sealed so that the driver or passengers cannot feel drafts during normal operations with the passenger doors closed.

31.10.1. Insulation FTA Docket 90-A

It is the Authority’s preference that all insulation materials shall comply with the Recommended Fire Safety Practices defined in FTA Docket 90-A, dated Oct. 20, 1993. At a minimum, all insulation materials shall comply with the requirements of FMVVSS 302.

Manufacturers shall endeavor to comply with the FTA Docket 90-A requirement or offer an approved equivalent.

31.11. Floor Covering

The floor covering shall have a nonskid walking surface that remains effective in all weather conditions. The floor covering, as well as transitions of flooring material to the main floor and to the entrance and exit area, shall be smooth and present no tripping hazards. Seams shall be sealed/welded per manufacturer’s specifications. The color and pattern shall be consistent throughout the floor covering.

The floor covering shall have the following salient features or Authority approved equivalent:

- Reduced weight to contribute to increased range on battery electric vehicles
- No reduction in aggregate content ensuring sustained slip resistance and safety performance
- A minimum thickness of 2.2 millimeters, heavy duty bus floor covering. May be comprised of flooring material with a felt backing
- High tensile strength
- High elongation strength
- Installation flexibility
- Flooring welds with high integrity
- Highly scratch resistant
- Long lasting visual appearance
- Naturally hygienic

31.11.1. Standee Line

The standee line shall be approximately 2 inches wide and shall extend across the bus aisle and contrast with the rest of the floor covering. The location of the standee shall be subject to approval by the Authority and agreed upon during pre-production. The floor covering color shall be subject to approval by the Authority and agreed upon during pre-production.

Any areas on the floor that are not intended for standees, such as areas “swept” during passenger door operation, shall be clearly and permanently marked.

31.11.2. Floor Covering Installation

The floor shall be easily cleaned and shall be arranged to minimize debris accumulation.

The manufacturer shall install the floor covering so that the following is met:

- Ease of installation
- Ease of maintenance
- Ease of cleaning
- In accordance with the floor covering manufacturers installation requirements and recommendations
- If necessary, a coving shall be installed at the transition line that is formed where the sub-floor meets the wall. The coving shall offer structure for the floor covering to rest upon so that floor “tearing” is prevented in that area

31.12. Access Doors to Interior Service Compartments

Access for maintenance and replacement of equipment shall be provided by panels and doors that appear to be an integral part of the interior. Access doors shall be hinged with gas props or over center springs, where practical, to hold the doors out of the maintenance personnel’s way. Panels shall prevent entry of mechanism lubricant into the bus interior. All fasteners that retain access panels shall be captive in the cover.

31.12.1. Access Doors That Do Not Require Tools or Keys to Open

Access doors that allow access to service areas shall be secured with quarter turn latches that can be turned by hand or 5/16-inch square key. If fasteners are used on non-service area access doors the access panels shall have the fasteners be captive in the cover and the opposite component of the fastener captive on the body.

31.12.2. Access Doors with Locks (ITS/Electronics Cabinet)

The ITS/ Electrical cabinet access door shall be secured with a keyed lock. The locks shall be standardized so that only one tool/key is required to open access doors on the bus. The locks shall be standardized to the Southco M3-10 #64-22-11 768854 with Southco key #H257.

31.12.3. Floor Access Panels

Access openings in the floor shall be sealed to prevent entry of fumes and water into the bus interior. Flooring material at or around access openings shall be flush with the floor and shall be edge-bound with stainless steel or another material that is acceptable to the Authority to prevent the edges from coming loose. Access openings shall be asymmetrical so that reinstalled flooring shall be properly aligned. Fasteners shall tighten flush with the floor.

The number of special fastener tools required for panel and access door fasteners shall be minimized. Preference: Maximization to the accessibility of the vehicle maintenance areas for technicians the tools required shall be standardized to be same as those on the Authority's existing vehicles e.g. 5/16-inch square key or approved equivalent.

31.13. Fare Collection Installation

Space and structural provisions shall be made for installation of currently available fare collection devices, which shall be as far forward as practicable. Location of the fare collection device shall not restrict traffic in the vestibule, including wheelchairs, and shall allow the driver to easily reach the farebox controls and to view the fare register. The farebox shall not restrict access to the driver's area, shall not restrict operation of driver controls, and shall not—either by itself or in combination with stanchions, or route destination signs—restrict the driver's field of view per SAE J1050. The location and mounting of the fare collection device shall allow use, without restriction, by passengers. The farebox location shall permit accessibility to the vault for easy manual removal or attachment of suction devices. The Farebox shall be mounted to the floor meaning the base floor where passengers tread not the operator step or the operator pedestal. The floor under the farebox shall be reinforced as necessary to provide a sturdy mounting platform and to prevent shaking of the farebox.

The vehicle manufacturer shall provide fare collection installation layout to the Authority for approval.

Farebox shall be installed per requirements as described in Automated Fare Collection section 39.17.

PASSENGER ACCOMMODATIONS

32. Interior Lighting

All interior lighting shall be LED (Light Emitting Diode) or approved equivalent. The light source shall be located to minimize windshield glare, with distribution of the light focused primarily on the passengers' reading plane while casting sufficient light onto the advertising display. The lighting system may be designed to form part of or the entire air distribution duct.

The lens material shall be translucent polycarbonate. Lenses shall be designed to effectively "mask" the light source. Lenses shall be sealed to inhibit incursion of dust and insects yet be easily removable for service. Access panels shall be provided to allow servicing of components located behind light panels. If necessary, the entire light fixture shall be hinged.

32.1. Passenger Area Lighting

32.1.1. First Row Lights

The first light on each side (behind the driver and the front door) shall be "on", meaning illuminated, when the master switch is in the "ON/Day Run", "ON/Night Run", or "ON/Night Park". As soon as the door closes, these lights shall go out. These lights shall be turned on at any time if the switch is in the "on" position.

32.1.2. Second Row Lights (Dimming)

To help reduce windshield reflection on suburban roads where street lighting is at a low level, the second light on each side, when "night run" or "night park" is selected, shall be controlled by the switch for interior lights; lights off in "off" and lights on in "on/normal." These lights shall be turned on at any time if the switch is in the "ON/Day Run" position.

NOTE- All interior lighting shall be turned off whenever the vehicle is in reverse.

32.1.3. First Light Modules Dim/Extinguish When Front Door Is Closed

When the master switch is in the "run" or "night/run" mode, the first light module on each side of the coach shall automatically extinguish or dim when the front door is in the closed position and illuminate when the door is opened.

NOTE- The interior lighting design shall require the approval of the Authority.

32.2. Operator’s Area Lighting

The driver’s area shall have a light to provide general illumination, and it shall illuminate the half of the steering wheel nearest the driver to a level of 5 to 10 fc (foot candles).

32.3. Seating Area Lighting

The interior lighting system shall provide a minimum 15 fc (foot candles) illumination on a 1 square foot plane at an angle of 45 degrees from horizontal, centered 33 inches above the floor and 24 inches in front of the seat back at each seat position. Allowable average light level for the rear bench seats shall be 7 fc (foot candles).

32.4. Vestibules/Doors Lighting

Floor surface in the aisles shall be a minimum of 10 fc, and the vestibule area a minimum of 4 fc with the front doors open and a minimum of 2 fc with the front doors closed. The front entrance area and curb lights shall illuminate when the front door is open and the master run switch is in the “lights” or “night run” position. Rear exit area and curb lights shall illuminate when the rear door is opened.

32.5. Step Lighting

Manufacturers shall endeavor to install step lighting for the intermediate steps between lower and upper floor levels or approved equivalent. The step lighting shall be a minimum of 4 fc and shall illuminate in all vehicle run positions. The step lighting shall be low profile to minimize tripping and snagging hazards for passengers and shall be shielded as necessary to protect passengers’ eyes from glare.

32.6. Ramp Lighting

Exterior and interior ramp lighting shall comply with all ADA and federal regulations.

32.7. Farebox/Card Reader Lighting

A light fixture shall be mounted in the ceiling above the farebox location. The fixture shall be capable of projecting a concentrated beam of light on the farebox. This light shall automatically turn on whenever the front doors are opened and the run switch is in the “night run” or “night park” position. The farebox/card reader lighting shall extinguish when the front doors are closed.

33. Passenger Seating

33.1. Arrangements and Seat Style

The passenger seating arrangement in the bus shall be such that seating capacity is maximized and in compliance to the following requirements.

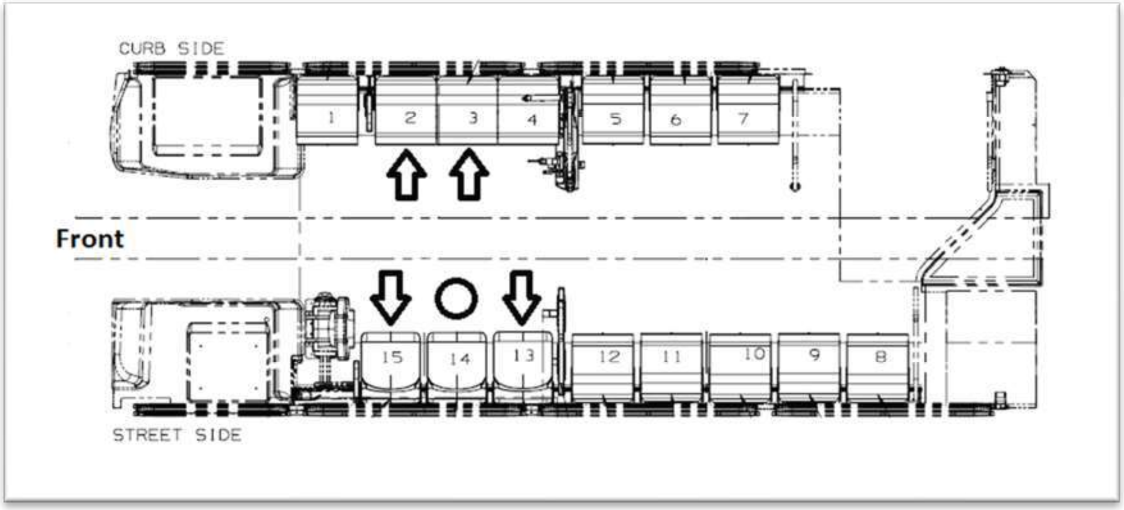
Perimeter Seating Arrangement

Passenger seats shall be arranged longitudinal within the vehicle, meaning the seats will face the centerline of the bus in the front section of the bus and rear of the bus as much as possible. Each seat shall have a minimum width of 17 inches, not including any armrest. Seating capacity with this arrangement shall be maximized to allow as many seated passengers as possible without compromising spatial requirements, not including the driver, with the specified seating arrangement.

Passenger seating is preferred to be Docket 90 compliant.

Passenger seating in the lower deck of the vehicle shall be individual flip up style seating that lock in the up and down positions with no arm rests and the flip up seating near the “Quantum” (Semi-automated ADA securement) shall be “theater style” seating which shall automatically return to the up position. A minimum of two seats directly next to the “Quantum” shall be “Theater style”.

Reference figure below for desired ADA buttons locations in the lower deck area. Where the arrows note the location of the ADA passenger stop request button “Square Pads” and the circle notes the location of the “Quantum” button.



33.2. Rearward Facing Seats

Proposers will be allowed rearward facing ADA designated securements. No other rearward facing seats shall be allowed. The Authority reserves the right of final approval.

33.3. Passenger Seating- Insert Material

Passenger seat backs and seat bottoms shall be of a plastic material. Vehicle manufacturer shall offer plastic seating insert designs with metal frames currently available and supported on the market so that the Authority can choose from a catalog.

33.4. Padded Inserts/Cushioned Seats

No requirement for padded nor cushioned seats per requirement in above section (33.3).

33.5. Drain Hole in Seats

There shall be no drain hole in seat inserts.

33.6. Hip-to-Knee Room

Hip-to-knee room measured from the center of the seating position, from the front of one seat back horizontally across the highest part of the seat to a vertical surface immediately in front, shall be a minimum of 26 inches at all seating positions in paired transverse seats immediately behind other seating positions, hip-to-knee room shall be no less than 27 inches.

33.7. Foot Room

Foot room, measured at the floor forward from a point vertically below the front of the seat cushion, shall be no less than 14 inches. Seats immediately behind the wheel housings and modesty panels may have foot room reduced (the Authority reserves the right of final approval).

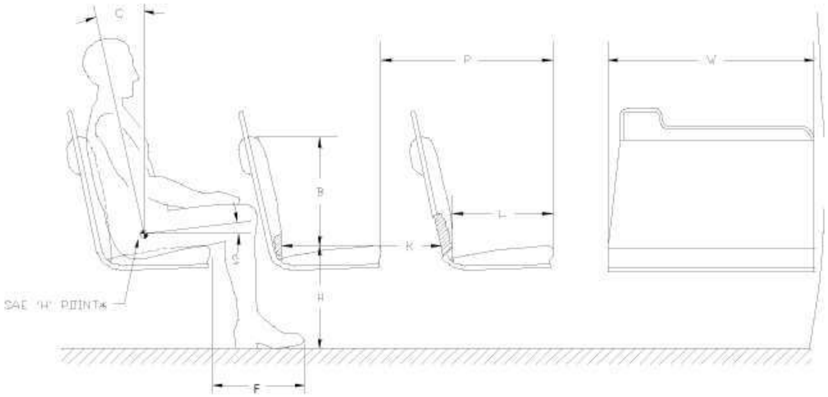
33.8. Aisles

The aisle between the seats shall be, at a minimum, 22 inches wide at seated passenger hip height. Seat backs shall be shaped to increase this dimension to no less than 24 inches at 32 inches above the floor (standing passenger hip height).

72.10. Dimensions

FIGURE 10

Seating Dimensions and Standard Configuration



Seat dimensions for the various seating arrangements shall have the dimensions as follows (refer to Figure 10):

- The width, W, of the two-passenger transverse seat shall be a minimum 35 inches.
- The length, L, shall be 17 inches, ±1 inch.
- The seat back height, B, shall be a minimum of 15 inches.
- The seat height, H, shall be 17 inches, ±1 inch for the rear lounge (or settee) and longitudinal seats, and seats located above raised areas for storage of underfloor components, a cushion height of up to 18 inches, ±2 inches, will be allowed. This shall also be allowed for limited transverse seats, but only with the express approval of the Authority.
- Foot room = F.
- The seat cushion slope, S, shall be between 5 and 11 degrees.
- The seat back slope, C, shall be between 8 and 17 degrees.
- Hip to knee room = K.
- The pitch, P, is shown as reference only.

33.9. Structure and Design

The passenger seat frame and its supporting structure shall be constructed and mounted so that space under the seat is maximized and is completely free of obstructions to facilitate cleaning.

Seats, structures, and restraints around the securement area should not infringe into the mobility device envelope or maneuverability.

The transverse seat structure shall be fully cantilevered from the sidewall with sufficient strength for the intended service. The lowest part of the seat assembly that is within 12 inches of the aisle shall be at least 10 inches above the floor.

In locations at which cantilevered installation is precluded by design and/or structure, other seat mounting may be allowed.

All transverse objects—including seat backs, modesty panels and longitudinal seats—in front of forward-facing seats shall not impart a compressive load in excess of 1000 lbs. onto the femur of passengers ranging in size from a 5th-percentile female to a 95th-percentile male during a 10g deceleration of the bus. This deceleration shall peak at 0.05 to 0.015 seconds from initiation. Permanent deformation of the seat resulting from two 95th-percentile males striking the seat back during this 10g deceleration shall not exceed 2 inches, measured at the aisle side of the seat frame at height H. The seat back should not deflect more than 14 inches, measured at the top of the seat back, in a controlled manner to minimize passenger injury. Structural failure of any part of the seat or sidewall shall not introduce a laceration hazard.

The seat assembly shall withstand static vertical forces of 500 lb. applied to the top of the seat cushion in each seating position with less than ¼ inch permanent deformation in the seat or its mountings. The seat assembly shall withstand static horizontal forces of 500 lb. evenly distributed along the top of the seat back with less than ¼ inch permanent deformation in the seat or its mountings. The seat backs at the aisle position and at the window position shall withstand repeated impacts of two 40 lb. sandbags without visible deterioration. One sandbag shall strike the front 40,000 times and the other sandbag shall strike the rear 40,000 times. Each sandbag shall be suspended on a 36-inch pendulum and shall strike the seat back 10,000 times each from distances of 6, 8, 10 and 12 inches. Seats at both seating positions shall withstand 4000 vertical drops of a 40 lb. sandbag without visible deterioration. The sandbag shall be dropped 1000 times each from heights of 6, 8, 10 and 12 inches. Seat bottoms (horizontal portion of the seat) shall withstand 100,000 randomly positioned 3½ inch drops of a squirming, 150 lb., smooth-surfaced, buttocks-shaped striker with only minimal wear on the seat covering and no failures to seat structure or cushion suspension components.

The back of each transverse seat may incorporate a handhold, if a handhold is available. If a handhold is offered then it shall have, no less than ⅞ inch in diameter for standees and seat access/egress. The handhold shall not be a safety hazard during severe decelerations. The handhold shall extend above the seat back near the aisle so that standees shall have a convenient vertical assist, no less than 4 inches long, that may be grasped with the full hand. This handhold shall not cause a standee using this assist to interfere with a seated 50th-percentile male passenger. The handhold shall also be usable by a 5th-percentile female, as well as by larger passengers, to assist with seat access/egress for either transverse seating position. The upper rear portion of the seat back and the seat back handhold immediately forward of transverse seats shall be padded and/or constructed of energy-absorbing materials. During a 10g deceleration of the bus, the HIC number (Head Injury Criterion as defined by SAE J211a) shall not exceed 400 for passengers ranging in size from a 5th percentile female through a 95th percentile male.

The seat back handhold may be deleted from seats that do not have another transverse seat directly behind and where a vertical assist is provided.

Longitudinal seats shall be the same general design as transverse seats but without seat back handholds. Longitudinal seats may be mounted on the wheelhouses. Armrests shall be included on the ends of each set of longitudinal seats except on the forward end of a seat set that is immediately to the rear of a transverse seat, the driver’s barrier, or a modesty panel, when these fixtures perform the function of restraining passengers from sliding forward off the seat. Armrests are not required on longitudinal seats located in the wheelchair parking area that fold up when the armrest on the adjacent fixed longitudinal seat is within 3.5 inches of the end of the seat cushion. Armrests shall be located from 7 to 9 inches above the seat cushion surface. The area between the armrest and the seat cushion shall be closed by a barrier or panel. The top and sides of the armrests shall have a minimum width of 1 inch and shall be free from sharp protrusions that form a safety hazard.

Seat back handhold and armrests shall withstand static horizontal and vertical forces of 250 pounds applied anywhere along their length with less than ¼ inch permanent deformation. Seat back handhold and armrests shall withstand 25,000 impacts in each direction of a horizontal force of 125 pounds with less than ¼ inch permanent deformation and without visible deterioration.

33.10. Passenger Seating USB Charge Port

No requirement.

33.11. Construction and Materials

Selected materials shall minimize damage from vandalism and shall reduce cleaning time. The seats shall be attached to the frame with tamper-resistant fasteners. Coloring shall be consistent throughout the seat material, with no visually exposed portion painted. Any exposed metal touching the sides or the floor of the bus shall be stainless steel. The seat back and seat bottom shall be contoured for lateral support, comfort and shall fit the framework to reduce exposed edges.

The minimum radius of any part of the seat back, handhold or modesty panel in the head or chest impact zone shall be a nominal ¼ inch. The seat back and seat back handhold (if offered) immediately forward of transverse seats shall be constructed of energy-absorbing materials to provide passenger protection and, in a severe crash, to allow the passenger to deform the seating materials in the impact areas. Complete seat assemblies shall be interchangeable to the greatest extent practicable.

34. Passenger Assists- Stanchions

Other than the stanchions mentioned specifically in this section, all vertical stanchions and all horizontal grab rails and those connecting to the walls and ceiling are to be either powder coated black or plain stainless steel. All powder coated stanchions and grab rails may be constructed of stainless steel or mild steel.

Passenger assists in the form of full grip, vertical stanchions or handholds shall be provided for the safety of standees and for ingress/egress. Passenger assists shall be convenient in location, shape and size for both the 5th-percentile female standee and the 95th-percentile male standee. Starting from the entrance door and moving anywhere in the bus and out the exit door, a vertical assist shall be provided either as the vertical portion of the seat back assist or as a separate item so that a 5th-percentile female passenger may easily move from one assist to another using one hand and then the other without losing support.

All handholds and stanchions at doorways, and around farebox, shall be powder-coated in high contrast yellow color. The forward-most vertical stanchions on either side of the aisle immediately behind the operator's area shall be powder-coated black to match the rest of vehicle.

34.1. Assists

Excluding those mounted on the seats and doors, the assists shall have a cross-sectional diameter between 1¼ and 1½ inches or shall provide an equivalent gripping surface with no corner radii less than ¼ inch. All passenger assists shall permit a full hand grip with no less than 1½ inches of knuckle clearance around the assist. Passenger assists shall be designed to minimize catching or snagging of clothes or personal items and shall be capable of passing the NHTSA Drawstring Test.

Any joints in the assist structure shall be underneath supporting brackets and securely clamped to prevent passengers from moving or twisting the assists. Seat handholds may be of the same construction and finish as the seat frame. Door-mounted passenger assists shall be of anodized aluminum, stainless steel, or powder-coated metal. Connecting tees and angles may be powder-coated metal castings. Assists shall withstand a force of 300 pounds applied over a 12-inch lineal dimension in any direction normal to the assist without permanent visible deformation. All passenger assist components, including brackets, clamps, screw heads and other fasteners used on the passenger assists, shall be designed to eliminate pinching, snagging and cutting hazards and shall be free from burrs or rough edges.

34.1.1. Front Doorway

Front doors, or the entry area, shall be fitted with ADA-compliant assists. Assists shall be as far outward as practicable but shall be located no farther inboard than 6 inches from the outside edge of the entrance step and shall be easily grasped by a 5th-percentile female boarding from street level. Door assists shall be functionally continuous with the horizontal front passenger assist, the vertical assist and the assists on the wheel housing or on the front modesty panel.

34.1.2. Vestibule

The aisle side of the driver’s barrier, the wheel housings, and when applicable the modesty panels shall be fitted with vertical passenger assists that are functionally continuous with the overhead assist and that extend to within 36 inches of the floor. These assists shall have sufficient clearance from the barrier to prevent inadvertent wedging of a passenger’s arm.

A horizontal passenger assist shall be located across the front of the bus and shall prevent passengers from sustaining injuries on the fare collection device or windshield in the event of a sudden deceleration. Without restricting the vestibule space, the assist shall provide support for a boarding passenger from the front door through the fare collection procedure. The assist shall be no less than 36 inches above the floor. The assists at the front of the bus shall be arranged to permit a 5th-percentile female passenger to easily reach from the door assist, to the front assist, to vertical assists on the driver’s barrier, wheel housings or front modesty panel.

34.1.3. Rear Doorway(s)

Vertical assists that are functionally continuous with the overhead assist shall be provided at the aisle side of the transverse seat immediately forward of the rear door and on the aisle side of the rear door modesty panel(s). Passenger assists shall be provided on modesty panels that are functionally continuous with the rear door assists. Rear doors, or the exit area, shall be fitted with assists having a cross-sectional diameter between 1¼ and 1½ inches or providing an equivalent gripping surface with no corner radii less than ¼ inch, and shall provide at least 1½ inches of knuckle clearance between the assists and their mounting. The assists shall be designed to permit a 5th-percentile female to easily move from one assist to another during the entire exiting process. The assists shall be located no farther inboard than 6 inches from the outside edge of the rear doorway step.

For an articulated bus, passenger assists will be provided to aid in the transition between the front and rear sections of the bus.

34.1.4. Overhead

Except forward of the standee line and at the rear door, a continuous, full-grip, overhead assist shall be provided. The assist shall be no less than 70 inches above the floor.

Grab straps or other extensions as necessary shall be provided for sections where vertical assists are not available and for use by passengers who cannot reach to 70 inches A minimum of 22 straps for a 40-foot bus shall be installed in the lower deck of the bus (11 straps on each side, curb and street side). The Authority reserves the right of final approval.

Grab straps should be plastic. The Authority reserves the right of final approval.

Overhead assists shall simultaneously support 150 pounds on any 12 inches length. No more than 5 percent of the full grip feature shall be lost due to assist supports.

34.1.5. Longitudinal Seat Assists

Longitudinal seats shall have vertical assists located between every other designated seating position, except for seats that fold/flip up to accommodate wheelchair securement. Assists shall extend from near the leading edge of the seat and shall be functionally continuous with the overhead assist. Assists shall be staggered across the aisle from each other where practicable and shall be no more than 52 inches apart or functionally continuous for a 5th percentile female passenger.

34.1.6. Wheel Housing Barriers/Assists

Unless passenger seating is provided on top of wheel housings, passenger assists shall be mounted around the exposed sides of the wheel housings (and propulsion compartments if applicable), which shall also be designed to prevent passengers from sitting on wheel housings. Such passenger assists shall also effectively retain items, such as bags and luggage, placed on top of wheel housings.

35. Passenger Doors

Doorways will be provided in locations and styles as follows. Passenger doors and doorways shall comply with ADA requirements. Passenger Doors should be ~~electrically~~ pneumatically driven. The vehicle manufacturer shall offer the widest doors on the market for the given door type.

35.1. Front door

Door shall be forward of the front wheels and under direct observation of the driver. The front door should be a slide-glide type. The front door shall have a wheelchair roll off guard if the door in the open position is wider than the ramp.

35.2. Rear Door(s)

35.2.1. 40-foot transit bus

Door shall be installed curbside centerline located rearward of the point midway between the front door centerline and the rearmost seat back. The rear door shall be a slide glide-type.

35.3. Door Materials and Construction

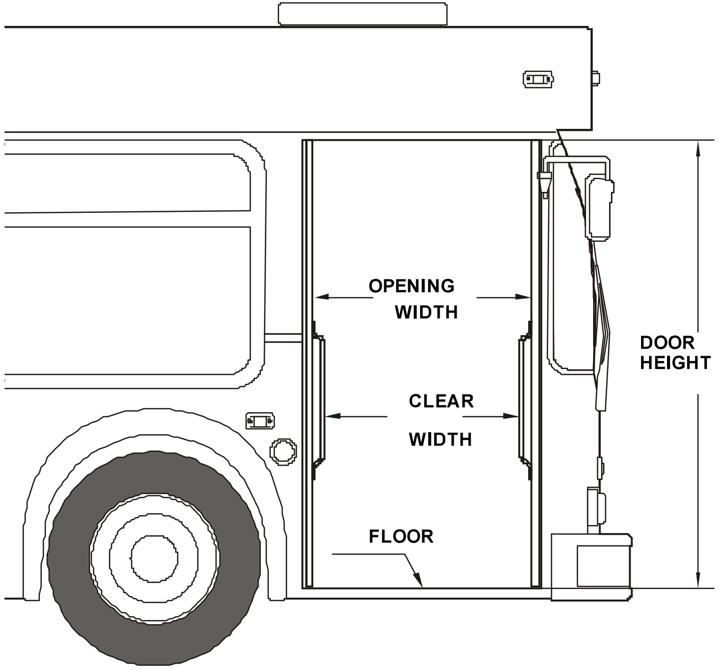
Structure of the doors, their attachments, inside and outside trim panels and any mechanism exposed to the elements shall be corrosion resistant. Door panel construction shall be of corrosion-resistant metal or reinforced non-metallic composite materials. When fully opened, the doors shall provide a firm support and shall not be damaged if used as an assist by passengers during ingress or egress. Door edges shall be sealed to prevent infiltration of exterior moisture, noise, dirt, and air elements from entering the passenger compartment, to the maximum extent possible based on door types.

The closing edge of each door panel shall have approximately 2 inches of soft weather stripping. The doors, when closed, shall be effectively sealed, and the hard surfaces of the doors shall be at least 4 inches apart (not applicable to single doors). The combined weather seal and window glazing elements of the front door shall not exceed 10 degrees of binocular obstruction of the driver's view through the closed door.

35.4. Door Dimensions

FIGURE 11

Transit Bus Minimum Door Opening



When open, the doors shall leave an opening no less than 75 inches in height. Front door clear width shall be a minimum of 32 inches with the doors fully opened. Rear door opening clear width shall be a minimum of 40 inches with the doors fully opened.

35.5. Door Glazing

The upper section of both front and rear doors shall be glazed for no less than 45 percent of the respective door opening area of each section. The lower section of the front door shall be glazed for no less than 25 percent of the door opening area of the section.

Door glazing shall be easily replaceable.

Full exterior glass quick change glazing hidden frame (tempered glass only).

The front door panel glazing material shall have a nominal ¼ inch thick tempered glass conforming with the requirements of ANSI Z26.1 Test Grouping 2 and the recommended practices defined in SAE J673.

Glazing material in the rear doorway door panels shall be the same as material, thickness, and color as the side windows defined in section 28.4.3 Side Windows or approved equivalent.

35.6. Door Projection

35.6.1. Exterior

The exterior projection of the front doors beyond the side of the bus shall be minimized and blocking of the line of sight of the rear exit door via the curbside mirror when the doors are fully open shall be minimized to the greatest extent practicable. The exterior projection of both doors shall be minimized as much as possible given the “slide glide” door styles during the opening or closing cycles or when doors are fully opened.

35.6.2. Interior

Projection of the doors inside the bus shall be minimized and risk of causing an obstruction of the rear door mirror or cause a hazard for standees shall be reduced to the greatest extent possible.

35.7. Door Height Above Pavement

It shall be possible to open and close either passenger door when the bus, loaded to gross vehicle weight rating, is not knelt and parked with the tires touching a 9 inches high curb on a street sloping toward the curb so that the street-side wheels are 5 inches higher than the right-side wheels.

35.8. Door Closing Force

Closing door edge speed shall not exceed 12 inches per second and opening door speed shall not exceed 19 inches per second. Power doors shall not slam closed under any circumstance, even if the door is obstructed during the closing cycle. If a door is obstructed during the closing cycle, the pressure exerted on the obstruction shall not increase once initial contact has been made.

Doors closed by a return spring or counterweight-type device shall be equipped with an obstruction-sensing device that, at a minimum, alerts the driver if an obstruction is detected between the closing doors. Doors closed by a return spring or counterweight type device, when unlocked, shall be capable of being pushed to the point where the door starts to open with a force not to exceed 25 pounds applied to the center edge of the forward door panel.

Whether or not the obstruction-sensing system is present or functional, it shall be possible to withdraw a 1½ inch diameter cylinder from between the center edges of a closed and locked door with an outward force not greater than 35 pounds.

35.8.1. Rear Door Closing Force

Power-close rear doors shall be equipped with an obstruction-sensing system such that if an obstruction is within the path of the closing doors, the doors will stop and/or reverse direction prior to imparting a 10 pounds of force on 1 square inch of that obstruction. If a contactless obstruction sensing system is employed, then it shall be capable of discriminating between the normal doorway environment and passengers or other obstructions within the doorway, and of altering the zones of detection based upon the operating state of the door system.

35.9. Door Actuators

Doors shall open or close completely in not more than 3.5 seconds from the time of control actuation and shall be subject to the closing force requirements.

Door actuators shall be adjustable so that the door opening and closing speeds can be independently adjustable to satisfy the above requirements. Actuators and the complex door mechanism shall be concealed from passengers but shall be easily accessible for servicing. The door actuators should be rebuildable.

Door actuators and associated linkages shall maximize door holding forces in the fully open and fully closed positions to provide firm, non-rattling, non-fluttering door panels while minimizing the force exerted by the doors on an obstruction midway between the fully open and closed positions.

The front and rear door actuator shall be installed on the side console in the operator area. The capability of the actuator shall be under the complete control of the vehicle operator and shall open and close in response to the position of the driver’s door control.

Doors that employ a “swing” or pantograph geometry and/or are closed by a return spring or counterweight-type device shall be equipped with a positive mechanical holding device that automatically engages and prevents the actuation mechanism from being back-driven from the fully closed position. The holding device shall be overcome only when the driver’s door control is moved to an “Exit Door Enable” position and the vehicle is moving at a speed of less than 2 mph, or in the event of actuation of the emergency door release.

Locked doors shall require a force of more than 300 lb. to open manually. When the locked doors are manually forced to open, damage shall be limited to the bending of minor door linkage with no resulting damage to the doors, actuators, or complex mechanism.

35.10. Door Emergency Operation

In the event of an emergency, it shall be possible to manually open doors designated as emergency exits from inside the bus using a force of no more than 25 pounds via actuating an unlocking device. The unlocking device shall be clearly marked as an emergency-only device and should require two distinct actions to actuate. The respective door emergency unlocking device shall be accessible from the doorway area. The unlocking device shall be easily reset by the operator without special tools or opening the door mechanism enclosure. The unlocking device shall be easily accessible by maintenance technicians without the use of tools. Easily accessible by maintenance technicians shall be taken to mean that the door emergency actuating mechanism shall be protected by a hinged cover. Doors that are required to be classified as “emergency exits” shall meet the requirements of FMVSS 217.

35.11. Door Control

The door control shall be located in the operator’s area within the hand reach envelope described in SAE J287, “Driver Hand Control Reach.” The driver’s door control shall provide tactile feedback (detents) to indicate commanded door position and resist inadvertent door actuation. The preferred location is on the operator side console.

The front door shall remain in commanded state position even if power is removed or lost.

35.12. Door Controller

Five-Position Driver’s Door Controller

The control device shall be protected from moisture. Mounting and location of the door control device handle shall be designed so that it is within comfortable, easy arm’s reach of the seated driver. The door control device handle shall be free from interference by other equipment and have adequate clearance so as not to create a pinching hazard.

Position of the door control handle shall result in the following operation of the front and rear doors:

- Center position: Front door closed, rear door(s) closed or set to lock.
- First position forward: Front door open, rear door(s) closed or set to lock.
- Second position forward: Front door open, rear door(s) open or set to open.
- First position back: Front door closed, rear door(s) open or set to open.
- Second position back: Front door open, rear door(s) open or set to open.

35.13. Door Open/Close

35.13.1. Operator-Controlled Door Dump Valve and Safety System

A control or valve in the operator’s compartment shall shut off the power to, and/or dump the power from, the front door mechanism to permit manual operation of the front door with the bus shut down. A master door switch, which is not within reach of the seated operator, when set in the “off” position shall close the rear/center doors (if applicable), deactivate the door control system, release the interlocks and permit only manual operation of the rear/center doors.

Door systems shall employ a safety system to prevent accidental door closures on passengers. The preferred system is known as a “Class” system. The “Class” system shall be installed on ~~all doors~~ the rear door only. The rear door shall be equipped with air sensitive edge.

35.13.2. Door Announcements

Should the door systems include an announcement function then a switch shall be installed to turn of the announcements when desired. A switch to turn off the announcements should be installed at each door. Switch should be located near/next to the door opening/closing apparatus. Switch shall be a toggle on/off.

Authority reserves the right of final switch location(s).

36. Accessibility Provisions

Space and body structural provisions shall be provided at the front door of the bus to accommodate a wheelchair loading system.

36.1. Loading System

An automatically controlled, power-operated ramp system compliant to requirements defined in 49 CFR Part 38, Subpart B, §38.23c shall provide ingress and egress quickly, safely and comfortably, for a passenger in a wheelchair from a level street and up to 9-inch curb.

The wheelchair loading system shall be located at the front door, have stainless steel construction, be electrically driven, without hydraulics, have a 30 ~~32~~ inch-wide ramp being of a simple hinged, flip-out type design being capable of deploying to the ground at a maximum 6:1 slope. The interior floor shall automatically lowers to a 1:6 incline when the outer ramp reaches a pre-determined angle. The ramp shall have a load capacity of 1,000 pounds and require a manual operation force of less than 20 pounds of force. The ramp shall have tension control to prevent “free falling” of ramp platform in either direction. The ramp shall include an object detection functionality that should the ramp encounter an obstruction, the drive motor is disabled and ramp motion stops. The electronic enclosure shall be watertight, and regular maintenance and repair shall be possible without removing the ramp.

36.2. Wheelchair Accommodations

The bus shall be equipped with one forward-facing wheelchair securement location on the curbside of the bus, and the streetside shall be equipped with one securement location that can accommodate either forward-facing wheelchair securement or rear-facing wheelchair securement. The streetside position need only accommodate one wheelchair at a time. The securement locations shall be as close to the wheelchair loading system as practical, shall provide parking space and securement system compliant with ADA requirements for passengers in a wheelchair. The wheelchair area footprint shall be 30 inches wide and not less than 60 inches long. All passenger securement devices must be stowed off the floor and out of the way when not in use.

The forward-facing securement system shall require only 3 attachment points to secure the wheelchair.

The rear-facing securement system shall be semi-automatic and electrically driven, securing the wheelchair without retractors. The system shall meet or exceed all current regulations for rear-facing transit, European Directives and ADA/CSA requirements. The backrest shall have dimensions approximately 28 inches wide x 33 inches long and 55 inches tall. Reference section 39.1 for ADA passenger control button installation location.

Both forward and rear-facing systems shall offer optional use lap and shoulder belts.

36.3. Interior Circulation

Maneuvering room inside the bus shall be compliant with 49 CFR Part 38, Subpart B, §38.29 and accommodate easy travel for a passenger in a wheelchair from the loading device and from the designated securement area. It shall be designed so that no portion of the wheelchair protrudes into the aisle of the bus when parked in the designated parking space(s). When the positions are fully utilized, an aisle space of no less than 22 inches shall be maintained. As a guide, no width dimension should be less than 34 inches. Areas requiring 90-degree turns of wheelchairs should have a clearance arc dimension no less than 45 inches, and in the parking area where 180-degree turns are expected, space should be clear in a full 60 inches diameter circle. A vertical clearance of 12 inches above the floor surface should be provided on the outside of turning areas for wheelchair footrests.

SIGNAGE AND COMMUNICATION

37. Destination Signs

A destination sign system shall be furnished on the front, on the curb side near the entrance door (40-foot). The Authority reserves the right of approval for the final installation location. The glass directly in front of the destination signs, meaning the same size as the sign, shall be clear (no tinting), applies to signs installed on the interior.

A route sign shall be installed on the exterior rear of the vehicle or approved equivalent. An electronic route sign shall be installed on the interior front curbside corner of the dash.

37.1. Destination Signs

37.1.1. General Design (40-foot)

The destination/ route signs shall have the following salient features or approved equivalent:

- Available in amber to best support multiple modes and provide optimal visibility
- 150 degree viewing angle
- Multiple discrete inputs are supported to trigger emergency alerts or automatically update messages based on current status of the vehicle
- Available for the front, side, rear or dash with optional integrated rear camera
- Automatic brightness adjustment, superior readability in daytime and nighttime conditions
- Slim design for ease of installation
- Allow message listing upload via USB, wireless or on board AVL system and diagnostic capabilities
- Backward compatible
- Compatible with RS232, J1708, RS485, and Ethernet
- Internally protected against voltage transients and RFI interference to ensure proper operation in the bus environment
- In the off position all signs shall be blank
- The displays shall consist of LEDs rated by their manufacturer for a 100,000-hour life expectancy.

All signs should be controlled via a single human-machine interface (HMI). In the absence of a single mobile data terminal (MDT), the HMI shall be conveniently located for the bus driver within reach of the seated driver.

37.1.2. Front Destination Sign

The front destination sign matrix display shall have amber colored LEDs with a message display area of 16 X 160 dots.

37.1.3. Side Destination Sign (40-foot)

The side destination sign shall have amber colored LEDs with a message area of 14 X 112. The display must be easily read from the sidewalk level. The sign shall be located as near as possible midway between the front door and the rear/mid door shall not block the driver’s critical horizontal line of sight. Display areas of destination signs shall be clearly visible in direct sunlight and/or at night. Parts shall be commercially available.

37.1.4. Rear Destination Sign

The rear run number display shall have amber colored LEDs with a message area of 16 X 48 dots. Sign shall be exterior mounted and encased in a weatherproof housing.

37.1.5. Dash “Run Number” Sign

The dash run number display shall be a four (4) character amber colored LED sign with a message area of 12 X 40 dots and shall be installed on the dash such that glare on the windshield is eliminated.

37.2. Destination sign compartments

The destination sign compartments shall meet the following minimum requirements:

- Front destination sign compartment shall have a USB-C power output next to the destination sign.
- Compartments shall be designed to prevent condensation and entry of moisture and dirt.
- Compartments shall be designed to prevent fogging of both compartment window and glazing on the unit itself.
- Access shall be provided to allow for service and cleaning of inside compartment window and unit glazing.
- The front window shall have an exterior display area of no less than 8.5 inches high by 56 inches wide.
- Compartments shall be easily accessible for maintenance including removal and installation of destination signs without further removal of components or disassembly.

No active defogging required.

38. Passenger Information and Advertising

38.1. Static Interior Displays

38.1.1. Interior Advertising

Advertising media 11 inches high and 0.09 inches thick shall be retained near the juncture of the bus ceiling and sidewall. The retainers may be concave and shall support the media without adhesives. The media shall be illuminated by the interior light system.

38.1.2. Brochure/ Map Rack

The vehicle shall be equipped with brochure/map holder. The holder shall be of heavy-duty ruggedized construction, painted metal, no sharp edges, easy to clean, not trap dirt, or allow for the accumulation of debris in the brochure pockets . The rack shall have a minimum of 8 pockets. Each pocket shall be designed to securely hold brochures that are 3.5 inches x 8.5 inches, while leaving a portion of the brochure visible.

38.2. Dynamic On-Board Digital Display

The vehicle shall be equipped with interior mounted, full-color, high-definition LCD onboard digital displays (ONDDs) capable of displaying various media and GTFS-RT data. The ONDDs will connect to the bus cellular router. Each bus shall come with all hardware, software, and licenses to fully configure, install, integrate and operate the ONDDs. License subscription shall be for at least one year.

Each 40-foot bus shall be equipped with two (2) displays.

The interior displays shall have the following features:

- Display size: 29inches
- Aspect Ratio: 32:9
- Resolution: 1080P
- Brightness: 400-600 units
- Power: 24vdc
- Ruggedized for transit applications
- IP54 Seal rating

Inputs required for displays:
- Door open (Cancels stop request)
- Standard stop request
- WC stop request
- Connected to cellular router

On Board Digital Display signs at a minimum shall be capable of displaying passenger “Stop Request” and “Next Stop”. The vendor shall use an Antaira LNX-500A-T internet switch or approved equivalent. The salient characteristics of Antaira LNX-500A-T are the following: Supports 5-port 10/100Tx RJ45 Fast Ethernet; supports auto MDI/MDI-X Function; 5-year warranty and redundant power input. Authority reserves the right of final configuration approval.

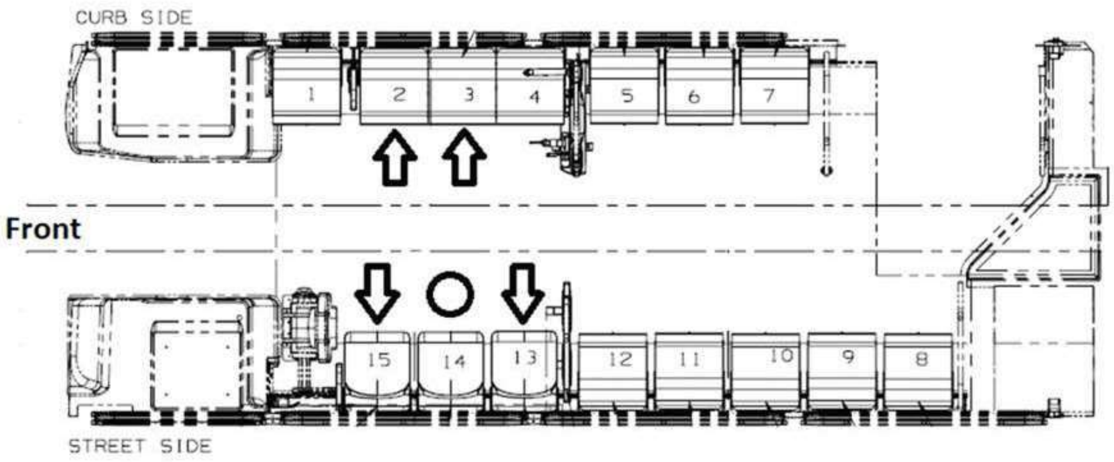
38.3. Exterior Displays

Exterior displays provision not required.

39. Passenger Stop Request/Exit Signal

39.1. Touch Button/ ADA Passenger Signal

ADA passenger “stop requested” signal system that complies with applicable ADA requirements defined in 49 CFR, Part 38.37, shall be provided. The system shall consist of square touch buttons, double chime and interior sign message. The touch buttons shall be accessible to all seated ADA passengers, with provisions for standees. It shall be easily accessible to all passengers, seated or standing. ADA passenger signal button(s) shall be provided on the bottom of flip up seats in the ADA area (wheelchair parking positions and in priority seating positions). Below is a drawing of the desired configuration:



Arrows indicate location of ADA Stop Request Buttons.

Circle indicates location of Semi-automatic wheelchair securement engagement button.

Final configuration shall be approved by the Authority.

39.2. Pull Cord Passenger Signal

A passenger “stop requested” signal system that complies with applicable ADA requirements defined in 49 CFR, Part 38.37, shall be provided. The system shall consist of a heavy-duty pull cable, chime and interior sign message. The pull cable shall be located the full length of the bus on the sidewalls at the level where the transom is located. If no transom window is required, then the height of the pull cable shall approximate this transom level and shall be no greater than 63 inches as measured from the floor surface. It shall be easily accessible to all passengers, seated or standing. Pull cable(s) shall activate one or more solid state or magnetic proximity switches. At each wheelchair passenger position and at priority seating positions, additional provisions shall be included to allow a passenger in a mobility aid to easily activate the “stop requested” signal. Exit signals located in the wheelchair passenger area shall be no higher than 4 foot above the floor. Instructions shall be provided to clearly indicate function and operation of these signals. The color of the pull cord cover or cable casing shall be clear. The Authority reserves the right of final configuration approval.

39.3. Auxiliary/Additional Stop Request Signals

Auxiliary stop request buttons shall be installed at each vertical stanchion throughout the interior of the vehicle. An auxiliary passenger “stop requested” signal shall be installed at the rear door to provide passengers standing in the rear door/exit area, a convenient means of activating the signal system. The signal shall be a heavy-duty push button type and shall be located so as not to conflict with the Authority’s plans for installing On Board Validators (typically on the vertical stanchion by mid/rear door). Authority shall reserve the right of final configuration.

39.4. Signal Chime

A single “stop requested” chime shall sound when the system is first activated. A double chime shall sound anytime the system is activated from wheelchair passenger areas. Separate signal lines shall be run from the two stop request systems to the radio box area to be connected to the CAD/AVL system and other systems as needed. Each stop request system shall illuminate a unique identifier on the dash to alert the operator which stop requests have been activated.

40. Communications/ Information

40.1. General, Information Level

Information Level components are those components whose primary function is the transmission of data to a system outside the vehicle; and/or the collection, control or display of data on the vehicle, none of which is necessary to the safe operation of the vehicle. The Authority shall receive a minimum of 2 (two) copies for each build of all the configurations for systems installed on the vehicle for the purpose of component replacement should a vehicle need to be rebuilt due to a catastrophic event. Copies of the following systems configurations shall be included but not limited to:

- Vehicle propulsion system(s)
- Vehicle Battery/ Charging Management system(s)
- Vehicle I/O system(s)
- Vehicle Door system(s)
- Vehicle Power Steering system(s)
- Camera Surveillance system(s)
- Auxiliary systems (Event Data Recorder, Data Logger, etc.)

40.2. IT Security Review and Requirements

For any system on the bus, or add-on system on the bus, that connects to the internet (i.e. cloud based), or connects to the CAN bus, there is risk of unauthorized access. To guard against unapproved access, the Authority requires a thorough review of security measures the bus manufacturer or their component supplier has undertaken to protect their network, and the bus network. For each system on the bus, the Vehicle Manufacturer shall submit a completed IT Security Form with the proposal. The Authority recognizes that not all risk can be mitigated however the expectation is the systems shall be as secure as possible and any unreasonable risk shall be required to be addressed.

40.3. Vehicle Area Network (VAN)

The VAN shall meet the requirements of SAE J1939 / J1708.

40.3.1. Network Cabling

The cabling for the Intelligent Transportation System (ITS) shall be supplied and installed by the vehicle manufacturer. The Authority is in-process of choosing an Intelligent Transportation System. Once chosen the vehicle manufacturer shall supply and install all cabling necessary for the chosen system.

The required ITS cabling and their associated costs may vary slightly between manufacturers due to the individual configuration of the proposer’s vehicle. The Vehicle Manufacturer should contact the Authority’s chosen ITS supplier for a list of cables and harnesses suited to the manufacturer’s vehicle.

All other cabling installed in the vehicle shall meet the requirements of SAE J2496.

40.4. Intelligent Transportation System (ITS) Integration with Other Networks

An interface shall be supplied to allow communication between the Information Level Network of the vehicle and the ITS. The goal being to supply the ITS with the required information.

The ITS, Intelligent Transportation System, typically requires SAE J1939/J1708 to communicate.

40.5. Intelligent Transportation System, ITS

The vehicles being purchased in this solicitation need to be equipped with an Intelligent Transportation Systems (ITS) that is used is Vontas. The vehicle manufacturer shall reach out to the Authority's chosen ITS vendor for ITS components with the exception of the radio RF deck unit. The radio RF deck unit will be supplied by the Authority and installed by the Authority post- delivery. The Authority intends to install a Harris XL 185 Radio. The vehicle shall be equipped with mounting brackets for the radio control head and remote mount unit. The Authority reserves the right to approve the final location of the radio components.

The Authority is requiring the removal of the commonly provided ITS interior sign and the signal that would have been sent to the commonly provided ITS interior sign shall now be directed to and integrated with the "Dynamic On-Board Digital Display", reference section 38.2.

The Vehicle Manufacturer shall supply and install the Authority's chosen Intelligent Transportation System, once determined by the Authority. Below is a list of components in a typical ITS and their typical locations:

TYPICAL ELECTRONIC AND ITS COMPONENT LIST

ITS Equipment	**Typical Mounting Location**
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□R□□□□R D□M	Dr□□□r□ □□□ □ar□□ □n□□ □□r□ dr□□□r □an □a□□y a□□□□□
□□□D□□□□□□□□□□R	Dr□□□r□ □□□ □ar□□ □n□□ □□r□ dr□□□r □an □a□□y a□□□□□
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D□□□□□□□□□□ □□□□□□□	□r□n□a□□□□ dr□□□r, □□d□, r□ar, and da□□□
R□D□□ □□□□□M□□□ □R□Y□□□□□□□□D□□□□	□□u□□□ □n□□n□□□□ur□ □□□□nd dr□□□r
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□□r□ □na□□r□□□ □□r □□□□rna□□□nn□□□□□n□	□y□□□a□y □ar□□□□□□ Rad□□ □□u□□□ □n□□ray
□□□a□□a□□□□ □□r □□□□rna□□□nn□□□□□n□	□y□□□a□y □ar□□□□□□ Rad□□ □□u□□□ □n□□ray
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[illegible]	[illegible]
[illegible]	

ITS Cabling	Typical From/To Routing
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[illegible]	[illegible]

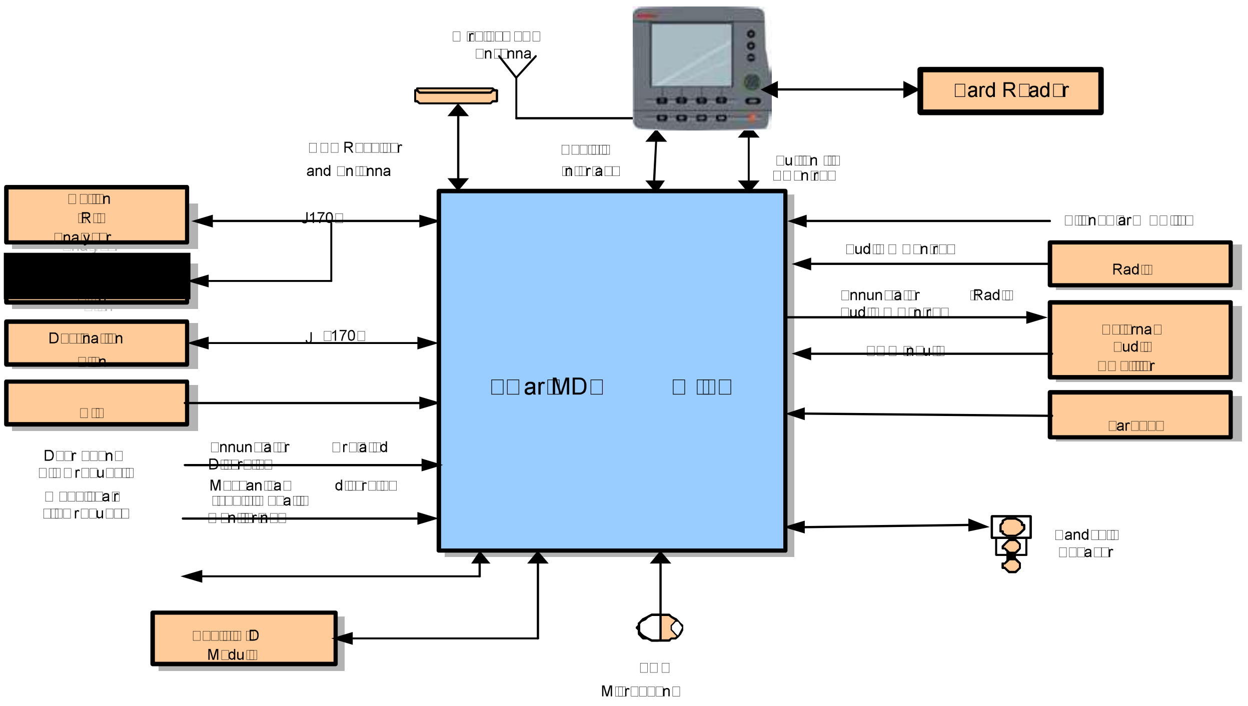
The vehicle manufacturer will need to work with the selected ITS supplier, once determined, to ensure the correct installation of the ITS components and integration with all applicable onboard components (refer to section 40.5.1. *Block Diagram*).

The Intelligent Transportation Systems (ITS) manufacturer/supplier shall conduct first article inspections and qualifications testing at the bus manufacturer's facility on the Authority's specific bus build.

The vehicle manufacturer shall validate and certify that all ITS components and installation kits are installed correctly on each vehicle in accordance with the ITS manufacturer/supplier's instructions.

The integration and testing of the ITS shall be the responsibility of the vehicle manufacturer.

40.5.1. Block Diagram (typical layout)



Information Level Components

40.6. Mobile Data Terminal (MDT)

The MDT is a multifunctional data collection device onboard transit vehicles that serves as the communication hub integrating many onboard components and performing two-way data communication.

The installation of the MDT will be determined by the Authority and provisions for the bracketry to hold the components and power/ground requirements shall be installed by the vehicle manufacturer. Final installation location is subject for review and acceptance by the Authority.

The Vehicle Manufacturer shall install the MDT/ DDU in a location to be approved by the Authority. Reference section 40.5.1 *Block Diagram*.

40.7. Automatic Vehicle Location (AVL)

The AVL, Automatic Vehicle Location system, component is yet to be determined. At a minimum, the Vehicle Manufacturer shall provide provisions for the AVL system. The provisions shall be, at a minimum, access to power (12+ volt- switched and unswitched), chassis ground, and antenna space all via conduit.

40.8. Automatic Passenger Counter (APC)

The APC, Automatic Passenger Counter system, a system for counting passengers entering and exiting by means of sensors mounted at each door and their numbers are summed up for each stop or station. The APC sensors and APC Gateway shall be IRMA Matrix 5, supplied and installed by the vehicle manufacturer. The APC system shall start counting/triggered when the door(s) begin to open. There should be one (1) sensor on a wide door and one (1) sensor on a door of regular width. The APC system will connect and report counting through the chosen CAD/AVL system.

40.9. Covert Emergency Alarm- Silent Alarm

The Covert Emergency Alarm is for the operator’s use in dangerous situations. It shall be supplied and installed by the vehicle manufacturer.

The alarm shall be integrated with the following Information Level components/functionality: when the alarm button is pressed, the radio transmits audio from a listen-in microphone, the External Destination Signs display an emergency message, and the CCTV tags and saves recordings.

The Covert Emergency Alarm (Silent Alarm) should be included in one of the ITS manufacturer/supplier cable harnesses referenced in section 40.5, Intelligent Transportation System, ITS, Network Cabling Table. The location of the alarm button shall be located as agreed upon between the Authority and vehicle manufacturer. The Authority reserves the right to approve the final location of covert emergency alarm.

40.10. Radio Handset and Control System

40.10.1. Driver’s Speaker

Each bus shall have a recessed speaker in the ceiling panel above the driver. This speaker shall be the same component used for the speakers in the passenger compartment. The speaker shall be compatible with the ITS/CAD/AVL system to be determined later.

40.10.2. Handset

Vehicle Manufacturer shall install a handset for driver use. The handset shall be compatible with the ITS/CAD/AVL system to be determined later. Reference section 40.5.

40.11. Automatic Voice Annunciation System (AVA)

The vehicle shall be equipped with an AVA system which is typically integrated with an ITS (Intelligent Transportation System). It shall be supplied and installed by the vehicle manufacturer. A complete listing of internal and external announcements for initial configuration by the manufacturer will be provided shortly after award of this contract.

40.11.1. Speakers

The vehicle shall be equipped with an adequate number of speakers, to be approved by the Authority. The speaker layout shall include number and location of interior and exterior speakers. The speakers shall be semi-flush mounted, on alternate sides of the bus passenger compartment, installed with proper phasing. Total impedance seen at the input connecting end should be eight (8) ohms. Mounting should be accomplished with “riv-nuts” and machine screws or approved equivalent.

Exterior speakers shall have an appearance integrated into the paint scheme of the bus, either painted to match adjacent color, or behind a perforated panel that is painted to match adjacent color.

The Authority prefers high performance speakers installed on the interior and exterior of the vehicle. There is a high preference to have the speakers supplied by REI.

40.12. Public Address System

A Public Address (PA) system shall be supplied and installed by the vehicle manufacturer that may be integrated to the Intelligent Transportation System, dependent upon the ITS system selected by the Authority. The PA shall comply with the ADA requirements of 49 CFR, Part 38.35 and enables the operator to address passengers either inside or outside the bus. Inside speakers shall broadcast, in a clear tone, announcements that are clearly perceived from all seat positions at approximately the same volume level. A speaker system shall be provided so announcements can be clearly heard by passengers standing outside the bus near the front door. An operator-controlled switch shall be capable of allowing selection of inside only, outside only, or both inside and outside speakers for announcements. The system shall be muted when not in use. A provision shall be provided to secure the “gooseneck” microphone in a stored position when not in use.

The operator’s microphone shall be supplied (gooseneck type microphone), installed by the vehicle manufacturer, and compatible with the ITS/CAD/AVL system. The microphone shall be vandal resistant, mounted on a heavy-duty, flexible gooseneck, which is secured with tamper-proof fasteners and will allow the operator to comfortably speak into it without using his/her hands. The microphone shall be activated by a foot switch. The foot switch shall be compatible with the selected ITS/CAD/AVL and shall have the following salient features:

- Foot Switch, Momentary (normally open circuit)
- Floor mounted, on the same pedestal with the foot turn signal switches

40.13. Radio/Electronics Box

An equipment enclosure shall be provided to accommodate all of the electronic components required. The enclosure shall be supplied and installed by the vehicle manufacturer. The enclosure shall be located directly behind the operator's barrier/area on the street side. The enclosure shall be lockable (keyed, “Southco” lock) and as large as practical to facilitate future expansion of electronic components. The enclosure shall be splash proof and properly ventilated when the service door is secured. The ITS enclosure shall include modular slide out trays which are removable and can be repositioned to accommodate component replacement or changes in equipment position as needed. Slide out trays shall incorporate heavy-duty slide or roller mechanism to support a minimum of 100 pounds of loading and shall be able to withstand the normal shock and vibration, (under full load) experienced in revenue service, without damage to the slide or roller mechanisms. The equipment enclosure shall be equipped with a minimum of two (2) extra slide out trays for future expansion. The slide out trays shall have the capability of locking in the stowed position so that potential for trays with electronic components installed to move while vehicle is moving is greatly reduced. Service light(s) with an on/off switch shall be provided within the enclosure. The service lighting shall provide enough light so that a technician can service the electronic components within the electronic enclosure. The service light(s) shall be subject to approval by the Authority.

The following signals shall be brought into the radio/electronics box and wired to a terminal strip (multiple if needed):

- Odometer Signal - Monitor
- Internal Speaker Wiring – Control
- External Speaker Wiring - Control
- Internal/External Speaker Switch Wiring - Control

- Operator Microphone Wiring – Control
- Interior AGC Microphone - Control
- Emergency Alarm Switch Wiring - Control
- Stop Request – Monitor
- Wheelchair Stop Request – Monitor
- Bike Rack Stop Request - Monitor
- Wheelchair Ramp Stow – Monitor
- Wheelchair Ramp Deploy – Monitor
- Front Door Open – Monitor
- Any Door Open – Control (used to cancel “stop request”)
- Front Door Closed – Monitor
- Rear Door Open – Monitor
- Rear Door Closed - Monitor
- Fire Alarm – Monitor
- J1939 VAN and Drivetrain – Monitor
- J1939 Destination sign (Luminator) – Control/Monitor
- J1708 Destination sign (Luminator) – Control/Monitor
- J1708 Farebox – Control/Monitor
- Ethernet Farebox- Control/Monitor

The following Main Power Requirements shall be brought from the vehicle's main power bus at the battery source into the equipment enclosure (radio/electronics box).

Red Wire Color unless otherwise specified, fused at source - (30 AMP for 12 Volt), #8 AWG stranded main 24-hour power, 12 VDC preferred unless otherwise specified

- Black Wire Color unless otherwise specified, #8 AWG stranded 12 VDC Return to Battery Ground (Chassis Return not acceptable)
- White Wire Color unless otherwise specified, fused at source - (10 AMP for 12 Volt), #14 AWG stranded IGN, 12 VDC preferred unless otherwise specified

At a minimum, the following auxiliary power connections shall be provided inside the radio box, all wired to a terminal strip, and with circuit protection provided and located inside the radio box:

- 2 (minimum) - 12V IGN
- 2 (minimum) - 12V BATT
- 2 (minimum) – 24V IGN
- 2 (minimum) – 24V BATT
- 2 (minimum) – GND

The radio/electronics box keyed lock assembly should be Southco M3-10 #64-22-11 768854 with Southco key #H257

Radio/Electronics box keys (#H257) should be provided by the vehicle manufacturer in a minimum quantity of one (1) for each vehicle and shall be delivered to the Authority on the delivery date of the vehicles.

40.14. Antennas and Two-way Radio

Antenna mounting shall conform to the electromagnetic suppression requirements of SAE J551. A roof mounted radio antenna requires a ground plane to prevent electronic noise being generated inside the vehicle. A metal roof can serve as a sufficient ground plane; however, a fiberglass roof requires either a metallic surface, or an antenna with a virtual ground plane.

40.14.1. Required Antennas

The vehicle manufacturer shall install antennas and provide antenna cables for the following systems:

- RF Deck Two-way Radio, Harris XL Series
    - 900 Mhz, NMO low profile, PCTEL Trooper MAX or approved equivalent by authority
- AVA/AVL System (reference section 40.5 Intelligent Transportation System)
    - GPS Antenna
    - WLAN Antenna
- Cellular router(s)- (reference sections 40.14.4 and 40.16)
    - One router, Dual 5G radio, Two (2) 9-n-1 Sierra antennas, Fakra connections
- Camera surveillance system
    - GPS, mounted in front destination sign area
- AVM System Antenna
    - Tri-band Antenna
    - GPS Antenna

40.14.2. Radio RF Deck

~~The Vehicle Manufacturer shall install the Authority's Radio RF Deck unit to be installed in the radio box. A Harris voice/data radio will be provided along with the ITS/CAD/AVL which shall be installed by the vehicle manufacturer.~~

The Authority may provide a test unit Radio RF Deck during production for the Vehicle Manufacturer to validate installation dimensions and test functionality and vehicle integration.

The Manufacturer shall provide the following:

- wiring harnesses
- antenna
- antenna cable
- Mounting Bracket

40.14.3. GPS Antenna/WLAN Antenna

The Vehicle Manufacturer shall supply and install the GPS antenna/receiver and the WLAN antenna and cabling. The cable distance from the radio antenna, GPS antenna/receiver, and WLAN antenna to the radio box shall be less than 25 feet. The location of the antennas shall not be more than 10 degrees from horizontal. The GPS antenna/receiver must be located at least 1 meter from other radiating elements.

40.14.4. Cellular Router Antennas

The Vehicle Manufacturer shall supply and install two (2) antennas per cellular modem, Sierra recommended model, appropriate length 9-in-1 antenna cables, and route the antenna cables in conduit to the radio box. Provisions of shelf space shall be made available in the radio/electronics box for the router. Reference section 40.13.

40.14.4.1. Antenna Maintenance Access

Interior access panels shall be installed to gain access to the antennas for maintenance testing and repair procedures, an interior access panel for each antenna shall be provided inside the vehicle at the point where the antenna is mounted to the roof panel and where the antenna cable attaches to the antenna. If antennas are mounted in a designated area on top of the vehicle, then provisions for maintenance access shall be provided.

40.14.4.2. Antenna Cable Conduits

Cable conduits shall be routed at the discretion of the Authority to ease cable replacement. Since cables are being installed during the bus build, the conduits should be considered on a case-by-case basis. These conduits should be 5/8" Inner Diameter or larger and be routed in a continuous fashion. The conduit shall have bend radiuses that will permit the ease of pulling cables (no sharp or right angles).

The radio antenna, GPS antenna/receiver, and WLAN antenna cables shall terminate in the radio/ electronics box enclosure.

40.15. Camera Surveillance System (Closed Circuit TV, CCTV)

The CCTV system shall be supplied and installed by the vehicle manufacturer. The Vehicle Manufacturer shall have the Camera Surveillance manufacturer perform a first article installation and certification. The CCTV system shall include ten (10) color cameras on the 40-foot bus, control system, an 8” reverse monitor if an integrated monitor within the mirror on the header is not offered, and a recording storage device. The system shall have the capability of marking and saving an event as specified by the Authority. The system module shall be located/installed in the electrical enclosure behind the operator above the street side wheel well or approved equivalent. Refer to figure 12, (40-foot) for general camera installation locations on 40-foot vehicles. The Authority reserves the right of final approval.

~~The Vehicle Manufacturer shall provide a minimum of one (1) year subscription/licensing for the Camera Surveillance Systems installed on the vehicles.~~

The CCTV system shall have a minimum of 2 (two) microphones. One microphone shall be mounted in the operator area and the second microphone shall be mounted near the rear door area on a 40-foot vehicle.

40.15.1. Digital Video Recorder (DVR)

The DVR system (component of the CCTV system) shall have a removable 8.0 Terra Byte (TB) Hard Disk Drive for storage and a recording capacity of no less than 20 days, and shall be programmable to automatically tag events, to include panic button activation or a hard deceleration/impact. The DVR shall have HD (high definition) recording and display capabilities. The system shall include a 3-axis accelerometer internal to the DVR. Tagged events shall be stored, and available through both wireless download and manual retrieval of the video on the DVR.

The DVR shall have all of the following salient features or approved equivalent:

- The CCTV system shall have 2 microphones at a minimum.

The CCTV system shall have the following salient features:

- Compatible with the Authority’s current security surveillance camera system software.

- The system shall be provided with compatible and interchangeable formats that support simultaneous recording of up sixteen (16) high definition cameras and an equal number of microphones [up to sixteen (16)].
- The system shall support two additional audio channels capable of synchronizing to user-selectable cameras.
- The Recorder shall provide PoE (Power over Ethernet) to up to sixteen (16) high definition IP cameras directly with no additional hardware required.
- The system shall be capable of recording all cameras at the highest resolution and quality at a minimum of 30 images per second per camera.
- The Recorder shall be ruggedized and secure with lockable recording media without the need for an additional enclosure.
- The system shall include a driver event switch that features a system status “heartbeat” style health indicator to provide visual confirmation that the system is operating properly.
- The system shall be capable of simultaneous recording, playback and remote access allowing multiple users to review video without interruption of recording.
- The system shall save the serial number of the hard disk drive to the system log in order to record and track the replacement of the recording media.
- The system shall have a recording capability of no less than 20 days of recording space on a 8TB SSD storage and shall be programmable to automatically tag events, to include panic button activation and a hard deceleration/impact. Tagged events shall be stored, and available through both wireless download and manual retrieval of the video on the DVR.
- All storage shall be removable. Systems that move data between multiple storage devices shall not be acceptable.
- The system shall record onto a removable hard disk drive equipped with a key lock to prevent tampering and shall be ‘swappable’ for use in any same model Recorder, regardless of the number of cameras supported.
- The system shall be capable of maintaining one (1) month of recorded high definition video at a rate of 30 images per second on every camera simultaneously on a single on-board drive.
- The system shall be made entirely of new materials and shall be engineered and constructed with rugged materials to protect the system from environmental elements including shock, dust and humidity.
- The Recorder shall be Mil-Spec Rated: STD-810G, for vibration and shock and include a shock absorbing mounting kit.
- The Recorder and cameras shall be NDAA compliant.
- The system shall be capable of configuring video quality, resolution and recording speed individually for each camera.
- The Recorder shall record video in user adjustable resolution settings of up to 12 MP, depending on camera capabilities.
- The system shall not require defragmentation, maintenance or any other housekeeping operations that may interrupt recording when the vehicle ignition is powered on.
- All recorded data shall be immediately available on the removable storage media; the system shall not require a waiting period or completion of any processes prior to obtaining access.

- The recorder shall feature an eSATA (External Serial Advanced Technology Attachment) port for virtually unlimited onboard storage options.
- The system shall include a built-in heater for operating in temperatures as low as -20°F. Systems that require an additional enclosure to comply with this requirement are not acceptable.
- The system shall have an optional hard disk player and software to allow for transferring of files directly from the HDD to a PC, where the images can be printed, emailed or saved onto another storage media.
- The system shall feature a built-in 3-axis accelerometer capable of tagging video or sending alarm notification when the vehicle exceeds a pre-determined G-force setting.
- The system shall be FCC Class A approved.
- The Recorder shall be designed to meet applicable requirements of ISO 16750-2 to address “Electrical disturbances from conduction and coupling”.
- The Recorder shall provide regulated 12-volt power for all peripherals (up to 18 watts).
- The Recorder shall have the option to remain operating for a pre-determined length of time after the vehicle ignition is set to off, up to twenty-four hours.
- The system shall be capable of streaming live video through cellular or wireless LAN options.
- The system shall feature a built-in GPS receiver.
- The system shall be equipped with a minimum of two (2) USB ports (at least one of which is USB 3.1 compatible) to allow for exporting video clips using USB flash memory.
- The Recorder shall include a Gigabit Ethernet port for system configuration and transmission of video using software over Wi-Fi or cellular networks.
- The Recorder shall feature H.264 and H.265 “Main Profile” video compression for superior video quality, network performance and recording duration. “Constrained Baseline Profile” or “Baseline Profile” type H.264/H.265 is not acceptable.
- The Recorder shall be programmable utilizing a mouse and LCD display.
- The system shall be capable of on-board viewing, downloading and control via laptop using the included software.
- The Recorder dimensions shall not exceed: 11.2” x 3.95” x 13.9” (Width x Height x Depth).
- Onboard system components shall be removable / replaceable as an entire component to minimize vehicle down times and simplify maintenance.
- IP cameras shall be set-up and configured for use during initial set up and for field replacement and/or adding additional cameras if needed at a later time per the Authority’s approval.
- Video clip samples shall be provided to display video quality recorded at the maximum recording quality and rate while maintaining on-board video on a single hard disk drive for a minimum of twenty (20) days, utilizing the hard disk drive specified in the base bid of this proposal.
- The system shall support geo-fencing to automate mode changes to the internal wireless module. The system shall automatically switch from AP mode to allow connection to supervisor or police vehicles while away from the facility, and switch to client mode to allow connection to facility wireless when the vehicle is within the vicinity of the facility.
- The Recorder shall feature an HDMI output port that is capable of displaying camera layouts of 1 to 9 cameras, at 1080p resolution. The display output shall be capable of switching camera layouts based on triggers.

- The Recorder shall have the ability to manage the PoE camera power in order to power down cameras after vehicle ignition is turned off to eliminate unnecessary recording and to increase data transfer rates in a power-saving mode.
- Predictable recording duration (i.e. not using event recording that makes it variable)
- Camera firmware updates shall be managed through the recorder.
- The recorder supports integrated third party cameras with Axis, Hitron and ONVIF protocol as well as Direct IP cameras.
- Ability to enable/disable audio/video recording based on event inputs
- Provide a connection for power loss data protection
- Logging of input voltage and temperature

The system shall have the following software/firmware salient features:

- License-free software that is capable of live viewing, playback, calendar and event searches, and administration shall be provided at no extra cost, and shall be compatible with Windows® 7, Windows® 8, and Windows® 10.
- All future software updates for license-free software shall be available free of charge.
- The software shall provide various levels of user access rights that allow and restrict access to various functions. The software shall feature 256 user passwords and 64 user groups.
- When equipped with GPS, the system shall provide historical and live software mapping to display routes of the vehicle location and speed charts.
- When equipped with GPS, the system software shall be capable of connecting to pre-recorded video by selecting a point on the map or selecting a point on the speed chart to view from that speed or location.
- To retrieve recorded video, the software shall provide searches by: event, time lapse, time and date, vehicle location and vehicle speed. Optional software shall allow for easy fleet-wide searches and wireless download of video based solely upon the date and a general map location.
- The software shall display the current time and date on the video.
- When events are detected, the unit shall display the event information and allow users to access the remote site directly to search the image associated with the event.
- The included software shall allow the user to connect to multiple units simultaneously and allow for viewing a minimum of sixty-four (64) camera views at one time. Optional management software shall feature secure, instant live access to simultaneously provide live viewing to multiple parties with no reduction in video quality or additional use of wireless bandwidth.
- The system shall feature optional software for automated event video upload to a central server repository.
- The software shall allow for automated software upgrades and simultaneous updates to multiple sites.
- Image adjustments, ePTZ (Electronic Pan, Tilt, Zoom) control, and alarm out controls shall be administered utilizing the software.
- When utilizing the software, the system shall provide ePTZ control and de-warping of 360-degree cameras during live and video playback.

- The software shall be capable of synchronizing the time of all Recorder systems utilizing a “master Recorder” or to GPS (Global Positioning System) time (if applicable). Daylight savings adjustments shall be automatic.
- The recorder’s software settings shall allow the system (when networked) to send email notification for any system event including video loss, camera obstruction, and hard drive “full status.” Optional software shall supply health information of the video system with error logs, reports and automatic notification for: video blind events, video loss events, disk errors, disk temperature events, fan errors, recorder errors, disk almost full and disk S.M.A.R.T (Self-monitoring, analysis and reporting technology) events.
- The recorder’s software settings shall allow the system to send notification to the vehicle driver or external systems for any system event including video loss, camera obstruction, hard drive “full status”, etc. When networked, the system shall be capable of sending notification to a central location. Optional management software shall support fleet-wide email notification of system events as well as a fleet-wide health summary featuring camera and Recorder health reports.
- Options for archiving/retrieving video shall include: Saving a video clip as a Windows Media Player (.avi, audio/video interleaved) file, saving as an image (.bmp, bitmap), or saving video as a self-executable format (.exe, executable file).
- Video clips saved using the self-executable format (.exe) shall be encrypted and viewed without the use of any additional software, providing the ability to easily transfer secure video evidence.
- Video clips shall include the option of viewing a single camera or multiple cameras on a single screen. Users shall have the ability to configure and save (for later use) various camera view layouts.
- Executable video clips shall display GPS map location vehicle and speed upon playback and metadata from other onboard systems.
- Video clips shall provide the option of saving a portion of the video clip (shorter in length and/or reducing the number of cameras) in order to make a smaller video clip from the original.
- The software shall feature the option to archive video clips requiring a password for reviewing.

The system shall have the following salient features for the Management Software or approved equivalent:

- Management software shall provide fleet-wide status reports, event logs, on-demand and automated video clip retrieval for easy fleet-wide video management.
- Management software shall provide access to an unlimited number of users and feature multiple user access-levels with password protection to ensure system settings are secure.
- User access-levels shall be configurable for individual vehicles or groups of vehicles, preventing access/visibility to vehicles and their respective data outside of the configured permissions.
- Software licenses may be provided on a per-vehicle basis and shall include 36 months of maintenance (software updates) at no additional charge.
- Management software shall be fully web-based and not require any client-side software other than the Google Chrome™ web-browser.

- Management software shall provide the ability to view video directly from supported web-browsers without downloading or exporting the video file.
- Users shall be capable of programming the software to automatically download video clips based on specific event types.
- All data logs and video clips shall be available for viewing anytime (regardless of current vehicle connection status) once the video clip has been uploaded.
- Users shall be capable of requesting downloads of custom video clips.
- Video clips scheduled or manually requested shall automatically download when the vehicle connects to the network.
- Management software shall be capable of retrieving video data from all available vehicles simultaneously to ensure such data is available to users in a timely manner.
- Software shall provide “connection status” to easily determine if a vehicle has not recently connected to the network.
- The user shall be capable of requesting multiple video clips simultaneously from multiple sites.
- Software shall provide chain of custody reports with a complete history of system and user actions associated with each video clip and live viewing sessions.
- Users with granted permission rights shall be capable of classifying reviewed video clips to save to temporary or long-term storage or schedule for deletion.
- Administrative users shall be capable of programming the software with an adjustable time period for storing the event log, temporary storage, long-term storage and deletion grace period (by which video clips are stored for a period time prior to deletion).
- Management software shall provide fleet-wide monitoring of camera and Recorder health events, including the ability to generate health event video clips, to ensure optimal functionality and prevent manual system checks.
- Users shall have the ability to configure daily emailed health status reports detailing overall system health including: Recorder health events, camera health events, vehicle connection status and server storage.
- Management software shall be compatible with all Recorder systems proposed.
- Software shall provide users the ability to add customizable “tags” to classify video clips based upon pre-determined criteria.
- Software shall support searching/filtering of video clips based upon vehicle ID, video event type, clip review/download status, last reviewed by (user), date/time, length, speed, tag, and vehicle location.
- Users shall be capable of inserting and saving notes or comments regarding a specific video clip to document essential data regarding a clip. Such notes shall be associated with specific times in the respective video clip.
- Management software shall allow users to view the last location of each vehicle in the fleet with a graphical map interface.
- Search capabilities shall support the download of video clips by location in a specified time period – software shall upload video clips for all vehicles within the location and time parameters selected.
- Management software shall provide secure live streaming capabilities, including the ability to view previously recorded video with fast-forward and reverse functions.
- Live streaming security access shall be configurable on an individual user basis.

- Management software shall provide the ability to protect the privacy of individuals in exported video clips by automatically blurring faces for individuals identified by authorized users.
- Face blurring shall not be limited to static regions of the video, it shall intelligently follow individuals to protect identity as they move throughout the video recording
- Authorized Users shall have the ability to selectively de-blur up to two faces, which will remove the privacy feature for desired individuals.
- Management software shall support ADNS functionality for enabled Recorders.
- Management software shall support the use of secondary IP addresses for dedicated transmission of live data and video over cellular connections.
- Management software shall support the use of LDAP (Lightweight Directory Access Protocol) to authenticate users with a single sign-on.

The Surveillance system Cameras shall have the following salient features/available options or approved equivalent:

- All cameras shall utilize 48-volt PoE (Power over Ethernet), supplied from the Recorder.
- Interior cameras shall be high definition, low light, IR Illuminating with a lux rating of 0.
- Interior cameras shall be color with a built-in high sensitivity microphone.
- Camera resolution setting options shall be up to 12MP / 8.6MO (2944 x 2944).
- 360-degree cameras with a resolution of 12MP / 8.6MO (2944 x 2944).
- 360-degree cameras shall provide low light IR illumination with a lux rating of 0.
- 360-degree cameras shall provide a built-in high sensitivity microphone.
- Exterior cameras shall be impact and tamper-resistant and rated a minimum of IP66 for proven durability in exterior mobile applications.
- Exterior cameras shall feature a UV coated dome for additional exterior protection.

The system shall offer the following salient features for warranty, service & support or approved equivalent:

- All hardware shall include, at a minimum, warranty of two (2) years parts and labor.
- Unlimited telephone and email technical support shall be provided at no additional charge for the life of the system.
- Additional extended warranties and service contracts shall be available.

The CCTV system shall have all necessary licensing provided, for a minimum of one (1) year, so that system operates seamlessly with existing like-CCTV systems the Authority may have. Authority reserves the right of final approval of the subscriptions/licensing.

The CCTV system shall have removable digital recorder, tag alarm push button switch, discreet and silent input for logging important events, and fail-safe circuit monitoring in case of wire breaks.

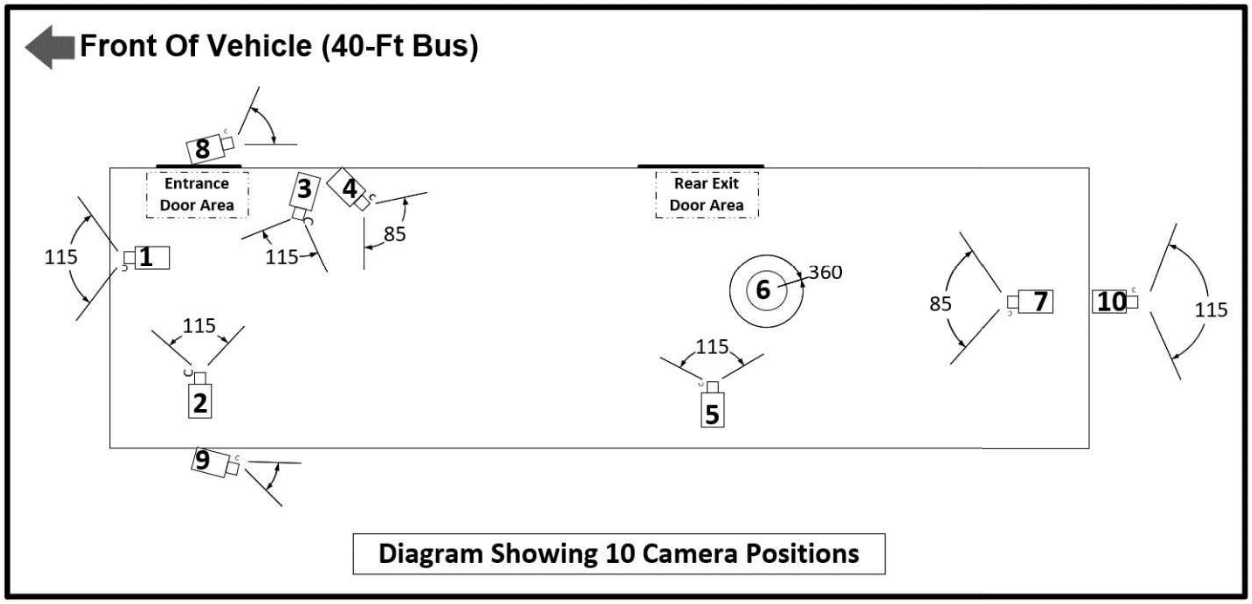
The cameras shall be mounted to provide a clear view of the entire passenger compartment and be protected to prevent tampering and vandalism. Outside cameras shall be securely installed and properly sealed to prevent water intrusion.

40.15.2. Cameras

The cameras shall be mounted to provide a clear view of the entire passenger compartment and be protected to pre-vent tampering and vandalism. Outside cameras shall be securely installed and properly sealed to prevent water intrusion. Refer to camera installation guidance in figure 12 labeled “camera installation guide” (40-foot bus).

FIGURE 12

40-foot Camera Installation Guide



Camera	Location
1	Forward Facing (4K, 115º Field View)
2	Front Door (115º Field View)
3	Operator (115º Field View)
4	Front to Back (85º Field View)
5	Rear Door (115º Field View)
6	Platform Steps (360º Field View)
7	Back to Front (85º Field View)
8	Curb Side (3.3mm Fixed Focal)
9	Street Side (3.3mm Fixed Focal)
10	Rear View / Back-Up (115º Field View)

Operator Rearview/Door Monitor

When the vehicle is in reverse, the exterior rear facing camera view shall appear on a minimum 8-inch monitor. When the rear door(s) is open, the monitor shall display a view of the rear door camera. The 8-

inch monitor shall be installed within close proximity to the operator seat so that monitor can be easily viewed with minimal head movement.

40.15.3. Awareness Monitors

Two (2) monitors shall be provided and installed, one 10-inch monitor and one 19-inch monitor or approved equivalents. The Authority shall retain the right of final configuration approval. The monitors shall continuously show a live “feed” of images from the vehicle’s interior cameras so as to create a more secure atmosphere.

40.15.3.1. 10-inch Awareness Monitor

The 10-inch monitor shall be installed on the header above the operator seat, facing the entrance door so that onboarding passengers may see the monitor. The monitor shall only display the camera “feed” that captures the entrance door as passengers board. The feed shall only display on the 10-inch awareness monitor when the front passenger door is in the open position.

40.15.3.2. 19-inch Awareness Monitor

The 19-inch monitor shall be installed on the side of the electronic enclosure facing the rear of the vehicle so passengers may see the “live feed” scrolling images from the vehicle’s interior cameras. The Authority reserves the right of final configuration approval.

40.16. Cellular Router

The manufacturer shall install the Authority’s preferred Cellular Router to be installed in the radio/electronics box. A Sierra Wireless XR-90 Cellular Router is the Authority’s preferred router.

The Manufacturer shall provide the following:

- One (1) cellular router (XR-90) per vehicle
  - The router will be dedicated to data transfer
  - Sierra XR90, 5G Dual Radio model
- two antennas, Sierra model, 9-n-1 for the router (or approved equivalent) shall be provided and installed
- Use of antenna adapters shall not be permitted for the connection to the router or antenna
- antenna cables for the router shall be routed to the radio box
- router installation location within the shelf space of the radio box shall be in a configuration approved by the Authority
- One Year AirLink subscription

40.17. Automated Fare Collection (AFC)

40.17.1. Farebox

The manufacturer shall ~~supply and install~~ provide electrical and mechanical provisions to install a GenFare, “Fastfare”, Farebox at the front of the bus near the front door. The manufacturer shall provide a 6” raiser to mount the farebox. The Genfare, “Fastfare”, farebox ~~shall~~ will have the following salient features:

- Approximate overall height of 36-inches tall
- Full color passenger display and audible signals
- Capable of being configured to accept multiple forms of payment as chosen by the Authority
- Capable of being re-configured allowing for change to the future needs of the Authority

- Capable of real-time communication to enable fare capping, record transactions, facilitate system monitoring/reporting, and software updates
- Accessible by people with disabilities
- Capable of integrating with legacy Genfare fareboxes and vaulting equipment
- Contains a security system capable of protecting data, prevent cash loss, with dual power systems
- Cashbox
- The farebox shall have the “Cap Metro” configuration- keys, programming, etc.

~~The Authority expects a fully functioning farebox installed and validated by the Vehicle Manufacturer as working.~~ The Authority will provide a farebox for the lead bus to confirm operation and installation. The Manufacturer shall pre-drill the farebox mounting points.

The Vehicle Manufacturer shall supply and install:

- ~~Farebox, approximately 36 inches tall, with all the salient listed features and a cash box~~
- ~~Arm, Ram Mount, 1.5" ball (RAM-201U) 6" GFI Part # C26499-0001~~
- Farebox wiring which shall be connected and labeled as referenced in Table 7.

Table 7

Wire	Label 1	Label 2	Label 3	Communications
Electrical Requirement	12V Battery	Ground	Ground (Shielded)	J1708 and Two CAT6 Shielded Ethernet cables
Amperage Requirement/ Notes	20 Amps			Runs ITS/ CAD/ AVL in the Radio/ Electronics box

The wiring shall be enclosed in a flexible conduit that runs continuous starting at the radio/electronics box and terminates at the location where the farebox shall be mounted. The power, grounding, and communication harness shall be contained within the flexible conduit. There shall be a minimum of twelve (12) inches of “slack/service loop” for each wire coiled underneath the farebox (future use).

NOTE: The Manufacturer shall take into account when designing and installing the driver barrier that the Farebox OCU (Operator Control Unit) will be mounted on the farebox and must be considered with respect to potential interference.

40.17.2. Provisions for Electronic Fare Media Validators (40-foot)

The manufacturer shall install provisions for the Authority’s Electronic Fare Media Validators to be installed at all doors (UMO). The Authority will supply and install the Validators post-delivery. The Authority shall approve the locations of the Electronic Fare Media Validators.

The Authority has a contract with an Automatic Fare Collection system and therefore all provisions shall be compatible with the chosen electronic fare collection supplier. The Authority will provide test units during production for the Vehicle Manufacturer to validate installation dimensions and test functionality and vehicle integration.

The Vehicle Manufacturer shall provide the following:

- Two (2) locations on a 40-foot vehicle- Front passenger assist (grab rail) near Farebox and rear stanchion nearest the exit door. Authority reserves the right of approval for final location configurations.
- Appropriate length of wire cables shall run from each mounting location to the network switch.
- Circuit connection blocks, for each cable shall be installed in “line”, in a maintenance accessible area, for ease of installation, maintenance, and component replacement.
- A □□□□500□□ Antaira (network switch) un-managed switch or approved equivalent, shall be used to connect the validators to the cellular router.
- An appropriate length CAT 6 Shielded cable shall connect the network switch to the cellular router.
- CAT 6 Shielded cables shall be provided from the validators to the internet switch.
- The vendor shall provide and install the mounting brackets included in UMO kit P/N VAL100-00-MA. The vendor shall re-pin the power and Cat6 cables using the Molex connector supplied in the kit.
- 12 volts at 3-5 amps, circuit protected, switched and unswitched power
- Chassis ground
- Wiring/cabling shall be included in the vehicle wiring diagrams that are supplied to the Authority

40.18. Event Data Recorder (EDR)

An EDR (Event Data Recorder) shall be installed on the bus, preferably near the front. The unit should be installed as low as possible. The EDR shall be able to record data from the Jl939 CAN line and connect/ communicate to the cellular router (reference section 40.16), for data offloading. The manufacturer or supplier of the EDR shall conduct a first article installation, inspection, qualification testing, and certification at the vehicle manufacturers facility. A copy certification that the EDR system is receiving the required signals shall be supplied to Authority for each vehicle in the build. Testing and verification that EDR system installed on each vehicle shall be supplied to the Authority as validation that the EDR is recording the required data. The Authority is requiring the preferred EDR system come with a twelve (12) year license subscription for each vehicle. The vehicle manufacturer shall provide any all service licenses to include updates for a minimum of ~~(12)~~ 1 years from the date of vehicle acceptance.

The EDR shall having the following salient features or approved equivalent:

- Power
    - Input Voltage: 9-34 V DC (42V & 72V peak respectively)
    - Power Consumption: <16W with cellular modem
- Communications
    - RS-232
    - USB 2.0
    - CAN 2.0
    - Wi-Fi 802.11n
    - Cellular Modem (3.5G/3G/2G, penta-band, worldwide coverage)
- Sensors
    - 3-axis accelerometer (2G/4G/8G/16G selectable, 50G optional)
    - GPS operating at up to 10 Hz
- Inputs
    - RPM (dedicated analogue sampled)

    - Speed (dedicated analogue sampled)
    - 8 x mixed signal analogue inputs (programmable frequency capture, analogue voltage, digital input emulation)
- Outputs
    - 4 x relay outputs (open collector 200 mA)
- Functions
    - RTC +/- 3ppm over -10 to 65 degrees C, 95 second per year free drift, corrected via GPS time synch
    - Backup battery with >10 years life
    - Networking (DHCP client, DNS client, HTTP server)
    - Firmware updates: on-board bootloader allowing remote updating
    - Data reporting & downloading via on-board HTTP server and USB mass storage
    - Device configuration via on-board HTTP server and USB mass storage
- Storage
    - On-board 64 GB non-volatile flash memory
- Environmental
    - Dimensions: 153 x 140* x 39 mm (*not including cables)
    - Weight: <500 g
    - Operating Temperature: -40 to 85 degrees C dependent on selected options
    - Ingress Protection: IP54 as standard, up to IP68 optional
    - Resistant to fluids found in typical industrial applications

Settings are to be finalized with the Authority during pre-production. The EDR shall also tag an event from a signal received over the Jl939 CAN line from the silent alarm switch signal and the camera event button and in turn broadcast these events to the vehicle monitoring system. The EDR shall also record, at a minimum, the following operational data: headlights, turn signals, and hazard lights “on” or “off”; vehicle ignition “on” or “off”; low air pressure warnings; vehicle movement forward, reverse, or idling; and parking brake “on” or “off”. The Authority reserves of the right of final configuration.

40.19. infoOn-Board Telematics

The vehicle shall be equipped with an onboard telematics reporting system. The on-board telematics data hub shall have the following capabilities at a minimum:

- Vehicle Monitoring
    - Vehicle statistics
    - Route energy statistics
    - Management reports
    - Telltale lights
    - Incident notifications
- Driving Behavior Monitoring
    - Driver style analysis
    - Regeneration profile
    - Summary reports
    - Actionable insights
    - Driver insights application
- Maintenance Monitoring
    - Battery status/ health insights

  - Fault logging overview
  - Diagnostic messages
  - Brake lining monitoring (if provided)
  - Auxiliary systems monitoring

The on-board telematics system shall have the following salient features or approved equivalent:

SYSTEM

- CPU- 800 MHz 2core ARM processor (i.MX6), or better
- RAM- 1 GB DDR (*Double Data Rate*), or better
- On-Board Memory- 8GB (eMMC- *expanded multi-media card*), or better
- Built in sensors
  - GPS sensor (*Global Positioning System*)
  - Gyro sensor
  - Barometric sensor
  - 3 Axis Accelerometer
- Operating system- Embedded

COMMUNICATION

- Ethernet- 1Gb/ps (*Gigabyte per second*)
- Wireless- Wi-Fi 802.11 a/b/g/n (2.4 + 5GHz)
- Cellular- GSM/UMTE/LTE (2G/3G/4G)

CONNECTORS

- TE Connectivity, Ampseal (23 pins)- 1 x RS485, 6 x Analog Inputs (0-10 V), 2 x Analog Outputs (0-10 V), 5 x Digital Outputs, 2 x CAN
- LAN Connector- 1 x RJ45
- USB (*Universal Serial Bus*)- 1 or more
- Antenna Connectors- 1 x WLAN (SMA), 1 x 2G/3G/4G Antenna (FME), 1 x GPS (SMA)

CERTIFICATIONS

- Automotive Standards- R_10_C5 Addendum 9: Regulation No. 10
- Environmental Standards- J1455:2017 Part 2-64, IP 65

The On- Board Telematics device shall be installed in the radio/electronics box in a location to be approved by the Authority.

The vehicle manufacturer shall include licensing/service subscription for a minimum of two years beginning from the date of vehicle acceptance.

The Authority reserves the right of final configuration approval.

40.20. Provisions - Inertia Based Camera Systems

The Vehicle Manufacturer shall install provisions for the Authority’s Inertia Based Camera Systems to be installed on the windshield. The Authority will install the Inertia Based Camera Systems hardware post-delivery.

The Authority's chosen inertia-based camera system is Lytx systems. The Authority will provide test units during production for the Vehicle Manufacturer to validate installation dimensions and test functionality and vehicle integration.

The Vehicle Manufacturer shall provide the following:

- wiring connected to the circuits in Table 8 below for each system and terminate the wiring harnesses in a 15 inch "slack/service" loop with labels located above the center of the windshield.

Table 8

Inertia Based Camera System	
Wire	Circuit
12-volt +	12-volt battery positive (unswitched, 10-amp circuit)
12-volt ignition	12-volt master switch ignition
Ground	Vehicle Ground

40.21. Provisions – Electronic Inspection Reporting System – "Zonar"

The Authority uses an electronic vehicle inspection system to aid the operators in performing the required pre-trip and post-trip vehicle inspections. The Vehicle Manufacturer shall install provisions for the electronic inspection reporting system. The provisions shall include:

- Constant input voltage 8-32 Volts DC at 3 -5 amps
- Switched power 8-32 Volts DC at 3 – 5 amps
- Chassis ground
- Battery ground
- 3 pin J1939

The provisional wiring shall be routed to the radio/electronics box and identified/labeled as Electronic Inspection Reporting system wiring or approved equal. The Authority reserves the right of final configuration approval.

40.22. Provisions for Upgrade of Automated Vehicle/Connected Vehicle Technology

The Vehicle Manufacturer shall consider installation of provisions where possible, which will aid in future retrofit and integration of Automated Vehicle/Connected Vehicle Technology. Systems may include Advanced Driving Assist Systems such as Lane Keeping, Automated Braking, Collision Avoidance, and Pedestrian Avoidance, and/or Autonomous Drive modes such as self-parking and auto-queueing in the depot. Physical provisions may include:

- additional electronic cabinet storage capacity for AV/AC computers,
- conduit with fishwire for LIDAR, RADAR, Optical Cameras, and Antennas,
- Reinforced mounting provisions for LIDAR, RADAR, Optical Cameras, and Antennas
- Provisions for Brake by Wire sensors and control units
- Provisions for Assisted Steering

40.23. Provisions for Tablet

The vehicle shall be equipped with a dash bracket and ram ball mount size C. The contractor shall provide USB power near the dash bracket.

- Brake system: Foundation brake components, including advancing mechanisms, as supplied with the axles, excluding friction surfaces
- Destination signs: All destination sign equipment for the front, side and rear signs, power modules and operator control
- Heating, ventilating: Roof and/or rear main unit only, excluding floor heaters and front defroster
- AC unit and compressor: Roof and/or rear main unit only, excluding floor heaters and front defroster
- Door systems: Door operating actuators and linkages
- Air compressor
- Air dryer (One Year/Unlimited miles)
- Wheelchair lift and ramp system: Lift and/or ramp parts and mechanical only
- Charge air cooler: Charge air cooler including core, tanks and including related surrounding framework and fittings
- Fire suppression: Fire suppression system including tank and extinguishing agent dispensing system
- Hydraulic systems: Including radiator fan drive and power steering as applicable
- Power Steering System
- Propulsion system cooling systems: Radiator including core, tanks and related framework, including surge tank and transmission cooler
- Power electronics: DC/DC converters, inverters, if supplied
- Fuel Storage and Delivery
- Surveillance system including cameras and video recorders
- Passenger seating excluding upholstery

The following subsystems shall be warranted to be free from Defects and Related Defects for 2 years or 100,000 miles, whichever comes first:

- Low-voltage and high-voltage electrical wiring and harnesses

1.1.6. Extension of Warranty

If, during the warranty period, repairs or modifications on any bus are made necessary by defective design, materials or workmanship but are not completed due to lack of material or inability to provide the proper repair for thirty (30) calendar days, then the applicable warranty period shall be extended by the number of days equal to the delay period.

1.1.7. Voiding of Warranty

The warranty shall not apply to the failure of any part or component of the bus that directly results from misuse, negligence, or repairs not conducted in accordance with the Contractor-provided maintenance manuals and with workmanship performed by adequately trained personnel in accordance with recognized standards of the industry. The warranty also shall be void if the Authority fails to conduct normal inspections and scheduled preventive maintenance procedures as recommended in the Contractor's maintenance manuals to the extent that omission caused the part or component failure. The Authority shall maintain documentation, auditable by the Contractor, verifying service activities in conformance with the Contractor's maintenance manuals.

1.1.8. Exceptions and Additions to Warranty

The warranty shall not apply to the following items:

- scheduled maintenance items
- normal wear-out items

- items furnished by the Authority

Should the Authority require the use of a specific product and has rejected the Contractor's request for an alternate product, then the standard Supplier warranty for that product shall be the only warranty provided to the Authority. This product will not be eligible under "Fleet Defects," below.

1.2. Serial Numbers

Upon delivery of each bus, the Contractor shall provide a complete electronic list of serialized units installed on each bus to facilitate warranty tracking. If supplied with the bus, the list shall include but is not limited to the following:

- Engine or traction motor(s)
- Propulsion system controller/inverter(s)
- Energy storage pack(s) or module(s)
- Power electronics: DC/DC converters, inverters
- Transmission (if applicable)
- HVAC system and major components
- Drive axle
- Power steering unit
- Air compressor
- Wheelchair ramp (if applicable)

The Contractor shall provide updated serial numbers resulting from warranty campaigns. The format of the list shall be approved by the Authority prior to delivery of the first production bus.

1.3. Pass-Through Warranty

Should the Contractor elect to not administer warranty claims on certain components and wish to transfer this responsibility to the sub-suppliers, or to others, the Contractor shall request this waiver.

Contractor shall state in writing that the Authority's warranty reimbursements will not be impacted. The Contractor also shall state in writing any exceptions and reimbursement including all costs incurred in transport of vehicles and/or components. At any time during the warranty period, the Contractor may request approval from the Authority to assign its warranty obligations to others, but only on a case-by-case basis approved in writing by the Authority. Otherwise, the Contractor shall be solely responsible for the administration of the warranty as specified. Warranty administration by others does not eliminate the warranty liability and responsibility of the Contractor.

1.4. Superior Warranty

The Contractor shall pass on to the Authority any warranty offered by a component Supplier that is superior to that required herein. The Contractor shall provide a list to the Authority noting the conditions and limitations of the Superior Warranty not later than the start of production. The Superior Warranty shall not be administered by the Contractor.

2. Fleet Defects

2.1. Occurrence and Remedy

A Fleet Defect is defined as cumulative failures of twenty-five (25) percent of the same components in the same or similar application in a minimum fleet size of twelve (12) or more buses where such items are covered by warranty. A Fleet Defect shall apply only to the base warranty period in sections entitled “Complete Bus,” “Propulsion System” and “Major Subsystems.” When a Fleet Defect is declared, the remaining warranty on that item/component stops. The warranty period does not restart until the Fleet Defect is corrected.

For the purpose of Fleet Defects, each option order shall be treated as a separate bus fleet. In addition, should there be a change in a major component within either the base order or an option order, the buses containing the new major component shall become a separate bus fleet for the purposes of Fleet Defects.

The Contractor shall correct a Fleet Defect under the warranty provisions defined in “Repair Procedures.” After correcting the Defect, the Authority and the Contractor shall mutually agree to and the Contractor shall promptly undertake and complete a work program reasonably designed to prevent the occurrence of the same Defect in all other buses and spare parts purchased under this Contract. Where the specific Defect can be solely attributed to particular identifiable part(s), the work program shall include redesign and/or replacement of only the defectively designed and/or manufactured part(s). In all other cases, the work program shall include inspection and/or correction of all the buses in the fleet via a mutually agreed-to arrangement. The Contractor shall update, as necessary, technical support information (parts, service and operator’s manuals) due to changes resulting from warranty repairs. The Authority may immediately declare a Defect in design resulting in a safety hazard to be a Fleet Defect. The Contractor shall be responsible to furnish, install and replace all defective units.

2.2. Exceptions to Fleet Defect Provisions

The Fleet Defect warranty provisions shall not apply to Authority-supplied items, such as radios, fare collection equipment, communication systems and tires. In addition, Fleet Defects shall not apply to interior and exterior finishes, hoses, fittings and fabric.

3. Repair Procedures

3.1. Repair Performance

The Contractor is responsible for all warranty-covered repair Work. To the extent practicable, the Authority will allow the Contractor or its designated representative to perform such Work. At its discretion, the Authority may perform such Work if it determines it needs to do so based on transit service or other requirements. Such Work shall be reimbursed by the Contractor.

3.2. Repairs by the Contractor

If the Authority detects a Defect within the warranty periods defined in this section, it shall, within thirty (30) days, notify the Contractor’s designated representative. The Contractor or its designated representative shall, if requested, begin Work on warranty-covered repairs within five calendar days after receiving notification of a Defect from the Authority. The Authority shall make the bus available to complete repairs timely with the Contractor’s repair schedule.

The Contractor shall provide at its own expense all spare parts, tools and space required to complete repairs. At the Authority's option, the Contractor may be required to remove the bus from the Authority's property while repairs are being performed. If the bus is removed from the Authority's property, then repair procedures must be diligently pursued by the Contractor's representative.

3.3. Repairs by the Authority

3.3.1. Parts Used

If the Authority performs the warranty-covered repairs, then it shall correct or repair the Defect and any Related Defects utilizing parts supplied by the Contractor specifically for this repair. At its discretion, the Authority may use Contractor-specified parts available from its own stock if deemed in its best interests.

3.3.2. Contractor-Supplied Parts

The Authority may require that the Contractor supply parts for warranty-covered repairs being performed by the Authority. Those parts may be remanufactured but shall have the same form, fit and function, and warranty. The parts shall be shipped prepaid to the Authority from any source selected by the Contractor within fourteen (14) days of receipt of the request for said parts and shall not be subject to an Authority handling charge.

3.3.3. Defective Component Return

The Contractor may request that parts covered by the warranty be returned to the manufacturing plant. The freight costs for this action shall be paid by the Contractor. Materials should be returned in accordance with the procedures outlined in "Warranty Processing Procedures."

3.3.4. Failure Analysis

The Contractor shall, upon specific request of the Authority, provide a failure analysis of Fleet Defect or safety-related parts, or major components, removed from buses under the terms of the warranty that could affect fleet operation. Such reports shall be delivered within 60 days of the receipt of failed parts.

3.3.5. Reimbursement for Labor and Other Related Costs

The Authority shall be reimbursed by the Contractor for labor, at a rate of $90.00 per hour, escalated 3% annually effective from the date of award. If the Authority tows any bus within the warranty period as described in section "Complete Bus", the Contractor will reimburse the Authority at the standard towing rate.

3.3.6. Reimbursement for Parts

The Authority shall be reimbursed by the Contractor for defective parts and for parts that must be replaced to correct the Defect. The reimbursement shall be at the current price at the time of repair and shall include taxes where applicable, plus 15 percent handling costs. Handling costs shall not be paid if parts are supplied by the Contractor and shipped to the Authority.

3.3.7. Reimbursement Requirements

The Contractor shall respond to the warranty claim with an accept/reject decision including necessary failure analysis no later than sixty (60) days after the Authority submits the claim and defective part(s), when requested. Reimbursement for all accepted claims shall occur no later than sixty (60) days from the date of acceptance of a valid claim. The Authority may dispute rejected claims or claims for which the Contractor did not reimburse the full amount. The parties agree to review disputed warranty claims during the following quarter to reach an equitable decision to permit the disputed claim to be resolved and closed. The parties also agree to review all claims at least once per quarter throughout the entire warranty period to ensure that open claims are being tracked and properly dispositioned.

3.3.8. Warranty after Replacement/Repairs

If any component, unit or subsystem is repaired, rebuilt or replaced by the Contractor or by the Authority with the concurrence of the Contractor, then the component, unit or subsystem shall have the unexpired warranty period of the original. Repairs shall not be warranted if Contractor-provided or authorized parts are not used for the repair, unless the Contractor has failed to respond within five days, in accordance with "Repairs by the Contractor."

If an item is declared to be a Fleet Defect, then the warranty stops with the declaration of the Fleet Defect. Once the Fleet Defect is corrected, the item(s) shall have three (3) months or remaining time and/or miles of the original warranty, whichever is greater. This remaining warranty period shall begin on the repair/replacement date for corrected items on each bus if the repairs are completed by the Contractor or on the date the Contractor provides all parts to the Authority.

3.3.9. Warranty Processing Procedures

The following list represents requirements by the Contractor to the Authority for processing warranty claims. One failure per bus per claim is allowed.

- bus number and VIN
- total vehicle life mileage at time of repair
- date of failure/repair
- acceptance/in-service date
- Contractor part number and description
- component serial number
- description of failure
- all costs associated with each failure/repair (invoices may be required for third-party costs):
- towing
- road calls
- labor
- materials
- parts
- handling
- troubleshooting time

3.3.10. Forms

The Authority's forms will be accepted by the Contractor if all of the above information is included. Electronic submittal may be used if available between the Contractor and the Authority.

3.3.11. Return of Parts

When returning defective parts to the Contractor, the Authority shall tag each part with the following:

- bus number and VIN
- claim number

- part number
- serial number (if available)

3.3.12. Timeframe

Each claim must be submitted no more than thirty (30) days from the date of failure and/or repair, whichever is later. All defective parts must be returned to the Contractor, when requested, no more than forty-five (45) days from the date of repair.

3.3.13. Reimbursements

Reimbursements are to be transmitted to the Authority or to the Authority’s contracted Service Provider(s), as determined by the Authority.

EXHIBIT H – AUTHORIZATION OF WORK PRODUCT

DESCRIPTION: **Gillig Hybrid Diesel Buses**
CONTRACT NO.: **500301**

Authority's Contracting Officer (CO)
A. The CO for administration of this Contract is **Sean Wighaman**
B. Phone: 512-369-6243
C. Email: sean.wighaman@capmetro.org

The Contracting Officer is responsible for the general administration of the Contract, negotiation of any changes, and issuance of written modifications, task order revisions, or Change Orders (as it pertains to Construction Contracts Only and results in a Contract modification – see below) to the Contract. If the parties desire to modify the Contract, or revise the Task Order of the Contract, in any way, only the Contracting Officer is authorized to issue a written modification for authorized signatures.

Authority's Project Manager (PM)
A. The PM for this Contract is **Jorge Flores**
B. Phone: 512-369-6271
C. Email: jorge.flores@capmetro.org

The Authority's PM for this Contract is responsible for the overall management and coordination of this Contract and will act as the central point of contact for the Authority. The PM has full authority to act for the Authority in the performance of any project connected to the Contract. However, the PM cannot authorize, in writing or orally, to commence any work. The PM shall meet with Contractor's PM to discuss problems as they occur. Any changes, including changes pursuant to the Changes clause in the Contract, will be handled solely by the CO. As needed, the Authority's PM may assist with development of Change Orders and Contract modifications with the Authority's CO.

Field Change Orders (Construction Contracts Only) – The Authority's PM is permitted to authorize work when an event occurs in the field during construction which requires immediate action. Immediately, but no later than three (3) business days following such action, the Authority's PM must provide a signed Change Order to the CO along with any other required procurement documentation in order to memorialize the Change Order in a task order revision or Contract modification.

The Contractor understands that should Contractor perform any work prior to written authorization by the Authority's CO, Contractor is not allowed to invoice for any additional cost or fee for services or goods under the Contract, nor is the Authority liable for any payment for any unauthorized work.

SIGNED and DATED

Contractor WILLIAM F. FAY, JR., VICE PRESIDENT SALES	DECEMBER 19, 2025 Date
E-SIGNED by Jorge Flores on 2025-12-22 16:00:08 GMT Authority's Project Manager (PM)	December 22, 2025 Date
E-SIGNED by Sean Wighaman on 2025-12-22 16:00:37 GMT Authority's Contracting Officer (CO)	December 22, 2025 Date