EXHIBIT 3.3

TRANSIT BUS
HEAVY DUTY TRANSIT BUS
TECHNICAL SPECIFICATIONS

SCOPE

NOTICE: This specification is NOT intended to restrict competition. All vehicles described herein will be used to provide ADA-accessible fixed route, route deviation, complementary paratransit, and/or demand response-type service. Vehicles will be expected to operate daily on all types of roads and in all types of climates. Vehicles will be started and stopped frequently, resulting in demands on the drivetrain, suspension, and braking systems. Components must be of the heaviest-duty available in order to provide maximum durability and reliability. Acceptable vehicles will provide safe, comfortable, and dependable operation throughout their useful service life.

Technical specifications define requirements for heavy-duty transit buses, which, by the selection of specifically identified alternative configurations, may be used for both suburban express service and general service on urban arterial streets. Buses shall have a minimum expected life of twelve (12) years or 500,000 miles, whichever comes first, and are intended for the widest possible spectrum of passengers, including children, adults, the elderly and people with disabilities.

SECTION 1. GENERAL REQUIREMENTS

1.1 The price quoted in any proposal submitted shall include all items of labor, material, tools, equipment, and other costs necessary to fully complete the manufacture and delivery of the vehicles here specified. The proposer shall not omit any part or detail which goes to make the vehicle ready for service, even if such part or detail is not addressed in this specification.

1.2 All parts, equipment, and accessories shall be new and completely installed, assembled, and/or adjusted as required. All exposed edges and surfaces shall be smooth, free from burrs and other projections and shall be neatly finished. Interior and exterior shall be washed and clean and vehicle shall arrive with a full tank of fuel. This specification is designed to require a complete vehicle of the class described that is constructed within agreed upon timeframes and ready for immediate operation upon delivery.

1.3 Whenever a specific trade or product name is used within this specification, the following statements apply: "… or approved equal with the same standards of quality, design and performance," and "…if available." All requests for approved equals must be submitted in accordance with the Request for Pre-Offer Change or Approved Equal or with the Form for Proposal Deviation.

SECTION 2. LEGAL REQUIREMENTS

2.1 The bus shall meet all applicable Federal Motor Vehicle Safety Regulations (FMVSS), Federal Motor Carrier Safety Regulations (FMCSR), and the Environmental Protection Agency (EPA) regulations in effect at the date of manufacture and the Manufacturer shall so certify. Manufacturers must be certified by the National Traffic Safety Administration to manufacture or alter vehicles in accordance with the Code of Federal Regulations, Title 49, Parts 567-568.

2.2 The contractor shall comply with all federal, state, and local regulations, including Altoona bus testing certification requirements. These shall include, but not be limited to, the Americans with Disabilities Act (ADA) as well as state and local accessibility, safety and security requirements. whether or not all specific regulations are addressed within the details of these vehicle specifications.

2.3 In the event of any conflict between the requirements of this specification and any applicable legal

requirements, the legal requirements shall prevail. Technical requirements that exceed the legal requirements are not considered to conflict.

SECTION 3. DEFINITIONS

(1) **Alternative.** An alternative specification condition to the default bus configuration. ITP may define alternatives to the default configuration to satisfy local operating requirements. Alternatives for the default configuration will be clearly identified.

(2) **Ambient Temperature.** The temperature of the surrounding air. For testing purposes, ambient temperature must be between 16 °C (50 °F) and 38 °C (100 °F).

(3) **Analog Signals.** A continuously variable signal that is solely dependent upon magnitude to express information content.

(4) **Audible Discrete Frequency:** An audible discrete frequency is determined to exist if the sound power level in any 1/3-octave band exceeds the average of the sound power levels of the two adjacent 1/3- octave bands by 4 decibels (dB) or more.

(5) **Battery Compartment.** Low-voltage energy storage, i.e. 12/24 VDC batteries.

(6) **Battery Management System (BMS).** Monitors energy, as well as temperature, cell or module voltages, and total pack voltage. The BMS adjusts the control strategy algorithms to maintain the batteries at uniform state of charge and optimal temperatures.

(7) **Braking Resistor.** Device that converts electrical energy into heat, typically used as a retarder to supplement or replace the regenerative braking.

(8) **Burst Pressure.** The highest pressure reached in a container during a burst test.

(9) **Capacity (fuel container).** The water volume of a container in gallons (liters).

(10) **Cells.** Individual components (i.e., battery or capacitor cells).

(11) **Code.** A legal requirement.

(12) **Combination Gas Relief Device.** A relief device that is activated by a combination of high pressures or high temperatures, acting either independently or together.

(13) **Composite Container for CNG.** A container fabricated of two or more materials that interact to facilitate the container design criteria.

(14) **Compressed Natural Gas (CNG).** Mixtures of hydrocarbon gases and vapors consisting principally of methane in gaseous form that has been compressed for use as a vehicular fuel.

(15) **Container.** A pressure vessel, cylinder, or cylinders permanently manifolded together used to store CNG.

(16) **Container Appurtenances.** Devices connected to container openings for safety, control or operating purposes.

(17) **Container Valve.** A valve connected directly to a container outlet.

(18) **Curb Weight.** Weight of vehicle, including maximum fuel, oil and coolant; and all equipment required for operation and required by this Specification, but without passengers or driver.

(19) **dBA.** Decibels with reference to 0.0002 microbar as measured on the “A” scale.

(20) **DC to DC Converter.** A module which converts a source of direct current (DC) from one voltage level to another.

(21) **Default Configuration Bus.** The bus described if no alternatives are selected. Signing, colors, the destination sign reading list and other information must be provided by the Purchasing Entity.

(22) **Defueling.** The process of removing fuel from a tank.

(23) **Defueling Port.** Device which allows for vehicle defueling, or the point at which this occurs.

(24) **Destroyed.** Physically made permanently unusable.

(25) **Discrete Signal.** A signal that can take only pre-defined values, usually of a binary 0 or 1 nature where 0 is battery ground potential and 1 is a defined battery positive potential.

(26) **DPF.** Diesel particulate filter.

(27) **Driver's Eye Range.** The 95th-percentile ellipse defined in SAE Recommended Practice J941, except that the height of the ellipse shall be determined from the seat at its reference height.

(28) **Energy Density.** The relationship between the weight of an energy storage device and its power output in units of watt-hours per kilogram (Wh/kg).

(29) **Energy Storage System (ESS).** A component or system of components that stores energy and for which its supply of energy is rechargeable by a PPU and/or an off-vehicle energy source.

(30) **Flow Capacity.** For natural gas flow, this is the capacity in volume per unit time (normal cubic meters/minute or standard cubic feet per minute) discharged at the required flow rating pressure.

(31) **Fuel Line.** The pipe, tubing or hose on a vehicle, including all related fittings, through which natural gas passes.

(32) **Fusible Material.** A metal, alloy or other material capable of being melted by heat.

(33) **Fire Resistant.** Materials that have a flame spread index less than 150 as measured in a radiant panel flame test per ASTM-E 162-90.

(34) **Fireproof.** Materials that will not burn or melt at temperatures less than 2000 °F.

(35) **Free Floor Space:** Floor area available to standees, excluding the area under seats, area occupied by feet of seated passengers, the vestibule area forward of the standee line, and any

floor space indicated by manufacturer as non-standee areas such as, the floor space “swept” by passenger doors during operation. Floor area of 1.5 sq. ft. shall be allocated for the feet of each seated passenger that protrudes into the standee area.

(36) **Fuel Management System.** Natural gas fuel system components that control or contribute to engine air fuel mixing and metering, and the ignition and combustion of a given air-fuel mixture. The fuel management system would include, but is not limited to, reducer/regulator valves, fuel metering equipment (e.g. carburetor, injectors), sensors (e.g., main throttle, wastegate).

(37) **GAWR (Gross Axle Weight Rated).** The maximum total weight as determined by the axle manufacturer, at which the axle can be safely and reliably operated for its intended purpose.

(38) **Gross Load.** 150 lbs. for every designed passenger seating position, for the driver, and for each 1.5 square feet of free floor space.

(39) **GVW (Gross Vehicle Weight).** Curb weight plus gross load.

(40) **GVWR (Gross Vehicle Weight Rated):** The maximum total weight as determined by the vehicle manufacturer, at which the vehicle can be safely and reliably operated for its intended purpose.

(41) **High Pressure.** Those portions of the CNG fuel system that see full container or cylinder pressure.

(42) **High Voltage (HV).** Greater than 50 volts (AC and DC).

(43) **Hose:** Flexible line.

(44) **Hybrid.** A vehicle that uses two or more distinct power sources to propel the vehicle.

(45) **Hybrid System Controller (HSC).** Regulates energy flow throughout hybrid system components in order to provide motive performance and accessory loads, as applicable, while maintaining critical system parameters (voltages, currents, temperatures, etc.) within specified operating ranges.

(46) **Hybrid Drive System (HDS).** The mechanical and/or electromechanical components, including the PPU and energy storage system, which comprise the traction drive portion of the hybrid propulsion system.

(47) **Intermediate Pressure.** The portion of a CNG system after the first pressure regulator, but before the engine pressure regulator. Intermediate pressure on a CNG vehicle is generally from 3.5 to 0.5 MPa (510 to 70 psi).

(48) **Inverter.** A module that converts DC to and from AC.

(49) **Labeled.** Equipment or materials to which has been attached a label, symbol or other identifying mark of an organization, which is acceptable to the authority having jurisdiction and concerned with product evaluation, which maintains periodic inspection of production labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

(50) **Leakage.** Release of contents through a Defect or crack. See *Rupture*.

(51) **Line:** All tubes, flexible and hard, that carry fluids.

(52) **Liner.** Inner gas-tight container or gas container to which the overwrap is applied.

(53) **Local Regulations.** Regulations below the state level.

(54) **Low-Floor Bus.** A bus that, between at least the front (entrance) and rear (exit) doors, has a floor sufficiently low and level so as to remove the need for steps in the aisle between the doors and in the vicinity of these doors.

(55) **Low Voltage (LV).** 50 volts or less (AC and DC).

(56) **Lower Explosive Limit.** The lowest concentration of gas where, given an ignition source, combustion is possible.

(57) **Maximum Service Temperature.** The maximum temperature to which a container/cylinder will be subjected in normal service.

(58) **Metallic Hose.** A hose whose strength depends primarily on the strength of its metallic parts; it can have metallic liners or covers, or both.

(59) **Metering Valve.** A valve intended to control the rate of flow of natural gas.

(60) **Module.** Assembly of individual components

(61) **Motor (Electric).** A device that converts electrical energy into mechanical energy.

(62) **Motor (Traction).** An electric motor used to power the driving wheels of the bus.

(63) **Operating Pressure.** The varying pressure developed in a container during service.

(64) **Physical Layer.** The first layer of the seven-layer International Standards Organization (ISO) Open Systems Interconnect (OSI) reference model. This provides the mechanical, electrical, functional and procedural characteristics required to gain access to the transmission medium (e.g., cable) and is responsible for transporting binary information between computerized systems.

(65) **Pipe:** Nonflexible line.

(66) **Pressure Relief Device (PRD).** A pressure and/or temperature activated device used to vent the container/cylinder contents and thereby prevent rupture of a NGV fuel container/cylinder, when subjected to a standard fire test as required by fuel container/cylinder standards.

NOTE: Since this is a pressure-activated device, it may not protect against rupture of the container when the application of heat weakens the container to the point where its rupture pressure is less than the rated burst pressure of the relief device, particularly if the container is partially full.

(67) **Power.** Work or energy divided by time

(68) **Power Density.** Power divided by mass, volume or area.

(69) **Propulsion System.** System that provides propulsion for the vehicle proportional to operator commands. Includes, as applicable, the HDS, energy storage system and the hybrid system controller.

(70) **Real-Time Clock (RTC).** Computer clock that keeps track of the current time.

(71) **Regenerative Braking.** Deceleration of the bus by switching motors to act as generators, which return vehicle kinetic energy to the energy storage system.

(72) **Rejectable Damage.** In terms of NGV fuel containers/cylinders, this is damage as outlined in CGA C-6.4, “Methods for External Visual Inspection of Natural Gas Vehicle Fuel Containers and Their Installations,” and in agreement with the manufacturer’s recommendations.

(73) **Retarder.** Device used to augment or replace some of the functions of primary friction based braking systems of the bus.

(74) **Rupture.** Sudden and unstable damage propagation in the structural components of the container resulting in a loss of contents. See *Leakage*.

(75) **Seated Load.** 150 lbs. for every designed passenger seating position and for the driver.

(76) **SLW (Seated Load Weight).** Curb weight plus seated load.

(77) **Serial Data Signals.** A current loop based representation of ASCII or alphanumeric data used for transferring information between devices by transmitting a sequence of individual bits in a prearranged order of significance.

NOTE: An example is the communication that takes place between two or more electronic components with the ability to process and store information.

(78) **Service Pressure.** The settled pressure at a uniform gas temperature of 21 °C (70 °F) and full gas content. It is the pressure for which the equipment has been constructed, under normal conditions. Also referred to as the nominal service pressure or working pressure.

(79) **Settled Pressure.** The gas pressure when a given settled temperature, usually 21 °C (70 °F), is reached.

(80) **Settled Temperature.** The uniform gas temperature after any change in temperature caused by filling has dissipated.

(81) **Solid State Alternator.** A module that converts high-voltage DC to low-voltage DC (typically 12/24 volt systems).

(82) **Sources of Ignition.** Devices or equipment that because of their modes of use or operation, are capable of providing sufficient thermal energy to ignite flammable compressed natural gas-air mixtures when introduced into such a mixture, or when such a mixture comes into contact with them

(83) **Special Tools.** Tools not normally stocked by the Purchasing Entity.

(84) **Specification.** A particular or detailed statement, account, or listing of the various elements, materials, dimensions, etc. involved in the manufacturing and construction of a product.

(85) **Standard.** A firm guideline from a consensus group.

(86) **Standards.** Standards referenced in “Part 5: Technical Specifications” are the latest revisions unless otherwise stated.

(87) **Standee Line.** A line marked across the bus aisle to designate the forward area that passengers may not occupy when the bus is moving.

(88) **State of Charge (SOC).** Quantity of electric energy remaining in the battery relative to the maximum rated Amp hour (Ah) capacity of the battery expressed in percent. This is a dynamic measurement used for the energy storage system. A full SOC indicates that the energy storage system cannot accept further charging from the engine driven generator or the regenerative braking system.

(89) **Stress Loops.** The “pig-tails” commonly used to absorb flexing in piping.

(90) **Structure.** The structure shall be defined as the basic body, including floor deck material and installation, load bearing external panels, structural components, axle mounting provisions and suspension beams and attachment points.

(91) **Thermally Activated Gas Relief Device.** A relief device that is activated by high temperatures and generally contains a fusible material.

NOTE: Since this is a thermally activated device, it does not protect against over-pressure from improper charging practices.

(92) **Wheelchair.** A mobility aid belonging to any class of three- or four-wheeled devices, usable indoors, designed for and used by individuals with mobility impairments, whether operated manually or powered.

SECTION 4. VEHICLE REQUIREMENTS

4.1. WEIGHT

4.1.1. It shall be a design goal to construct each bus as light in weight as possible without degradation of safety, appearance, comfort, traction or performance.

4.1.2. Buses at a capacity load shall not exceed the tire factor limits, brake test criteria or structural design criteria.

4.2. CAPACITY - The vehicle shall be designed to carry the gross vehicle weight, which shall not exceed the bus GVWR.

4.3. SERVICE LIFE - The minimum useful design life of the bus in transit service shall be at least twelve (12) years or 500,000 miles. It shall be capable of operating at least 40,000 miles per year, including the 12th year.

4.4. MAINTENANCE AND INSPECTION

4.4.1. Scheduled maintenance tasks shall be related and shall be, in accordance with the manufacturer's recommended preventative maintenance schedule (along with routine daily service performed during the fueling operations).

4.4.2. Test ports, as required, shall be provided for commonly checked functions on the bus, such as air intake, exhaust, hydraulic, pneumatic, charge-air and engine cooling systems.

4.4.3. The coach manufacturer shall give prime consideration to the routine problems of maintaining the vehicle. All coach components and systems, both mechanical and electrical, which will require periodic physical Work or inspection processes shall be installed so that a minimum of time is consumed in gaining access to the critical repair areas. It shall not be necessary to disassemble portions of the coach structure and/or equipment such as seats and flooring under seats in order to gain access to these areas. Each coach shall be designed to facilitate the disassembly, reassembly, servicing or maintenance, using tools and equipment that are normally available as standard commercial items.

4.4.4. Requirements for the use of unique specialized tools will be minimized. The body and structure of the coach shall be designed for ease of maintenance and repair. Individual panels or other equipment which may be damaged in normal service shall be repairable or replaceable. Ease of repair shall be related to the vulnerability of the item to damage in service.

Contractor shall provide a list of all special tools and pricing required for maintaining this equipment. Said list shall be submitted as a supplement to the Pricing Schedule.

NOTE: Tools such as compartment door keys, bellows gauges and other tools that are required for daily maintenance and inspections shall not be included in the special tool list and shall be furnished for each coach.

4.5. INTERCAHNGEABILITY

4.5.1. Unless otherwise agreed, all units and components procured under this Contract, whether provided by Suppliers or manufactured by the Contractor, shall be duplicates in design, manufacture and installation to ensure interchangeability among buses in each order group in this procurement. This interchangeability shall extend to the individual components as well as to their locations in the buses. These components shall include, but are not limited to, passenger window hardware, interior trim, lamps, lamp lenses and seat assemblies. Components with non-identical functions shall not be, or appear to be, interchangeable.

4.5.2. Any one component or unit used in the construction of these buses shall be an exact duplicate in design, manufacture and assembly for each bus in each order group in this Contract. Contractor shall identify and secure approval for any changes in components or unit construction provided within a Contract.

4.5.3. In the event that the Contractor is unable to comply with the interchangeability requirement, the Contractor must notify Purchasing Entity and obtain Purchasing Entity's prior written approval, including any changing in pricing.

The Purchasing Entity shall review proposed product changes on a case-by-case basis and shall have the right to require extended warranties to ensure that product changes perform

as least as well as the originally supplied products.

4.6. TRAINING

4.6.1. The Contractor shall have at least one qualified instructor who shall be available at The Purchasing Entity's (or one of its joint procurement partners) property for as many days and for as many hours as necessary per month for one month prior to, and up to three months after, acceptance of the first bus. Instructor(s) shall conduct schools and advise the personnel of the Purchasing Entity on the proper operation and maintenance of the equipment. The Contractor also shall provide visual and other teaching aids (such as manuals, slide presentations and literature) for use by the Purchasing Entity's own training staff and which become the property of the Purchasing Entity. The training program shall be divided into two (2) complete sections, one section for the Maintenance personnel and the other section for Transportation personnel.

4.6.2. A detailed schedule and lesson plan must be provided; for both the Maintenance and Transportation, training program, ninety (90) days before the scheduled delivery date of the first bus; for review and approval by the Purchasing Entity. The Contractor shall include, as part of the lesson plan, the name of the instructors. Utilization of vendor presenters is encouraged and supported by the Purchasing Entity. The Contractor is responsible for scheduling and costs of vendor presenters. Training may occur on 1st, 2nd or 3rd shift depending on agencies schedule.

4.6.3. Courses of instruction shall consist of the following, but not limited to: Operator and Maintenance Orientation, Operator Training, Electrical/Multiplexing, Engine and Accessories, Transmission/Powertrain, HVAC, Doors, Mobility/ADA Lift-Ramp-Securement Devices, Brakes and Air Systems, Suspension/Steering/Axles, and Body Components.

4.6.4. Technical/Service Representatives - The Contractor shall, at its own expense, have one or more competent technical service representatives available on request to assist the Purchasing Entity in the solution of engineering or design problems within the scope of the specifications that may arise during the warranty period. This does not relieve the Contractor of responsibilities under the provisions of "Section 7: Warranty Requirements."

4.7. OPERATING ENVIRONMENT - The bus shall achieve normal operation in ambient temperature ranges of 10 ºF to 115 ºF, at relative humidity between 5 percent and 100 percent, and at altitudes up to 3000 feet above sea level. Degradation of performance due to atmospheric conditions shall be minimized at temperatures below 10 °F, above 115 °F or at altitudes above 3000 feet. Altitude requirements above 3000 feet will need separate discussions with the engine manufacturer to ensure that performance requirements are not compromised. Speed, gradability and acceleration performance requirements shall be met at, or corrected to, 77 °F, 29.31 in. Hg, dry air per SAE J1995.

4.8. NOISE

4.8.1. INTERIOR NOISE

4.8.1.1. The combination of inner and outer panels and any material used between them shall provide sufficient sound insulation so that a sound source with a level of 80 dBA measured at the outside skin of the bus shall have a sound level of 65 dBA or less at any point inside the bus. These conditions shall prevail with all openings, including doors and windows, closed and with the engine and

accessories switched off.

4.8.1.2. The bus-generated noise level experienced by a passenger at any seat location in the bus shall not exceed 80 dBA. The driver area shall not experience a noise level of more than 75 dBA.

4.8.2. EXTERIOR NOISE - Airborne noise generated by the bus and measured from either side shall not exceed 80 dBA under full power acceleration when operated 0 to 35 mph at curb weight. The maximum noise level generated by the bus pulling away from a stop at full power shall not exceed 83 dBA. The bus-generated noise at curb idle shall not exceed 65 dBA. If the noise contains an audible discrete frequency, a penalty of 5 dBA shall be added to the sound level measured. The Contractor shall comply with the exterior noise requirements defined in local laws and ordinances identified by the Purchasing Entity and SAE J366.

4.9. FIRE SAFETY

4.9.1. The bus shall be designed and manufactured in accordance with all applicable fire safety and smoke emission regulations. These provisions shall include the use of fire-retardant/low-smoke materials, fire detection systems, bulkheads and facilitation of passenger evacuation.

4.9.2. An automatic fire suppression system will be provided. At least five (5) temperature sensitive fire detection sensors shall be provided. They shall be located in the engine compartment under all horizontal bulkheads, above and downwind of the major heat sources, and in areas likely to be wetted by leaking flammable fluids. Additional sensors shall be located in other potentially critical areas. The sensors shall detect over temperature in the critical areas and shall activate the fire alarm bell and warning light in the driver's compartment. The sensors shall return to their normal setting and deactivate alarms when the temperature returns to normal.

4.9.3. All materials used in the construction of the passenger compartment of the bus shall be in accordance with the Recommended Fire Safety Practices defined in FMVSS 302, dated October 20, 1993. Materials entirely enclosed from the passenger compartment, such as insulation within the sidewalls and sub-floor, need not comply. In addition, smaller components and items, such as seat grab rails, switch knobs and small light lenses, shall be exempt from this requirement.

4.10. RESPECT FOR THE ENVIRONMENT - In the design and manufacture of the bus, the Contractor shall make every effort to reduce the amount of potentially hazardous waste. In accordance with Section 6002 of the Resource Conservation and Recovery Act, the Contractor shall use, whenever possible and allowed by the specifications, recycled materials in the manufacture of the bus.

4.11. DIMENSIONS

4.11.1. PHYSICAL SIZE - With exceptions such as exterior mirrors, marker and signal lights, bumpers, fender skirts, washers, wipers, ad frames, cameras, object detection systems, bicycle racks, feelers and rub rails, the bus shall have the following overall dimensions at static conditions and design height.

4.11.2. BUS LENGTH - For ease of use, the following tolerances will be allowable for each given bus length. Bus length is determined as the measurement from bumper to bumper.

- **30-ft bus:** 29 ft., 11 in. to 34 ft., 11 in.
- **35-ft bus:** 35 ft to 39 ft, 11 in.
- **40-ft bus:** 40 ft. to 44 ft., 11 in.

4.11.3. BUS WIDTH – BODY WIDTH SHALL BE 102 (+0, -1 In).

4.11.4. BUS HEIGHT

4.11.4.1. MAXIMUM OVERALL HIGHT - Maximum overall height shall be 140 in., including all rigid, roof-mounted items such as A/C, exhaust, fuel system and cover, CNG fuel tanks, etc,

4.11.4.2. STEP HEIGHT - The step height shall not exceed 16.5 in. at either doorway without kneeling and shall not exceed 15.5 in. at the step. A maximum of two steps is allowed to accommodate a raised aisle floor in the rear of the bus.

4.11.4.3. UNDERBODY CLEARANCE - The bus shall maintain minimum clearance dimensions as defined in SAE Standard J689, regardless of load up to the gross vehicle weight rating.

4.11.4.4. RAMP CLEARANCES

a) The approach angle is the angle measured between a line tangent to the front tire static loaded radius arc and the initial point of structural interference forward of the front tire to the ground.

b) The departure angle is the angle measured between a line tangent to the rear tire static loaded radius arc and the initial point of structural interference rearward of the rear tire to the ground.

c) The breakover angle is the angle measured between two lines tangent to the front and rear tire static loaded radius and intersecting at a point on the underside of the vehicle that defines the largest ramp over which the vehicle can roll.

Angle	30-to-40-ft Bus
Approach	8.6 degrees (min.)
Front breakover	8 degrees (min.)
Departure	8.7 degrees (min.)

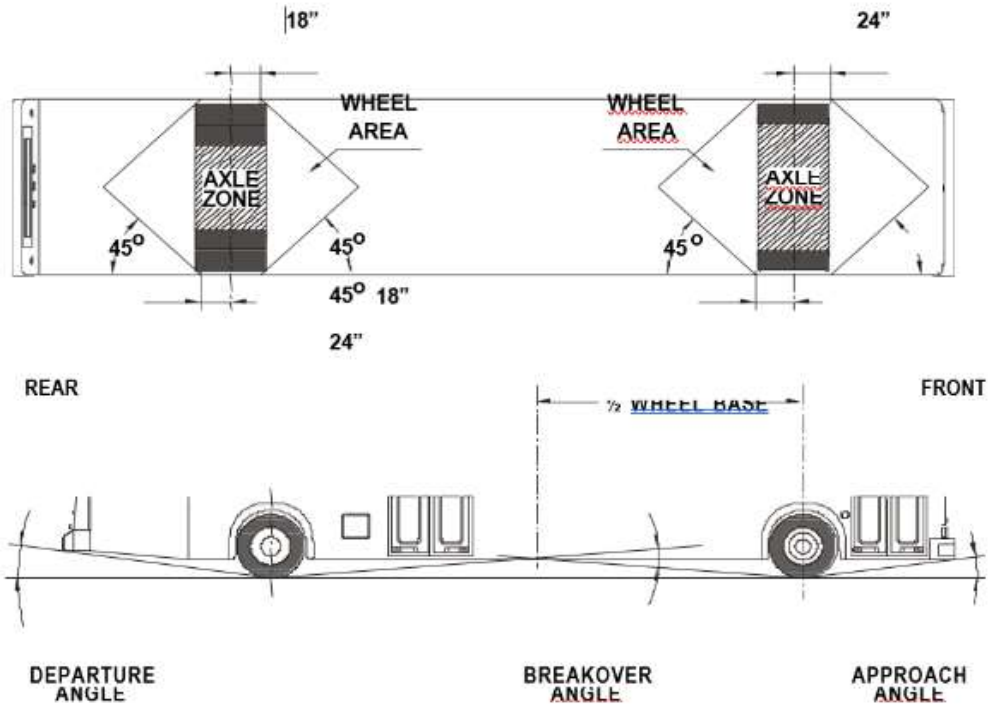
4.11.4.5. GROUND CLEARANCE

a) Ground clearance shall be no less than 9 in., (8 in. at jacking pad) except within the axle zone and wheel area.

b) Axle zone clearance, which is the projected area between tires and wheels on the same axial centerline, shall be no less than 5.4 in.

c) Wheel area clearance shall be no less than 8 in. for parts fixed to the bus body and 6 in. for parts that move vertically with the axles.

Transit Bus Minimum Road Clearance



4.11.4.6. FLOOR HEIGHT - Height of the step above the street shall be no more than 16 in. measured at the centerline of the front and rear doorway. The floor may be inclined along the longitudinal axis of the bus, and the incline shall not exceed 3.5 degrees off the horizontal except locally at the doors where 2 degree slope toward the door is allowed. All floor measurements shall be with the bus at the design running height and on a level surface and with the standard installed tires. A maximum of two steps is allowed to accommodate a raised aisle floor in the rear of the bus.

4.11.4.7. INTERIOR HEADROOM - Headroom above the aisle and at the centerline of the aisle seats shall be no less than 78 in. in the forward half of the bus tapering to no less than 74 in. forward of the rear settee. At the centerline of the window seats, headroom shall be no lower than 65 in., except for parcel racks and reading lights, if specified. Headroom at the back of the rear bench seat may be reduced to a minimum of 56 in., but it shall increase to the ceiling height at the front of the seat cushion. In any area of the bus directly over the head of a seated passenger and positioned where a passenger entering or leaving the seat is prone to strike his or her head, padding shall be provided on the overhead paneling.

4.11.4.8. AISLE WIDTH

4.11.4.8.1. The minimum clear aisle width between pairs of transverse seats with all

attached hardware shall be at least 22 in.

4.11.4.8.2. The aisle width between the front wheelhouses shall be at least 35.5 in., and the entire area between the front wheelhouses shall be available for passengers and mobility aid devices.

4.11.4.9. BRT STYLING OPTION

4.11.4.9.1. The contractor shall bid a BRT styling package as an option

4.11.4.9.2. The BRT styled bus shall be a modern aerodynamic looking, smooth sided, and aesthetically pleasing design.

4.11.4.9.3. The front cap shall be a composite material and shall have a two-piece windshield glazing design that includes an integrated destination sign glass and windshield defroster system. The street side glazing shall have a tint band. The front cap shall have a left and right front quarter window, with dedicated quarter window wipers for safety and to minimize accumulation of splash and spray. The front roof appearance shall be enhanced by a composite forward roof top fairing to provide an advanced aerodynamic look. The Headlamps shall be of a modern appearance, long life projection beam type. The front turn signals shall be of modern, LED style de- sign, which complements the front headlamps.

ALTERNATIVE: As an alternative, a one-piece windshield design shall be made available and priced separately.

4.11.4.9.4. The Mirrors shall be Class A type and well suited to enhance and compliment the clean aerodynamic design. The mirrors shall be high mounted, aesthetically pleasing and aerodynamically styled. Glazing's shall be two-pieced flat face and convex and shall be heated and remote operated.

ALTERNATIVE: As an alternative, low mount mirrors shall be made available and priced separately.

4.11.4.9.5. The front and rear close out shall be of advanced / composite design to complement the front cap and wrap- around the front corners of the bus. The close out / chassis / front bumper areas shall be able to support a bike rack if needed. The front and rear bumpers need to complement the aerodynamic styling of the bus and shall be of black (unpainted) energy absorbing material.

4.11.4.9.6. The rear of the coach will have a smooth, modern designed; composite body cap shall have an advanced aerodynamic shape that maintains and complements the aerodynamics of the coach.

4.11.4.9.7. The rear composite cap will have full opening engine and air conditioning compartment doors with door props suited to support and hold open the compartment doors. The rear appearance shall be further complemented by an aerodynamically shaped upper roof fairing that is opposite in shape of the front faring, maintaining the aerodynamic styling.

4.11.4.9.8. The rear tail lamps shall include three lamps, stop, turn and reverse, all of a 4" LED design along with a third center mounted LED brake lamp.

4.12. VEHICLE PERFORMANCE

4.12.1. POWER REQUIREMENTS - The propulsion system shall be sized to provide sufficient power to enable the bus to meet the defined acceleration, top speed, and gradability requirements, and operate all propulsion-driven accessories using actual road test results and computerized vehicle performance data.

4.12.1.1. TOP SPEED - The bus shall be capable of achieving a top speed of 65 mph on a straight, level road at GVWR with all accessories operating. The bus shall be capable of safely maintaining the vehicle speed according to the recommendations by the tire manufacturer.

NOTE: Values are assumed to be sustained. Manufacturer shall supply the Purchasing Entity with data if there is a variance between peak performance and sustained vehicle performance.

4.12.1.2. GRADEABILITY

4.12.1.2.1. Gradeability requirements shall be met on grades with a dry commercial asphalt or concrete pavement at GVWR with all accessories operating.

4.12.1.2.2. The propulsion system and drivetrain shall enable the bus to achieve and maintain a speed of 40 mph on a 2½ percent ascending grade and 15 mph on a 10 percent ascending grade continuous.

NOTE: Values are assumed to be sustained. Manufacturer shall supply the Purchasing Entity with data if there is a variance between peak performance and sustained vehicle performance.

4.12.1.2.3. ACCELERATION - The acceleration shall meet the requirements below and shall be sufficiently gradual and smooth to prevent throwing standing passengers off-balance. Acceleration measurement shall commence when the accelerator is depressed.

Maximum Start Acceleration Times on a Level Surface[1]

Speed (mph)	Maximum time (seconds)
10	5
20	10
30	18
40	30
50	60
Top speed	

1. Vehicle weight = GVWR

4.12.1.2.4. OPERATING RANGE - The operating range of the coach shall be designed to

meet the operating profile.

a) **DIESEL -** The operating range of the coach when run on the Altoona Test cycle shall be at least 400 mi (644 km) or 22 hrs. with full fuel capacity.

b) **CNG - t**he operating range of the coach when run on the Altoona Test cycle shall be at least 350 mi (564 km) with an initial gas settled pressure of 3600 psi at 70 degrees F.

c) **HYBRID**
- The operating range of the coach when run on the Altoona Test cycle shall be at least 400 mi on a full tank of fuel.
- Energy storage system state of charge connection methods stated in SAE J2711 shall be utilized.

d) **ELECTRIC**

4.12.2. FUEL ECONONY - Test results from the Altoona fuel economy tests or other applicable test procedures shall be provided to the Purchasing Entity. Results shall include vehicle configuration and test environment information. Fuel economy data shall be provided for each design operating profile. The design operating profile is assumed to be defined by the Altoona fuel duty cycle. The Purchasing Entity will provide a percentage of each duty cycle that is representative of Agency's service.

4.12.2.1. HYBRID - Energy storage system state of charge correction methods stated in SAE J2711 shall be utilized.

4.13. POWER PLANT

4.13.1. ENGINE

4.13.1.1. The engine shall comply with applicable local, state, and/or federal emissions and useful life requirements. The engine shall operate for 300,000 miles on the design operating profile without major failure or significant deterioration. Components of the fuel management and/or control system shall have a design life of not less than 150,000 miles without replacement or major service. The lifetime estimate is based on the design operating profile.

4.13.1.2. The engine shall be equipped with an electronically controlled management system, compatible with either 12- or 24-volt power distribution. The engine control system shall be capable of transmitting and receiving electronic inputs and data from other drivetrain components and broadcasting that data to other vehicle systems. Communication between electronic drivetrain components and other vehicle systems shall be made using the communications networks. The engine's electronic management system shall monitor operating conditions and provide instantaneous adjustments to optimize both engine and bus performance. The system shall be programmable to allow optimization of programmable features.

4.13.1.3. The engine starting system shall be protected by an interlock that prevents its

engagement when the engine is running. Special equipment or procedures may be employed to start the bus when exposed to temperatures less than 30 °F for a minimum of four hours without the engine in operation. All cold weather starting aids, engine heating devices and procedures shall be of the type recommended by the engine manufacturer and approved by the Purchasing Entity. The integration of all systems on the vehicle relative to engine idle speed shall be the responsibility of the vehicle manufacturer to meet the requirements of the transit property.

4.13.1.4. The engine control system shall protect the engine against progressive damage. The system shall monitor conditions critical for safe operation and automatically de-rate power and/or speed and initiate engine shutdown as needed.

4.13.1.5. The base engine shall be a CUMMINS MODEL L9 series engine, inline 6 cylinder, 4 cycle, 8.9 liter, charge- air-cooled and turbocharged rated at 280 hp. @ 1930 rpm and a minimum of 925 ft. lbs. torque @ 1200 RPM, equipped in compliance with all applicable EPA regulations in effect or approved equal.

4.13.1.5.1. ENGINE (CNG)
ALTERNATIVE: A Cummins L9N engine meeting all regulatory requirements when operating on fuel equal to CARB Specifications for Compressed Natural Gas #2292.5 will be provided. The four predominant characteristics that must be met are Methane, Ethane, Butane, and Propane. The L9N engine shall be made available for the Hybrid bus option.

4.13.1.5.2. BASE ENGINE (DIESEL)
ALTERNATIVE:**:** A Cummins model B6.7 280 HP engine shall be made available for the Hybrid bus package.

(a) Engine – Diesel

(1) The preferred engine shall be powered by a Cummins L9 280 HP diesel engine or approved equal capable of providing the performance to satisfy the operating conditions in geo- graphical areas throughout the state of Michigan. The engine shall have a minimum design life of 12 years or 500,000 miles, whichever comes first, and it shall be designed to require no more than one (1) major overhaul to achieve this lifetime. The engine and the trans- mission shall be compatible with each other in that the electronic controls of the engine shall interface with the transmission and vice versa, if controls are used. Engine shall meet all current Federal EPA requirements. A copy of the engine certification shall be supplied with the proposal.

(2) The engine shall comply with applicable local, state, and/or federal emissions and useful life requirements. Components of the fuel management and/or control system shall have a design life of not less than 150,000 miles without replacement or major service. The lifetime estimate is based on the design operating profile.

(3) The engine shall be equipped with an electronically controlled

management system, compatible with either 12- or 24-volt power distribution. The engine control system shall be capable of transmitting and receiving electronic inputs and data from other drivetrain components and broadcasting that data to other vehicle systems. Communication between electronic drivetrain components and other vehicle systems shall be made using the communications networks. The engine's electronic management system shall monitor operating conditions and provide instantaneous adjustments to optimize both engine and bus performance. The system shall be programmable to allow optimization of programmable features.

(4) The engine starting system shall be protected by an interlock that prevents its engagement when the engine is running. Special equipment or procedures may be employed to start the bus when exposed to temperatures less than 30°F for a minimum of four hours without the engine in operation. All cold weather starting aids, engine heating devices and procedures shall be of the type recommended by the engine manufacturer and approved by the Purchasing Entity. The integration of all systems on the vehicle relative to engine idle speed shall be the responsibility of the vehicle manufacturer to meet the requirements of the transit property. A 120 volt @ 100 watt engine block heater will be located in the rear engine compartment.

(b) Automatic Engine Protection/Shutdown Override Feature

(1) The engine control system shall protect the engine against progressive damage. The system shall monitor conditions critical for safe operation and automatically de-rate power and/or speed and initiate engine shutdown as needed. The on-board diagnostic system shall trigger an audible alarm and warning light to signal the operator when the engine control unit detects a malfunction and the engine protection system is activated.

(2) Automatic shutdown shall occur when parameters established for the functions below are exceeded:

i. Coolant Level
ii. Coolant Temperature
iii. Oil Pressure
iv. Oil Temperature
v. Exhaust Temperature
vi. Fire Suppression

(3) The automatic shutdown for the Fire Suppression feature shall occur when the Fire Suppression system is discharged.

(4) A control shall be available to the operator, to allow temporary override (30-45 seconds) of the engine protection/shutdown system if engine power is required to move the bus in emergency conditions. Override action shall be recorded. This data shall be retrievable by the Purchasing Entity.

(5) The fast idle device shall be activated and controlled both automatically and manually by the engine control system. This device will operate only when the transmission is in neutral.

(6) The integration of all systems on the vehicle relative to engine idle speed shall be the responsibility of the vehicle manufacturer and shall meet the requirements of the transit property.

(7) The engine starting system shall be protected by an interlock that prevents its engagement when the engine is running.

(8) Engine throttle operation shall be inhibited, through interlocks, whenever:
   i. Front or rear door open
      (Front door optional: selection made by the Purchasing Entity)
   ii. The vehicle is kneeled
   iii. Wheelchair ramp is in operation
   iv. Rear door emergency release
   v. Fast Idle Operation

(9) Failure of the engine throttle control shall not result in an unsafe condition. Loss of air or electrical throttle control shall inhibit throttle.

(10) A rear mounted engine speed control (hand throttle) will be provided.

The engine shall have on-board diagnostic capabilities, able to monitor vital functions, store out- of-parameter conditions in memory, and communicate faults and vital conditions to service personnel. Diagnostic reader device connector ports, suitably protected against dirt and moisture, shall be provided in operator's area and near or inside engine compartment. The on-board diagnostic system shall inform the operator via visual and/or audible alarms when out-of-parameter conditions exist for vital engine functions. All removable caps shall be tethered including the caps for the diagnostic connector ports in the operator's area and in the engine compartment.

4.13.1.5.3. PROPULSION SYSTEM (HYBRID)

ALTERNATIVE:**:**

Propulsion System Description

The bus shall be powered by a hybrid propulsion system. Function and operation of the bus shall be transparent to the Bus Operator and passengers. The OEM shall assure that the bus structure can successfully accept the installation of the propulsion system and be operated on the stated duty-cycle for a period of 12 years without a structural failure. At a minimum, propulsion system shall comply with applicable local, state, and/or federal emissions and useful life requirements. The propulsion system shall comply with local, state, and federal (maintenance) and other applicable sections.

The Hybrid Drive System shall be rated for the GVWR (or greater) of the bus.

Propulsion System Services

The propulsion system shall be arranged so that accessibility for all routine maintenance is assured. No special tools, other than dollies and hoists, shall

be required to remove the propulsion system or any subsystems. However, the Purchasing Entity recognizes that properly rated test equipment and safe electrical work practices are essential when servicing high voltage hybrid components. The exhaust system, air cleaner, air compressor, starter (if used), alternator, radiator, all engine accessories, and any other component requiring service or replacement shall be easily removable. Contractor shall provide all specialty tools and diagnostic equipment required for maintaining the Propulsion System in accordance with Special Tools List.

Primary Propulsion Unit and Traction Motor
The PPU and traction motor may be configured in a variety of methods. The definition of motor in the context of this specification assumes the device can provide or consume energy as well as provide or retard mechanical motion.

Energy Storage (ESS) and Controller
Design and performance shall be provided to the Purchasing Entity. Energy storage shall be of a commercial design capable of operating in a transit environment. The primary charging of the energy storage system shall be accomplished by the on-board PPU and regenerative braking.

ALTERNATIVE:

For hybrid buses, replace standard bus alternator with hybrid beltless alternator manufactured by Vanner, or equivalent.

Hybrid System Controller (HSC)

The HSC regulates energy flow throughout hybrid system components in order to provide motive performance and accessory loads, as applicable, while maintaining critical system parameters (e.g., voltages, currents, temperatures, etc.) within specified operating ranges.

The controller shall monitor and process inputs and execute outputs as appropriate to control the operation of all propulsion system components.

A repair facility, certified by the manufacturer, must be located within 50 miles of ITP's Wealthy Operations Center.

4.13.2. COOLING SYSTEMS

The cooling systems shall be of sufficient size to maintain all engine and transmission fluids and engine intake air at safe, continuous operating temperatures during the most severe operations possible and in accordance with engine and transmission manufacturers' cooling system requirements. The cooling system fan controls should sense the temperatures of the operating fluids and the intake air, and if either is above safe operating conditions the cooling fan should be engaged. The fan control system shall be designed with a fail-safe mode of "fan on." The cooling system shall meet the requirements stated in the operating environment.

4.13.2.1. ENGINE COOLING

(1) The engine shall be cooled by a water-based, pressure type, cooling system

that does not permit boiling or coolant loss during the operations described above. Engine thermostats shall be easily accessible for replacement. Shutoff valves shall allow filter replacement without coolant loss. Valves shall permit complete shutoff of lines for the heating and defroster units, and water booster pumps. The water boost pump shall be a long life brushless design. All low points in the water-based cooling system shall be equipped with a standard with a 1/4" MPT brass hex plug. Air vent valves shall be fitted at high points in the cooling system unless it can be demonstrated that the system is self-purging.

(2) A Modine E-Fan electric fan system or approved equal shall be provided. Electric fans shall be brushless, variable speed, reversible and have a corrosion resistant metal shroud with finger guards that meet SAE spec J1308_200808. The fans should provide electronic feedback control and have diagnostics capability through the standard SAE J1939 diagnostics port. The cooling system shall consist of multiple electric DC brushless pusher type variable speed fans with electronic feedback controls. Electric fan motor speeds shall have a minimum operating range of 0-5500 rpm with capability of manual or automatic reverse operation in order to assist in debris removal. The cooling system shall be equipped with a master controller with the following capabilities; automatically reduce fan speed when the vehicle stops to minimize noise.

ALTERNATIVE::
As an option, an EMP electric fan system will be made available and priced separately.
As an option, a hydraulic drive fan system will be made available and price separately.

(3) A means of determining satisfactory engine coolant level shall be provided. A spring-loaded, push-button type valve or lever shall be provided to safely release pressure or vacuum in the cooling system with both it and the water filler no more than +/- 60 inches above the ground. Radiator and charge air cooler fan(s) shall be electrically driven and capable of a manual reverse operations for periodic self-cleaning of the radiator and charge air cooler.

ALTERNATIVE: For roof mounted radiators, a pressure filler will be provided in the engine compartment no more than +/- 60 in. above the ground.

ALTERNATIVE: **Screen in Front of Radiator**
The radiator input shall be protected by an easily cleanable screen designed to collect large debris. Radiators with a fin density greater than 12 fins per in. or a louvered slit design shall not be used. No heat-producing components or climate control system components shall be mounted between the engine cooling air intake aperture and the radiator. The radiator and charge air cooler shall be designed to withstand thermal fatigue and vibration associated with the installed configuration. The radiator and charge air cooler cores shall be easily cleaned (to include engine side core surface) with standard pressure-washing equipment.

Standard Requirement for Coolant Filtration

The engine cooling system shall be equipped with a properly sized water filter with a spin-on element and an automatic system for releasing supplemental coolant additives as needed to replenish and maintain protection properties. When replacing the water filter, only the water in the filter will be lost.

Standard Control and Drive Design
Control and drive of the radiator and charge air cooler fan(s) shall be the Contractor's standard design.

ALTERNATIVE: **Self-Cleaning**
Radiator and charge air cooler fan(s) shall be electrically driven and capable of automated reverse operations for periodic self-cleaning of the radiator and charge air cooler.

Cooling Fan Controls
The cooling fan shall be temperature controlled, allowing the engine to reach operating temperature quickly.

4.13.2.2. CHARGE AIR COOLING

The charge air cooling system also referred to as after-coolers or inter-coolers shall provide maximum air intake temperature reduction with minimal pressure loss. The charge air radiator shall be sized and positioned to meet engine manufacturer's requirements. The charge air radiator shall not be stacked ahead of or behind the engine radiator and shall be positioned as close to the engine as possible unless integrated with the radiator. The charge air cooler shall be of durable corrosion resistant construction. Air ducting and fittings shall be protected against heat sources and shall be configured to minimize restrictions and maintain sealing integrity.

ALTERNATIVE:

If roof mounted over vestibule area; the radiator, charge air cooler and oil cooler shall be stacked horizontally provided specified operating temperatures are maintained during the design operating profile at the temperature ranges outlined in the Design Operating Environment.

4.13.2.3. TRANSMISSION COOLING

The transmission shall be cooled by a dedicated heat exchanger sized to maintain operating fluid within the transmission manufacturer's recommended parameters of flow, pressure and temperature. The transmission cooling system shall be matched to retarder and engine cooling systems to ensure that all operating fluids remain within recommended temperature limits established by each component manufacturer. The engine cooling system should provide coolant bypass flow to the transmission cooling system with the engine thermostats closed.

4.13.2.4. TRANSMISSION COOLING

An auxiliary diesel fired heater Pro Heat or approved equal, Model X-45 45,000 BTU, 24 volt, activated by ignition switch with independent switch on operator dash shall be provided to supplement the heat supplied by the engine and shall

have an output necessary to meet the performance criteria specified in 5.4.20. The heater shall be equipped with safety devices to prevent the following: over-fueling, overheating due to loss of coolant or water pump failure, and operation during conditions of low battery voltage. The auxiliary heater shall be equipped with a self-priming fuel pump and be capable of functioning in the preheat mode. The auxiliary heater shall be electronically controlled with appropriate diagnostics for troubleshooting.

ALTERNATIVE::
As an alternate, no auxiliary diesel fired heater is required.

4.13.2.5. HYBRID DRIVE SYSTEM COOLING

Thermal management system shall maintain hybrid system components within design operating temperature limits.

4.13.3. TRANSMISSION COOLING

(1) A means of determining satisfactory engine coolant level shall be provided. A spring-loaded, controls. Gross input power, gross input torque and rated input speed shall be compatible with the engine. The transmission shall be designed to operate for not less than 300,000 miles on the design operating profile without replacement or major service. The transmission should be easily removable without disturbing the engine and accessible for service.

(2) The electronic controls shall be capable of transmitting and receiving electronic inputs and data from other drivetrain components and broadcasting that data to other vehicle systems. Communication between electronic drivetrain components and other vehicle systems shall be made using the communications networks. Electronic controls shall be compatible with either 12- or 24-volt power distribution, provide consistent shift quality and compensate for changing conditions such as variations in vehicle weight and engine power.

(3) A nominal brake pedal application of 6 to 10 psi shall be required by the driver to engage forward, or reverse range from the neutral position to prevent sudden acceleration of the bus from a parked position.

(4) The electronically controlled transmission shall have on-board diagnostic capabilities, be able to monitor functions, store and time stamp out-of-parameter conditions in memory and communicate faults and vital conditions to service personnel. The transmission shall contain built-in protection software to guard against severe damage. The on-board diagnostic system shall trigger a visual alarm to the driver when the electronic control unit detects a malfunction.

- The transmission will be an Allison Model B400R or approved equal, that comes with Integral Hydraulic Retarder.
- The transmission for the 30’ bus will be an Allison Model B300R or approved equal, with Integral Hydraulic Retarder.
- The transmission for the 30’ bus will be an Allison Model B300R or approved equal, with Integral Hydraulic Retarder.
- The transmission shall come equipped with synthetic transmission fluid.
- An electronic transmission fluid level monitoring and protection system shall be

provided.

ALTERNATIVE:

- As an option, the Voith 864.8 transmission will be made available and priced separately.
- As an option the ZF 6AP1420B will be made available and priced separately

Automatic Neutral Function with Manual Re-engagement
The transmission shall automatically shift to neutral whenever the door brake interlock is applied for five minutes. The driver shall be required to apply the service brake to re-engage forward range.

4.13.4. RETARDER

(1) The powertrain shall be equipped with a retarder designed to extend brake lining service life. The application of the retarder shall cause a smooth blending of both retarder and service brake function and shall not activate the brake lights

(2) Actuation of ABS and/or automatic traction control (ATC) shall override the operation of the brake retarder.

Standard Requirement for Retarder Activation
The retarder shall be adjustable within the limits of the powertrain and activated when the brake pedal is depressed. The Purchasing Entity will work with the OEM/drive system manufacturer to determine retarder performance settings.

Accessible Retarder Disable Switch
The retarder disable switch shall be accessible to the seated driver. Disabling retarder shall be recorded for the Purchasing Entity data collection.

4.13.5. MOUNTING

All power plant mounting shall be mechanically isolated to minimize transfer of vibration to the body structure and provide a minimum clearance of 0.75 in. Mounts shall control the movement of the power plant so as not to affect performance of belt-driven accessories or cause strain in piping and wiring connections to the power plant.

4.13.5.1. SERVICE

The propulsion system shall be arranged for ease of access and maintenance. The Contractor shall list all special tools, fixtures or facility requirements recommended for servicing. The muffler, exhaust system, air cleaner, air compressor, starter, alternator, radiator, all accessories and any other component requiring service or replacement shall be easily removable and independent of the engine and transmission removal. An engine oil pressure gauge and coolant temperature gauge shall be provided in the engine compartment. These gauges shall be easily read during service and mounted in an area where they shall not be damaged during minor or major repairs.

Engine oil and the radiator filler caps shall be hinged to the filler neck and

closed with spring pressure or positive locks to prevent leakage. All fluid fill locations shall be properly labeled to help ensure that correct fluid is added. All fillers shall be easily accessible with standard funnels, pour spouts and automatic dispensing equipment. All lubricant sumps shall be fitted with magnetic-type drain plugs. A centrifugal, non- disposable engine bypass oil filter shall be provided.

ALTERNATIVE:

Unique Fluid (Lubricant) Fillers
The engine, transmission and hydraulic reservoir shall each incorporate a unique lubricant fill fitting to prevent cross-contamination of lubricant types. Fitting types shall be specified by the Purchasing Entity.

The engine and transmission shall be equipped with sufficient heavy-duty fuel and oil filters for efficient operation and to protect the engine and transmission between scheduled filter changes. All filters shall be easily accessible and the filter bases shall be plumbed to ensure correct reinstallation.

Engine Oil Pressure and Coolant Temperature Gauges
Engine oil pressure and coolant temperature gauges required in engine compartment.

Engine Aire Cleaner
An air cleaner with a dry filter element shall be provided. The location of the air intake system shall be designed to minimize the entry of dust and debris and to maximize the life of the air filter. The engine air duct shall be designed to minimize the entry of water into the air intake system. Drainage provisions shall be included to allow any water/moisture to drain prior to entry into air filter.

4.13.6. HYDRAULIC SYSTEMS

Hydraulic system service tasks shall be minimized and scheduled no more frequently than those of other major coach systems. All elements of the hydraulic system shall be easily accessible for service or unit replacement. Critical points in the hydraulic system 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 tamper-proof priority system shall prevent the loss of power steering during operation of the bus if other devices are also powered by the hydraulic system.

The hydraulic system shall operate within the allowable temperature range as specified by the lubricant manufacturer.

Hydraulic System Sensors
Sensors in the main hydraulic system, excluding those in the power steering system, shall indicate on the driver's on-board diagnostic panel conditions of low hydraulic fluid level.

4.13.6.1. 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 shall 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.

All hoses, pipes, lines and fittings shall be specified and installed per the manufacturer's recommendations.

4.13.6.2. FITTINGS AND CLAMPS

All clamps shall maintain a constant tension at all times, 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 engine 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.

4.13.6.3. CHARGE AIR PIPING

Charge air piping and fittings shall be designed to minimize air restrictions and leaks. Piping shall be as short as possible, and the number of bends shall be minimized. Bend radii shall be maximized to meet the pressure drop and temperature rise requirements of the engine manufacturer. The cross-section of all charge air piping shall not be less than the cross-section of the intake manifold inlet. Any changes in pipe diameter shall be gradual to ensure a smooth passage of air and to minimize restrictions. Piping shall be routed away from heat sources as practicable and shielded as required to meet the temperature rise requirements of the engine manufacturer.

Charge air piping shall be constructed of stainless steel, aluminized steel or anodized aluminum, except between the air filter and turbocharger inlet, where piping may be constructed of fiberglass. Connections between all charge air piping sections shall be sealed with a short section of reinforced hose and secured with stainless steel constant tension clamps that provide a complete 360-degree seal.

4.13.7. RADIATOR

Radiator piping shall be stainless steel or brass tubing, and if 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 maintain a constant tension at all times, expanding and contracting with the hose in response to temperature changes and aging of the hose material.

4.13.8. OIL AND HYDRAULIC LINES

Oil and hydraulic lines shall be compatible with the substances they carry. The lines shall be designed and intended for use in the environment where they are installed. For

example, high–temperature resistant in the engine compartment, resistant to road salts near the road surface, and so on. Lines within the engine compartment shall be composed of steel tubing where practicable, except in locations where flexible lines are required.

Hydraulic lines of the same size and with the same fittings as those on other piping systems of the bus, but not interchangeable, shall be tagged or marked for use on the hydraulic system only.

4.13.9. FUEL

4.13.9.1. FUEL LINES

(1) 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.

(2) 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.

(3) 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.

(a) Fuel Lines - Diesel
Fuel lines shall be capable of carrying the type of fuel specified by the Purchasing Entity (i.e., up to B20 type fuel).

(b) Fuel Lines - CNG

(1) Fuel lines shall comply with NFPA-52. All tubing shall be a minimum of seamless stainless steel (ASTM A269 or equivalent). Fuel lines and fittings shall not be fabricated from cast iron, galvanized pipe, aluminum, plastic, or copper alloy with content exceeding 70 percent copper. Pipe fittings and hoses shall be clear and free from cuttings, burrs or scale. Pipe thread joining material that is impervious to CNG shall be utilized as required. Fuel lines shall be identifiable as fuel lines only.

(2) High-pressure CNG lines shall be pressure tested to 3600 psi pressure prior to fueling. CNG, nitrogen or clean, dry air shall be used to pressure test the lines/assembly. The bus manufacturer shall have a documented procedure for testing the high pressure line assembly.

(3) Fuel lines shall be securely mounted, braced and supported using “split-block” type or stainless steel P-clamps; all mounting clamps shall be mounted to a rigid structure to minimize vibration and shall be protected against damage, corrosion or breakage due to strain, rubbing,

or wear. “Floating clamps” (not mounted to a rigid structure) shall not

be permitted. Fuel lines shall not be used to secure other components (wires, air lines, etc.).

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

(5) Fuel hose connections, where possible, shall be less than 60 inches in length, made from materials resistant to corrosion and action of natural gas, and protected from fretting and high heat and shall be supported approximately every 12 inches.

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.

4.13.9.2. DESIGN AND CONSTRUCTION

4.13.9.2.1. DESIGN AND CONSTRUCTION, DIESEL

Fuel Tank(s)

The fuel tank(s) shall be made of corrosion resistant stainless steel. The fuel tank shall be made of 3CR12 structural stainless steel.

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). All systems on all model buses will be compatible with all blends of Bio-Diesel fuel based on the manufacturer's recommendation.

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.

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.

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

The “Fast Fill” fuel filler shall be located on the right side near the exit door of the bus. The hinged filler cap shall be recessed into the body so that spilled fuel will not run onto the outside surface of the bus. The filler shall accommodate a 1-1/2 inch diameter nozzle and fill rate of 40 gallons per minute of foam free fuel without spitting back or causing the nozzle to shut off before the tank is full. An audible signal shall indicate when the tank is essentially full.

Buses shall be equipped to accept fueling from the Emco-Wheaton Posi/Lock 105 Fueling System. The fuel filler neck assembly shall be an EMCO-Wheaton Posi/Lock Model 105. An anti-spill check valve that is adaptable to the Emco-Wheaton G2251 fuel nozzle shall be supplied. All related components must be compatible and approved by Emco-Wheaton for their system.

Dry-Break Fuel Filler
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. The dry break system shall be compatible with the Purchasing Entity’s system. The fuel filler cap shall be hinged. Equipment will be finalized at pre- production meeting.

ALTERNATIVE:
As an option, a gravity fuel fill system will be made available and priced separately.

4.13.10. DESIGN AND CONSTRUCTION, CNG

Fuel Containers/Cylinders

(1) CNG fuel containers/cylinders must be designed, constructed, manufactured, and tested in accordance with at least one of the following:

(a) NFPA 52-Standard for Compressed Natural Gas (CNG)

(b) Vehicular Fuel Systems FMVSS 304

(c) Any local standard(s) specifically intended for CNG fuel containers

(2) The design and construction of the fuel system supplied by the OEM shall comply with federal and local regulations.

Installation

(1) Fuel cylinders shall be installed in accordance with ANSI/IAS NGV2 - 2019, Basic Requirements for Compressed Natural Gas Vehicles (NGV) Fuel Containers and NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems Code, 2019 edition Section 303. The placement of tanks shall be limited to the roof of the vehicle.

(2) Fuel cylinders, attached valves, pressure relief devices, and mounting brackets should be installed and protected so that their operation is not affected by bus washers and environmental agents such as rain, snow, ice or mud. These components should be protected from significant damage caused by debris or collision.

(3) For safety purposes, the roof mounted tanks must be accessible to maintenance personnel with- out the requirement to walk on top of the closed tank enclosure to open the enclosure doors. The enclosure doors shall be secured with non-keyed twist latches and shall incorporate hand holds to assist in opening the enclosure doors once unlatched. When opened, the enclosure doors shall be secured to prevent from over-extension. The open enclosure doors shall also pro- vide a certain degree of fall prevention. Once the tanks are exposed, for safety purposes, access should be provided in the middle of the roof line without having to walk on top of or over the tanks in order to inspect or service the tanks, valves, regulators or Pressure Relief Devices (PRD). This access shall be constructed in a manner that avoids the need to walk on the actual roof covering. Access to the roof mounted tanks shall be through the rear roof hatch.

(4) CNG fueled buses shall be equipped with an active automatic gas detection system which shall annunciate unsafe levels of methane. The automatic gas detection system shall be integrated with an onboard fire suppression system.

Labeling

CNG fuel systems shall be labeled in accordance with NFPA 52, “Compressed Natural Gas (CNG) Vehicular Fuel Systems Code,” 2019 edition.

Pressure Relief Devices (PRDs)

PRDs must be designed, constructed, manufactured and tested in accordance with ANIS/IAS PRD1 - 2019, “Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers” and ANSI/IAS NGV2- 2019, “Basic Requirements for Compressed Natural

Gas Vehicle (NGV) Fuel Containers." All natural gas fuel system piping, including the PRD vent line, shall be stainless steel. All PRDs must be vented to outside.

Valves
Valves must be installed in accordance with ANSI/IAS NGV2 - 2019, "Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers" and NFPA 52, "Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems."

Fuel Filler

(1) The fuel filler shall be located 7 to 38 feet (on a 30-, 35- and 40-foot bus) 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.

(2) The fill and vent receptacles shall be located within an enclosure on the right side of the bus. The access door shall be sized to allow full viewing of gauges, ease of hookups and maneuver of fuel nozzle.

(3) The fuel fill receptacle and vent receptacle attachment shall be robust and capable of routine fueling connects/disconnects without deflection or metal fatigue, and capable of withstanding mechanical loads induced by a fueling drive away incident without attachment failure.

Fueling System
The CNG fueling port receptacle shall be an ANSI/AGA NGV1 or NGV2 certified receptacle as designated by the Purchasing Entity. The bus shall be capable of being fueled by a nozzle determined by the Purchasing Entity. The fueling port receptacle location shall be such that connection by fueling personnel can be performed without physical strain or interference. A dust cap shall be permanently "tethered" to the fueling port receptacle. The fueling port receptacle access door shall be equipped with an interlock sensor that disables the engine starting system when the access door is open, to prevent drive-a-ways. The interlock shall be of the type such that if the sensor fails, the bus will not start.

(1) Fueling site characteristics such as pressure, flow rate, and temperature shall be provided by the Purchasing Entity

Defueling System

(1) The CNG defueling port shall be an NGV-3.1/CGA-12.3 certified receptacle. The CNG defueling port shall be located on the curbside of the bus, in a location that is compatible with the Purchasing Entity's defueling station operation.

(2) The de-fueling system shall incorporate the following characteristics:

i. Dust cap permanently "tethered" to the defueling port.

ii. Device(s) to prevent inadvertent defueling. Specifications to be provided by the Purchasing Entity. Components compatible with the Purchasing Entity's defueling operation.

4.13.11. EMISSIONS AND EXHAUST

4.13.11.1. EXHAUST EMISSIONS

The engine and related systems shall meet all applicable emission and engine design guidelines and standards.

4.13.11.2. EXHAUST SYSTEM

Exhaust gases and waste heat shall be discharged from the roadside rear corner of the roof. The exhaust pipe shall be of sufficient height to prevent exhaust gases and waste heat from discoloring or causing heat deformation to the bus. The entire exhaust system shall be adequately shielded to prevent heat damage to any bus component, including the exhaust after-treatment compartment area. The exhaust outlet shall be designed to minimize rain, snow or water generated from high-pressure washing systems from entering into the exhaust pipe and causing damage to the after-treatment.

4.13.11.3. EXHAUST AFTER TREAMENT

An exhaust after treatment system will be provided to ensure compliance to all applicable EPA regulations in effect.

Diesel Exhaust Fluid Injection

If required by the engine manufacturer to meet NOx level requirements specified by EPA, a DEF injection system will be provided. The DEF system will minimally include a tank, an injector, a pump, an ECM and a selective catalytic converter. The tanks shall be designed to store DEF in the operating environment described in the “Operating Environment” section. The DEF fluid lines shall be designed to prevent the DEF from freezing. The DEF injection system shall not be damaged from a cold soak at 10 °F.

ALTERNATIVE:

Optional and priced separately; A Posi-Lock fill mechanism will be provided.

4.13.11.4. PARTICULATE AFTER TREAMENT

If required by the engine manufacturer to meet particulate level requirements specified by EPA, a particulate trap will be provided. The particulate trap shall regenerate itself automatically if it senses clogging. Regeneration cycles and conditions will be defined by the engine manufacturer.

4.13.11.5. FIRE SUPPRESSION SYSTEM

(a) Fire Suppression System

(1) An Amerex V25 automatic fire suppression system will be provided to ensure adequate coverage in the engine compartment and main electrical box areas should a fire event happens. The system shall incorporate a telltale, dash mounted operator warning light, audible indicator and switch, automatically shutting off all fans and climate control systems in the event of discharge.

(2) The system installed shall be certified by the vehicle manufacturer that it is suitable for use in the proposed vehicle in case the unit fails to function during an on board vehicle event or fire. Each vehicle shall be

delivered with a certificate identifying the vehicle identification number (VIN) for which it applies. The system shall be U.L., U.C.L., and F.M. listed and meet all D.O.T. and
F.M.V.S.S. and be certified by the vehicle and equipment manufacturer.

NOTE: **Fire Suppression shall be mandatory on all Hybrid and CNG buses and shall be included in the price of each respective fuel alternative.**

ALTERNATIVE
As an option, a delete for the Fire Suppression for the diesel bus will be included. A Fire Detection System will be made available for diesel powered buses.

4.13.12. STRUCTURE

4.13.12.1. GENERAL DESIGN

The structure of the bus shall be designed to withstand the transit service conditions typical of an urban duty cycle throughout its service life. The vehicle structural frame shall be designed to operate with minimal maintenance throughout the 12-year design operating profile. The design operating profile specified by Purchasing Entity shall be considered for this purpose.

4.13.12.2. ALTOONA TESTING

Prior to acceptance of first bus, the vehicle must have completed any FTA-required Altoona testing. Any items that required repeated repairs or replacement must undergo the corrective action with supporting test and analysis. A report clearly describing and explaining the failures and corrective actions taken to ensure any and all such failures will not occur shall be submitted to the Purchasing Entity.

The Altoona Test Report shall be provided to the Purchasing Entity with the Proposal submittal. If not available, then the report shall be provided prior to first acceptance of bus.

4.13.12.3. STRUCTURAL VALIDATION

4.13.12.3.1. STRUCTURAL ANALYSIS

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

4.13.12.3.2. 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 6

in. curb or in a 6 in. deep hole.

4.13.12.3.3. 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 minimize audible, visible or sensible resonant vibrations during normal service.

4.13.12.3.4. ENGINE COMPARTMENT BULKHEADS

The passenger and engine compartment shall be separated by fire-resistant bulkheads. The engine compartment shall include areas where the engine and exhaust system are housed. This bulkhead shall preclude or retard propagation of an engine compartment fire into the passenger compartment and shall be in accordance with the Recommended Fire Safety Practices defined in FTA Docket 90A, dated October 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 engine 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. Engine 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.

4.13.12.3.5. 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 6 in. 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 with no more than 3 in. 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 in. from ground level shall withstand a static load of 2000 lbs. applied perpendicular to the bus by a pad no larger than 5 sq. in. This load shall not result in deformation that prevents installation of new exterior panels to restore the original appearance of the bus. The transit bus, at GVWR and under static conditions, shall not exhibit deformation or deflection that impairs operation of doors, windows or other mechanical

elements. Static conditions include the vehicle at rest with any one wheel or dual set of wheels on a 6 inch curb or in a 6 inch deep hole.

The sidewall structure shall be capable of withstanding impacts of 200 foot pounds of energy from a steel faced spherical missile no less than 9 inches in diameter and of a 500 pound load applied anywhere along their length by a rigid plate 1 foot in length with no visible damage to the supporting structure. A damaged portion of the supporting structure shall be replaceable without requiring removal or replacement of the entire structure.

The bus chassis shall be stainless steel with an integrated side impact barrier to provide additional safety to the passengers in the low floor area.

4.13.12.4. CORROSION

The bus flooring, sides, roof, understructure and axle suspension components shall be designed to resist corrosion or deterioration from atmospheric conditions and de-icing 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 Purchasing Entity 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.

Corrosion-Resistance Requirements for Exposed and Interior Surfaces of Tubing Below Lower Window Level

All exposed surfaces and the interior surfaces of tubing and other enclosed members below lower window line shall be corrosion resistant through application of a corrosion protection system.

ALTERNATIVE

Corrosion Resistance Requirements for Exposed and Interior Surfaces of Tubing Throughout Entire Vehicle - All exposed surfaces and the interior surfaces of tubing and other enclosed members shall be corrosion resistant through application of a corrosion protection system.

ALTERNATIVE

Additional Corrosion Resistance Requirements

The vehicle shall be constructed using only inherently corrosion-resistant materials and fasteners such as stainless steel or

composites to minimize deterioration. The structure shall not require corrosion-preventive coatings or after-treatments, either during construction or throughout the service life of the vehicle.

4.13.13. 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. If applicable, 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.

A plug connector permanently mounted at the front of the bus 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. 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. The location of these shop air connectors shall facilitate towing operations.

Lifted (Unsupported) 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 and towing of the bus, at curb weight, while the front wheels are clear off the ground. These devices shall also permit common flat towing.

ALTERNATIVE

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 bus. The method of attaching the tow bar or adapter shall require the specific approval of the Purchasing Entity. Any tow bar or adapter exceeding 50 lbs. should have means to maneuver or allow for ease of use and application. Each towing device shall accommodate a crane hook with a 1 in. throat.

4.13.14. 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 in. 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.

4.13.15. HOISTING

The bus axles or jacking plates shall accommodate the lifting pads of a two-post hoist system. 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.

4.13.16. FLOOR

4.13.16.1. DESIGN

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 not less than ¼ in. or installed in a fully sealed butt joint. Similarly, a molding or cover shall prevent debris accumulation between the floor and wheel housings. The vehicle floor in the area of the entrance and exit doors shall have a lateral slope not exceeding 2 degrees to allow for drainage.

Bi-level Floor Design

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

ALTERNATIVE

Sloped Floor Design

The floor of the bus shall be of a sloped low floor design. Aft of the rear door extending to the rear settee riser, the floor may be sloped but shall not exceed 5.5 degrees off the horizontal.

4.13.16.2. 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 in. 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 lbs. applied through the flat end of a ½ in. diameter rod, with 1/32-inch radius, without permanent visible deformation.

4.13.16.3. 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). It shall be impervious to wood-destroying insects such as termites.

Composite Flooring
Composite flooring throughout the bus shall be provided.

ALTERNATIVE

Flooring with manufactured noise-reduction characteristics.

4.13.17. PLATFORMS

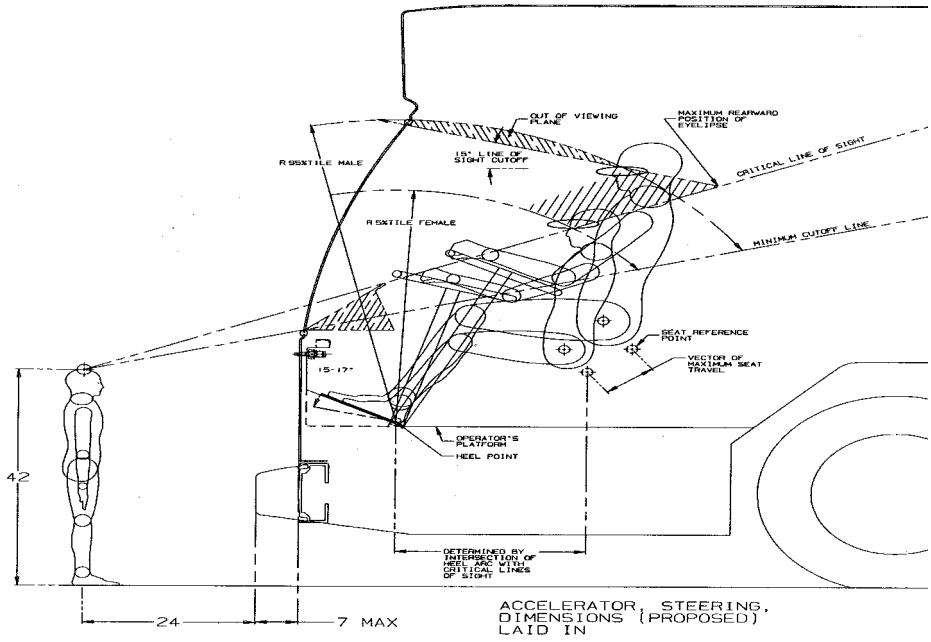
4.13.17.1. DRIVER'S AREA

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.

4.13.17.2. 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 in. above the road surface, 24 in. from the leading edge of the bumper. 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. The figure below illustrates a means by which the platform height can be determined, using the critical line of sight.

Determining Platform Height



4.13.17.3. FAREBOX

Farebox placement should minimize impact to passenger access and minimize interference with the driver's

line of sight.

Driver Interface Required; Platform Needed to Bring Height to Driver Access
If the driver's platform is higher than 12 in., then the farebox is to be mounted on a platform of suitable height to provide accessibility for the driver without compromising passengers' access.

4.13.17.4. REAR STEP AREA TO REAR AREA

If the vehicle is of a bi-level floor design, 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 in. 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 skid-resistant material 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.

4.13.18. WHEEL HOUSING

4.13.18.1. DESIGN AND CONSTRUCTION

Sufficient clearance and air circulation shall be provided around the tires, wheels and brakes to preclude overheating when the bus is operating on the design operating profile. Wheel housings shall be constructed of corrosion-resistant and fire-resistant material.

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 color-impregnated to match interior finishes. The lower portion extending to approximately 10 to 12 in. above floor shall be equipped with scuff-resistant coating or stainless steel trim.

Wheel housings, as installed and trimmed, shall withstand impacts of a 2 in. steel ball with at least 200 ft.- lbs. of energy without penetration.

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.

4.13.18.2. ARTICULATED JOINT (Not Used

4.13.18.3. RACEWAY (Not Used

4.13.18.4. Bellows (Not Used)

4.14. CHASSIS

4.14.1. SUSPENSION

4.14.1.1. GENERAL REQUIREMENTS

The front and rear 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.

4.14.1.2. ALIGNMENT

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

4.14.1.3. SPRINGS AND SHOCK ABSORBERS

4.14.1.3.1. SUSPENSION TRAVEL

The suspension system shall permit a minimum wheel travel of 2.75 in. jounce-upward travel of a wheel when the bus hits a bump (higher than street surface), and 2.75 in. 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 in. at any point from the height required. The safe operation of a bus cannot be impacted by ride height up to 1 in. from design normal ride height.

4.14.1.3.2. 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 less after hitting road perturbations. 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.

4.14.1.3.3. LUBRICATION

Standard Grease Fittings

All elements of steering, suspension and drive systems requiring scheduled lubrication shall be provided with grease fittings conforming to SAE Standard 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 less than every 6000 miles.

4.14.1.3.4. KNEELING

A kneeling system shall lower the entrance(s) of the bus a minimum of 2.5 in. 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:

1. Downward control must be held to allow downward kneeling movement.
2. Release of the control during downward movement must completely stop the lowering motion and hold the height of the bus at that position.

3. 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 kneeling control shall be disabled when the bus is in motion. The bus shall kneel at a maximum rate of 1.25 in. per second at essentially a constant rate. After kneeling, the bus shall rise within 3 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, and the jerk shall not exceed 0.3g/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. A warning light mounted near the curbside of the front door, a minimum 2.5 in. 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.

4.14.2. WHEELS AND TIRES

4.14.2.1. 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.

Wheels and rims shall be 22.5 x 8.25 integral formed steel drop center construction. Wheels shall be compatible with tires in size and load carrying capacity. Front wheels and tires shall be balanced as an assembly.

Alcoa Aluminum and machine finished with Dura-Brite and Dura-Flange, including one spare wheel. White painted steel wheels shall be provided. Wheels shall be hub-mounted. (one spare will be provided).

ALTERNATIVE
White painted steel wheels shall be provided. Wheels shall be hub-mounted.

4.14.2.2. 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 Purchasing Entity, will arrange for delivery of tubeless tires provided by its Mileage Contractor. Six (6) tires required per coach. These tires will be supplied "No Charge" to the Bus Manufacturer, who is to mount the tires on the designated wheels and to the bus. Bus Manufacturer must instruct the common carrier to adhere to the most current tire drive-a-way recommendations as provided by the tire manufacturer.

4.14.2.3. STEERING

Electrically assisted steering shall be provided to reduce steering effort. Hydraulically assisted steering shall be provided.

ALTERNATIVE

Power steering hydraulic pump shall be electrically driven.

ALTERNATIVE

Hydraulically assisted steering shall be provided. The steering gear shall be an integral type with the number and length of flexible lines minimized or eliminated. Engine driven hydraulic pump shall be provided for the power steering. Electrically assisted steering shall be provided to reduce steering effort.

4.14.2.4. STEERING AXLE

Oiled-Type Front Bearings

The front axle shall be non-driving with a load rating sufficient for the bus loaded to GVWR and shall be equipped with sealed, oiled-type front wheel bearings.

ALTERNATIVE

Front Bearings

As an alternative, grease-type front bearings.

ALTERNATIVE

Independent Suspension Axle

The front axle shall be of an independent suspension design, non-driving, with a load rating sufficient for the bus loaded to GVWR and shall be equipped with grease 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 (frontlock) wheel shall be within 2 degrees of true Ackerman up to 50 percent lock measured at the inside (backlock) wheel. The steering geometry shall be within 3 degrees of true Ackerman for

the remaining 100 percent lock measured at the inside (backlock) wheel.

ALTERNATIVE

Grease Seals

As an option, grease seals will be made available and will be priced separately.

4.14.2.4.1. STEERING WHEEL

TURNING EFFORT

Steering effort shall be measured with the bus at GVWR, stopped with the brakes released and the engine at normal idling speed on clean, dry, level, commercial asphalt pavement and the tires inflated to recommended pressure.

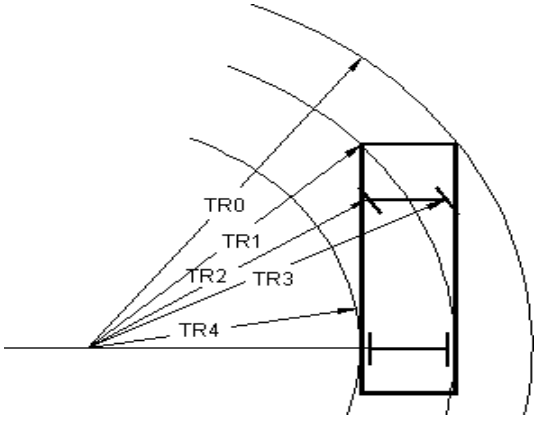
Under these conditions, the torque required to turn the steering wheel 10 degrees shall be no less than 5 ft.- lbs. and no more than 10 ft.-lbs. Steering torque may increase to 70 ft.-lbs. when the wheels are approaching the steering stops, as the relief valve activates.

Power steering failure shall not result in loss of steering control. With the bus in operation, the steering effort shall not exceed 55 lbs. 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.

Turning Radius

Bus Length	Maximum Turning Radius
30 ft.	31 ft. (TR0)
35 ft.	39 ft. (TR0)
40 ft.	46 ft. (TR0)



STEERING WHEEL, GENERAL

The steering wheel diameter shall be approximately 18-20 in.; the rim

diameter shall be ⅞ in. to 1¼ in. and shaped for firm grip with comfort for long periods of time.

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, as described in SAE 1050a, Sections 4.2.2 and 4.2.3). Placement of steering column must be as far forward as possible, but either in line with or behind the instrument cluster.

STERRING 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.

STEERING WHEEL TELESCOPIC ADJUSTMENT

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

Steering Wheel Height[1] 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 degrees	29 in.	0 degrees	34 in.
15 degrees	26.2 in.	15 degrees	31.2 in.
25 degrees	24.6 in.	25 degrees	29.6 in.
35 degrees	22.5 in.	35 degrees	27.5 in.

1. Measured from bottom portion closest to driver.

4.14.2.5. DRIVE AXLE

The bus shall be driven by a single reduction transit type axle with 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 design operating profile without replacement or major repairs. The lubricant drain plug shall be magnetic type. The axle and driveshaft components shall be rated for both propulsion and retardation modes with respect to duty cycle.

NOTE: The retardation duty cycle can be more aggressive than propulsion.

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.

ALTERNATIVE
As an alternative, Stemco Data Trac prop hubometer or equivalent with digital readout.

ALTERNATIVE
As an alternative, a “hubometer” " should be installed on rear axle, curbside -

Veeder Root or equivalent

4.14.2.5.1. NON-DRIVE AXLE (NOT Used)

4.14.2.6. TURNING RADIUS

Maximum Turning Radius

Bus Length (approximate)	Maximum Turning Radius (see Figure 4)	Purchasing Entity Requirement (not used)
30 ft.	31 ft. (TR0)	
35 ft.	39 ft. (TR0)	
40 ft.	44 ft. (TR0)	

4.14.2.7. BRAKES

4.14.2.7.1. SERVICE BRAKE

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

ALTERNATIVE

Visible stroke indicators may be combined with electronic brake monitoring system and vehicle brake warning system to notify driver and maintenance of unsafe brake conditions.

4.14.2.7.2. ACTUATION

Air-Actuated Brakes

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 70 lbs. at a point 7 in. 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 ECU for the ABS system shall be protected, yet in an accessible location to allow for ease of service.

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

Automatic Traction Control

Microprocessor controlled automatic traction control (ATC) shall be provided.

4.14.2.7.3. 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 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.

ALTERNATIVE

Remote brake wear indicator.

4.14.2.7.4. HUBS AND DRUMS

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 design operating profile for the duration of the initial manufacturer's warranty.

Drum Brakes

(1) The service brakes shall be two (2) shoe, internal-expanding, air operated S-cam type brakes at each wheel. The brakes must be capable of stopping the vehicle in accordance with the performance requirements of State and Federal regulations in effect at the time of manufacture. Parking brake shall be spring applied, air released chamber mounted on the rear axle assembly. All brake linings shall be of non- asbestos material three-quarters (3/4) inch thick. Brake shoe return springs shall be the heaviest available.

(2) Spring brake chambers shall be provided, and shall comply with requirements of State and Federal regulations FMVSS 121 in effect at time of manufacturer on the front and rear of these buses. At a minimum the front chamber shall be size 24 and the rear shall be size 36. The emergency air tank shall be piped to a service valve at the left front corner of the bus to fill the tank for towing the vehicle.

(3) Brake shoe effective area shall total a minimum of 932 square inches. Brake shoes shall be operated by cams which in return are operated by automatic slack adjusters. Slack adjusters shall be equipped with grease fittings and be capable of automatic adjustments throughout the life of the lining and drum assembly. Brake lines shall be installed so that the possibility of damage is minimized.

(4) Lines and hoses shall be clamped and supported in a manner which minimizes long, unsupported hose lengths and precludes rubbing against any part of the bus.

(5) The parking and emergency brakes shall be with a 40 PSI setting, controlled by a manual valve located convenient to the operator for safe, convenient access. Valve operation shall be "pull to set brakes" and "push to release" type brake system.

(6) This brake shall have stopping ability that is equal to or better than required by Federal and State regulations. It shall automatically apply if air system pressure falls below half the normal value or such other value as is recommended by the manufacturer. This parking/ emergency brake shall be of spring brake design. The manufacturer will provide in their proposal a statement of brake efficiency at empty and loaded capacity.

ALTERNATIVE

As an option, a brake stroke and wear monitoring system shall be made available and priced separately.

ALTERNATIVE

As an option, four wheel disk brakes will be made available and priced separately.

4.14.2.7.5. PARKING/EMERGENCY BRAKE

Air 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.

ALTERNATIVE

Emergency Brake

An emergency brake release shall be provided to release the brakes in the event of automatic emergency brake application. The driver shall be able to manually depress and hold down the emergency brake release valve to release the brakes and maneuver the bus to safety. Once the driver releases the emergency brake release valve, the brakes shall engage to hold the bus in place.

4.14.2.8. INTERLOCKS

4.14.2.8.1. 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 in. 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 engine at idle and 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 (FEMA) 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 and unsecured condition, unless the door master switch has been actuated to intentionally release the interlocks.

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 front doors are open, selection to be made by the Purchasing Entity at pre-production meeting.

4.14.2.9. PNEUMATIC SYSTEM

4.14.2.9.1. 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 compartment and near the front bumper area for towing. Retained caps shall be installed to protect fitting against dirt and moisture when not in use. Air for the compressor shall be filtered. The air system shall be protected per FMVSS 121.

4.14.2.9.2. AIR COMPRESSOR

The 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 while not exceeding the fast idle speed setting of the engine.

ALTERNATIVE

The electrically 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 while not exceeding the fast idle speed setting of the engine.

4.14.2.9.3. AIR LINES AND FITTINGS

Air lines, except necessary flexible lines, shall conform to the installation and material requirements of SAE Standard J1149 for copper tubing with standard, brass, flared or ball sleeve fittings, or SAE Standard J844 for nylon tubing if not subject to temperatures over 200 ^{o} 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:

- **Green:** Indicates primary brakes and supply.
- **Red:** Indicates secondary brakes.
- **Brown:** Indicates parking brake
- **Yellow:** Indicates compressor governor signal.
- **Black:** Indicates accessories.

Line supports 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 more than 5-ft intervals. Nylon lines

may be grouped and shall be supported at 30 in. intervals or less.

The compressor discharge line between power plant and body-mounted equipment shall be flexible convoluted copper or 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-ft 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.

4.14.2.9.4. AIR RESERVOIRS

All air reservoirs shall meet the requirements of FMVSS Standard 121 and SAE Standard J10 and shall be equipped with drain plugs and guarded or flush type drain valves. Major structural members shall protect these valves and any automatic moisture ejector 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.

4.14.2.9.5. 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.

No requirements for additional oil separator provision.

4.15. ELECTRICAL, ELETRONIC AND DATA COMMUNICATION SYSTEM

4.15.1. OVERVIEW

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.

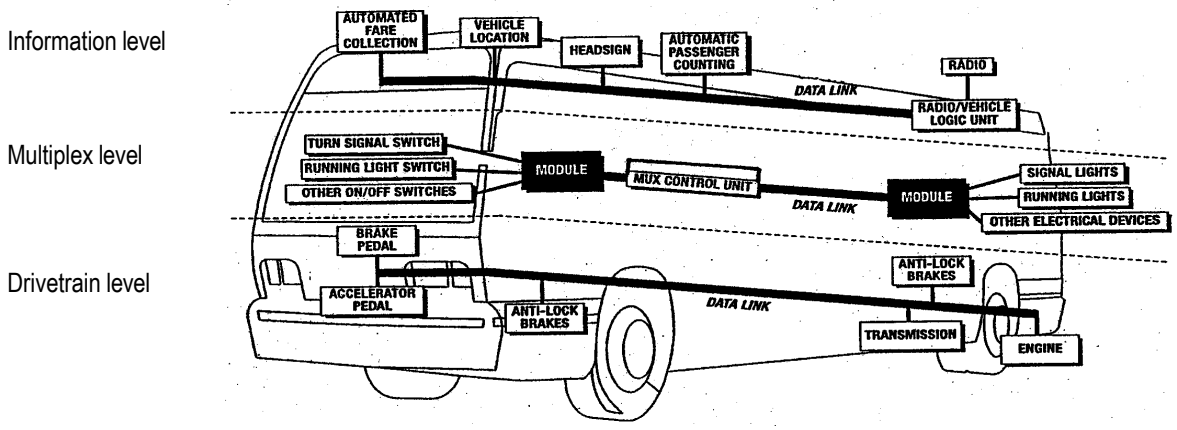
The data communication system consists of the bi-directional communications networks that electronic devices use to share data with other electronic devices and systems. Communication networks are essential to integrating electronic functions, both onboard the vehicle and off.

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 levels to reflect the use of multiple data networks:

- **Drivetrain level:** Components related to the drivetrain including the propulsion system components (engine, transmission and hybrid units), and anti-lock braking system (ABS), which may include traction control.
- **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, fare boxes, 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; and gateway devices.

Data Communications Systems Levels



4.15.2. 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.

Power plant wiring shall be an independent wiring harness. Replacement of the engine compartment wiring harness(es) shall not require pulling wires through any bulkhead or removing any terminals from the wires.

4.15.3. ENVIRONMENTAL AND MOUNTING REQUIREMENTS

(1) 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.

(2) Power-plant wiring shall be an independent wiring harness. Replacement of the engine compartment wiring harness(es) shall not require pulling wires through any bulkhead or removing any terminals from the wires.

4.15.3.1. ENVIRONMENTAL AND MOUNTING REQUIREMENTS

(1) 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.

(2) 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 design operating profile. As a recommendation, no vehicle component shall generate, or be affected by, electro- magnetic interference or radio frequency interference (EMI/RFI) that can disturb the performance of electrical/electronic equipment as defined in SAE J1113 and UNECE Council Directive 95/54 (R-10).

(3) The Purchasing Entity shall follow recommendations from bus manufacturers and subsystem Suppliers regarding methods to prevent damage from voltage spikes generated from welding, jump starts, shorts, etc.

(4) All electrical/electronic hardware mounted in the interior of the vehicle shall be inaccessible to passengers and hidden from view unless intended to be viewed. The hardware shall be mounted in such a manner as to protect it from splash or spray.

(5) All electrical/electronic hardware mounted on the exterior of the vehicle, that is not designed to be in- stalled in an exposed environment, shall be mounted in a sealed enclosure.

(6) All electrical/electronic hardware and its mounting shall comply with the shock and vibration requirements of SAE J1455.

(7) Electrical cables and wiring shall be adequate for all anticipated loads. The main wiring harness shall, to the maximum extent practical, be installed inside the bus body passenger compartment and, where that is not practical, shall be secured in frame rail raceways. The Contractor shall route and secure all wiring so that it does not rub anywhere. Routing of step well light wiring shall be such as to avoid rubbing door posts, etc. When wires or looms pass through metal, the wires shall be protected by a rubber grommet.

(8) Each electrical panel, i.e. front and exit door panels, battery compartment, and front electrical panel shall provide an explanation of the respective electrical circuits and components contained within and shall be furnished in a silk-screened or water/oil proof diagram on the inside of the door panel.

(9) All engine compartment wiring and light wiring shall be insulated from the heat and be resistant to oil and grease. Electrical equipment, junction boxes and connectors shall not be placed where they are subjected to excessive heat, oil, grease, or road spray. All multiple terminal connectors shall be military (cannon plug) type, fully sealed and protected with a potting compound to prevent outside dirt and corrosives from entering the wiring, connectors, or plugs.

(10) All main power supply terminals shall be covered with electric post rubber cover.

(11) All electrical end plugs shall be covered. The wiring harnesses shall incorporate ten percent (10%) spare wires. Wiring located in the engine compartment shall be routed away from high-heat sources or shielded and/or insulated from temperatures exceeding the wiring and connector operating requirements. All cables and harnesses shall be secured to prevent chafing or shorting against each other or any part of the vehicle.

(12) Clamps shall be rubber or PVC clad aircraft type. Grommets or other protective material shall be in- stalled at points where wiring penetrates metal structures.

(13) All wiring shall start and end at a junction block or component.

(14) All inline and bulkhead connectors are to be of the weather pack sealed type.

(15) Multi-pin connectors shall be protected internally from corrosion with silicone dielectric grease (Dow Corning #4). All circuits except the engine emergency shut-off and speedometer circuits must be protected by reset circuit breakers that clearly indicate their position when tripped. Each breaker must be labeled. Circuit breakers must have plastic dust caps.

(16) Provide constant power for powering systems, such as but not limited to the fire suppression, radio, farebox, and DC-DC converter that require constant power when battery cutoff switch is off.

(17) The windshield wiper and headlamps electric circuit shall be protected by modified auto-reset circuit breakers sized to the requirement of the load.

(18) Rubber Covers shall be provided for all the Electric Posts.

(19) All junction boxes located in the engine compartment shall be designed to allow thorough steam cleaning of the engine compartment area without intrusion of water.

(20) Major junction panels shall be readily accessible for maintenance, not located behind or alongside seat or other fixed/semi-fixed obstructions. Access panels and junction box covers shall have seals which will preclude entry of rain, wash water, road debris, etc. All wiring and junction panel terminals shall be numbered and color coded for easy identification. A diagram showing the coding as the bus was built shall be furnished.

(21) The Contractor shall supply at least two spare circuits in the main harness between the front and rear of the bus. The main harness from the engine compartment shall be equipped with multiple circuit can- non type connectors.

4.15.3.2. HARDWARE MOUNTING

The mounting of the hardware shall not be used to provide the sole source ground, and all hardware shall be isolated from potential EMI/RFI, as referenced in SAE J1113.

All electrical/electronic hardware mounted in the interior of the vehicle shall be inaccessible to passengers and hidden from view unless intended to be viewed. The hardware shall be mounted in such a manner as to protect it from splash or spray.

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

All electrical/electronic hardware and its mounting shall comply with the shock and vibration requirements of SAE J1455.

4.15.4. GENERAL ELECTRICAL REQUIREMENTS

4.15.4.1. BATTERIES

4.15.4.1.1. LOW-VOLTAGE BATTERIES (24V)

(1) Low-Voltage Batteries (24V)
Two (2) twelve volt (12V) lead acid filled thermal battery units, size 8D, with side post connectors with minimum 1300 cold cranking amps at zero degrees Fahrenheit with a reserve capacity of 425 minutes or greater will be required.

ALTERNATIVE
As an option, four (4) Group 31 Batteries will be made available and priced separately.

As an option, two (2) Group 31 Batteries will be made available with a Super Capacitor and priced separately.

4.15.4.1.2. BATTERY CABLES

The battery terminal ends and cables 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, be flexible and sufficiently long to reach the batteries with the tray in the extend- ed position without stretching or pulling on any connection and shall not lie directly on top of the batteries. Except as interrupted by the master battery switch, battery and starter wiring shall be continuous cables with connections secured by bolted terminals and shall conform to specification requirements of SAE Standard J1127 – Type SGT, SGX or GXL and SAE Recommended Practice J541.

4.15.4.1.3. MASTER BATTERY SWITCH

A single master switch shall be provided near the battery compartment for the disconnecting of all battery positives (12V and 24V), except for safety devices such as the fire suppression system and other systems as specified. 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 prevent corrosion from fumes and battery acid when the batteries are washed off or are in normal service. The access door shall be labeled "Battery Emergency Shut-Off Switch."

Turning the master switch off with the power-plant operating shall shut off the engine and shall not damage any component of the electrical system. The master switch shall be capable of carrying and interrupting the total circuit load.

Four Group 31 Maintenance-Free Batteries
Four Group 31 Series deep cycling maintenance-free battery units shall be provided. Each battery shall have a minimum of 1300 cold cranking amps. Each battery shall have a purchase date no more than one year from the date of release for shipment to the Purchasing Entity.

ALTERNATIVES

Two 8D Maintenance-Free Batteries
Each battery shall have a purchase date no more than 120 days from date of release, and shall be fully maintained prior to shipment to the Purchasing Entity. Battery compartment must be well ventilated to prevent hydrogen buildup while protecting the compartment from road spray, water intrusion and de-icing chemicals.

Same Size Terminal Ends
Positive and negative terminal ends shall be the same size.

ALTERNATIVES

Different Size Terminal Ends
Positive and negative terminal ends shall be different sizes.

a) BATTERY CABLES

The battery terminal ends and cables 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, be flexible and 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 the master battery switch, battery and starter wiring shall be continuous cables with connections secured by bolted terminals and shall conform to specification requirements of SAE Standard J1127 – Type SGT, SGX or GXL and SAE Recommended Practice J541.

2100 strand 4/0 cable or greater recommended.

ALTERNATIVE

Color code each voltage.

b) JUMP START
Jump-Start Connector

As an option Hella N.A.T.O. (8JB001935-001) Olive jumper points will be made available and priced separately.

ALTERNATIVE
Front and Rear jumper Points shall be included using an Anderson Power Products Catalog #HB350R, Description 350A Red 2/0 type female plug unit.

c) 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 vehicle shall be equipped with a 12VDC and 24VDC quick disconnect switch(es). The battery compartment door shall conveniently accommodate operation of the 12VDC and 24VDC quick disconnect switch(es).

The battery quick disconnect access door shall be identified with a decal. The decal size shall not be less than
3.5 × 5 in. (8.89 × 12.7 cm).

The battery hold-down bracket shall be constructed of a non-metallic material (plastic or fiberglass).

This 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 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 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 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 and filled. A locking device shall retain the battery tray to the stowed position.

If not located in the engine compartment, the same fire-resistant properties must apply to the battery compartment. No sparking devices should be located within the battery box.

d) AUXILLARY ELECTRONIC POWER SUPPLY – Not Required

e) MASTER BATTERY SWITCH

A single master switch shall be provided near the battery compartment

for the disconnecting of all battery positives (12V and 24V), except for safety devices such as the fire suppression system and other systems as specified. 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 prevent corrosion from fumes and battery acid when the batteries are washed off or are in normal service.

Turning the master switch off with the power plant operating shall shut off the engine and shall not damage any component of the electrical system. The master switch shall be capable of carrying and interrupting the total circuit load.

Single Switch
The batteries shall be equipped with a single switch for disconnecting both 12V and 24V power.

f) LOW-VOLTAGE GENERATION AND DISTRIBUTION

The low-voltage generating system shall maintain the charge on fully charged batteries, except when the vehicle is at standard idle with a total low voltage generator load exceeding 70 percent of the low voltage generator nameplate rating.

Voltage monitoring and over-voltage output protection (recommended at 32V) shall be provided.

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.

g) CIRCUIT PROTECTION

All branch circuits, except battery-to-starting motor and battery-to-generator/alternator circuits, shall be protected by current-limiting devices such as circuit breakers, fuses or solid state devices sized to the requirements of the circuit. Electronic circuit protection for the cranking motor shall be provided to prevent engaging of the motor for more than 30 seconds at a time to prevent overheating. The circuit breakers or fuses shall be easily accessible for authorized personnel. Fuses shall be used only where it can be

demonstrated that circuit breakers are not practicable. This requirement applies to in-line fuses supplied by either the Contractor or a Supplier. Fuse holders shall be constructed to be rugged and waterproof. All manual reset circuit breakers critical to the operation of the bus shall be mounted in a location convenient to the Purchasing Entity mechanic with visible indication of open circuits. The Purchasing Entity shall consider the application of automatic reset circuit breakers on a case-by-case basis. The Contractor shall show all in-line fuses in the final harness drawings. Any manually resettable circuit breakers shall provide a visible indication of open circuits. Any manually resettable circuit breakers shall provide a visible indication of open circuits.

Circuit breakers or fuses shall be sized to a minimum of 15 percent larger than the total circuit load. The current rating for the wire used for each circuit must exceed the size of the circuit protection being used.

4.15.4.2. GROUNDS

The battery 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 four ground ring/spade terminal connections shall be made per ground stud. Electronic equipment requiring an isolated ground to the battery (i.e., electronic ground) shall not be grounded through the chassis.

4.15.4.3. LOW VOLTAGE/LOW CURRENT WIRING AND TERMINALS

All power and ground wiring shall conform to specification requirements of SAE Recommended Practice J1127, J1128 and J1292. Double insulation shall be maintained as close to the junction box, electrical compartment or terminals as possible. The requirement for double insulation shall be met by wrapping the harness with plastic electrical tape or by sheathing all wires and harnesses with non-conductive, rigid or flexible conduit.

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 present in the harness. 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 non-conductive 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 necessarily located under the vehicle shall be insulated from water, heat, corrosion and mechanical damage. Where feasible, front to rear electrical harnesses should be installed above the window line of the vehicle.

All wiring harnesses over 5 ft. long and containing at least five wires shall include 10 percent (minimum one wire) excess wires for spares. This requirement for spare wires does not apply to data links and communication cables. Wiring harness length shall allow end terminals to be replaced twice without pulling, stretching or replacing the wire. Terminals shall be crimped to the wiring according to the 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 either use 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 7 AWG 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.

Wiring located in the engine compartment shall be routed away from high-heat sources or shielded and/or insulated from temperatures exceeding the wiring and connector operating requirements.

The instrument panel and wiring shall be easily accessible for service from the driver’s seat 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.

4.15.4.4. 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 less than 40,000 hours (except cranking motors, washer pumps and wiper motors). All electric motors shall be easily accessible for servicing.

4.15.4.5. ELECTRICAL COMPARTMENTS

All relays, controllers, flashers, circuit breakers and other electrical components shall be mounted in easily accessible electrical compartments. All compartments exposed to the outside environment shall be corrosion-resistant and sealed. The components and their functions in each electrical compartment shall be identified and their location permanently recorded on a drawing attached to the inside of the access panel or door. The drawing shall be protected from oil, grease, fuel and abrasion.

The front compartment shall be completely serviceable from the driver’s seat, vestibule or from the outside. “Rear start and run” controls shall be mounted in an

accessible location in the engine compartment and shall be protected from the environment.

4.15.5. 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.

All electronic component Suppliers shall ensure that their equipment is self-protecting in the event of shorts in the cabling, and also in over-voltage (over 32V DC on a 24V DC nominal voltage rating with a maximum of 50V DC) 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.

4.15.5.1. WIRING AND TERMINALS

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

4.15.5.1.1. DISCRETE I/O (INPUTS/OUTPUTS)

All wiring to I/O devices, either at the harness level or individual wires, shall be labeled, stamped 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.

4.15.5.1.2. 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 RF applications, have separate shielding techniques that also shall be used as applicable.

NOTE: A shield grounded at both end forms a ground loop, which can cause intermittent control or faults.

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.

4.15.5.1.3. COMMUNICATIONS

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

network specifications.

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

4.15.5.1.4. 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. Connectors shall be minimized, since each connector and crimp has a loss that will attribute to attenuation of the signal. 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.

4.15.5.1.5. AUDIO

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

4.15.6. MULTIPLEXING

4.15.6.1. GENERAL

The primary purpose of the multiplexing system is control of components necessary to operate the vehicle. This is accomplished by processing information from input devices and controlling output devices through the use of an internal logic program.

Versatility and future expansion shall be provided for by expandable system architecture. The multiplex system shall be capable of accepting new inputs and outputs through the addition of new modules and/or the utilization of existing spare inputs and outputs. All like components in the multiplex system shall be modular and 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 (10%) of the total number of inputs and outputs, or at least one each for each voltage type utilized (0V, 12V, 24V), at each module location shall be designated as spares.

ALTERNATIVE

No spares shall be designated.

4.15.6.2. 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.

4.15.6.2.1. I/O SIGNALS

The input/output for the multiplex system may contain three types of electrical signals: discrete, 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 (0-12V, 10-24V, etc.) or current signal (4- 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 on-board components.

4.15.7. DATA COMMUNICATIONS

4.15.7.1. GENERAL

All data communication networks shall be either in accordance with a nationally recognized interface standard, such as those published by SAE, IEEE or ISO, 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 levels 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.

4.15.7.2. DRIVETRAIN LEVEL

Drivetrain components, consisting of the engine, transmission, retarder, anti-lock 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 and/or J1708/J1587 with forward and backward compatibilities or other open protocols.

4.15.7.2.1. 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.

4.15.7.2.2. PROGRAMMABILITY (SOFTWARE)

The drivetrain level components shall be programmable by the Purchasing Entity with limitations as specified by the sub- system Supplier.

4.15.7.3. MULTIPLEX LEVEL

4.15.7.3.1. 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. A hardware gateway and/or wireless communications system are options if requested by the Purchasing Entity. The communication port(s) shall be located as specified by the Purchasing Entity.

4.15.7.3.2. DIAGNOSTICS AND FAULT PROTECTION

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 on-board 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 or a handheld unit. Either unit shall have the ability to check logic function. The diagnostic data can be incorporated into the information level network or the central data access system.

ALTERNATIVE

Provide Mock-Up Board

A mock-up board, where key components of the multiplexing system are replicated on a functional model, shall be provided as a tool for diagnostic, design verification and training purposes. If proposed, the mock-up board should be priced separately in the Pricing Schedule.

4.15.7.3.3. 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 displays 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.

ALTERNATIVE:

Revision control labels shall be physically located near the programming port.

4.15.7.4. ELECTRONIC NOISE CONTROL

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

Electrical and electronic sub-systems 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.

4.15.8. DRIVER PROVISIONS, CONTROLS AND INSTRUMENTATION

4.15.8.1. DRIVER'S AREA CONTROLS

4.15.8.1.1. 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 Recommended Practice J680, Revised 1988, "Location and Operation of Instruments and Controls in Motor Truck Cabs," and be essentially within the hand reach envelope described in SAE Recommended Practice J287, "Driver Hand Control Reach."

4.15.8.1.2. GLARE

The driver's work area shall be designed to minimize glare to the extent possible. 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.

4.15.8.1.3. VISORS/SUN SHADES

Front and Side Sun Shade/Visor

Adjustable sun visor(s) shall be provided for the driver's windshield and the driver's side window. Visors shall be shaped to minimize light leakage between the visor and windshield pillars. Visors shall store out of the way and shall not obstruct airflow from the climate control system or interfere with other equipment, such as the radio handset or the destination control. Deployment of the visors shall not restrict vision of the rearview mirrors. Visor adjustments shall be made easily by hand with positive locking and releasing devices and shall not be subject to damage by over-tightening. Sun visor construction and materials shall be strong enough to resist breakage during adjustments. Visors may be transparent, but shall not allow a visible light transmittance in excess of 10 percent. Visors, when deployed, shall be effective in the driver's field of view at angles more than 5 degrees above the horizontal.

ALTERNATIVE

Driver's Window Sunscreens

An adjustable roller type sunscreen shall be provided over the driver's windshield and/or the driver's side window. The sunscreen shall be capable of being lowered to the midpoint of the driver's window. When deployed, the screen shall be secure, stable and shall not rattle, sway or intrude into the driver's field of view due to the motion of the coach or as a result of air movement. 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 extent possible. When lowered, shade/sunscreen will not obstruct driver's view of driver's side high mount mirror.

4.15.8.1.4. 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 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 also 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 Recommended Practice J2402, "Road Vehicles – Symbols For Controls, Indicators, and Tell Tales," where available and applicable. Color of switches and controls shall be dark with contrasting typography or symbols.

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.

4.15.8.1.5. 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 specified otherwise.

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 shall be illuminated using backlighting.

The indicator panel shall be located in Area 1 or Area 5, 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 shall have an outlet level between 80 and 83 dBA when measured at the location of the operator's ear.

On-board 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 3 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.

Consideration shall be provided for future additions of spare indicators as the capability of onboard diagnostic systems improves. Blank spaces shall contain LEDs.

Transit Bus Instruments and Alarms

Device	Description	Location	Function	Visual/ Audible
Master run switch	Rotary, four-position detent	Side console	Master control for bus, off, day run, night run and clearance ID lights	
Engine start, front	Approved momentary switch	Side console	Activates engine starter motor	
Engine start, rear	Approved momentary switch	Engine compartment	Activates engine starter motor	
Engine run, rear	Three-position toggle switch	Engine compartment	Permits running engine from rear start, normal front run position and off	Amber light
Drive selector	Touch panel switch	Side console	Provides selection of propulsion: forward, reverse and neutral	Gear selection

HVAC	Switch or switches to control HVAC	Side console	Permits selection of passenger ventilation: off, cool, heat, low fan, high fan or full auto with on/off only	
Driver's ventilation	Rotary, three-position detent	Side console or Dash left wing	Permits supplemental ventilation: fan off, low or high	
Defroster fan	Rotary, three-position detent	Side console or Dash left wing	Permits defroster: fan off, low, medium or high	
Defroster temperature	Variable position	Side console or Dash left wing	Adjusts defroster water flow and temperature	
Windshield wiper	One-variable rotary position operating both wipers	Dash left wing	Variable speed control of left and right windshield wipers	
Windshield washer	Push button	Dash left wing	Activates windshield washers	
2 - Dash Fans	3 position dash fan	Center of dash	Supplement driver ventilation	
Dash panel lights	Rotary rheostat or stepping switch	Side Console or Dash left wing	Provides adjustment for light intensity in night run position	
Interior lights	Three-position switch	Side console	Selects mode of passenger compartment lighting: off, on, normal	
Fast idle	Two-position switch	Side console	Selects high idle speed of engine	
WC ramp/ kneel enable	Two-position switch[1]	Side console or Dash right wing	Permits operation of ramp and kneel operations at each door remote panel	Amber light
Front door ramp/kneel enable	Two-position keyed switch[1]	Front door remote or Dash right wing	Permits ramp and kneel activation from front door area, key required[1]	Amber light
Front door ramp	Three-position momentary switch	Right side of steering wheel	Permits deploy and stow of front ramp	Red light
Front kneel	Three-position momentary switch	Front door remote	Permits kneeling activation and raise and normal at front door remote location	Amber or red dash indicator. Ext alarm and Amber light
Silent alarm	Recessed push button, NO and NC contacts momentary	Side console	Activates emergency radio alarm at dispatch and permits covert microphone and/or enables destination sign emergency message	
Video system event switch	Momentary on/off momentary switch with plastic guard	Side console	Triggers event equipment, triggers event light on dash	Amber light

Passenger door control	Five-position handle type detent or two momentary push buttons	Side console, forward	Permits open/close control of front and rear passenger doors	Red light
Rear door override	Two-position switch in approved location	Side console, forward	Allows driver to override activation of rear door passenger tape switches	
Engine shutdown override	Momentary switch with operation protection	Side console	Permits driver to override auto engine shutdown	
Hazard flashers	Two-position switch	Side console or Dash right wing	Activates emergency flashers	Two green lights
Fire suppression	Red push button with protective cover	Dash left wing	Permits driver to override and manually discharge fire suppression system	Red light
Mobile data terminal	Mobile data terminal coach operator interface panel	Above right dash wing	Facilitates driver interaction with communication system and master log-on	LCD display with visual status and text messages
Farebox interface	Farebox coach operator interface panel	Near farebox	Facilitates driver interaction with farebox system	LCD display
Destination sign interface	Destination sign interface panel	in approved location	Facilitates driver interaction with destination sign system, manual entry	LCD display
Turn signals	Momentary push button (two required) raised from other switches	Left foot panel	Activates left and right turn signals	Two green lights and optional audible indicator
PA manual	Momentary push button	In approved location	Permits driver to manually activate public address microphone	
PA speaker select switch	Two position toggle	In approved location	Permits driver to select either interior only or interior & exterior speakers	
Low profile microphone	Low-profile discrete Mounting	Steering column	Permits driver to make announcements with both hands on the wheel and focusing on road conditions	
High beam	Detente push button	In approved location	Permits driver to toggle between low and high beam	Blue light
Parking brake	Pneumatic PPV	Side console or Dash left wing	Permits driver to apply and release parking brake	Red light
Park brake release	Pneumatic PPV	Vertical side of the side console or dash center	Permits driver to push and hold to release brakes	
Hill holder	Two-position momentary switch	Side console	Applies brakes to prevent bus from rolling	

Master door/ interlock	Multi-pole toggle, detented	Out of operator's reach	Permits driver override to disable door and brake/throttle interlock	Red light
Warning interlocks deactivated	Red indicator light	Dash panel center	Illuminates to warn drive that interlocks have been deactivated.	Red light
Retarder disable	Multi-pole switch detented	Within reach of Operator or approved location	Permits driver override to disable brake retardation/regeneration	Red light
Alarm acknowledge	Push button momentary	Approved location	Permits driver to acknowledge alarm condition	
Rear door passenger sensor disable	Multi-pole toggle, detented	In sign compartment or Driver's barrier compartment	Permits driver to override rear door passenger sensing system	
Indicator/ alarm test button	Momentary switch or programming[1]	Dash center panel	Permits driver to activate test of sentry, indicators and audible alarms	All visuals and audibles
Auxiliary power	110-volt power receptacle	Approved location	Property to specify what function to supply	
Speedometer	Speedometer, odometer, and diagnostic capability, 5-mile increments	Dash center panel	Visual indication of speed and distance traveled, accumulated vehicle mileage, fault condition display	Visual
Air pressure gauge	Primary and secondary, 5 psi increments	Dash center panel	Visual indication of primary and secondary air systems	Red light and buzzer
Fire detection	Coach operator display	Property specific or dash center	Indication of fire detection activation by zone/location	Buzzer and red light
Door obstruction	Sensing of door obstruction	Dash center	Indication of rear door sensitive edge activation	Red light and buzzer
Door ajar	Door not properly closed	Property specific or dash center	Indication of rear door not properly closed	Buzzer or alarm and red light
Low system air pressure	Sensing low primary and secondary air tank pressure	Dash center	Indication of low air system pressure	Buzzer and red light
Engine coolant indicator	Low coolant indicator may be supplied as audible alert and visual and/or text message	Within driver's sight	Detects low coolant condition	Amber light
Hot engine indicator	Coolant temperature indicator may be supplied as audible alert and visual and/or text message	Within driver's sight	Detects hot engine condition and initiates time delay shutdown	Red light

Low engine oil pressure indicator	Engine oil pressure indicator may be supplied as audible alert and visual and/or text message	Within driver's sight	Detects low engine oil pressure condition and initiates time-delayed shutdown	Red light
ABS indicator	Detects system status	Dash center	Displays system failure	Amber light
HVAC indicator	Detects system status	Dash center	Displays system failure	Amber or red light
Charging system indicator (12/24 V)	Detect charging system status	Dash center	Detects no charge condition and optionally detects battery high, low, imbalance, no charge condition, and initiates time-delayed shutdown	Red light flashing or solid based on condition
Fuel tank level	Analog gauge, graduated based on fuel type	Dash center	Indication of fuel tank level/pressure	
DEF gauge	Level Indicator	Center dash	Displays level of DEF tank and indicates with warning light when low	Red light
Active regeneration	Detects Status	Dash center	Indication of electric regeneration	Amber or red light

1. Indicate area by drawing. Break up switches control from indicator lights.

4.15.8.1.6. DRIVER 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.

a) 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 an angle of 10 to 18 degrees at full throttle.

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.

b) PEDAL DIMENSIONS AND POSITION

The floor-mounted accelerator pedal shall be 10 to 12 in. long and 3 to 4 in. wide. Clearance around the pedal must allow for no interference precluding operation.

1 to 2 in. Between Brake and Accelerator Pedals

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 in. Both pedals should be located approximately on the same plane coincident to the surface of the pedals.

4.15.8.1.7. BRAKE AND ACCELERATOR PEDALS

Adjustable Brake and Accelerator Pedals

Both pedals shall be adjustable forward and rearward a minimum of 3 in. The adjustment shall be made by use of a dash-mounted toggle or rocker switch. The switch shall be clearly labeled to identify it as pedal adjustment and shall be within easy reach of the driver. Pedal adjustment shall be enabled only when the bus is stationary and the parking brake engaged.

ALTERNATIVE:

Non-adjustable brake pedal.

4.15.8.1.8. DRIVER FOOT SWITCHES

Floor-Mounted Foot Control Platform

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 shall be located no closer to the seat front than the heel point of the accelerator pedal.

The control switches for the turn signals shall be mounted on an inclined, floor-mounted stainless steel enclosure or metal plate mounted to an incline integrated into the driver's platform, located to the left of the steering column. The location and design of this enclosure shall be such that foot room for the operator is not impeded. The inclined mounting surface shall be skid-resistant. All other signals, including high beam and public address system shall be in approved location.

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

ALTERNATIVE

Other Floor-Mounted Controls

The following may be floor mounted, momentary or latching, as identified by the Purchasing Entity.

- PA System
- Hazard
- Silent Alarm

4.15.9. DRIVER'S AMENITIES

4.15.9.1. COAT HANGER

A suitable hanger shall be installed in a convenient, approved location for the driver's coat.

ALTERNATIVE:

Coat Hook

A hook and loop shall be provided to secure the driver's coat.

4.15.9.2. DRINK HOLDER

No drink holder.

ALTERNATIVES:
A device shall be provided to securely hold the driver'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.

4.15.9.3. STORAGE BOX

An enclosed driver storage area shall be provided with a positive latching door and/or lock.

ALTERNATIVE:

No storage box.

4.15.10. WINDSHIELD WIPERS AND WASHERS

4.15.10.1. WINDSHIELD WIPERS

The bus shall be equipped with a variable speed synchronized and intermittent 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.

ALTERNATIVE:

Wiper Powered by Compressed Air
If powered by air, exhaust from the wiper motors shall be muffled or piped under the floor of the bus.

ALTERNATIVE:

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

4.15.10.2. WINDSHIELD WASHERS

The windshield washer system, when used with the wipers, shall deposit washing fluid evenly and completely wet the entire wiped area.

The windshield washer system shall have a minimum 3-gallon reservoir, located for easy refilling from outside of the bus. Reservoir pumps, lines and fittings shall be corrosion-resistant and must include a means to determine fluid level. The washer lines and nozzles shall be mounted and routed in a manner that will impede freezing of the fluid within the lines/nozzles

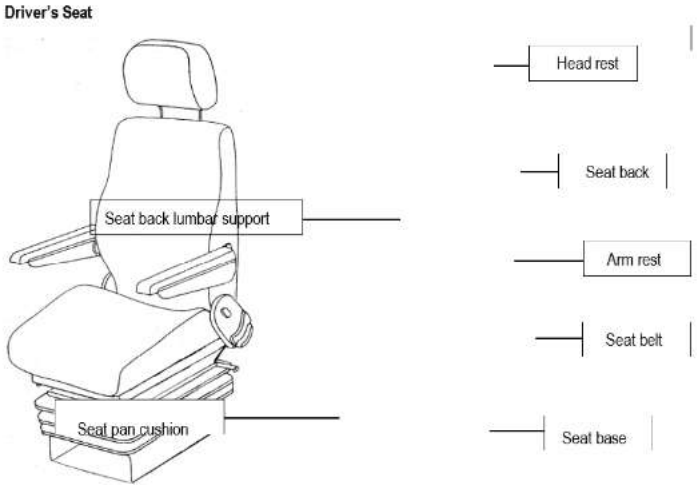
ALTERNATIVE:

Heated or insulated washer solvent reservoir, lines, and nozzles to aid in the prevention of freezing shall be made available and priced separately.

ALTERNATIVE:

Body mounted washer nozzles shall be made available and priced separately.

4.15.11. DRIVER'S SEAT



4.15.11.1. DIMENSIONS

The driver'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.

4.15.11.1.1. 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 in. at its minimum length and no more than 20.5 in. at its maximum length.

4.15.11.1.2. 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 in., with a minimum 6 in. vertical range of adjustment.

ALTERNATIVE:

H-Point

The reference point for seat height shall be determined by establishing the H-point.

4.15.11.1.3. 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).

4.15.11.1.4. 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 in.). On all low-floor buses, the seat-base shall travel horizontally a minimum of 9 in. It shall adjust no closer to the heel point than 6 in. On all high-floor buses, the seat base shall travel a minimum of 9 in. and adjust no closer to the heel-point than 6 in.

4.15.11.1.5. SEAT PAN CUSHION WIDTH

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

4.15.11.1.6. SEAT SUSPENSION

The driver’s seat shall be appropriately dampened to support a minimum weight of 600 lbs. The suspension shall be capable of dampening adjustment in both directions.

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

4.15.11.1.7. 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 in. Seat back will include dual recliner gears on both sides of the seat.

Height

The driver's seat back height, measured from the point of intersection of the uncompressed seat cushion with the seat back to the top of the back, shall be a minimum of 18 inches.

4.15.11.1.8. HEADRESTS

The driver’s seat shall be provided with an adjustable headrest.

ALTERNATIVE:

No Headrest.

4.15.11.1.9. 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 in.

4.15.11.1.10. 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.

4.15.11.2. SEAT BELT

The belt assembly should be an emergency locking retractor (ELR) 3 point seat belt only. (both lap and shoulder seat belts) 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 seat belt assemblies as installed in the bus shall withstand static horizontal forces as required in FMVSS 207 and 210. Seat belt webbing shall be bright orange in color. The lap belt assembly shall be a minimum of 72 in. in length.

ALTERNATIVE:

All seatbelt assemblies shall come equipped with a warning switch device to remind operators to buckle up.

ALTERNATIVE:

The lap belt assembly shall be 72 in. in length with an 8-in. extension

ALTERNATIVE:

Seat Belt Retractor

An Auto-Locking Retractor (ALR) shall be made available.

4.15.11.3. ADJUSTABLE ARMREST

No armrests.

ALTERNATIVE:

One armrest, right side.

ALTERNATIVE:

One armrest, left side.

ALTERNATIVE:

Two armrests.

4.15.11.4. 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.

4.15.11.5. SEAT STRUCTURE AND MATERIALS

Cushions

Cushions shall be fully padded with at least 3 in. of materials in the seating areas at the bottom and back. Materials shall adhere to FMVSS 302 or FTA Docket 90A standards.

4.15.11.6. PEDESTAL

Powder-coated steel.

ALTERNATIVE:

Stainless steel.

4.15.11.7. SEAT OPTIONS

ALTERNATIVE:

Alternate, driver seat Recaro Metro AM 80 or equivalent.

4.15.11.8. MIRRORS

4.15.11.8.1. EXTERIOR MIRRORS

The bus shall be equipped with a 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 with a breakaway mounting system. 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.

Combination plane/convex mirrors are preferred. The mirrors shall be located so as to provide the driver a view to the rear along both sides of the bus and shall be adjustable both in the horizontal and vertical directions to view the rearward scene. The roadside rearview mirror shall be positioned so that the driver's line of sight is not obstructed.

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

ALTERNATIVE:

Spring loaded mirror heads auto return.

ALTERNATIVE:

Mirrors with integrated turn signal, one side.

ALTERNATIVE:

Mirrors with integrated turn signal, both sides.

ALTERNATIVE:

Mirrors with external mounted turn signal, one side.

ALTERNATIVE:

Mirrors with external mounted turn signal, both sides.

4.15.11.8.2. INTERIOR MIRRORS

Mirrors shall be provided for the driver to observe passengers throughout the bus without leaving the seat and without shoulder movement. The driver shall be able, without needing to adjust the mirror, to observe passengers in the front/entrance and rear/exit areas, anywhere in the aisle, and in the rear seats.

4.16. WINDOWS

4.16.1. GENERAL

30-ft Bus – A minimum of 6000 sq. in. of window area, including operator and door windows, shall be required on each side of the standard configuration bus.

40-ft Bus – A minimum of 10,000 sq. in. of window area, including operator and door windows, shall be required on each side of the standard configuration bus.

4.16.2. WINDSHIELD

The windshield shall permit an operator's field of view as referenced in SAE Recommended Practice 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 3½ ft. high no more than 2 ft. in front of the bus. The horizontal view shall be a minimum of 90 degrees 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.

4.16.2.1. GLAZING

The windshield glazing material shall have a ¼ in. nominal thickness laminated safety glass conforming to the requirements of ANSI Z26.1 Test Grouping 1A and the Recommended Practices defined in SAE J673.

Shaded Band

The upper portion of the windshield above the driver's field of view shall have a dark, shaded band with a
minimum luminous transmittance of 5 percent when tested in accordance to ASTM D-1003.

4.16.3. DRIVER'S SIDE WINDOW

The driver's side window shall be the sliding type, requiring only the rear half of sash to latch upon closing, and shall open sufficiently to permit the operator to easily adjust the street-side outside rearview mirror. When in an open position, the window shall not rattle or close during 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 glazing material shall have a single-density tint.

The driver's view, perpendicular through operator's side window glazing, should extend a minimum of 33 in. (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 in. (560 mm) above the operator's floor to ensure visibility of an under-mounted convex mirror. Driver's window construction shall maximize ability for full opening of the window.

The driver's side window glazing material shall have a ¼ in. nominal thickness laminated safety glass conforming with the requirements of ANSI Z26.1-1996 Test Grouping 2 and the Recommended Practices defined in SAE J673.

The design shall prevent sections from freezing closed in the winter. Light transmittance shall be 75 percent on the glass area below 53 in. from the operator platform floor. On the top fixed over bottom slider configuration, the top fixed area above 53 in. may have a maximum 5 percent light transmittance.

ALTERNATIVE:

Quick Change Operator's Side Window

Glazing in the window assembly shall be replaced without removing the window from its installed position on the bus or manipulation of the rubber molding surrounding the glazing. The glazing shall be held in place mechanically by a formed metal extruded ring constructed to last the life of the vehicle.

4.16.4. SIDE WINDOWS

4.16.4.1. CONFIGURATION

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 engine operation or normal road excitation is not apparent. All aluminum and steel material will be treated to prevent corrosion.

4.16.4.2. EMERGENCY EXIT (EGRESS) CONFIGURATION

All side windows shall be fixed in position, except as necessary to meet the emergency escape requirements. Side windows shall have bonded, seamless hidden frames and shall be open able with inward-opening transom panels.

ALTERNATIVE:

Maximum Egress

Every window shall be capable of being made an egress window.

ALTERNATIVE:

Quick Change Passenger Side Windows
Glazing in the window assembly shall be replaced without removing the window from its installed position on the bus or manipulation of the rubber molding surrounding the glazing. The glazing shall be held in place mechanically by a formed metal extruded ring constructed to last the life of the vehicle.

4.16.4.3. CONFIGURATION

All side windows, except windows in passenger doors and those smaller than 500 sq. in., shall have window panels that are operable by passengers. Operable window panels shall be equipped with latches that secure the window in the fully open and fully closed positions.

Each operable side window shall incorporate an upper transom portion. The transom shall be between 25 and 35 percent of the total window area and shall be either fixed or vent style. The lower portion of the window shall be fixed. The transom portion shall be hinged along the lower edge and open inward.

4.16.4.4. MATERIALS

Safety Glass Glazing Panels
Side windows glazing material shall have a minimum of 3/16 in. 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.

ALTERNATIVE:

Polycarbonate Glazing Panels
Side window glazing material shall have a minimum of 3/16 in. nominal thickness. The material shall conform to the requirements of ANSI Z26.1-1977, “Standard for Type AS-5 Safety Glazing Materials,” except for Test Number 17, which shall subject the specimens to 1000 cycles and the arithmetic mean of the percentages of light scattered shall not exceed 5 percent. Windows shall be polycarbonate sheet with an abrasion-resistant coating on both sides of the window.

ALTERNATIVE:

Acrylic Glazing Panels
Side window glazing material shall have a minimum of 3/16 in. nominal thickness. The material shall conform with the requirements of ANSI Z26.1-1996, “Standard for Type AS-5 Safety Glazing Materials,” except for Test Number 17, which shall subject the specimens to 1000 cycles and the arithmetic mean of the percentages of light scattered shall not exceed 5 percent. Windows shall be cell cast acrylic sheet with an abrasion-resistant coating on both sides of the window.

ALTERNATIVE:

Laminated Glazing Panels (Not Available on Hidden Frame [Seamless] Windows)
Side windows glazing material shall have a minimum of 3/16 in. nominal thickness laminated safety glass. The material shall conform to applicable requirements of ANSI Z26.1-1996 and the Recommended Practices defined in SAE J673.

ALTERNATIVE:

Laminated and Tempered Safety Glazing with Anti-vandalism Polyester Sacrificial Film
All glazing material that is aft of the standee line shall be equipped with 6 mm laminated polyester film. This 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.

ALTERNATIVE:

Laminated and Tempered Safety Glazing with Anti-vandalism Polyester Sacrificial Film
All glazing material that is aft of the standee line shall be equipped with 6 mm laminated polyester film. This 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.

ALTERNATIVE:

Anti-Vandalism Sacrificial Liner ("Quick Change")
All glazing material aft of the standee line shall be equipped with necessary bracketry, fasteners and clear acrylic liner that shall be easily removable in the event of vandalism. The acrylic liner shall be clear and shall have minimal effect on the transmittance of the underlying glazing. This material shall not be adversely affected by ultraviolet rays and shall withstand normal cleaning practices. The installation of the liner shall prevent clouding or fogging. This acrylic sacrificial liner must be replaced without removing the window from its installed position on the bus, without removing the tempered glazing from the sash, and without the removal or manipulation of the window assembly's rubber molding.

Windows on the bus sides and in the rear door shall be tinted a neutral, gray color, complementary to the bus exterior. The maximum solar energy transmittance shall not exceed 37 percent, as measured by ASTM E-424. Luminous transmittance shall be measured by ASTM D-1003. Windows over the destination signs shall not be tinted. The luminous transmittance of the windows shall be equal to 50 percent.

Windows on the bus sides and in the rear door shall be tinted a neutral color, complementary to the bus exterior. The maximum solar energy transmittance shall not exceed 37 percent, as measured by ASTM E-424, and the luminous transmittance shall be no less than 16 percent, as measured by ASTM D-1003. Window at the destination/location sign shall

not be tinted in the vicinity of the sign.

4.16.4.5. **REAR WINDOW -** No requirement for rear window.

ALTERNATIVE:

Rear Window Requirement
A rear window shall be provided. The rear window shall be glazed with same material (including anti- vandalism provision if required) and tint as side windows. 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.

4.17. HEATIN, VENTILATIONG AND AIR CONDITIONING

4.17.1. CAPACITY AND PERFORMANCE

The HVAC climate control system shall be capable of controlling the temperature and maintaining the humidity levels of the interior of the bus as defined in the following paragraphs.

The HVAC unit may either be roof or rear-mounted. [Note that a rear-mounted unit will preclude a rear window and that the term “roof-mounted unit” includes units mounted on top of or beneath the roof surface.] In the case of roof-mounted units, accessibility and serviceability of preventative maintenance components shall be provided, minimizing the need for maintenance personnel to work on the roof of the bus.

With the bus running at the design operating profile with corresponding door opening cycle, and carrying a number of passengers equal to 150 percent of the seated load, the HVAC system shall control the average passenger compartment temperature within a range between 65 and 80 °F, while maintaining the relative humidity to a 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 95 °F and at any ambient relative humidity levels between 5 and 50 percent.

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

When bus is operated in outside ambient temperatures in the range of -10 to 10 °F, the interior temperature of the bus shall not fall below 55 °F while the bus is running on the design operating profile.

System capacity testing, including pull-down/warm-up, stabilization and profile, shall be conducted in accordance to the APTA’s “Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System.”

The recommended locations of temperature probes are only guidelines and may require slight modifications to address actual bus design. Care must be taken to avoid placement of sensing devices in the immediate path of an air duct outlet. In general,

the locations are intended to accurately represent the interior passenger area.

Additional testing shall be performed as necessary to ensure compliance to performance requirements stated herein.

ALTERNATIVE (DIESEL BUSES)

Fully AC high-voltage electric-driven A/C system with full hermetic AC compressor, condenser fan, evaporator blower motors and brushless AC generators.

Capacity and Performance Requirements

The air-conditioning portion of the HVAC system shall be capable of reducing the passenger compartment temperature from 110 to 90 °F in less than 20 minutes after engine start-up. Engine temperature shall be within the normal operating range at the time of start-up of the cool-down test, and the engine speed shall be limited to fast idle, which may be activated by a driver-controlled device. During the cool-down period, the refrigerant pressure shall not exceed safe high-side pressures, and the condenser discharge air temperature, measured 6 in. from the surface of the coil, shall be less than 45 °F above the condenser inlet air temperature. The appropriate solar load as recommended in the APTA "Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System," representing 4 p.m. on August 21, shall be used. There shall be no passengers on board, and the doors and windows shall be closed.

ALTERNATIVE (HYBRID BUSES)

Fully AC high-voltage electric-driven A/C system with full hermetic AC compressor, condenser fan, evaporator blower motors.

ALTERNATIVE (HYBRID BUSES)

Fresh Air Circulation

The HVAC design shall be capable of introducing a minimum 15% of fresh air circulation within the HVAC system.

ALTERNATIVE:

Hotter Ambient Conditions

The air conditioning portion of the HVAC system shall be capable of reducing the passenger compartment temperature from 110 °F to 70 °F +/-3 °F in less than 30 minutes after system engagement for 30, 35 and 40- foot buses. Engine temperature shall be within the normal operating range at the time of start-up of the cool-down test, and the engine speed shall be limited to fast idle at ¾ max governed speed that may be activated by a driver-controlled device. During the cool-down period, the refrigerant pressure shall not exceed safe high-side pressures, and the condenser discharge air temperature, measured 6 in. from the surface of the coil, shall be less than 45 °F above the condenser inlet air temperature. No simulated solar load shall be used. There shall be no passengers on board, and the doors and windows shall be closed.

ALTERNATIVE:

Colder Ambient Conditions

The pull-up requirements for the heating system shall be in accordance with Section 9 of APTA's "Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning." With ambient temperature at -20 °F, and vehicle cold soaked at that temperature, the bus heating system shall warm the interior passenger compartment to

an average temperature of 70 °F ±2 °F within 70 minutes.

ALTERNATIVE:

R134a

The air conditioning system shall meet these performance requirements using R134a. **NOTE:** Selection of this refrigerant may impact pull-down performance.

ALTERNATIVE:

The air conditioning system shall meet these performance requirements using R407C.

4.17.2. **CONTROLS AND TERMPERATURE UNIFORMITY**

The HVAC system excluding the driver's heater/defroster shall be centrally controlled with an advanced electronic/diagnostic control system with provisions for extracting/reading data. The system shall be compliant with J1939 Communication Protocol for receiving and broadcasting of data.

Hot engine coolant water shall be delivered to the HVAC system driver's defroster/heater and other heater cores by means of an auxiliary coolant pump, sized for the required flow, which is brushless and seal-less having a minimum maintenance free service life for both the brushless motor and the pump of at least 40,000 hours at full power.

Manual Mode Selection of Climate Control System

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 °F of specified temperature control set-point.

ALTERNATIVE:

Fully Automatic Climate Control System

The climate control system shall be fully automatic and control the interior average temperature to within ±2 °F of specified temperature control set-point.

ALTERNATIVE:

Manually Adjustable Temperature Control Set Point

The climate control system shall have the provision to allow the driver to adjust the temperature control set- point at a minimum of between 68 and 72 °F. From then on, all interior climate control system requirements shall be attained automatically, unless re-adjusted by driver.

The driver shall have full control over the defroster and driver's heater. The driver shall be able to adjust the temperature in the driver's area through air distribution and fans. The interior climate control system shall switch automatically to the ventilating mode if the refrigerant compressor or condenser fan fails.

Interior temperature distribution shall be uniform to the extent practicable 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 in. above the floor, shall not vary by more than 5 °F with doors closed. The interior temperatures, measured at the same height above the floor, shall not vary more than ± 5 °F 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 °F will be allowed for limited, localized areas provided the majority of the measured temperatures fall within the specified requirement.

4.17.3. AIR FLOW

4.17.3.1. 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 ft. per minute (cfm) per passenger based on the standard configuration bus carrying a number of passengers equal to 150 percent of the seated load. Airflow shall be evenly distributed throughout the bus, with air velocity not exceeding 100 ft. 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 (150 percent of seated load) when operating in the heating mode. The fans shall not activate until the heating element has warmed sufficiently to ensure at least 70 °F air outlet temperature. The heating air outlet temperature shall not exceed 120 °F 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.

4.17.3.2. DRIVER'S AREA

The bus interior climate control system shall deliver at least 100 cfm of air to the driver'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 Recommended Practice J382, "Windshield Defrosting Systems Performance Requirements," and shall have the capability of diverting heated air to the driver's feet and legs. The defroster or interior climate control system shall maintain visibility through the driver's side window.

4.17.3.3. CONTROLS FOR THE CLIMATE CONTROL SYSTEM (CCS)

The controls for the driver's compartment for heating, ventilation and cooling systems shall be integrated and shall meet the following requirements:

- The heat/defrost system fan shall be controlled by a separate switch that has an "off" position and at least two positions for speed control. All switches and controls shall preclude the possibility of clothing becoming entangled, and shields shall be provided, if required. If the fans are approved by the Purchasing Entity, an "on-off" switch shall be located to the right of or near the main defroster switch.
- A manually operated control valve shall control the coolant flow through the heater core.

- If a cable-operated manual control valve is used, the cable length shall be kept to a minimum to reduce cable seizing. Heater water control valves shall be “positive” type, closed or open. The method of operating remote valves shall require the concurrence of the Purchasing Entity project manager.

4.17.3.4. **DRIVER’S COMPARTMENT REQUIREMENTS**

A separate heating, ventilation and defroster system for the driver’s area shall be provided and shall be controlled by the driver. The system shall meet the following requirements:

- The heater and defroster system shall 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 the 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 shall be provided. The driver shall have complete control of the heat and fresh airflow for the driver’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.

A ventilation system shall be provided to ensure driver comfort and shall be capable of providing fresh air in both the foot and head areas. Vents shall be controllable by the driver 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.

4.17.3.5. **DRIVER’S COOLING**

A separate fan unit shall provide 100 cfm of air to the driver’s area through directionally adjustable nozzles and an infinitely variable fan control, both of which shall be located above and ahead of the driver. No dedicated evaporator is required for the driver’s area.

ALTERNATIVE:

Separate Dedicated Evaporator

Using a separate, dedicated evaporator, the Climate Control System shall be designed to maintain the driver’s compartment temperatures within the range specified for the passenger compartment. The unit shall operate when the climate control switch is in the “Cool” position. It shall have a separate thermostatic control.

ALTERNATIVE:

Air from the evaporator shall be provided to the driver’s area through vents

located on the dash in front of the driver.

ALTERNATIVE:

Driver's booster blower.

4.17.3.6. **AIR FILTRATION**

Air shall be filtered before discharge into the passenger compartment. The filter shall meet the ANSI/ASHRAE 52.1 requirement for 5 percent or better atmospheric dust spot efficiency, 50 percent weight arrestance, and a minimum dust holding capacity of 120 g per 1000 cfm cell. Air filters shall be easily removable for service. Air filters shall be cleanable.

ALTERNATIVE:

Disposable Type Filters
Air filters shall be of disposable type

ALTERNATIVE:

Electronic Filtering/Anti-Microbial Devices
Devices used to suppress dust, control odors, and help control various harmful micro-organisms shall be made available and priced separately.

4.17.3.7. **ROOF VENTILATORS**

One Roof Ventilator
One power roof ventilator shall be provided in the front roof of the bus.

ALTERNATIVE:

Two Roof Ventilators
Two roof ventilators shall be provided in the roof of the bus, one approximately over or just forward of the front axle and the other approximately over the rear axle.

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 sq. in. and shall be capable of being positioned as a scoop with either the leading or trailing edge open no less than 4 in., or with all four edges raised simultaneously to a height of no less than 3½ in. An escape hatch shall be incorporated into the roof ventilator. Roof ventilator(s) shall be sealed to prevent entry of water when closed.

ALTERNATIVE:

An electronically controlled hatch shall be installed.

4.17.4. **MAINTAINABILITY**

Manually controlled shut-off valves in the refrigerant lines shall allow isolation of the compressor and dehydrator filter for service. To the extent practicable, self-sealing couplings utilizing O-ring seals shall be used to break and seal the refrigerant lines during removal of major components, such as the refrigerant compressor. Shut-off 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 bus 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 in. of floor level shall be constructed to resist damage and corrosion.

ALTERNATIVE:
High and low refrigerant pressure analog gauges to be located in the return air area.

ALTERNATIVE:
High and low refrigerant pressure electronic gauges to be located in the return air area.

4.17.5. **ENTRANCE/EXIT AREA HEATING -** No requirements for entrance/exit area heating.

ALTERNATIVE:

Entrance/Exit Area Heating
Heat shall be supplied to the entrance and exit areas to maintain a tread surface temperature no less than 35 °F in an ambient of -10 °F to prevent accumulation of snow, ice or slush with the bus operating under design operating profile and corresponding door opening cycle.

4.17.6. **FLOOR-LEVEL HEATING** - No requirements for floor-level heating.

ALTERNATIVE:

Forced-Air Floor-Level Heating
Sufficient floor-level heaters shall be provided to evenly supply heated forced air through floor ducts across the length of bus. Floor ducts may be discontinued at the upper level, but additional provisions to prevent cold floors and ensure temperature uniformity shall be included. Control of the floor-level heating shall be through the main heating system electronic control.

ALTERNATIVE:

Convector Air Floor-Level Heating
Sufficient floor-level heaters shall be provided that evenly supply convector air across the length of the bus. Control of the floor-level heating shall be through the main heating system's electronic control.

ALTERNATIVE:

Warm Wall Heating
Sufficient heaters shall be provided with ducting to blow warm air upward through a cavity in the wall and discharge the warm air at the base of the windows. Control of the warm wall heating shall be through the main heating system electronic control.

4.18. EXTERIOR PANELS, FINISHES AND EXTERIOR LIGHTING

4.18.1. 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 any body feature 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.

ALTERNATIVE:
As an alternative, all elements of a complete "BRT" style (or equal appearance) package will be offered as an alternate. Included in this design should be BRT Front caps, BRT Rear caps, bonded side windows, BRT style aerodynamic exterior mirrors (power adjusted and heated), and a two-piece BRT style (or approved equal) front windshield and any other BRT styling provisions as may be offered.

4.18.1.1. **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 body material surfaces.

ALTERNATIVE:

Requirements for protection against graffiti/vandalism for body material surfaces.

4.18.1.2. **ROOF-MOUNTED EQUIPMENT**

A non-skid, clearly marked walkway or steps shall be incorporated on the roof to provide access to equipment without damaging any system or bus paneling.

4.18.2. **PEDESTRIAN SAFETY**

Exterior protrusions along the side and front of the bus greater than ½ in. and within 80 in. 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. Advertising frames shall protrude no more than ⅞ in. from the body surface. Grilles, doors, bumpers and other features on the sides and rear of the bus shall be designed to minimize toeholds or handholds.

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

4.18.3. **REPAIR AND REPLACEMENT**

4.18.3.1. **SIDE BODY PANELS**

Structural elements supporting exterior body panels shall allow side body panels below the windows to be repaired in lengths not greater than 12.5 ft. Exterior surface panels shall not be installed or retained with visible rivets or fasteners. Exterior panels shall be divided into sections that are repairable or replaceable by a 3M mechanic in less than 30 minutes for a section up to 5 feet long (excludes painting). Panels longer than 5 feet long may take proportionally longer times (excludes painting).

ALTERNATIVE:

Easily Replaceable Lower Side Body Panels
The lower section (approximately 17.5 in.) of the side body panels (low-floor buses) or skirt panels (high- floor buses) shall be made of impact-resistant material and shall be easily and quickly replaceable.

ALTERNATIVE:

Easily Replaceable Full-Height Side Body Panels
Easily replaceable full-height side body panels between the window and floor shall be easily and quickly replaceable in sections.

4.18.4. **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.

4.18.5. **LICENSE PLATE PROVISIONS**

Provisions shall be made to mount standard-size U.S./Canada 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. **No front plate or holder is required.**

4.18.5.1. **RUB RAILS -** No requirement for rub rails.

ALTERNATIVE:

Requirement for Rub Rails
Rub rails composed of flexible, resilient material shall be provided to protect both sides of the bus body from damage caused by minor sideswipe accidents with automobiles. Rub rails shall have vertical dimensions of no less than 2 in. (50 mm) with the centerline no higher than 35 in. above the ground between the wheel wells. The rub rails shall withstand impacts of 200 ft-lbs. of energy from a steel-faced spherical missile no less than 9 in. in diameter and of a 500 lb. load applied anywhere along their length by a rigid plate 1 ft. in length, wider than the rub rail, and with a ¼ in. end radii, with no visible damage to the rub rail, retainer or supporting structure.

The rub rail may be discontinued at doorways and wheel wells. A damaged portion of the rub rail shall be replaceable without requiring removal or

replacement of the entire rub rail.

4.18.6. **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.

ALTERNATIVE:

No fender skirts required.

4.18.7. **WHEEL COVERS** - Wheel covers are not required.

4.18.7.1. **SPLASH APRONS**

Splash aprons, composed of ¼ in. minimum composition or rubberized fabric, shall be installed behind and/or in front of wheels as needed to reduce road splash and protect underfloor components. The splash aprons shall extend downward to within 6 in. 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.

ALTERNATIVE:

Full width rear splash apron.

ALTERNATIVE:

Other Locations

Splash apron in front of either or both front wheels to reduce splashing on ramp/lift and left mirror.

4.18.8. **SERVICE COMPARTMENTS AND ACCESS DOORS**

4.18.8.1. **ACCESS DOORS**

Conventional or pantograph hinged doors shall be used for the engine compartment and for all auxiliary equipment compartments including doors for checking the quantity and adding to the engine coolant, engine lubricant and transmission fluid. 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.

4.18.8.2. ACCESS DOOR LATCH/LOCKS

Requirement for Latches on Access Doors
Access doors larger than 100 sq. in. 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 in. square male tool to open or lock.

ALTERNATIVE:

Other Locks and Latches
The Purchasing Entity may define any required locks or latches for access doors.

4.18.9. BUMPERS

4.18.9.1. LOCATION

Bumpers shall provide impact protection for the front and rear of the bus with the top of the bumper being 27 in., ± 2 in., 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.

4.18.9.2. FRONT BUMPER

No part of the bus, including the 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 lbs. 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 in. Provision shall be made for an integrated bike rack.

4.18.9.3. REAR BUMPTER

No part of the bus, including the 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 ft. 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 in. high, and at accelerations up to 2 mph/sec. 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 lbs., 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 preclude 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 in.

4.18.9.4. BUMPER MATERIAL

Bumper material shall be corrosion-resistant and withstand repeated impacts of the specified loads without sustaining damage. Visible surfaces shall be black. These bumper qualities shall be sustained throughout the service life of the bus.

4.18.10. FINISH AND COLOR

4.18.10.1. 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 assure 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 completely 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.

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 patch 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 adhesion tester as outlined in ASTM D4541-85. Adhesion shall be a minimum 300 ft-lbs. 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.

Paint and graphics specifications will be provided to the selected Contractor.

ALTERNATIVE:

Maintenance-Free Exterior Finish, Color Impregnated Panels or Unpainted Panels

Except for periodic cleaning, exterior surfaces of the bus shall be maintenance-free, permanently colored and not require refinish/repaint for the life of the vehicle. Durable, peel-resistant, pressure-sensitive appliqués shall be used for any striping and coloring required.

ALTERNATIVE:

Four-color complex color schemes

As an option, the manufacturer should quote a four-color paint scheme with additional decals.

4.18.11. DECALS, NUMBERING AND SIGNING

Monograms, numbers and other special signing shall be applied to the inside and outside of the bus as required. Signs shall be durable and fade-, chip- and peel-resistant. They may be painted signs, decals or pressure-sensitive appliqués. 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, Subpart B, 38.27.

Consult with the individual joint procurement member to determine decaling and logo requirements. The Purchasing Entity uses 3M Scotchcal, Series 50 vinyl for stripes and logos. Purchasing Entity logos are custom printed on reflective material. Colors used are 3M black, 3M white, 3M Intense Blue – 47 and 3M Cardinal Red – 53.

ALTERNATIVE:

Reflective Striping

A 3” reflective strip to match bus color shall be included at the bottom of all side panels and along the bottom of the engine compartment door.

4.18.11.1. PASSENGER INFORMATION

ADA priority seating signs as required and defined by 49 CFR, Part 38.27 shall be provided to identify the seats designated for passengers with disabilities.

Requirements for a public information system in accordance with 49 CFR, Part 38.35 shall be provided.

4.18.12. EXTERIOR LIGHTING

Exterior lighting and reflectors shall comply, as applicable, with Part 393, Subpart B of the FMCSA and FMVSS 108.

All exterior lights shall be designed to prevent entry and accumulation of moisture or dust. Commercially available LED-type lamps shall be utilized at all exterior lamp locations except headlights. Lamps, lenses and fixtures shall be interchangeable to the extent practicable. Two hazard lamps at the rear of the bus shall be visible from behind when the engine service doors are opened. Light lenses shall be designed and located to prevent damage when running the vehicle through an automatic bus washer. 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.

Standard Lamps

All LED lamps shall be standard installation of the OEM. The entire assembly shall be specifically coated to protect the light from chemical and abrasion degradation.

ALTERNATIVE:

Potted Lamps

LED lamps shall be potted type and designed to last the life of the bus.

4.18.12.1. BACKUP LIGHT/ALARM

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

4.18.12.2. DOORWAY LIGHTING

Lamps at the front and rear passenger doorways 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 for a distance of 3 ft. 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.

4.18.12.3. TURN SIGNALS

Turn-signal lights shall be provided on the front, rear, curb and street sides of the bus in accordance with FMVSS 108 and Part 393, Subpart B of the FMCSA as applicable.

ALTERNATIVE:

Wraparound Front Turn Signals

Front turn signals shall be of wrap-around design or shall be designed to be visible from the front and the near side of the bus.

4.18.12.4. HEADLIGHTS

Roved headlamps shall be designed for replacement without removing the headlamp bezel.

Standard Installation
Standard OEM headlight installation shall be provided in accordance with FMVSS 108 and Part 393, Subpart B of the FMCSA as applicable.

ALTERNATIVE:

Daytime Running Lights
Headlamps shall incorporate a daytime running light feature.

ALTERNATIVE:

LED/Halogen
Headlamps shall be LED/halogen, sealed beam.

4.18.12.5. BRAKE LIGHTS

Brake lights shall be provided in accordance with FMVSS 108 and Part 393, Subpart B of the FMCSA as applicable.

Contractor to provide and install two (2) additional stop lights located above the engine access door.

Stoplights must be lettered to say “stop” in accordance with Michigan law.

ALTERNATIVE:

High and Center Mount Red Brake Lamp
Bus shall include red, high and center mount brake lamp(s) along the backside of the bus in addition to the lower brake lamps required under FMVSS 108. The high and center mount brake lamp(s) shall illuminate steady with brake application.

ALTERNATIVE:
Install red LED light for retarded over-ride. This light to be installed on right upper right of rear of coach.

ALTERNATIVE:
Bus shall include amber high and center mount lamp(s) along the backside of the bus that illuminate steady when the transmission is in forward mode and when the throttle is completely released (0 percent engagement). The amber lamps shall automatically extinguish, regardless of transmission and throttle condition, with brake application. Operation of the amber lamps shall be programmable with the multiplex system.

4.18.12.6. SERVICE AREA LIGHTING (INTERIOR AND EXTERIOR)

LED lamps shall be provided in the engine 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 compartment, the communication box, junction/apparatus panels 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.

Engine compartment lamps shall be controlled by a switch mounted near the rear start controls. 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 30 minutes to prevent damage caused by inadvertently leaving the service area lighting switch in the on position after repairs are made.

4.19. INTERIOR PANELS AND FINISHES

4.19.1. GENERAL REQUIREMENTS

Materials shall be selected on the basis of maintenance, durability, appearance, safety, 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 in. 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.

DEFAULT - No requirement for anti-graffiti/vandalism surface treatments.

ALTERNATIVE:

Requirements for additional anti-graffiti/vandalism treatments for interior surfaces.

ALTERNATIVE:

Internal surfaces, as possible, to be stainless steel or other resistant material.

4.19.2. 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. Interior panel required to meet FMVSS 302. Interior side trim panels and driver's barrier shall be melamine, anodized aluminum, fiberglass or other tamper resistant and cleanable material.

4.19.2.1. DRIVER 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 passenger 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 entire partition assembly for mounting of such equipment as flare kits, fire extinguishers (1.2 kg), microcomputer, public address amplifier, etc. Dark or black panels are preferred behind the driver's head. The panel should be isolated for noise control and attached with rubber grommets.

DEFAULT

Wheel-Well-to-Ceiling Configuration of Driver's Barrier
The driver's barrier shall extend from the top of the wheel well to the ceiling the level of the seated driver and shall fit close to the bus side windows and wall to prevent passengers from reaching the driver or the driver's personal effects.

ALTERNATIVE

Full-Height (Floor-to-Ceiling) Configuration of Driver's Barrier
The driver's barrier shall extend continually 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 limit passenger conversation.

ALTERNATIVE

Driver's Barrier
An optional clear polycarbonate protective barrier between the driver and passengers to aid in the prevention of the spread of germs shall be made available and priced separately. The barrier will be located to the right of the driver while seated in the driver seat, permanently mounted, hinged for ease of driver entrance, and exit, and latched to secure closure.

ALTERNATIVE

Slide Stow Driver Protection System (DPS)
A fixed barrier with extended slide door equal to ArrowGuard Slide System

4.19.2.2. 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 its 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 1 and 1½ in. above the floor. Panels forward of longitudinal seats shall extend to below

the level of the seat cushion. Dividers positioned at the doorways shall provide no less than a 2½ in. 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 passengers assist are not provided by other means.

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

ALTERNATIVE:

Additional floor clearances for cleaning, toe clearance.

ALTERNATIVE:

Clear non-glass panel from above the modesty panel to the top of the daylight opening and attached to the stanchion.

4.19.2.3. 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.

4.19.2.4. 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 or carpeting and trimmed with stainless steel, aluminum or composite.

The rear bulkhead paneling shall be contoured to fit the ceiling, side walls 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 liter being thrown or drawn through the grille. If it is necessary to remove the panel to service components located on the rear bulkhead, 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.

4.19.2.5. 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.

4.19.2.6. FASTENING

Interior panels shall be attached so that there are no exposed unfinished or 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 where required shall be tamper-resistant.

4.19.2.7. 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.

Insulation shall meet the requirements of FMVSS 302.

ALTERNATIVE:

FTA Docket 90-A
All insulation materials shall comply with the Recommended Fire Safety Practices defined in FTA Docket 90- A, dated October 20, 1993.

4.19.2.8. FLOOR COVERING

The floor covering shall have a non-skid 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. Flooring must comply with ASTM C-501-66 Abrasion Resistance, DIN 51963 Wear Resistance and, ASTM D2047-82 Anti-Skid Resistance. The standee line shall be a minimum of 2 in. wide and shall extend across the bus aisle. The color and pattern shall be consistent throughout the floor covering. The floor shall be easily cleaned.

ALTERNATIVE:

Standee Line
The location of the standee line shall be identified by each individual Purchasing Entity.

4.19.2.9. INTERIOR LIGHTING

The passenger interior lighting system shall be an I/O Controls LED lighting system. The interior lighting system shall provide a minimum 15 foot-candle illumination on a 1 square foot plane at an angle of 45 degree from horizontal, center 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 foot-candles. Floor surface in the aisles shall be a minimum of 10 foot-candles, vestibule area a minimum of 4 foot-candles with the front doors open and minimum of 2 foot-candles with the from doors closed. The front entrance area and curb lights shall illuminate when the front door is open and master run switch is in the "Lights" positions. Rear exit area and curb lights shall illuminate when rear door is unlocked.

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.

4.19.2.10. PASSENGER

Automatically Dimming First Row Lights

The first light on each side (behind the driver and the front door) is normally turned on only when the front door is opened, in "night run" and "night park." As soon as the door closes, these lights shall go out. These lights shall be turned on at any time if the toggle switch is in the "on" position.

ALTERNATIVE:

Dimming Second Row Lights

To help eliminate 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 toggle switch; off in "off" and on in "normal." These lights shall be turned on at any time if the toggle switch is in the "on" position.

All interior lighting shall be turned off whenever the transmission selector is in reverse and the engine run switch is in the "on" position. The Purchasing Entity prefers that the interior lighting system use Light Emitting Diodes (LED) for illumination and employ programmable logic chips, which allow programming the operation of each individual lamp as required.

The interior lighting design shall require the approval of the Purchasing Entity.

4.19.2.11. DRIVER AREA

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 foot-candles.

4.19.2.12. SEATING AREAS

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

4.19.2.13. VESTIBULES/DOORS

Floor surface in the aisles shall be a minimum of 10 foot-candles, and the vestibule area a minimum of 4 foot-candles with the front doors open and a minimum of 2 foot-candles with the front doors closed. The front entrance area and curb lights shall illuminate when the front door is open and master run switch is in the “lights” positions. Rear exit area and curb lights shall illuminate when the rear door is unlocked.

4.19.2.14. STEP LIGHTING

Step lighting for the intermediate steps between lower and upper floor levels shall be a minimum of 4 foot- candles and shall illuminate in all engine 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.

4.19.2.15. RAMP LIGHTING

Exterior and interior ramp lighting shall comply with CFR Part 49, Sections 19.29 and 19.31.

4.19.2.16. **TURNTABLE LIGHTING** – NOT REQUIRED

4.19.2.17. FAREBOX LIGHTLING

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 will automatically come on whenever the front doors are opened and the run switch is in the “night run” or “night park” position.

ALTERNATIVE:

No farebox light.

4.19.3. FARE COLLECTION

Space and structural provisions shall be made for installation of currently available fare collection devices and shall be as far forward as practicable. Location of the fare collection device shall not restrict traffic in the vestibule, including wheelchairs if a front door loading device is used, and shall allow the driver to easily reach the farebox controls and to view the fare register. The fare box shall not restrict access to the driver area, shall not restrict operation of driver controls and shall not — either by itself or in

combination with stanchions, transfer mounting, cutting and punching equipment, or route destination signs — restrict the driver's field of view per SAE Recommended Practice J1050. The location and mounting of the fare collection device shall allow use, without restriction, by passengers. The fare box location shall permit accessibility to the vault for easy manual removal or attachment of suction devices. Meters and counters on the fare box shall be readable on a daily basis. The floor under the fare box shall be reinforced as necessary to provide a sturdy mounting platform and to prevent shaking of the fare box.

The Purchasing Entity will either install its own fare box, or specify a fare box for Contractor to install.

ALTERNATIVE:

The installation contactless fare collection/validation shall be made available and priced separately.

4.19.4. INTERIOR ACCESS PANELS AND DOORS

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 mechanic'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.

Access doors shall be secured with hand screws or latches. All fasteners that retain access panels shall be captive in the cover.

ALTERNATIVE:

Access Doors with Locks

Access doors shall be secured with locks. The locks shall be standardized so that only one tool is required to open access doors on the bus.

4.19.4.1. INTERIOR ACCESS PANELS AND DOORS

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 Purchasing Entity 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.

4.20. PASSENGER ACCOMODATIONS

4.20.1. PASSENGER SEATING

4.20.1.1. 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.

Note: The Purchasing Entity recognizes that ramp location, foot room, hip-to-knee room, doorway type, width, seat construction, floor level type, seat spacing requirements, ramp or lift, number of wheelchair positions, etc. ultimately affect seating capacity and layout.

Forward-Facing Seat Configuration
Passenger seats shall be arranged in a transverse, forward-facing configuration, except at the wheel housings, if applicable, where aisle-facing seats may be arranged as appropriate with due regard for passenger access and comfort. Other areas where aisle-facing seats may be provided are at wheelchair securement areas and platforms (such as for fuel tank storage space).

ALTERNATIVE:

Perimeter Seating Arrangement
For 30-ft. buses, passenger seats shall be arranged in longitudinal rows facing the centerline of the bus. One row of transverse, forward facing seats shall be provided at the rear of the bus. Each seat shall have a minimum width of 17 in., not including any armrest.

ALTERNATIVE:

Combination Forward-Facing and Perimeter Seating Arrangement
Passenger seats shall be arranged in a transverse, two-position forward-facing configuration at the front section of the bus, and in longitudinal rows facing the centerline of the bus with one row of transverse, forward facing seats provided at the rear of the bus. Each seat shall have a minimum width of 17 in., not including any armrest.

4.20.1.2. REARWARD FACING SEAT (NOT USED)

4.20.1.3. TURNTABLE SEATING (NOT USED)

4.20.1.4. PADDED INSERTS/CUSHIONED SEATS

The passenger seats shall be equipped with non-padded inserts throughout the bus.

ALTERNATIVE:

Padded Inserts
The passenger seats shall be equipped with vandal-resistant padded inserts throughout the bus (measure to uncompressed surface).

ALTERNATIVE:

Fully Cushioned Seats
The passenger seats shall be fully cushioned throughout the bus (measure to compressed surface, 150-lb person).

ALTERNATIVE:

Padded Seat Configuration
Seating and interior trim shall have features to improve passenger comfort. The seat cushion and back shall be padded with a cellular foam product and is no less than ½-in. thick in areas contacted and loaded by passengers in the normal seated position and shall be covered with vinyl and/or fabric material.

Seats, back cushions and other pads shall be securely attached and shall be detachable by means of a simple release mechanism so that they are easily removable by the maintenance staff but not by passengers. To the extent practicable, seat cushions and pads shall be interchangeable throughout the bus. Materials shall have high resistance to tearing, flexing and wetting.

ALTERNATIVE:

Cushioned Seat Configuration
Seating and interior trim shall have features to maximize passenger comfort. The seat cushion shall be supported by springs. The seat cushion and back shall be padded with, a cellular foam product and is no less than 2 in. thick in areas contacted and loaded by passengers in the normal seated position and shall be upholstered with vinyl and/or fabric materials.

Seats, back cushions and other pads shall be securely attached and shall be detachable by means of a simple release mechanism so that they are easily removable by maintenance personnel but not by passengers. To the extent practicable, seat cushions and pads shall be interchangeable throughout the bus. Materials shall have high resistance to tearing, flexing and wetting.

ALTERNATIVE:

Seating Options
As an option, the 4one – CitiSeat, Angel, Citi Pro, Mariella, Gemini, Aries, Patriot seats and the American Seating – N2005, Insight, Insight prime+, Metropolitan, Vision will be made available and priced separately.

4.20.1.5. DRAIN HOLE IN SEATS (NOT USED)

4.20.1.6. 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 vertical surface immediately in front, shall be a minimum of 26 in. At all seating positions in paired transverse seats immediately behind other seating positions, hip- to-knee room shall be no less than 27 in.

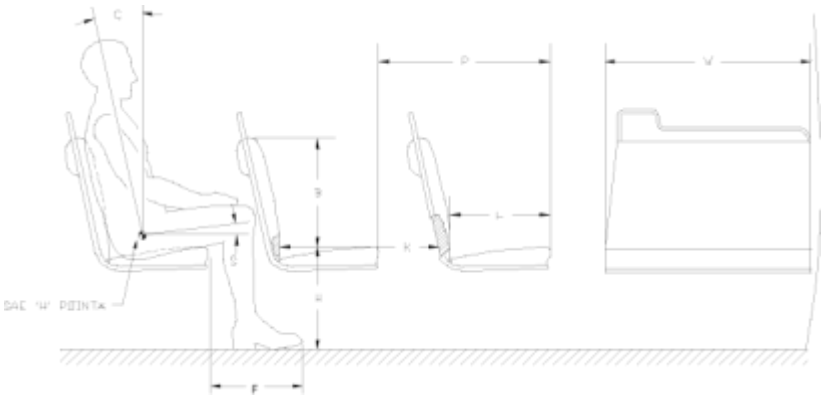
4.20.1.7. FOOT ROOM
Foot room, measured at the floor forward from a point vertically below the front of the seat cushion, shall be no less than 14 in. Seats immediately behind the wheel housings and modesty panels may have foot room reduced.

4.20.1.8. AISLES
The aisle between the seats shall be no less than 20 in. wide at seated passenger

hip height. Seat backs shall be shaped to increase this dimension to no less than 24 in. at 32 in. above the floor (standing passenger hip height).

4.20.1.9. DIMENSIONS

Seating Dimensions and Standard Configuration



DEFAULT:

Seat dimensions for the various seating arrangements shall have the dimensions as follows (refer to Figure 7):

- The width, W, of the two-passenger transverse seat shall be a minimum 35 in.
- The length, L, shall be 17 in., ±1 in.
- The seat back height, B, shall be a minimum of 15 in.
- The seat height, H, shall be 17 in., ± 1 in. For the rear lounge (or settee) and longitudinal seats, and seats located above raised areas for storage of under-floor components, a cushion height of up to 18 in., ±2 in., will be allowed. This shall also be allowed for limited transverse seats, but only with the expressed approval of The Purchasing Entity.
- 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.

4.20.1.10. 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 in. of the aisle shall be at least 10 in. 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 in., measured at the aisle side of the seat frame at height H. The seat back should not deflect more than 14 in., 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 lbs. applied to the top of the seat cushion in each seating position with less than ¼-in. permanent deformation in the seat or its mountings. The seat assembly shall withstand static horizontal forces of 500 lbs. evenly distributed along the top of the seat back with less than ¼-in. 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-in. pendulum and shall strike the seat back 10,000 times each from distances of 6, 8, 10 and 12 in. 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 in. Seat cushions shall withstand 100,000 randomly positioned 3½-in. 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 shall incorporate a handhold no less than ⅞ in. 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 in. 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 (as defined by SAE Standard 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 3½ in. of the end of the seat cushion. Armrests shall be located from 7 to 9 in. 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 in. 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 lbs. applied anywhere along their length with less than ¼-in. permanent deformation. Seat back handhold and armrests shall withstand 25,000 impacts in each direction of a horizontal force of 125 lbs. with less than ¼-in. permanent deformation and without visible deterioration.

4.20.1.11. 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, pads and cushions shall be contoured for individuality, lateral support and maximum 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-in. The seat back and seat back handhold immediately forward of transverse seats shall be constructed of energy-absorbing materials to provide passenger protection and, in a severe crash, allow the passenger to deform the seating materials in the impact areas. Complete seat assemblies shall be interchangeable to the extent practicable.

The Purchasing Entity will select seat fabric, or approve the Contractor's recommendation of seat fabric on the basis of durability, ease of maintenance and pleasing texture and appearance.

ALTERNATIVE:

Additional Flip Seats

The Purchasing Entity is interested in utilizing flip seats to maximize flexibility in seating area, e.g. to accommodate stowing of strollers.

4.20.2. PASSENGER ASSISTS

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 95th-percentile male and the 5th-percentile female 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 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 the other without losing support. All handholds and vertical stanchions at front doorway, at interior steps and throughout the bus shall be powder-coated in a high- contrast yellow color.

4.20.2.1. ASSISTS

Excluding those mounted on the seats and doors, the assists shall have a cross-sectional diameter between 1¼ and 1½ in. or shall provide an equivalent gripping surface with no corner radii less than ¼ in. All passenger assists shall permit a full hand grip with no less than 1½ in. 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 lbs. applied over a 12-in. 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.

4.20.2.2. 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 in. 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 and the vertical assist and the assists on the wheel housing or on the front modesty panel.

4.20.2.3. 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 in. 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 in. 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.

4.20.2.4. REAR DOORWAY

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 in. or providing an equivalent gripping surface with no corner radii less than ¼ in., and shall provide at least 1½ in. 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 in. from the outside edge of the rear doorway step.

4.20.2.5. OVERHEAD

Except forward of the standee line and at the rear door, a continuous, full grip, overhead assist shall be provided. This assist shall be located over the center of the aisle seating position of the transverse seats. The assist shall be no less than 70 in. above the floor.

Grab straps shall be provided for sections where vertical assists are not available and for the use by passengers who cannot reach to 70 in.

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

4.20.2.6. LONGITUDINAL SEAT ASSISNGMENTS

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 in. apart or functionally continuous for a 5th percentile female passenger.

4.20.2.7. WHEEL HOUSING BARRIERS/ASSISTS

Unless passenger seating is provided on top of wheel housing, 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 housing. Decal indicating area is not for sitting or storage will be included.

ALTERNATIVE:

As an option a storage box to accommodate the stowage of safety items such as fire extinguisher, warning triangles, and first-aid kit mounted to the top of the curbside front wheel housing shall be made available and priced separately.

4.20.3. PASSENGER DOORS

Doorways will be provided in the locations and styles as follows. Passenger doors and doorways shall comply with ADA requirements. Front door shall be located forward of the front wheels and under direct observation of the driver. Rear door shall be located forward of the rear wheels.

DEFAULT

If air-powered, the door system shall operate per specification at air pressures between 90 and 130 psi.

ALTERNATIVE:

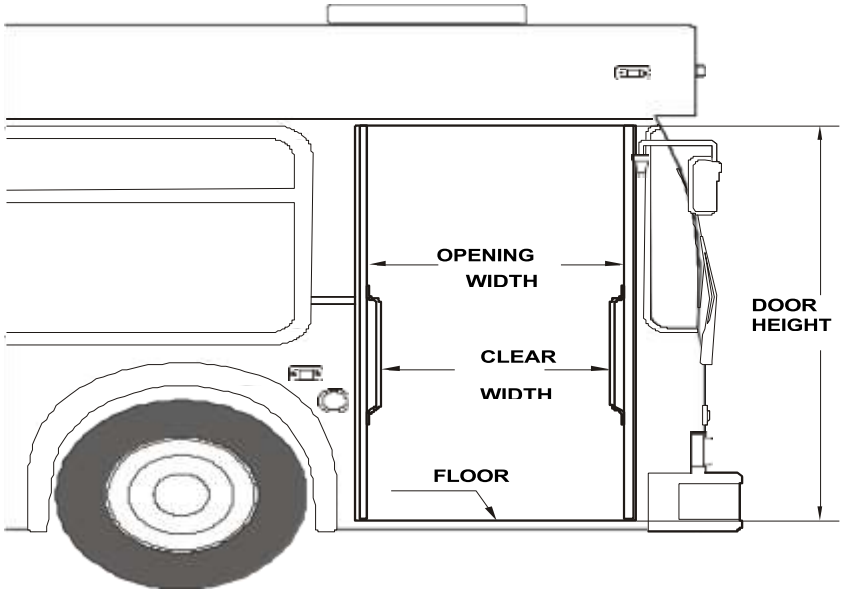
Electric-powered doors.

4.20.3.1. 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 no less than 2 in. of soft weather stripping. The doors, when closed, shall be effectively sealed, and the hard surfaces of the doors shall be at least 4 in. apart. 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.

4.20.3.2. DIMENSIONS



Transit Bus Minimum Door Opening

When open, the doors shall leave an opening no less than 75.3 in. in height.

If the Purchasing Entity requires a minimum rear door clear width of 31¾ in. or greater and an outward opening (swing) door is specified, then the maximum outboard excursion of 13 in. may be exceeded.

DEFAULT

31¾-in. Minimum Doorway Clear Width

Front door clear width shall be a minimum of 31¾ in. with the doors fully opened.

Rear door opening clear width shall be a minimum of 24 in. with the doors fully opened. If a rear door ramp or lift is provided, then the clear door opening width shall be a minimum of 31¾ in. with door fully opened.

ALTERNATIVE:

The BRT option shall have an option for a 34” front door without sensitive edge, and a 48” rear door with a sensitive edge.

4.20.3.3. 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.

DEFUALT

Zip type glazing rubber.

ALTERNATIVE

Quick change glazing exterior frame.

ALTERNATIVE

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

ALTERNATIVE

Bonded or adhesive.

DEFAULT

The front door panel glazing material shall have a nominal ¼ in. thick laminated safety glass conforming with the requirements of ANSI Z26.1 Test Grouping 2 and the Recommended Practices defined in SAE J673.

ALTERNATIVE

The front door panel glazing material shall have a nominal ¼ in. 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 defined by the Purchasing Entity.

4.20.3.4. DOOR PROJECTIONS

Exterior

The exterior projection of the front doors beyond the side of the bus shall be minimized and shall not block the line of sight of the rear exit door via the curb side mirror when the doors are fully open. The exterior projection of both doors shall be minimized and shall not exceed 13 in. during the opening or closing cycles or when doors are fully opened

Interior

Projection inside the bus shall not cause an obstruction of the rear door mirror or cause a hazard for standees.

4.20.3.5. 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 an 8-in. high curb on a street sloping toward the curb so that the street side wheels are 5 in. higher than the right side wheels.

4.20.3.6. CLOSING FORCE

Closing door edge speed shall not exceed 12 in. per second, and opening door speed shall not exceed 19 in. 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.

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-lb force on 1 sq. in. of that obstruction. If a contactless obstruction sensing system is employed, 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.

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 lbs. 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 in. diameter cylinder from between the center edges of a closed and locked door with an outward force not greater than 35 lbs.

4.20.3.7. 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 shall be rebuildable. If powered by compressed air, exhaust from the door system shall be routed below the floor of the bus to prevent accumulation of any oil that may be present in the air system and to muffle sound.

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 rear door actuator(s) 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.

A switch located within reach of the seated operator shall, when actuated, restore rear door function to
complete operator control, as described in the "Default."

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 lbs. 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.

4.20.3.8. REAR DOOR INTERLOCKS

See "Hardware Mounting" for door system interlock requirements.

4.20.3.9. 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 lbs. after actuating an unlocking device. The unlocking device shall be clearly marked as an emergency-only device and shall 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. Doors that are required to be classified as "Emergency Exits" shall meet the requirements of FMVSS 217.

4.20.3.10. DOOR CONTROL

The door control shall be located in the operator's area within the hand reach

envelope described in SAE Recommended Practice J287, “Driver Hand Control Reach.” The driver’s door control shall provide tactile feedback to indicate commanded door position and resist inadvertent door actuation. Doors shall be operated by a single control, conveniently located and operable in a horizontal plane by the driver's left hand.

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

4.20.3.11. 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.

4.20.3.12. DOOR OPEN/CLOSE

Operation of, and power to, the passenger doors shall be completely controlled by the operator.

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, deactivate the door control system, release the interlocks, and permit only manual operation of the rear/center doors.

ALTERNATIVE:
The exit (rear/center) door activation will be “touch to open” whereas the door will open automatically by means of the passenger touching the door or door handle once the operator releases the lock mechanism electronically from the driver controls.

4.20.4. ACCESSIBILITY/PROVISIONS

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

4.20.4.1.1. LOADING SYSTEMS

There are two options:

- low-floor ramp
- platform (boarding bridgeplate) level boarding

4.20.4.1.2. LIFT

The wheelchair lift control system must be capable of receiving multiplex command from vehicle interlocks.

An automatically controlled, power-operated wheelchair lift system compliant to requirements defined in 49 CFR 571.403 (FMVSS 403) shall provide ingress and egress quickly, safely and comfortably, both in forward and rearward directions, for a passenger in a wheelchair from a level street or curb.

The wheelchair lift mounted in front step well.

ALTERNATIVE:

Folding Lifts

When the system is not in use, the passageway shall appear normal. In the stored position of the ramp, no tripping hazards shall be present, and any resulting gaps shall be minimized. The controls shall be simple to operate with no complex phasing operations required, and the loading system operation shall be under the surveillance and complete control of the driver. If the loading system and controls are at the rear doors, a keyed switch shall be provided in the driver's area to disable the loading system. The bus shall be prevented from moving during the loading or unloading cycle by a throttle and brake interlock system. The loading system shall be inhibited from stowing/deploying when a passenger is on the ramp/platform. A passenger departing or boarding via the ramp shall be able to easily obtain support by grasping the passenger assist located on the doors or other assists provided for this purpose. The platform shall be designed to protect the ramp from damage and persons on the sidewalk from injury during the extension/retraction or lowering/raising phases of operation.

The loading platform shall be covered with a replaceable or renewable nonskid material and shall be fitted with devices to prevent the wheelchair from rolling off the sides during loading or unloading.

Deployment or storage of the ramp shall require no more than 15 seconds. The device shall function without failure or adjustment for 500 cycles or 5000 miles in all-weather conditions on the design operating profile when activated once during the idle phase. A manual override system shall permit unloading a wheelchair and storing the device in the event of a primary power failure. The manual operation of the ramp shall not require more than 35 lbs. of force.

4.20.4.1.3. LOADING SYSTEM FOR 30- TO 45-FT LOW-FLOOR BUS

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, both in forward and

rearward directions, for a passenger in a wheelchair from a level street or curb.

DEFAULT:

Front Door Location of Loading System, Flip-Out Design Ramp with 6:1 Slope

The wheelchair loading system shall be located at the front door, with the ramp being of a simple hinged, flip-out type design being capable of deploying to the ground at a maximum 6:1 slope.

ALTERNATIVE:

Front Door Location of Loading System, Flip-Out Design Ramp with 6:1 Slope

The wheelchair loading system shall be located at the front door, with the ramp being a flip-out type design being capable of deploying to the ground at a maximum 6:1 slope.

The Purchasing Entity is interested in a flip-out ramp that can accommodate 600 lbs. without deformation.

4.20.4.1.4. LOADING SYSTEM FOR LEVEL BOARDING ON A 45- TO 60-FT LOW-FLOOR BRT (NOT USED)

4.20.4.1.5. WHEELCHAIR ACCOMODATIONS

NOTE: The Purchasing Entity will approve acceptable securement system.

Two Forward-Facing Wheelchair Securement Locations

Two forward-facing locations, as close to the wheelchair loading system as practical, shall provide parking space and securement system compliant with ADA requirements for a passenger in a wheelchair.

Wheelchair Securing System

The wheelchair securement shall be the American Seating Company telescoping ARM or approved equal with Q'Straint or approved equal belts in the front and Q'Straint Belts and Retractors in the rear. At a minimum, all restraint systems must meet C.F.R. 49, FMVSS, FTA and ADA standards.

ALTERNATIVE:

As an option the American Seating Reliant system, the 4ONE Q-pod and 4ONE V-Pro, Q'Straint Belts and Retractors will be made available and priced separately.

ALTERNATIVE:

The Purchasing Entity is interested in reviewing wheelchair securement systems that allow the wheelchair user to park and secure their chair with minimal or no driver assistance.

ALTERNATIVE:

Additional (Beyond Two) Number of Wheelchair Securement Locations NOT USED

ALTERNATIVE

Non-Forward Facing
All passenger securement devices must be stowed off the floor and out of the way when not in use.

4.20.4.1.6. INTERIOR CIRCULATION

Maneuvering room inside the bus shall 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 20 in. shall be maintained. As a guide, no width dimension should be less than 34 in. Areas requiring 90-degree turns of wheelchairs should have a clearance arc dimension no less than 45 in., and in the parking area where 180-degree turns are expected, space should be clear in a full 60-in.-diameter circle. A vertical clearance of 12 in. above the floor surface should be provided on the outside of turning areas for wheelchair footrest.

4.21. SIGNAGE AND COMMUNICATION

4.21.1. DESTINATION SIGNS

A destination sign system shall be furnished on the front, on the right side near the front door, and a route sign on the rear of the vehicle.

ALTERNATIVE:

Street and Curb Side Route Sign
The sign located near the front 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.

ALTERNATIVE:
As an alternative, no rear route sign is needed.

All signs shall 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.

The destination sign compartments shall meet the following minimum requirements:

- 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 unit itself.
- Access shall be provided to allow cleaning of inside compartment window and unit glazing.
- Front window shall have an exterior display area of no less than 8.5 in. high by 56 in.

wide.

ALTERNATIVE:
No active defogging required.

ALTERNATIVE
Provide Run number sign.

4.21.2. PASSENGER INFORMATION AND ADVERTISING

4.21.2.1. INTERIOR DISPLAYS

Provisions shall be made on the rear of the driver's barrier or equipment box located on the wheel well for a frame to retain information such as routes and schedules.

Advertising media 11 in. high and 0.09 in. 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.

ALTERNATIVE:
As an alternative, a next stop display which uses a GPS triggered automated voice annunciation system for announcing the vehicle location to passengers at key locations, should be provided.

4.21.2.2. EXTERIOR DISLAYPS – No provision is necessary

ALTERNATIVE:
As an alternative, advertising frames should be provided for both sides and the rear of the bus.

4.21.3. PASSENGER STOP REQUEST/EXIST SIGNAL

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, the height of the pull cable shall approximate this transom level and shall be no greater than 63 in. 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. Stop request indicator light at driver's console must be clearly visible and distinct from other signals.

An auxiliary passenger "stop requested" signal shall be installed at the rear door to provide passengers standing in the rear door/exit area convenient means of activating the signal system. The signal shall be a heavy-duty push button type located in the rear

door vicinity. Button shall be clearly identified as “passenger signal.”

ALTERNATIVE:

Additional “Stop Request” Button on Rear Door Stanchion

A heavy-duty “stop request” signal button shall be installed on modesty panel stanchion immediately forward of the rear door and clearly identified as “STOP.”

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.

Exit signals located in the wheelchair passenger area shall be no higher than 4 feet above the floor. Instructions shall be provided to clearly indicate function and operation of these signals.

ALTERNATIVE:

Passenger signal system shall be arranged with push button switches accessible by each seated passenger and on stanchions and at rear door locations for standees.

4.21.4. COMMUNICATIONS

4.21.4.1. VIDEO SURVEILLANCE SYSTEM

A Safe-Fleet/SEON 12 Camera system w/ GPS, UPS, wireless video download capabilities, and 4 TB HDD, and impact sensor will be priced separately. A 10” surveillance monitor shall be mounted in the driver’s compartment above the operator in addition to a 17” surveillance monitor mounted on the rearward facing side of the electrical equipment box.

Provide all wiring and mounting locations for a SEON 12 Camera system

ALTERNATIVE:

Provide for an on-board audio/video surveillance system capable of at least 7 camera inputs, audio, and GPS tracking, if possible. Multiple brands to be quoted, including Angel Trax, REI, Safety Vision, Apollo, others. Include "equipment box" on wheel well cover behind driver.

ALTERNATIVE:

Provide all wiring and mounting locations for a multi-camera surveillance system for the later provision of and installation of cameras, recorder, microphone, etc. The Purchasing Entity will specify what camera system cable is to be installed, what locations for pre-wiring and the quantity.

4.21.4.2. PUBLIC ADDRESS SYSTEM

A public address system shall be provided on each bus for facilitating radio system and driver-originated announcements to passengers.

ALTERNATIVE:

The speaker cable shall terminate at the instrument panel area on the curb side

with a minimum of 3 feet of extra speaker cable. An end connector shall be supplied so a lead can be connected from the radio control head in order to make announcements directly from the transit control center to passengers through the PA system.

4.21.4.2.1. SPEAKERS

Six interior and one weather-proof exterior loudspeakers shall be provided, semi-flush mounted, on alternate sides of the bus passenger compartment, installed with proper phasing. Total impedance seen at the input connecting end shall be 8 Ohms. Mounting shall be accomplished with riv-nuts and machine screws.

4.21.5. AUTOMATIC PASSENGER COUNTER (APC)

All vehicles will require an APC system. The APC system shall be installed.

ALTERNATIVE:

As an alternative an infrared APC system shall be installed.

ALTERNATIVE:

No APC system is required.

4.21.6. AUTOMATIC VEHICLE LOCATOR SYSTEM (AVL)

4.21.6.1. AVL

All vehicles will be pre-wired to accommodate an Avail Technologies Automatic Vehicle Locator System (AVL). Vendor must work with Avail to coordinate install.

4.21.7. RADIO HANDSET AND CONTROL SYSTEM

4.21.7.1. DRIVERS 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. It shall have 8 Ohms of impedance.

4.21.7.2. HANDSET

Contractor will install a handset for driver use.

4.21.7.3. DRIVER DISPLAY UNIT (DDU)

Contractor shall install a driver display unit as close to the driver's instrument panel as possible.

Emergency Alarm

Contractor shall install an emergency alarm that is accessible to the driver but hidden from view.

ALTERNATIVE:
As an alternative, provide for a deduct of this system and for installation of a power source and a 2-way radio antenna in the vehicle. This antenna will be provided to the bus builder by the Purchasing Entity and a 2-way radio will be installed by the Purchasing Entity after delivery.

4.21.8. BIKE RACKS

Holes and mounting hardware will be installed to allow for the installation of two and three position bike racks. Bike racks will be installed by the consortium members.

ALTERNATIVE:
As an alternative, two position bike racks manufactured by Sport Works, Midwest Bus or other approved equals will be installed on the bus.

5. WARRANTY REQUIREMENTS

WR 1. Basic Provisions

WR 1.1 Warranty Requirements

WR 1.1.1 Contractor Warranty

Warranties in this document are in addition to any statutory remedies or warranties imposed on the Contractor. Consistent with this requirement, the Contractor warrants and guarantees to the original Purchasing Entity each complete bus and specific subsystems and components as follows. Performance requirements based on design criteria shall not be deemed a warranty item.

WR 1.1.2 Complete Bus

The complete bus, propulsion system, components, major subsystems and body and chassis structure are warranted to be free from Defects and Related Defects for one year or 50,000 miles, whichever comes first, beginning on the date of revenue service but not longer than 15 days after acceptance under “Inspection, Testing and Acceptance.” The warranty is based on regular operation of the bus under the operating conditions prevailing in the Purchasing Entity’s locale.

WR 1.1.3 Body and Chassis Structure

Body, body structure, structural elements of the suspension and engine cradle are warranted to be free from Defects and Related Defects for three years or 150,000 miles, whichever comes first.

Primary load-carrying members of the bus structure, including structural elements of the suspension, are warranted against corrosion failure and/or Fatigue Failure sufficient to cause a Class 1 or Class 2 Failure for a period of 12 years or 500,000 miles, whichever comes first.

WR 1.1.4 Propulsion System

Propulsion system components, specifically the engine, transmission or drive motors, and generators (for hybrid technology) and drive and non-drive axles shall be warranted to be free from Defects and Related Defects for the standard two years or unlimited miles, whichever comes first. An Extended Warranty to a maximum of five years or 300,000 miles, whichever comes first, may be purchased at an additional cost. The propulsion system manufacturer’s standard warranty, delineating items excluded from the Extended Warranty, shall be submitted in accordance with the Request for Pre-Offer Change or Approved Equal or with the Form for Proposal Deviation.

ALTERNATIVE:
As an option, the cost for Five (5) year / five hundred thousand (500,000)miles warranty coverage for both the engine and transmission will be made available and priced separately.

WR 1.1.5 Emission Control System (ECS)

The Contractor warrants the emission control system for five years or 100,000 miles, whichever comes first. The ECS shall include, but is not limited to, the following components:

- complete exhaust system, including catalytic converter (if required)
- after-treatment device
- components identified as emission control devices

WR 1.1.6 Subsystems

Other subsystems shall be warranted to be free from Defects and Related Defects for a minimum of two years or 100,000 miles, whichever comes first. Other subsystems are listed below:

- 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
- Wheelchair lift and ramp system: Lift and/or ramp parts and mechanical only
- Starter
- Alternator: Alternator only. Does not include the drive system.
- 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.
- Engine cooling systems: Radiator including core, tanks and related framework, including surge tank.
- Transmission cooler
- Passenger seating excluding upholstery
- Fuel storage and delivery system
- Surveillance system including cameras and video recorders

OR

(1) Complete Bus

i. One (1) year / fifty thousand (50,000) miles warranty coverage on parts and labor, whichever comes first. All warranties stated in this section apply, whichever comes first on coverage expiration.

(2) Sub-Systems and Components

i. Engine - Two (2) year / unlimited miles warranty coverage on parts and labor.

As an option, the cost for Five (5) year / three hundred thousand (300,000) miles warranty coverage will be made available and priced separately.

ii. Transmission - two (2) year / unlimited miles warranty coverage on parts and labor.

As an option, the cost for five (5) year / three hundred thousand (300,000) miles warranty coverage will be made available and priced separately.

iii. Differential - two (2) years / unlimited miles warranty coverage on parts and labor.

iv. HVAC - two (2) years / unlimited miles warranty on parts and labor.

v. Basic Body Structure - three (3) years / 150,000miles warranty on parts and labor.

vi. Structure/Body Integrity - seven (7) years/ 350,000 miles warranty on parts and Labor.

vii. Exterior Paint - three (3) years / unlimited miles warranty on parts.

viii. Sub-Flooring and Rubber Flooring - twelve (12) years / unlimited miles warranty on parts and labor.

ix. All other components, sub-systems or appurtenances are to carry the manufacturer's basic warranty,
but in no event will any warranty be less than one (1) year on parts and labor.

WR 1.1.7 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. The list shall include, but is not limited to:

- engine
- transmission
- alternator (and hybrid beltless alternator)
- starter
- A/C compressor and condenser/evaporator unit
- 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 Purchasing Entity prior to delivery of the first production bus.

WR 1.1.8 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, the applicable warranty period shall be

extended by the number of days equal to the delay period.

WR 1.2 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, accident 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 Purchasing Entity fails to conduct normal inspections and scheduled preventive maintenance procedures as recommended in the Contractor's maintenance manuals and if that omission caused the part or component failure. The Purchasing Entity shall maintain documentation, auditable by the Contractor, verifying service activities in conformance with the Contractor's maintenance manuals.

WR 1.3 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 Purchasing Entity

Should the Purchasing Entity 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 Purchasing Entity. This product will not be eligible under "Fleet Defects," below.

The Contractor shall not be required to provide warranty information for any warranty that is less than or equal to the warranty periods listed.

WR 1.3.1 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 Purchasing Entity'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 Purchasing Entity to assign its warranty obligations to others, but only on a case-by-case basis approved in writing by the Purchasing Entity. 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.

WR 1.3.2 Superior Warranty

The Contractor shall pass on to the Purchasing Entity any warranty offered by a component Supplier that is superior to that required herein. The Contractor shall provide a list to the Purchasing Entity 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.

WR 1.4 Fleet Defects

WR 1.4.1 Occurrence and Remedy

A Fleet Defect is defined as cumulative failures of twenty (20) 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 Purchasing Entity 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 of 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 Purchasing Entity 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.

WR 1.4.2 Exceptions to Fleet Defect Provisions

The Fleet Defect warranty provisions shall not apply to the Purchasing Entity -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.

WR 2. Repair Procedures

WR 2.1 Repair Performance

The Contractor is responsible for all warranty-covered repair Work. To the extent practicable, the Purchasing Entity will allow the Contractor or its designated representative to perform such Work. At its discretion, the Purchasing Entity 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.

WR 2.2 Repairs by the Contractor

If the Purchasing Entity 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 Purchasing Entity. The Purchasing Entity 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 Purchasing Entity’s option, the Contractor may be required to remove the bus from the Purchasing Entity’s property while repairs are being affected. If the bus is removed from the Purchasing Entity’s property, repair procedures must be diligently pursued by the Contractor’s representative.

WR 2.3 Repairs by The Purchasing Entity

WR 2.3.1 Parts Used

If the Purchasing Entity performs the warranty-covered repairs, 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 Purchasing Entity may use Contractor-specified parts available from its own stock if deemed in its best interests.

WR 2.3.2 Contractor-Supplied Parts

The Purchasing Entity may require that the Contractor supply parts for warranty-covered repairs being performed by the Purchasing Entity. Those parts may be remanufactured but shall have the same form, fit and function, and warranty. The parts shall be shipped prepaid to the Purchasing Entity from any source selected by the Contractor within two (2) days of receipt of the request for said parts and shall not be subject to an Purchasing Entity handling charge.

WR 2.3.3 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.”

WR 2.3.4 Failure Analysis

The Contractor shall, upon specific request of the Purchasing Entity, 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.

WR 2.3.5 Reimbursement for Labor and Other Related Costs

The Purchasing Entity shall be reimbursed by the Contractor for labor. The amount shall be determined by the Purchasing Entity for a qualified mechanic at the current straight time wage rate per hour, which includes fringe benefits and overhead adjusted for the Purchasing Entity’s most recently published rate in effect at the time the Work is performed, plus the cost of towing the bus if such action was necessary and if the bus was in the normal service area. These wage and fringe benefit rates shall not exceed the rates in effect in the Purchasing Entity’s service garage at the time the Defect correction is made.

WR 2.3.6 Reimbursement for Parts

The Purchasing Entity 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 fifteen (15) percent handling costs. Handling costs shall not be paid if part is supplied by Contractor and shipped to the Purchasing Entity.

WR 2.3.7 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 Purchasing Entity 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 Purchasing Entity 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.

WR 2.4 Warranty after Replacement/Repairs

If any component, unit or subsystem is repaired, rebuilt or replaced by the Contractor or by the Purchasing Entity with the concurrence of the Contractor, the component, unit or subsystem shall have the unexpired warranty period of the original. Repairs shall not be warranted if the 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, 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 Purchasing Entity.

WR 2.4.1 Warranty Processing Procedures

The following list represents requirements by the Contractor to the Purchasing Entity 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

WR 2.5 Forms

The Purchasing Entity’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 Purchasing Entity.

WR 2.6 Return of Parts

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

- bus number and VIN
- claim number
- part number
- serial number (if available)

WR 2.7 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 date of repair.

WR 2.8 Reimbursements

Reimbursements are to be transmitted to the following address.

Accounts Receivable
Interurban Transit Partnership – The Rapid 300 Ellsworth Ave. SW
Grand Rapids, MI 49503

SECTION 8: QUALITY ASSURANCE

QA 1. Contractor's In-Plant Quality Assurance Requirements

QA 1.1 Quality Assurance Organization

QA 1.1.1 Organization Establishment

The Contractor shall establish and maintain an effective in-plant quality assurance organization. It shall be a specifically defined organization and should be directly responsible to the Contractor's top management.

QA 1.1.2 Control

The quality assurance organization shall exercise quality control over all phases of production, from initiation of design through manufacture and preparation for delivery. The organization shall also control the quality of supplied articles.

QA 1.1.3 Authority and Responsibility

The quality assurance organization shall have the authority and responsibility for reliability, quality control, inspection planning, establishment of the quality control system, and acceptance/rejection of materials and manufactured articles in the production of the transit buses.

QA 1.2 Quality Assurance Organization Functions

QA 1.2.1 Minimum Functions

The quality assurance organization shall include the following minimum functions:

- **Work instructions:** The quality assurance organization shall verify inspection operation instructions to ascertain that the manufactured product meets all prescribed requirements.
- **Records maintenance:** The quality assurance organization shall maintain and use records and data essential to the effective operation of its program. These records and data shall be available for review by the resident inspectors. Inspection and test records for this procurement shall be available for a minimum of one year after inspections and tests are completed.
- **Corrective action:** The quality assurance organization shall detect and promptly ensure correction of any conditions that may result in the production of defective transit buses. These conditions may occur in designs, purchases, manufacture, tests or operations that culminate in defective supplies, services, facilities, technical data or standards.

QA 1.2.2 Basic Standards and Facilities

The following standards and facilities shall be basic in the quality assurance process:

- **Configuration control:** The Contractor shall maintain drawings, assembly procedures, and other documentation that completely describe a qualified bus that meets all of the options

and special requirements of this procurement. The quality assurance organization shall verify that each transit bus is manufactured in accordance with these controlled drawings, procedures, and documentation.

- **Measuring and testing facilities:** The Contractor shall provide and maintain the necessary gauges and other measuring and testing devices for use by the quality assurance organization to verify that the buses conform to all specification requirements. These devices shall be calibrated at established periods against certified measurement standards that have known, valid relationships to national standards.

- **Production tooling as media of inspection:** When production jigs, fixtures, tooling masters, templates, patterns, and other devices are used as media of inspection, they shall be proved for accuracy at formally established intervals and adjusted, replaced, or repaired as required to maintain quality.
- **Equipment use by resident inspectors:** The Contractor's gauges and other measuring and testing devices shall be made available for use by the resident inspectors to verify that the buses conform to all specification requirements. If necessary, the Contractor's personnel shall be made available to operate the devices and to verify their condition and accuracy.

QA 1.2.3 Maintenance of Control

The Contractor shall maintain quality control of purchases:

- **Supplier control:** The Contractor shall require that each Supplier maintains a quality control program for the services and supplies that it provides. The Contractor's quality assurance organization shall inspect and test materials provided by Suppliers for conformance to specification requirements. Materials that have been inspected, tested, and approved shall be identified as acceptable to the point of use in the manufacturing or assembly processes. Controls shall be established to prevent inadvertent use of nonconforming materials.
- **Purchasing data:** The Contractor shall verify that all applicable specification requirements are properly included or referenced in purchase orders of articles to be used on transit buses.

QA 1.2.4 Manufacturing Control

- **Controlled conditions:** The Contractor shall ensure that all basic production operations, as well as all other processing and fabricating, are performed under controlled conditions. Establishment of these controlled conditions shall be based on the documented Work instructions, adequate production equipment and special working environments if necessary.
- **Completed items:** A system for final inspection and test of completed transit buses shall be provided by the quality assurance organization. It shall measure the overall quality of each completed bus.
- **Nonconforming materials:** The quality assurance organization shall monitor the Contractor's system for controlling nonconforming materials. The system shall include procedures for identification, segregation and disposition.
- **Statistical techniques:** Statistical analysis, tests and other quality control procedures may be used when appropriate in the quality assurance processes.
- **Inspection status:** A system shall be maintained by the quality assurance organization for identifying the inspection status of components and completed transit buses. Identification may include cards, tags or other normal quality control devices.

QA 1.2.5 Inspection System

The quality assurance organization shall establish, maintain and periodically audit a fully documented inspection system. The system shall prescribe inspection and test of materials, Work in process and completed articles. As a minimum, it shall include the following controls:

- **Inspection personnel:** Sufficient trained inspectors shall be used to ensure that all materials, components and assemblies are inspected for conformance with the qualified bus design.

- **Inspection records:** Acceptance, rework or rejection identification shall be attached to inspected articles. Articles that have been accepted as a result of approved materials review actions shall be identified. Articles that have been reworked to specified drawing configurations shall not require special identification. Articles rejected as unsuitable or scrap shall be plainly marked and controlled to prevent installation on the bus. Articles that become obsolete as a result of engineering changes or other actions shall be controlled to prevent unauthorized assembly or installation. Unusable articles shall be isolated and then scrapped. Discrepancies not**e**d by the Contractor or resident inspectors during assembly shall be entered by the inspection personnel on a record that accompanies the major component, subassembly, assembly, or bus from start of assembly through final inspection. Actions shall be taken to correct discrepancies or deficiencies in the manufacturing processes, procedures or other conditions that cause articles to be in nonconformity with the requirements of the Contract specifications. The inspection personnel shall verify the corrective actions and mark the discrepancy record. If discrepancies cannot be corrected by replacing the nonconforming materials, then the Purchasing Entity shall approve the modification, repair or method of correction to the extent that the Contract specifications are affected.
- **Quality assurance audits:** The quality assurance organization shall establish and maintain a quality control audit program. Records of this program shall be subject to review by the Purchasing Entity.

QA 2. Inspection

QA 2.1 Inspection Stations

Inspection stations shall be at the best locations to provide for the Work content and characteristics to be inspected. Stations shall provide the facilities and equipment to inspect structural, electrical, hydraulic and other components and assemblies for compliance with the design requirements.

Stations shall also be at the best locations to inspect or test characteristics before they are concealed by subsequent fabrication or assembly operations. These locations shall minimally include underbody structure completion, body framing completion, body prior to paint preparation, water test, engine installation completion, underbody dress-up and completion, bus prior to final paint touchup, bus prior to road test and bus final road test completion.

QA 2.2 Resident Inspectors

QA 2.2.1 Resident Inspector's Role

The Purchasing Entity shall be represented at the Contractor's plant by resident inspectors, as required by FTA. Resident inspectors may be the Purchasing Entity employees or outside contractors. The Purchasing Entity shall provide the identify of each inspector and shall also identify their level of authority in writing. They shall monitor, in the Contractor's plant, the manufacture of transit buses built under the procurement. The presence of these resident inspectors in the plant shall not relieve the Contractor of its responsibility to meet all of the requirements of this procurement. The Purchasing Entity shall designate a primary resident

inspector, whose duties and responsibilities are delineated in “Pre-Production Meetings,” “Authority” and “Pre-Delivery Tests,” below. Contractor and resident inspector relations shall be governed by the guidelines included as Attachment A to this “Section 8: Quality Assurance.”

QA 2.2.2 Pre-Production Meetings

The primary resident inspector may participate in design review and pre-production meetings with the Purchasing Entity. At these meetings, the configuration of the buses and the manufacturing processes shall be finalized, and all Contract documentation provided to the inspector.

No less than thirty (30) days prior to the beginning of bus manufacture, the primary resident inspector may meet with the Contractor’s quality assurance manager and may conduct a pre-production audit meeting. They shall review the inspection procedures and finalize inspection checklists. The resident inspectors may begin monitoring bus construction activities two weeks prior to the start of bus fabrication.

QA 2.2.3 Authority

Records and data maintained by the quality assurance organization shall be available for review by the resident inspectors. Inspection and test records for this procurement shall be available for a minimum of one year after inspections and tests are completed.

The Contractor’s gauges and other measuring and testing devices shall be made available for use by the resident inspectors to verify that the buses conform to all specification requirements. If necessary, the Contractor’s personnel shall be made available to operate the devices and to verify their condition and accuracy.

Discrepancies noted by the resident inspector during assembly shall be entered by the Contractor’s inspection personnel on a record that accompanies the major component, subassembly, assembly or bus from start of assembly through final inspection. Actions shall be taken to correct discrepancies or deficiencies in the manufacturing processes, procedures or other conditions that cause articles to be in nonconformity with the requirements of the Contract specifications. The inspection personnel shall verify the corrective actions and mark the discrepancy record. If discrepancies cannot be corrected by replacing the nonconforming materials, the Purchasing Entity shall approve the modification, repair or method of correction to the extent that the Contract specifications are affected.

The primary resident inspector shall remain in the Contractor’s plant for the duration of bus assembly Work under this Contract. Only the primary resident inspector or designee shall be authorized to release the buses for delivery. The resident inspectors shall be authorized to approve the pre-delivery acceptance tests. Upon request to the quality assurance supervisors, the resident inspectors shall have access to the Contractor’s quality assurance files related to this procurement. These files shall include drawings, assembly procedures, material standards, parts lists, inspection processing and reports, and records of Defects.

QA 2.2.4 Support Provisions

The Contractor shall provide office space for the resident inspectors in close proximity to the final assembly area. This office space shall be equipped with desks, outside and interplant telephones, Internet access, file cabinet and chairs.

QA 2.2.5 Compliance with Safety Requirements

At the time of the Pre-Production meeting, the Contractor shall provide all safety and other operational restrictions that govern the Contractor’s facilities. These issues will be discussed and

the parties will agree which rules/restrictions will govern the Purchasing Entity's inspector(s) and any other Purchasing Entity representatives during the course of the Contract.

QA 3. Acceptance Tests

QA 3.1 Responsibility

Fully documented tests shall be conducted on each production bus following manufacture to determine its acceptance to the Purchasing Entity. These acceptance tests shall include pre-delivery inspections and testing by the Contractor and inspections and testing by the Purchasing Entity after the buses have been delivered.

QA 3.2 Pre-Delivery Tests

The Contractor shall conduct acceptance tests at its plant on each bus following completion of manufacture and before delivery to the Purchasing Entity. These pre-delivery tests shall include visual and measured inspections, as well as testing the total bus operation. The tests shall be conducted and documented in accordance with written test plans approved by the Purchasing Entity.

Additional tests may be conducted at the Contractor's discretion to ensure that the completed buses have attained the required quality and have met the requirements in Section 6: Technical Specifications. The Purchasing Entity may, prior to commencement of production, demand that the Contractor demonstrate compliance with any requirement in that section if there is evidence that prior tests have been invalidated by the Contractor's change of Supplier or change in manufacturing process. Such demonstration shall be by actual test, or by supplying a report of a previously performed test on similar or like components and configuration. Any additional testing shall be recorded on appropriate test forms provided by the Contractor and shall be conducted before acceptance of the bus.

The pre-delivery tests shall be scheduled and conducted with thirty (30) days notice so that they may be witnessed by the resident inspectors, who may accept or reject the results of the tests. The results of pre- delivery tests, and any other tests, shall be filed with the assembly inspection records for each bus. The underfloor equipment shall be available for inspection by the resident inspectors, using a pit or bus hoist provided by the Contractor. A hoist, scaffold or elevated platform shall be provided by the Contractor to easily and safely inspect bus roofs. Delivery of each bus shall require written authorization of the primary resident inspector. Authorization forms for the release of each bus for delivery shall be provided by the Contractor. An executed copy of the authorization shall accompany the delivery of each bus.

QA 3.2.1 Visual and Measured Inspections

Visual and measured inspections shall be conducted with the bus in a static condition. The purpose of the inspection testing includes verification of overall dimension and weight requirements, that required components are included and are ready for operation, and that components and subsystems designed to operate with the bus in a static condition do function as designed.

QA 3.2.2 Total Bus Operation

Total bus operation shall be evaluated during road tests. The purpose of the road tests is to observe and verify the operation of the bus as a system and to verify the functional operation of the subsystems that can be operated only while the bus is in motion.

Each bus shall be driven for a minimum of fifteen (15) miles during the road tests. If requested, computerized diagnostic printouts showing the performance of each bus shall be produced and provided to the Purchasing Entity. Observed Defects shall be recorded on the test forms. The bus

shall be retested when Defects are corrected and adjustments are made. This process shall continue until Defects or required adjustments are no longer detected.

QA 4. Purchasing Entity -Specific Requirements NOT USED

Attachment A: New Bus Manufacturing Inspection Guidelines

This attachment was developed by the APTA Bus Equipment and Maintenance Committee and is intended as a guideline for use by transit systems (Agencies) and vehicle manufacturers (Contractors).

Two lists are included to reflect the expectations of both the transit system and the vehicle manufacturer.

Pre-Building Phase

Bus Manufacturer's Expectations	Transit System's Expectations
1. act/transit system inspectors must be given all Contract documentation before beginning the inspection process. 2. The bus manufacturer's inspection process should be reviewed at pre-production audit meeting. Inspectors should be present and understand the difference among various manufacturing processes. At least one key customer and manufacturer representative who will follow the entire procurement from start to finish should be present. 3. When change orders are required, they need to be made as early in the process as possible. If change orders have an impact on the delivery schedule, consideration should be given to a delivery schedule revision. 4. Transit system inspection forms should be provided to manufacturers prior to the build so that the manufacturers will know what items the customer believes are critical. The inspection forms should be provided to the manufacturer after completion so that the Defects to be corrected can be identified. 5. If the transit system requires sole-source components, it should obtain assistance for the first installation of new components. 6. The transit system should have a decision maker at the pre-production audit meeting. 7. The transit system should make every effort to inform manufacturers of what they want. Hidden agenda items buried in the Contract to not promote the cooperative environment desired. 8. The parties should agree on what necessitates a line shutdown before the build begins.	1. Manufacturers should have a formal, approved quality assurance (QA) program and must adhere to the program. Any changes in the approved program must be resubmitted to the transit system for approval. 2. At the pre-production audit meeting with the transit system: • Representatives from contracts, engineering, quality and production should be represented. • Manufacturers should ensure good communication among their departments regarding Contract requirements. • A formal sales release must be ready for review at the meeting, and a final sales release must be ready before production. • Manufacturers should not use the meeting to sell parts. • Manufacturers should supply test information and other documents required to meet expectations. 3. Manufacturers should have application and installation approvals from Suppliers whenever possible. On installations of new major components, the sub-Supplier must be present at initial production. 4. Manufacturers should read and understand the specification prior to bid. Specification clarifications should be made during the approved equals process. Ask the appropriate questions at pre-bid meetings. 5. The manufacturer's service representative should be involved with the pre-production audit meeting and initial production, and/or at final acceptance. 6. Prior to build, the manufacturer should be able to provide the transit system a complete Bill of Materials for the buses to be built.

Process During Building Phase

Bus Manufacturer's Expectations	Transit System's Expectations
1. One person should be the primary inspector from start to finish. The primary inspector should be included in the design review process and pre- production meetings. The rotation of personnel with different expectations and standards causes difficulties. The first or second bus should stay at the manufacturer's location as a quality standard and be delivered last. 2. An adequate number of experienced inspectors should be available to prevent production line movement delays. 3. Inspectors should be available to support the manufacturing effort Monday through Friday, consistent with the manufacturer's production personnel hours. 4. Inspection should be conducted in a cooperative, professional manner. The inspector must *want* to solve problems. 5. Only one person should be able to make stop ship calls, and the reason for the stop ship *must* be immediately available. The stop ship should be in writing. 6. Problems identified should be brought to the attention of the manufacturer at the stage when they occur rather than at a future stage or when the vehicle is complete.	1. The resident inspector should have access to a complete set of engineering drawings and documents for the bus being built. Engineering or manufacturing changes must be formally documented and included in documents provided to transit systems. 2. Manufacturers should maintain the build schedule if possible. Changes in the build schedule and requests for overtime and weekend Work must be communicated as early as possible. 3. Buses that are not ready or complete should not be presented for final inspection. 4. Manufacturers should have a formal internal/external communications process and feedback for inspection problems and resolutions. Manufacturers should provide early resolution of problems identified by inspectors. QA procedures must be revised to reflect problem corrections. 5. The attitude of manufacturers and QA personnel is important; remember who the customer is. However, there must be mutual respect. 6. The transit system is not responsible for redesigning the bus, correcting problems or providing manufacturing quality. It audits only. Manufacturers should not need a learning period to determine acceptable quality standards. 7. Buses should be identical and interchangeable within an order unless provided by the transit system. 8. Inspection Work should be spread evenly during the workday to the extent possible.

Post-Building Phase

Bus Manufacturer's Expectations	Transit System's Expectations
1. To ensure prompt payment, the transit system should increase the rate of the final acceptance process. 2. The on-property final acceptance inspection should be primarily for shipping damage and Defects that occur during shipment. It should not be a complete vehicle inspection with criteria different from those used at the plant.	1. Defects noted at the property final inspection should be repaired in a timely and acceptable manner.