American Public Transportation Association

Standard

Bus

Procurement

Guidelines

40 ft. Low Floor - CNG
Technical Specifications
This Standard Bus Procurement Guidelines – Low Floor CNG is the technical portion of the Standard Bus Procurement Guidelines (SBPG) for low floor CNG buses. This document has been developed through an open and inclusive industry consensus process, funded by the Transit Cooperative Research Program (TCRP) and under the guidance of the American Public Transportation Association (APTA). These specifications will provide benefits to the entire industry for years to come.

The Low Floor CNG Technical Specifications are the culmination of many hours of work by the CNG Working Group, under TCRP Project C-12. With the dedicated efforts and guidance of the Co-Chairs, the Working Group did an outstanding job in preparing a document that will provide substantial and long reaching benefits to the Transit Industry. This effort and the cooperation exhibited by the members of the CNG Working Group are to be commended.

For the procurement of heavy duty, low floor CNG buses this Part 5 – Technical Specification is intended to be used with Parts 1-4 of the Standard Bus Procurement Guidelines - Commercial Terms and Conditions (which can be downloaded from the APTA web site at www.apta.com).

Regular reviews and revisions are planned to keep these specifications current. This document will be revised to add the specification being developed by the Operator Workstation and Electrical Interface working groups when those specifications are finalized. Other technical specifications available include the 35/40-foot heavy duty, low floor diesel and the 35/40-foot heavy duty, high floor diesel. These specifications are available on the APTA web site as well. Additional specifications and revisions will be posted at this site, as they become available.
# Standard Bus Procurement Guidelines

## Low Floor CNG Technical Specifications

### CNG Working Group

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**American Public Transportation Association**

Frank J. Cihak, Chief Engineer and Special Projects Manager
STANDARD BUS PROCUREMENT GUIDELINES
LOW FLOOR CNG

FOR 35/40 FOOT HEAVY-DUTY, LOW FLOOR, COMPRESSED NATURAL GAS (CNG) POWERED TRANSIT BUS
5 TECHNICAL SPECIFICATIONS
## 5 TECHNICAL SPECIFICATIONS

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5.1 GENERAL

5.1.1 SCOPE

Part 5: Technical Specifications define requirements for a heavy duty, low floor, Compressed Natural Gas (CNG) powered transit bus which, by the selection of specifically identified alternative configurations, may be used for both suburban express service and general service on urban arterial streets. It shall have a minimum expected life of 12 years or 500,000 miles which ever comes first and is intended for the widest possible spectrum of passengers, including children, adults, the elderly, and persons with disabilities.

5.1.2 DEFINITIONS

The following are definitions of special terms used in Part 5.

(1) **dBA.** Decibels with reference to 0.0002 microbar as measured on the "A" scale.

(2) **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.

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

(4) **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 square feet shall be allocated for the feet of each seated passenger that protrudes into the standee area.

(5) **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 operator.

(6) **Seated Load.** One hundred fifty pounds for every designed passenger seating position and for the operator.

(7) **Gross Load.** One hundred fifty pounds for every designed passenger seating position, for the operator, and for each 1.5 square feet of free floor space.

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

(9) **GVW (Gross Vehicle Weight).** Curb weight plus gross load.
(10) **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.

(11) **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.

(12) **Heavy Heavy-Duty Gas Engine (HHDG).** Heavy heavy-duty gas engines have sleeved cylinder liners, are designed for multiple rebuilds, and a rated horsepower that generally exceeds 250.

(13) **Operator'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.

(14) **Fireproof.** Materials that will not burn or melt at temperatures less than 2,000° F.

(15) **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.

(16) **Human Dimensions.** The human dimensions used in Part 5: Technical Specifications are defined in Humanscale 1/2/3, N. Diffrient, A. R. Tilley, J. C. Bardagjy, MIT Press.

(17) **HIC (Head Injury Criteria).** The following equation presents the definition of head injury criteria:

\[
\left[ \frac{1}{t_1 - t_2} \int_{t_1}^{t_2} (a) dt \right]^{2.5} (t_2 - t_1)
\]

where:

- **a** = the resultant acceleration at the center of gravity of the head form expressed as a multiple of g, the acceleration of gravity.

- **t_1** and **t_2** = any two points in time during the impact.

(18) **Baseline Configuration Bus.** The bus described by Part 5: Technical Specifications if no alternatives are selected. Signing, colors, the destination sign reading list and other information must be provided by the Procuring Agency in attachments to Part 5: Technical Specifications.
(19) **Alternative.** An alternative specification condition to the baseline configuration bus. The Procuring Agency may define alternatives to the baseline configuration to satisfy local operating requirements. Alternatives for the baseline configuration will be clearly identified.

(20) **Design Operating Profile.** The operating profile for design purposes shall consist of simulated transit type service. The duty cycle is described in the figure “Transit Bus Duty Cycle.” The duty cycle consists of three phases to be repeated in sequence: a central business district (CBD) phase of 2 miles with 7 stops per mile and a top speed of 20 mph, an arterial route phase of 2 miles with 2 stops per mile and a top speed of 40 mph, and a commuter phase of 4 miles with 1 stop and a maximum speed of 55 mph and a 5 minute idle phase.

<table>
<thead>
<tr>
<th>Phase</th>
<th>Stops/Mile</th>
<th>Top Speed (mph)</th>
<th>Miles</th>
<th>Accel. Dist. (ft.)</th>
<th>Accel. Time (s)</th>
<th>Cruise Dist. (ft.)</th>
<th>Cruise Time (s)</th>
<th>Decel. Rate (fps/ps)</th>
<th>Decel. Dist. (ft.)</th>
<th>Decel. Time (s)</th>
<th>Dwell Time (s)</th>
<th>Cycle Time (min-s)</th>
<th>Total Stops</th>
</tr>
</thead>
<tbody>
<tr>
<td>CBD</td>
<td>7</td>
<td>20</td>
<td>2</td>
<td>155</td>
<td>10</td>
<td>540</td>
<td>18.5</td>
<td>6.78</td>
<td>60</td>
<td>4.5</td>
<td>7</td>
<td>9-20</td>
<td>14</td>
</tr>
<tr>
<td>Idle</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>5-0</td>
<td>-</td>
</tr>
<tr>
<td>Arterial</td>
<td>2</td>
<td>40</td>
<td>2</td>
<td>1035</td>
<td>29</td>
<td>1350</td>
<td>22.5</td>
<td>6.78</td>
<td>255</td>
<td>9</td>
<td>7</td>
<td>4-30</td>
<td>4</td>
</tr>
<tr>
<td>CBD</td>
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<td>20</td>
<td>2</td>
<td>155</td>
<td>10</td>
<td>510</td>
<td>18.5</td>
<td>6.78</td>
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<td>9-20</td>
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<td>1035</td>
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<td>255</td>
<td>9</td>
<td>7</td>
<td>4-30</td>
<td>4</td>
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<tr>
<td>CBD</td>
<td>7</td>
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<td>2</td>
<td>155</td>
<td>10</td>
<td>510</td>
<td>18.5</td>
<td>6.78</td>
<td>60</td>
<td>4.5</td>
<td>7</td>
<td>9-20</td>
<td>14</td>
</tr>
<tr>
<td>Commuter</td>
<td>1 stop for phase</td>
<td>Max. or 55</td>
<td>4</td>
<td>5500</td>
<td>90</td>
<td>2 miles + 4580 ft.</td>
<td>188</td>
<td>6.78</td>
<td>480</td>
<td>12</td>
<td>20</td>
<td>5-10</td>
<td>1</td>
</tr>
<tr>
<td>Total</td>
<td>14</td>
<td></td>
<td>47-10</td>
<td>51</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
<td>14</td>
</tr>
</tbody>
</table>

Average Speed - 17.8 mph
The bus shall be loaded to SLW and shall average approximately 18 mph while operating on this duty cycle. Operation shall continue regardless of the ambient temperature or weather conditions. The passenger doors shall be opened and closed at each stop, and the bus shall be knelt at each stop during the CBD phase. The braking profile shall be:

- 16 percent of the stops at 3 ft/sec/sec
- 50 percent of the stops at 6 ft/sec/sec
- 26 percent of the stops at 9 ft/sec/sec
- 8 percent of the stops at 12 ft/sec/sec

These percentages of stops shall be evenly distributed over the three phases of the duty cycle. For scheduling purposes, the average deceleration rate is assumed.
Alternative: High Density Urban Operating Profile. Additional requirements for Procuring Agencies with more demanding operating profiles.

A High Density Urban (HDU) Operating Profile may be applicable to transit agencies operating in a highly populated urban area. In addition to the above requirements, this profile shall be taken into account during the design of subsystems such as charging, air, brakes and radiator/coolers. The HDU profile consists of mostly CBD type operating with some arterial, and minimal commuter. However, number of stops per mile and loading conditions may be greater than those specified for the CBD cycle. The HDU profile is characterized by the following:

- Average Speed: 9 to 10 mph
- Average Idle Time: 50%
- Percent Time at 0 to 19 mph: 80% range
- Percent Time at 20 mph & above: 20%

Average speed is defined as the average engine hours versus miles traveled. Much of the “idle” time is due to stop and go nature of the service of the HDU operation. The majority of this idle time is while the bus is in gear and stopped in traffic, or at bus stops, as well as frequent brake applications per mile due to traffic congestion and traffic signals. Procuring Agency can provide additional operating characteristics to expand on these.

(21) Class of Failures. Classes of failures are described below.

a. **Class 1: Physical Safety.** A failure that could lead directly to passenger or operator injury or represents a severe crash situation.

b. **Class 2: Road Call.** A failure resulting in an en route interruption of revenue service. Service is discontinued until the bus is replaced or repaired at the point of failure.

c. **Class 3: Bus Change.** A failure that requires removal of the bus from service during its assignments. The bus is operable to a rendezvous point with a replacement bus.

d. **Class 4: Bad Order.** A failure that does not require removal of the bus from service during its assignments but does degrade bus operation. The failure shall be reported by operating personnel.

(22) Maintenance Personnel Skill Levels. Defined below are maintenance personnel skill levels used in Part 5: Technical Specifications.

a. 5M: Specialist Mechanic or Class A Mechanic Leader
b. 4M: Journeyman or Class A Mechanic
c. 3M: Service Mechanic or Class B Servicer
d. 2M: Mechanic Helper or Bus Servicer
e. 1M: Cleaner, Fueler, Oiler, Hostler, or Shifter
In attachments to Part 5: Technical Specifications, the Procuring Agency may relate the skill levels and ratings of mechanics in its operation to the above definitions.

**Note:** Whenever a specific time is indicated to access components or complete a task, it is assumed the vehicle is in the location where the work is to be performed. All necessary equipment is in its correct position (tools, jacks, vehicle lifts, lighting, fluid recovery systems, etc.) and ready for use.

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

(24) **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. A “common wheelchair” is such a device that does not exceed 30 inches in width and 48 inches in length measured two inches above the ground, and does not weigh more than 600 pounds when occupied.

(25) **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.

(26) **Low Floor Bus.** A bus which, 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.

(27) **Discrete Signals.** A signal which 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.

(28) **Analog Signals.** A continuously-variable signal that is solely dependent upon magnitude to express information content. Note: Analog signals are used to represent the state of variable devices such as rheostats, potentiometers, temperature probes, etc.

(29) **Serial Data Signals.** Serial data signals are 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.

(30) **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.
(31) **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).

(32) **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).

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

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

(35) **CNG Cylinder.** A container constructed, inspected, and maintained in accordance with U.S. Department of Transportation or Transport Canada regulations, or ANSI/IAS NGV2, Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers, or CSA B51, Boiler, Pressure Vessel and Pressure Piping Code.

**CNG Cylinder Types.**

- **Type 1.** Metal
- **Type 2.** Resin impregnated continuous filament with metal liner with a minimum burst pressure of 125% of service pressure. The cylinder may be either hoop-wrapped or full-wrapped (Hoop Wrapped: Reinforcement by a composite material applied in a substantially circumferential pattern over the cylindrical portion of the liner so that the filament does not transmit any significant stresses in a direction parallel to the container/cylinders longitudinal axis. Full Wrapped: The reinforcement by a composite material applied over the entire liner, including the domes.)
- **Type 3.** Resin impregnated continuous filament with metal liner. The container may be either hoop-wrapped or full-wrapped.
- **Type 4.** Resin impregnated continuous filament with a nonmetallic liner.

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

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

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

(39) **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.
(40) **Container.** A pressure vessel, cylinder, or cylinders permanently manifolded together used to store CNG.

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

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

(43) **Defueling.** The process of removing fuel from a CNG vehicle.

(44) **Defueling Port.** Device which allows for, or point at which, a vehicle is defueled.

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

(46) **Fill Pressure for CNG.** The pressure attained at the actual time of filling. Fill pressure varies according to the gas temperatures in the container, which are dependent on the charging parameters and the ambient conditions. The maximum dispensed pressure shall not exceed 125 percent of service pressure.

(47) **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.

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

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

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

(51) **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 (510-70 psi).

(52) **Labeled.** Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization, that is acceptable to the authority having jurisdiction and concerned with product evaluation, that 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.

(53) **Leakage.** Release of contents through a defect or crack. See "Rupture."

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

(55) **Lower Explosive Limit.** The lowest concentration of gas where, given an ignition source, combustion is possible.
(56) **Maximum Service Temperature.** The maximum temperature to which a container/cylinder will be subjected in normal service.

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

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

(59) **Operating Pressure.** The varying pressure which is developed in a container during service.

(60) **Pressure Activated Gas Relief Device.** 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.

(61) **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.

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

(63) **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.

(64) **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.

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

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

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

(68) **Stress Loops.** The "pig-tails" commonly used to absorb flexing in piping.
(69) 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.

(70) 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.

### 5.1.3 ABBREVIATIONS

The following is a list of abbreviations used in Part 5: Technical Specifications.

1. **ADA**  
   Americans with Disabilities Act

2. **ANSI**  
   American National Standards Institute

3. **ASHRAE**  
   American Society of Heating, Refrigerating and Air Conditioning Engineers

4. **ASTM**  
   American Society for Testing and Materials

5. **CAN/CGA**  
   Canadian Gas Association

6. **CFR**  
   Code of Federal Regulations

7. **CGA**  
   Compressed Gas Association

8. **CHP**  
   California Highway Patrol

9. **CNG**  
   Compressed Natural Gas

10. **DOE**  
    U.S. Department of Energy

11. **DOT**  
    U.S. Department of Transportation

12. **EMI**  
    Electromagnetic Interference

13. **EPA**  
    U.S. Environmental Protection Agency

14. **FMEA**  
    Failure Modes and Effects Analysis
(15) **FMCSR**  Federal Motor Carrier Safety Regulations
(16) **FMVSS**  Federal Motor Vehicle Safety Standards
(17) **FTA**  U.S. Federal Transit Administration
(18) **IAS**  International Approval Services
(19) **I/O**  Input/Output
(20) **ISO**  International Organization for Standardization
(21) **JIC**  Joint Industrial Council
(22) **LED**  Light Emitting Diode
(23) **LEL**  Lower Explosive Limit
(24) **LNG**  Liquefied Natural Gas
(25) **MAWP**  Maximum Allowable Working Pressure
(26) **MPH**  Miles Per Hour
(27) **NAFTP**  The National Alternative Fuel Training Program
(28) **NATEF/SAE**  The National Automotive Technicians Education Foundation/ Automotive Service Excellence
(29) **NFPA**  National Fire Protection Association
(30) **NGV**  Natural Gas Vehicle
(31) **NHTSA**  National Highway Traffic Safety Administration
(32) **OEM**  Original Equipment Manufacturer
(33) **OSHA**  Occupational Safety and Health Administration
(34) **PRD**  Pressure Relief Device
(35) **RFI**  Radio Frequency Interference
(36) **SAE**  SAE International
(37) **SPI**  Society of the Plastics Industry
5.1.3.1 REFERENCED PUBLICATIONS

The documents or portions thereof referenced within this specification shall be considered part of the requirements of the specification. The edition indicated for each referenced document is the current edition, as of the date of the APTA issuance of this specification.

5.1.4 LEGAL REQUIREMENTS

The contractor shall comply with all applicable Federal, state and local regulations. Local regulations are defined as those below the state level. These shall include, but not be limited to, Federal ADA as well as state and local accessibility, safety and security requirements.

The bus shall meet all applicable FMVSS and shall accommodate all applicable FMCSR regulations in effect at the date of manufacture.

In the event of any conflict between the requirements of this Specification and any applicable legal requirement, the legal requirement shall prevail. Technical requirements that exceed the legal requirements are not considered to conflict.

5.1.5 OVERALL REQUIREMENTS

The contractor shall ensure that the application and installation of major bus sub-components and systems are compliant with all such sub-component vendors’ requirements and recommendations. Components used in the vehicle shall be of heavy-duty design and proven in transit service.

5.1.5.1 DIMENSIONS

5.1.5.1.1 Physical Size

With the exceptions of exterior mirrors, marker and signal lights, bumpers, fender skirts, washers, wipers, ad frames and rubrails, the bus shall have the following overall dimensions as shown in the figure “Transit Bus Exterior Dimensions” at static conditions and design height.
Baseline: Use for 40-ft length bus.

1. Body Length: 40 feet ± 3 inches

Alternative: Use for 35-ft length bus. Also see Sections 5.1.5.2, 5.1.5.3, 5.4.5.1.1 and 5.4.7.

1. Body Length: 35 feet ± 3 inches

Baseline: Use for 102-inch width bus.

2. Body Width: 102 inches (+0, -1 inch)

3. Maximum Overall Height: 140 inches, includes all rigid roof mounted items such as A/C, exhaust, fuel system and cover, etc.

TRANSIT BUS EXTERIOR DIMENSIONS

5.1.5.1.2 Underbody Clearance

The bus shall maintain the minimum clearance dimensions as shown in the figure “Transit Bus Minimum Road Clearance” and defined in SAE Standard J689, regardless of load up to the gross vehicle weight rating.
Ramp Clearances. Approach angle shall be no less than 8.5 degrees. Breakover angle shall be no less than 8 degrees. Departure angle shall be no less than 9 degrees.

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.

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.

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.

Ground Clearance. Ground clearance shall be no less than 10 inches, except within the axle zone and wheel area.

Axle Clearance. Axle zone clearance, which is the projected area between tires and wheels on the same axial centerline, shall be no less than 5½ inches.

Wheel Area Clearance. Wheel area clearance, shall be no less than 8 inches for parts fixed to the bus body and 6 inches for parts that move vertically with the axles.

5.1.5.1.3 Floor Height
Height of the floor above the street shall be no more than 15½ inches 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 be less than 3 1/2° off the horizontal except locally at the doors where 2° 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 305 tires.

5.1.5.1.4 Interior Headroom

Headroom above the aisle and at the centerline of the aisle seats shall be no less than 78 inches in the forward half of the bus tapering to no less than 74 inches forward of the rear settee. At the centerline of the window seats, headroom shall be no lower than 65 inches. Headroom at the back of the rear bench seat may be reduced to a minimum of 56 inches, 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/her head, padding shall be provided on the overhead paneling.

5.1.5.2 WEIGHT

Curb weight of the bus, as defined in Section 5.1.2 of these Specifications, shall not exceed ______ pounds. (Procuring Agency to insert weight, considering specific configuration including bus width, seating style and configuration, and glazing material.)

5.1.5.3 CAPACITY

The vehicle shall be designed to carry the Gross Vehicle Weight as defined in Section 5.1.2, which shall not exceed the bus GVWR.

5.1.5.4 SERVICE LIFE AND MAINTENANCE

5.1.5.4.1 Service Life

The bus shall be designed to operate in transit service for at least 12 years or 500,000 miles. It shall be capable of operating at least 40,000 miles per year including the twelfth year.

5.1.5.4.2 Maintenance and Inspection

Scheduled maintenance or inspection tasks as specified by the Contractor shall require a skill level of 3M or less. Scheduled maintenance tasks shall be related and shall be, in general, at intervals of 6,000 miles (along with routine daily service performed during the fueling operations). Oil/filter change intervals may be extended, as indicated from a regular oil analysis program undertaken in cooperation with the engine manufacturer.
Any special tools required to maintain the bus shall be provided in quantities as specified in attachments to Part 5: Technical Specifications. Additional requirements for Maintenance and Inspection Equipment are also provided in these attachments.

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

The Contractor shall provide a manual listing the times required for typical repair and service items on the bus.

5.1.5.4.2.1 CNG Cylinder Visual Inspection

A general visual inspection of all cylinders shall occur during routine maintenance, or as specified in the agency safety plan. The purpose of this general inspection is to look for signs of gross external damage or abuse to the cylinders. This cursory inspection can be performed by a skill level of 3M or less.

A detailed visual inspection of all cylinders shall occur every 3 years (NGV2) or every 3 years or 36,000 miles (FMVSS 304). This detailed visual inspection shall be performed by an experienced third party or a trained in-house individual, following criteria established by CGA pamphlet C-6.4 (Methods for External Visual Inspection of Natural Gas Vehicle Fuel Containers and Their Installations). If a question arises, the respective coach manufacturer and cylinder manufacturer should be consulted.

5.1.5.4.3 Accessibility

All systems or components subject to periodic maintenance or that are subject to periodic failures shall be readily accessible for service and inspection. To the extent practicable, removal or physical movement of components unrelated to the specific maintenance and/or repair tasks involved shall be unnecessary.

As a goal, relative accessibility of components, measured in time required to gain access, shall be inversely proportional to frequency of maintenance and repair of the components. Specific maintainability requirements are defined in other sections of Part 5: Technical Specifications.

The location of CNG cylinders shall allow access for routine external surface cylinder cleaning and inspections. CNG cylinder labels shall be readily viewable without requiring cylinder rotation or the removal of any components, with the exception of cylinder protection devices (shields). CNG cylinder manual shut-off valves (if equipped) shall be easily accessible to allow for CNG fuel system shut-off or CNG cylinder isolation. Non-skid roof surfaces/walkways shall be incorporated on buses when roof-top CNG cylinder access is provided.

5.1.5.4.4 Interchangeability
Components with identical functions shall be interchangeable to the extent practicable. These components shall include, but 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. A component shall not be used in an application for which it was neither designed nor intended.

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.

Durable labels should be displayed in the engine compartment, fuel storage compartment(s), and on other fuel system component compartments stating that CNG fuel system components may not be interchangeable within a vehicle or between vehicles. In recognition that fuel system components may not be fully interchangeable, the issue of fuel system component interchangeability must be addressed in the vehicle maintenance manual.

5.1.5.5 OPERATING ENVIRONMENT

The bus shall achieve normal operation in ambient temperature ranges of 10°C to 115°C, at relative humidity between 5 percent and 100 percent, and at altitudes up to 3,000 feet above sea level. Degradation of performance due to atmospheric conditions shall be minimized at temperatures below 10°C, above 115°F, or at altitudes above 3,000 feet. Altitude requirements above 3,000 feet will need separate discussions with the engine manufacturer to ensure performance requirements are not compromised.

Special equipment or procedures may be employed to start the bus after being exposed for more than 4 hours to temperatures less than 30°C without the engine in operation. Speed, gradability, and acceleration performance requirements shall be met at, or corrected to, 77°F, 29.31 inches Hg, dry air per SAE J1995. The interior climate control system shall perform in accordance with Section 5.4.8 of Part 5: Technical Specifications.

5.1.5.6 NOISE

5.1.5.6.1 Interior Noise

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.

The bus-generated noise level experienced by a passenger at any seat location in the bus shall not exceed 83 dBA and the operator shall not experience a noise level of more than 75 dBA under the following test conditions. The bus shall be empty except for test personnel, not to exceed 4 persons, and the test equipment. All openings shall be closed and all accessories shall be operating during the test. The bus
shall accelerate at full throttle from a standstill to 35 mph on level commercial asphalt or concrete pavement in an area free of large reflecting surfaces within 50 feet of the bus path. During the test, the ambient noise level in the test area shall be at least 10 dBA lower than the bus under test. Instrumentation and other general requirements shall conform to SAE Standard J366. If the noise contains an audible discrete frequency as defined in Section 5.1.2, a penalty of 5 dBA shall be added to the sound level measured.

5.1.5.6.2 Exterior Noise

Airborne noise generated by the bus and measured from either side shall not exceed 83 dBA under full power acceleration when operated at or below 35 mph at curb weight and just prior to transmission upshift. 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 as defined in Section 5.1.2, a penalty of 5 dBA shall be added to the sound level measured. All noise readings shall be taken 50 feet from and perpendicular to, the centerline of the bus with all accessories operating. Instrumentation, test sites, and other general requirements shall be in accordance with SAE Standard J366. The pull away test shall begin with the front bumper even with the microphone. The curb idle test shall be conducted with the rear bumper even with the microphone.

In addition, the Contractor shall comply with the exterior noise requirements defined in local laws and ordinances identified by the Procuring Agency.

5.1.5.7 FIRE SAFETY

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, firewalls, and facilitation of passenger evacuation.

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 FTA Docket 90, dated October 20, 1993. Materials entirely enclosed from the passenger compartment, such as insulation within the sidewalls, need not comply. In addition, smaller components and items, such as seat grabrails, switch knobs and small light lenses, shall be exempt from this requirement.

Fire sensing and suppression systems as required in Section 5.5.9 shall be provided.

See Section 5.4.1.6 for Fire Walls.

The requirements for passenger evacuation provisions related to doors, windows, and escape hatches are defined in Section 5.4 of Part 5: Technical Specifications.

5.1.5.8 ELDERLY AND DISABLED PASSENGERS
The contractor shall comply with all applicable Federal requirements defined in the Americans with Disabilities Act, 49 CFR Part 38, and all state and local regulations regarding mobility-impaired persons. Local regulations are defined as those below the state level.

5.1.5.8.1 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 generated by the Procuring Agency when maintaining the bus in accordance with the procedures contained in the manufacturer’s maintenance manuals. The manufacturer shall use, whenever possible, low mercury fluorescent lighting tubes, PCB free ballast units, cleanable filters (unless required otherwise by the Procuring Agency), and non-asbestos brake blocks and gaskets. 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.

5.2 PROPULSION SYSTEM

5.2.1 VEHICLE PERFORMANCE

5.2.1.1 POWER REQUIREMENTS

Propulsion system and drive train shall provide power to enable the bus to meet the defined acceleration, top speed, and gradability requirements, and operate all propulsion-driven accessories. Power requirements are based on heavy, heavy-duty gas (HHDG) engines certified for use in all 50 states using actual road test results or computerized vehicle performance data.

5.2.1.2 TOP SPEED

The bus shall be capable a top speed of _______ m.p.h. (Procuring Agency to insert number, understanding that top speed requirements may affect other performance characteristics) on a straight, level road at GVWR with all accessories operating.

5.2.1.3 GRADABILITY

Gradability requirements shall be met on grades with a dry commercial asphalt or concrete pavement at GVWR with all accessories operating. The propulsion system and drive train shall enable the bus to achieve and maintain a speed of 40 mph on a 2-1/2 percent ascending grade and 7 m.p.h. on a 16 percent ascending grade.

5.2.1.4 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 – (Idle Start.)

MAXIMUM IDLE START ACCELERATION TIMES ON A LEVEL SURFACE
(Vehicle weight = GVWR, 50-State Power Plant)

<table>
<thead>
<tr>
<th>SPEED (MPH)</th>
<th>TIME (SEC)</th>
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<tbody>
<tr>
<td>10</td>
<td>5.6</td>
</tr>
<tr>
<td>20</td>
<td>11.0</td>
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<tr>
<td>30</td>
<td>20.0</td>
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<tr>
<td>40</td>
<td>31.0</td>
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</table>
5.2.1.5 OPERATING RANGE

The operating range of the coach when run on the transit coach duty cycle shall be at least 350 miles with an initial gas settled pressure of 3,600 psi (US) or 3,000 psi (Canada) at 70°F (21°C).

5.2.2 DRIVETRAIN

5.2.2.1 POWER PLANT

5.2.2.1.1 Engine

The HHDG engine shall be designed to operate for not less than 300,000 miles without major failure or significant deterioration. Components of the fuel management and/or control system shall be designed to operate for not less than 150,000 miles without replacement or major service. Exception: Spark plugs and wires, spark coil, oxygen sensor. Mileage intervals are based on the design operating profile defined in Section 5.1.2.

The engine shall meet all requirements of Part 5: Technical Specifications when operating on fuel equal to CARB Specifications for Compressed Natural Gas #2292.5. The four predominant characteristics that must be met are Methane, Ethane, Butane, and Propane.

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 specified in Section 5.5.5.2.1. 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 engine performance.

In order to avoid potential warranty disputes during the engine warranty period, initial performance settings shall only be changed with the authorization from the bus and engine manufacturers.

The engine control system shall have onboard diagnostic capabilities able to monitor vital engine functions, store and time stamp 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. Optional requirements for additional ports are identified in Section 5.5.6. The onboard diagnostic system shall inform the operator via visual and/or audible alarms when out of parameter conditions exist for vital engine functions. Conditions that require an operator alarm are identified in Section...
5.4.6.1.6. Data communication requirements for the on-board Drivetrain diagnostic system are identified in Section 5.5.5.2.2.

The engine starter 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 engine 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 Procuring Agency. The requirements for specific cold weather starting aids are included in attachments to Part 5: Technical Specifications.

**Baseline: Standard requirements for a fast idle device.**

- The engine shall be equipped with an operator-controlled fast idle device. The fast idle control shall be a two-way toggle mounted on the dash or side console and shall activate only with the transmission in neutral and the parking brake applied. This device may be used to help meet the requirements of bus cool down in Section 5.4.8.

**Baseline: No requirement for an auxiliary heater.**

An auxiliary heater fired by CNG fuel shall be provided to supplement the heat supplied by the engine and shall have an output necessary to meet the performance criteria specified in Section 5.4.8.1. The heater shall be equipped with safety devices to prevent the following: overfueling, overheating due to loss of coolant or water pump failure, and operation during conditions of low battery voltage. The auxiliary heater shall be capable of functioning in the preheat mode. The auxiliary heater shall be electronically controlled with appropriate diagnostics for troubleshooting. Operational and diagnostic data shall be stored and shall be retrievable through an IBM compatible PC.

**Alternative: Automatically activated fast idle.**

The fast idle device shall be activated and controlled automatically by the engine control system.

**Baseline: Auxilliary heater.**

The engine control system shall protect the engine against progressive damage. The system shall monitor conditions critical for safe operation and automatically derate power and/or speed and initiate engine shutdown as needed. The on-board diagnostic system, as described in Section 5.4.6.1.6, shall trigger a visual and audible alarm to the operator when the engine control unit detects a malfunction and the engine protection system is activated.

Automatic shutdown shall only occur when parameters established for the functions below are exceeded:

- Coolant Level
- Coolant Temperature
- Exhaust Temperature
Oil Pressure

| Baseline: No requirement for an automatic engine protection/shutdown override feature. |
| Alternative: Use for automatic engine protection/shutdown override feature. |

A control shall be available to the operator which, when constantly depressed, will allow the drive to delay the engine shutdown but not the FSS System activation and alarm system.

5.2.2.1.2 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/fans control 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 in new condition shall have an ambient capacity of at least 110° F with water as coolant and sea level operation.

5.2.2.1.2.1 Engine Cooling

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 magnetically coupled, brushless design. All low points in the water-based cooling system shall be equipped with drain cocks. Air vent valves shall be fitted at high points in the cooling system unless it can be demonstrated that the system is self-purging. A sight glass to determine satisfactory engine coolant level shall be provided and shall be accessible by opening one of the engine compartment’s access doors. A spring-loaded, push button type valve to safely release pressure or vacuum in the cooling system shall be provided with both it and the water filler no more than 60 inches above the ground and both shall be accessible through the same access door.

The radiator, and charge air cooler if integrated, shall be of durable corrosion-resistant construction with bolted-on removable tanks. The radiator shall be designed so a 2M mechanic can gain access to a substantial portion of the side facing the engine for the purpose of cleaning the radiator in five minutes or less. Radiators with a fin density greater than 12 fins per inch, and louvered/slit designs, are more susceptible to clogging and deteriorating cooling performance over time and shall not be used.
Radiator piping shall meet the requirements of Section 5.2.2.2.4. 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.

<table>
<thead>
<tr>
<th>Baseline: Standard requirement for coolant filtration.</th>
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<tbody>
<tr>
<td>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.</td>
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</table>

<table>
<thead>
<tr>
<th>Alternative: Delete the requirement for coolant filtration.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The water filter and its plumbing shall not be provided.</td>
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<table>
<thead>
<tr>
<th>Baseline: Standard requirements for cooling fan operation.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The cooling fan shall be temperature controlled, allowing the engine to reach operating temperature quickly. The temperature-controlled fan shall not be driven when the coolant temperature falls below the minimum level recommended by the engine manufacturer.</td>
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</table>

<table>
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<tr>
<th>Alternative: Fixed fan operation.</th>
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<tbody>
<tr>
<td>The cooling fan shall operate continuously with the engine.</td>
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</tbody>
</table>

5.2.2.1.2.2 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 or behind the engine radiator and shall be positioned as close to the engine as possible unless integrated with the radiator. Air ducting and fittings shall be protected against heat sources, and shall be configured to minimize restrictions and maintain sealing integrity.

5.2.2.1.2.3 Transmission Cooling

The transmission shall be cooled by a separate 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.
5.2.2.1.3 Transmission

The transmission shall be multiple speed, automatic shift with torque converter, retarder and electronic controls. Gross input power, gross input torque and rated input speed shall be compatible with the engine. A 3M mechanic, with optional assistance, shall be able to remove and replace the transmission assembly for service in less than 16 total combined man-hours. 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 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 specified in Section 5.5.5.2.1. 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. A brake pedal application of 15 to 20 psi shall be required by the operator to engage forward or reverse range from the neutral position to prevent sudden acceleration of the bus from a parked position.

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. A diagnostic reader device connector port, suitably protected against dirt and moisture, shall be provided in the operator’s area. Optional requirements for additional ports are identified in Section 5.5.6. The on-board diagnostic system shall trigger a visual alarm to the operator when the electronic control unit detects a malfunction as described in Section 5.4.6.1.6.

- **Baseline:** No requirements for transmission fluid level monitoring/protection system.
- **Alternative:** Use for requiring a transmission fluid level monitoring/protection system.

An electronic transmission fluid level monitoring and protection system shall be provided. This system shall allow a 2M or 3M mechanic to accurately determine transmission fluid levels during checking or oil change and shall be in addition to the manual dipstick. This system shall also provide protection against any damage resulting from improper fluid level conditions.

The transmission shall have an auto neutral feature that shall cause it to automatically and immediately shift to “Neutral” whenever the transmission is left in gear and the parking brake is applied. This system shall also automatically shift the transmission to “Neutral,” after a 5-minute delay, whenever the exit door brake interlock is applied.

5.2.2.1.4 Retarder

The transmission shall be equipped with an integral hydraulic retarder designed to extend brake lining service life. The application of the retarder shall cause a smooth blending of both retarder and service
brake functions without exceeding jerk requirements as defined in Section 5.2.2.1.5. Brake lights shall illuminate when the retarder is activated.

| θ  Baseline: Standard requirement for retarder activation. |
| The retarder shall be activated when the brake pedal is depressed. |
| θ  Alternative: Throttle activation of the retarder. |
| The retarder shall become partially engaged (approximately 1/4 to 1/3 of its total application, with a resulting deceleration of no greater than 0.03 g) when the throttle is completely released (e.g., zero throttle). Maximum retarder shall be achieved when brake pedal is depressed prior to engagement of service brakes with a maximum resulting deceleration of approximately 0.13 g. The resulting decelerations specified include the effects of engine braking, wind resistance and rolling resistance. |

The thermostatically controlled cooling fan shall be activated when the retarder is engaged and the coolant temperature exceeds the maximum limit established by the engine and transmission manufacturers.

5.2.2.1.5  Jerk

Jerk, the rate of change of acceleration measured at the centerline, floor level of the bus shall be minimized throughout the shifting of each transmission range and retarder application and shall be no greater than 0.3 g/sec. for a duration of a quarter-second or more.

5.2.2.2  MOUNTING

The power plant shall be mounted in a compartment in the rear of the bus. All power plant mounting shall be mechanically isolated to minimize transfer of vibration to the body structure as defined in Section 5.4.1.5. Mounts shall control 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.

5.2.2.2.1  Service

The power plant 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 power plant. Two 3M mechanics shall be able to remove and replace the engine and transmission assembly in less than 12 total combined man-hours. 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. All fluid fill locations shall be properly labeled to help ensure correct fluid is added and all fillers shall be easily accessible with standard funnels, pour spouts, and automatic dispensing equipment. All lubricant sumps shall be fitted with magnetic-type, external, hex head, drain plugs.

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. To the extent practicable, the filters shall be of the spin-on, disposable type or integral with the engine and transmission. All filters shall be easily accessible and the filter bases shall be plumbed to assure correct reinstallation. Fuel and oil lines shall meet the requirements of Section 5.2.2.2.4.

An oil sampling and fill provision compatible with the Procuring Agency’s equipment and defined in attachments to Part 5: Technical Specifications, shall be included in the engine compartment.

*Baseline:* No engine bypass oil filter.

*Alternative:* Use for additional bypass engine oil filters.

A centrifugal, non-disposable bypass engine oil filter shall be provided.

An air cleaner with a dry filter element and a graduated air filter restriction indicator shall be provided. The filter shall be removable by a 3M mechanic in 10 minutes or less. The location of the air intake system shall be designed to minimize the entry of dust and debris and 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.

### 5.2.2.2 Accessories

Engine-driven accessories shall be mounted for quick removal and repair. Accessory drive systems shall operate without unscheduled adjustment for not less than 50,000 miles on the design operating profile. These accessories shall be driven at speeds sufficient to assure adequate system performance during extended periods of idle operation and low route speed portion of the design operating profile. Belt guards shall be provided as required for safety and shall be sturdy in design and installation and readily removable.

### 5.2.2.3 Hydraulic Systems

Any accessory may be driven hydraulically. The hydraulic system shall demonstrate a mean time between repairs in excess of 50,000 miles. Hydraulic system service tasks shall be minimized and scheduled no more frequently than those of other major coach systems. All elements of the hydraulic
Standard Bus Procurement Guidelines – Low Floor CNG

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. All hydraulic lines shall meet the requirements of Section 5.2.2.2.4, and all elements of the hydraulic system shall meet the noise limits defined in Section 5.1.5.6. 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. All elements of the hydraulic system shall meet the accessibility loading requirements of Section 5.4.5.4.2.

θ Baseline: No requirement for hydraulic system sensors.

θ Alternative: Hydraulic system sensors.

Sensors in the hydraulic system, excluding those in the power steering system, shall indicate on the operator's on-board diagnostic panel conditions of low hydraulic fluid level. Specific systems for which low hydraulic fluid level sensors are required are included in attachments to Part 5: Technical Specifications.

5.2.2.2.4 Fluid Lines, Fittings and Clamps, and Charge Air Piping

All lines and piping shall be supported to prevent chafing damage, fatigue failures, and tension strain. Lines passing through a panel, frame, or bulkhead shall be protected by grommets (or similar device) that fit snugly to both the line and the perimeter of the hole that the line passes through to prevent chafing and/or wear.

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.

Compression fittings shall be standardized as much as practicable 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.

5.2.2.2.4.1 Radiator

Radiator piping shall be stainless steel or brass tubing and, if practicable, hoses shall be eliminated. Necessary hoses shall be a premium, silicone rubber type that is impervious to all bus fluids. All hoses shall be as short as practicable. All hoses shall be secured with premium, stainless steel clamps that provide a complete 360° 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.

5.2.2.2.4.2 Oil & 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 which they are installed, i.e., high temperatures in engine compartment, road salts, oils, etc. Lines shall be capable of withstanding maximum system pressures. Lines within the engine compartment shall be composed of steel tubing where practicable except in locations where flexible lines are specifically required by the Procuring Agency in attachments to Part 5: Technical Specifications.

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.

5.2.2.4.3 Fuel Lines

This section was written to be in compliance with NFPA-52 for U.S. buses and CAN/CGA-B149.4-M91 for Canadian buses. All tubing shall be a minimum of seamless Type 304 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 securely mounted, braced, and supported every 24 inches, or as designed by the bus manufacturer to minimize vibration, 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 a protected location(s) to prevent line or manifold damage from unsecured objects or road debris.

Fuel hose and hose connections, where permitted, shall be less than 48 inches in length, made from materials resistant to corrosion and action of natural gas, and protected from fretting and high heat.

High pressure CNG lines shall be pressure tested to a minimum of 125% of system working pressure prior to fueling. CNG or Nitrogen shall be used to pressure test the lines/assembly. The bus manufacturer shall have a documented procedure of testing the high pressure line assembly.

5.2.2.4 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 exhaust manifolds and other heat sources, 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° seal.

5.2.2.3 FUEL SYSTEM

Note: The Procuring Agency's CNG fueling and defueling station characteristics relating to the design and construction of the CNG bus fuel system will be provided as detailed in Section 5.6 (Procuring Agency Specifications).

5.2.2.3.1 Fuel Containers - Cylinders

5.2.2.3.1.1 Operating Range

The operating range of the coach, when run on the transit coach duty cycle, shall be at least 350 miles with a gas settled pressure of 3600 psi (US) or 3,000 psi (Canada) at 70°F (21°C).

5.2.2.3.1.2 Fuel Capacity

Shall be sufficient to meet the required Operating Range stated without exceeding the estimated curb weight of this bus configuration/Specification as stated in Section 5.2.1.5.

5.2.2.3.1.3 Design and Construction

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

US applications:
   NFPA 52-Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems
   FMVSS 304
   Any local standard(s) specifically intended for CNG fuel containers

Canadian applications:
   CSA-B51, PART 2
   CSA/CGA-B149.4
   CMVSS 301.2
   Any local standard(s) specifically intended for CNG fuel containers

5.2.2.3.1.4 Installation
Fuel cylinders shall be installed in accordance with ANSI/IAS NGV2 - 1998, Basic Requirements for Compressed Natural Gas Vehicles (NGV) Fuel Containers and NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems Code, 1998 edition Section 303. In the case of a low floor transit bus, the placement of tanks shall be limited to the roof of the vehicle or in the compartment above the engine of the vehicle.

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 road debris or collision.

5.2.2.3.1.5 Labeling

CNG fuel systems shall be labeled in accordance with NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems Code, 1998 edition. (Moved from section 5.4.3.11)

5.2.2.3.1.6 Pressure Relief Devices

PRD’s must be designed, constructed, manufactured, and tested in accordance with ANIS/IAS PRD1 - 1998, Pressure Relief Devices for Natural Gas Vehicle (NGV) Fuel Containers and ANSI/IAS NGV2-1998, 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.

5.2.2.3.1.7 Valves


5.2.2.3.2 Fuel Filler

The fuel filler shall be located 7 to 38 feet behind the centerline of the front door on the curbside of the bus. The filler cap shall be retained to prevent loss and shall be recessed into the body so that spilled fuel will not run onto the outside surface of the bus.

Fuel system shall be capable of being filled (for 350 mile range) from 500 psi to a settled pressure of 3600 psi (US) or 3,000 psi (Canada) in a maximum of five minutes.

The fuel lines forward of the engine bulkhead shall per Section 5.2.2.4.

5.2.2.3.3 CNG Fueling System
The CNG fueling port receptacle shall be an ANSI/AGA NGV1 certified receptacle. The coach shall be capable of being fueled by a nozzle (insert Procuring Agency’s standard fueling nozzle). 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 which disables the engine starting system when the access door is open, to prevent drive-aways. The interlock shall be of the type such that if the sensor fails, the coach will not start.

Fueling site characteristics such as pressure, flow rate, and temperature shall be provided by the Procuring Agency in attachments to Part 5: Technical Specifications.

5.2.2.3.4 CNG De-Fueling System

The CNG de-fueling port shall be an ANSI/AGA NGV1 certified receptacle. The CNG de-fueling port shall be located on the curbside of the coach, in a location that is compatible with the Procuring Agency’s de-fueling station operation. The de-fueling system shall incorporate the following characteristics:

- Dust Cap permanently "tethered" to the de-fueling port
- Device(s) to prevent inadvertent de-fueling. Specifications to be provided by Procuring Agency.
- Location/method of attaching CNG fuel system to earth ground
- Components compatible with Procuring Agency’s de-fueling operation.

5.2.2.4 FINAL DRIVE

The bus shall be driven by a single heavy-duty axle at the rear with a load rating sufficient for the bus loaded to GVWR. Transfer of gear noise to the bus interior shall be minimized. The drive axle shall be designed 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, external hex head. If a planetary gear design is employed, the oil level in the planetary gears shall be easily checked through the plug or sight gauge. The drive shaft shall be guarded to prevent it striking the floor of the coach or the ground in the event of a tube or universal joint failure.

5.2.2.5 EMISSIONS/EXHAUST

5.2.2.5.1 Exhaust Emissions

The engine shall meet all applicable emission standards.

5.2.2.5.2 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. 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 catalyst.

5.3 CHASSIS

5.3.1 SUSPENSION

5.3.1.1 GENERAL REQUIREMENTS

Both 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. Normal replacement items, such as one suspension bushing, shock absorbers, or air spring shall be replaceable by a 3M mechanic in 30 minutes or less. Adjustment points shall be minimized and shall not be subject to a loss of adjustment in service. Necessary adjustments shall be easily accomplished without removing or disconnecting the components.

5.3.1.2 SPRINGS AND SHOCK ABSORBERS

5.3.1.2.1 Travel

The suspension system shall permit a minimum wheel travel of 3 inches jounce-upward travel of a wheel when the bus hits a bump (higher than street surface), and 3 inches 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 ±1/2 inch at any point from the height required in Section 5.1.5.1.3.

5.3.1.2.2 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 3 cycles or less after hitting road perturbations. Shock absorbers shall maintain their effectiveness for at least 50,000 miles of the service life of the bus. Each unit shall be replaceable by a 2M mechanic in less than 15 minutes. The shock absorber bushing shall be made of elastomeric material that will last the life of the shock absorber.
5.3.1.2.3  Lubrication

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 without flexible hose end from a pit or with the bus on a hoist. Each element requiring lubrication shall have its own grease fitting with a relief path. Lubricant specified shall be standard for all elements on the bus serviced by standard fittings. Additional requirements for lubrication if any are contained in Attachments to Part 5: Technical Specifications.

5.3.1.2.4  Kneeling

A kneeling system shall lower the entrance(s) of the bus a minimum of 2.5 inches during loading or unloading operations regardless of load up to GVWR, measured at the longitudinal centerline of the entrance door(s), by the driver using a three position, spring loaded to center switch. Downward direction will lower the bus. Release of switch at anytime will completely stop lowering motion and hold height of the bus at that position. Upward direction of the switch will allow the system to go to floor height without the driver having to hold the switch up.

Brake and Throttle interlock shall prevent movement when the bus is knelled. The kneeling control shall be disabled when the bus is in motion. The bus shall kneel at a maximum rate of 1.25 inches per second at essentially a constant rate. After kneeling, the bus shall rise within 2 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 acceleration shall not exceed 0.2g and the jerk shall not exceed 0.3g/sec.

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, minimum 3" 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.

5.3.1.3  WHEELS AND TIRES

5.3.1.3.1  Wheels

Wheels and rims shall be hub-piloted with θ steel, θ brushed aluminum, θ 1-sided polished aluminum, or θ 2-sided polished aluminum rims (Procuring Agency to check appropriate box) and shall resist rim flange wear. 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.

5.3.1.3.2  Tires
Tires shall be suitable for the conditions of transit service and sustained operation at the maximum speed capability of the bus. Load on any tire at GVWR shall not exceed the tire supplier's rating. The tires shall be provided under a lease agreement between the Procuring Agency and tire supplier or supplied by the Contractor. *(Procuring agency to check appropriate box. Additional details shall be provided by Procuring Agency after award)*

- **Baseline:** Use for low profile 305/70R 22.5 tires
  
  The buses shall be equipped with low profile (305/70R 22.5) tires, Load range H as appropriate for the bus design.

- **Alternative:** Use for low profile 275/70R 22.5 tires
  
  The buses shall be equipped with low profile (275/70R 22.5) tires, Load range H as appropriate for the bus design. The use of low profile (275/70R22.5) tires may cause changes in the approach and departure angles and the ground clearance.

- **Alternative:** Procuring Agency to designate the size

### 5.3.2 STEERING

#### 5.3.2.1 FRONT AXLE

- **Baseline:** Use for solid beam axle and grease-type front bearings and seals.
  
  The front axle shall be solid beam, 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.

- **Alternative:** Use for 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:** Use for 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 lubrication fittings easily accessible from a pit or hoist.
5.3.2.2 STRENGTH

Fatigue life of all steering components shall exceed 1,000,000 miles. No element of the steering system shall sustain a Class I failure when one of the tires hits a curb or strikes a severe road hazard. Inadvertent alternations of steering as a result of striking road hazards are steering failures.

5.3.2.3 TURNING RADIUS

Outside body corner turning radius for a standard configuration 40-foot long bus shall not exceed 44 feet. Alternate: 35-foot long bus shall have a turning radius not to exceed 39 feet.

5.3.2.4 STEERING TURNING EFFORT

The steering wheel shall be removable with a standard or universal puller. The steering column shall have full tilt and telescoping capability allowing the operator to easily adjust the location of the steering wheel.

Hydraulically assisted power steering shall be provided. The steering gear shall be an integral type with flexible lines eliminated or the number and length minimized. With the bus on dry, level, commercial asphalt pavement, and tires inflated to recommended pressure and the front wheels positioned straight ahead, the torque required to turn the steering wheel 10 degrees shall be no less than 5 foot pounds and no more than 10 foot pounds. Steering torque may increase to 70 foot pounds when the wheels are approaching the steering stops, as the relief valve activates. 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. Power steering failure shall not result in loss of steering control. With the bus in operation the steering effort shall not exceed 55 pounds at the steering wheel rim and perceived free play in the steering system shall not materially increase as a result of power assist failure. Gearing shall require no more than seven turns of the steering wheel lock-to-lock.

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

5.3.2.5 STEERING WHEEL - GENERAL

The steering wheel diameter shall be no less than 18” and no more than 20”; the rim diameter shall be 7/8” to 1 1/4” and shaped for firm grip with comfort for long periods of time.

The steering wheel shall be removable with a standard or universal puller. Steering wheel spokes and wheel thickness should be such as to insure that visibility is within the range of a 95-percentile range as described in SAE 1050a, section 4.2.2 and 4.2.3. Placement of steering column must be as far forward as possible, but either in-line or behind the instrument cluster.

5.3.2.6 STEERING WHEEL TILT
The steering wheel shall have a rearward tilt adjustment range of no less than 40 degrees as measured from the horizontal and upright position.

5.3.2.7 STEERING WHEEL TELESCOPIC ADJUSTMENT

Measurement - From the top of the rim of the steering wheel in the horizontal position to the cab floor at the heel point.

The steering wheel shall adjust to maximum height of 5” and a minimum low-end adjustment of 29”.

The following chart is acknowledged as the standard for measurements of thigh clearance, resting elbow height, the slope of the steering wheel, and the height of the wheel, and the relationship of one to another, to assist in determining the appropriate telescopic range.
(Based on Drillis and Contini, 1966)

<table>
<thead>
<tr>
<th></th>
<th>Thigh Clearance</th>
<th>Resting Elbow Height</th>
</tr>
</thead>
<tbody>
<tr>
<td>5 Percentile Female</td>
<td>19.1&quot;</td>
<td>22.1&quot;</td>
</tr>
<tr>
<td>95 Percentile Male</td>
<td>25.6&quot;</td>
<td>30.4&quot;</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Steering Wheel Height (Measured from Bottom Portion Closest to Driver)</th>
<th>Relative to Angle of Slope</th>
</tr>
</thead>
<tbody>
<tr>
<td>At Minimum Telescopic Height Adjustment (29&quot;)</td>
<td>At Maximum Telescopic Height Adjustment (5&quot;)</td>
</tr>
<tr>
<td>Angle of Slope</td>
<td>Height</td>
</tr>
<tr>
<td>0 degrees</td>
<td>29&quot;</td>
</tr>
<tr>
<td>15 degrees</td>
<td>26.2&quot;</td>
</tr>
<tr>
<td>25 degrees</td>
<td>24.6&quot;</td>
</tr>
<tr>
<td>35 degrees</td>
<td>22.5&quot;</td>
</tr>
</tbody>
</table>
5.3.3 BRAKES

5.3.3.1 SERVICE BRAKE

5.3.3.1.2 Actuation

Service brakes shall be controlled and actuated by a compressed air system. Force to activate the brake pedal control shall be an essentially linear function of the bus deceleration rate and shall not exceed 50 pounds at a point 7 inches above the heel point of the pedal to achieve maximum braking. The heel point is the location of the driver’s heel when foot is rested flat on the pedal and the heel is touching the floor or heel pad of the pedal. A microprocessor controlled Automatic Braking System (ABS) shall be provided. The microprocessor 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

| θ Baseline: No Automatic Traction Control required. |
| θ Alternative: Automatic traction control |
| Microprocessor controlled Automatic Traction Control (ATC) shall be provided. |

Actuation of ABS and/or ATC shall override the operation of the brake retarder.

5.3.3.1.3 Friction Material

The entire service brake system, including friction material, shall have a minimum overhaul or replacement life of 30,000 miles with a brake retarder on the design operating profile. Brakes shall be self-adjusting throughout this period. Visible stroke indicators shall be provided to allow service personnel to easily identify when the brakes are not in correct adjustment. 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.

5.3.3.1.4 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 shall not leak or weep lubricant for 100,000 miles when running on the design operating profile.
Baseline: Use for drum brakes.

The bus shall be equipped with brake drums. Brake drums shall allow machining to ¼ inch oversize.

Alternative: Use for disc brakes on front axle.

The bus shall be equipped with brake drums on the rear axle and disc brakes on the front axle. The brake drums shall allow machining to ¼ inch oversize and brake discs shall allow machining the surfaces up to ¼ inch each side to obtain smooth surfaces.

Alternative: Disc brakes front and rear.

The bus shall be equipped with disc brakes on both the front and rear axles and the brake discs shall allow machining the surfaces up to ¼ inch each side to obtain smooth surfaces.

The brake system material and design shall be selected to absorb and dissipate heat quickly so the heat generated during braking operation does not glaze brake linings. The heat generated shall not increase the temperature of tire beads and wheel contact area to more than that allowed by the tire manufacturer.

5.3.3.2 PARKING / EMERGENCY BRAKE

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. An emergency brake release shall be provided to release the brakes in the event of automatic emergency brake application. The parking brake valve button will pop out when air pressure drops below requirements of FMVSS 121. 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 operator releases the emergency brake release valve, the brakes shall engage to hold the bus in place.

5.3.4 PNEUMATIC SYSTEM

5.3.4.1 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 5psi as indicted on the instrument panel mounted air gauges, within 15 minutes from the point of governor cut-off.

Provision shall be made to apply shop air to the bus air systems using a standard tire inflation type valve. A quick disconnect fitting specified in attachments to Part 5: Technical Specifications, 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 through the main engine air cleaner system. The air system shall be protected by a pressure relief valve set at 150psi and shall be equipped with check valve and pressure protection valves to assure partial operation in case of line failures.

5.3.4.2 AIR COMPRESSOR

The engine-driven air compressor shall be sized to charge the air system from 40psi to the governor cutoff pressure in less than 3 minutes while not exceeding the fast idle speed setting of the engine.

5.3.4.3 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 degrees F. 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-foot intervals. Nylon lines may be grouped and shall be supported at 2-foot 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-foot intervals or less.

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

5.3.4.4 AIR RESERVOIRS
All air reservoirs shall meet the requirements of FMVSS Standard 121 and SAE Standard J10 and shall be equipped with clean-out 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 brass drain valves which discharge below floor level with lines routed to eliminate the possibility of water traps and/or freezing in the drain line.

5.3.4.5 AIR SYSTEM DRYER

An air dryer shall prevent accumulation of moisture and oil in the air system. The air dryer system shall include a replaceable desiccant bed, electrically heated drain, and activation device. A 2M/3M mechanic shall replace the desiccant in less than 15 minutes.

- **Baseline:** No requirements for additional oil separator provision.
- **Alternative:** Use for requiring additional oil separator provision.

A provision shall be included to collect/remove oil from the air system to prevent affecting function and/or damaging pneumatic system components.

5.4 BODY

5.4.1 GENERAL

5.4.1.1 DESIGN

The bus shall have a clean, smooth, simple design, primarily derived from bus performance requirements and passenger service criteria established by Part 5: Technical Specifications. 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 interior of 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 on any window of the bus of spray and splash generated by the bus’ wheels on a wet road shall be minimized.

5.4.1.2 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-inch reduction in any interior dimension. Windows
shall remain in place and shall not open under such a load. These requirements must be met without the roof mounted CNG cylinders installed.

The bus shall withstand a 25-mph impact by a 4,000-pound automobile at any point, excluding doorways, along either side of the bus with no more than 3 inches of permanent structural deformation at seated passenger hip height. This impact shall not result in sharp edges or protrusions in the bus interior.

Exterior panels below 35 inches from ground level shall withstand a static load of 2,000 pounds applied perpendicular to the bus by a pad no larger than 5 inches square. This load shall not result in deformation that prevents installation of new exterior panels to restore the original appearance of the bus.

In addition to the above requirements, NFPA-52 and local regulations must be met.

5.4.1.3 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; add-on devices and trim, where necessary, shall be minimized and integrated into the basic design.

| 0 Baseline: No requirement for protection against graffiti/vandalism for body material surfaces. |
| 0 Alternative: Additional requirements for protection against graffiti/vandalism for body material surfaces. Also see Sections 5.4.3 and 5.4.4. |

The body material surfaces shall be protected against graffiti and vandalism. The specific requirements for the treatment of exterior surfaces are defined in Section 5.4.3 and interior surfaces in Section 5.4.4.

5.4.1.4 CORROSION

The bus flooring, sides, roof, understructure, axle suspension components shall resist corrosion or deterioration from atmospheric conditions and road salts for a period of 12 years or 500,000 miles which ever comes first. It shall maintain structural integrity and nearly maintain original appearance throughout its service life, provided that it is maintained by the Procuring Agency in accordance with the procedures specified in the Contractor’s service manual. With the exception of periodically inspecting the visible coatings applied to prevent corrosion and reapplying these coatings in limited spots, the Contractor shall not require the complete reapplication of corrosion compounds over the life of the bus.
Baseline: Use for corrosion resistance requirements for exposed surfaces 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.

Alternative: Use for corrosion resistance requirements for exposed surfaces 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.

Alternative: Use for additional corrosion resistance requirements.

The vehicle shall be constructed using only inherently corrosion-resistant materials and fasteners 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.

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 2-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.

Additional requirements for corrosion protection are contained in attachments to Part 5: Technical Specifications.

5.4.1.5 RESONANCE AND VIBRATION

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

5.4.1.6 FIRE PROTECTION

The passenger and engine compartments shall be separated by a bulkhead(s) that shall, by incorporation of fireproof materials in its construction, be a firewall. The engine compartment shall include areas where the engine and exhaust system are housed including the muffler, if mounted above the horizontal shelf. This firewall 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 90, dated October 20, 1993. Only necessary openings shall be allowed in the firewall, and these shall be fireproofed. Any passageways for the climate control system air shall be separated from the engine compartment by fireproof material. Piping through the bulkhead shall have copper,
brass, or fireproof fittings sealed at the firewall with copper or steel piping on the forward side. Wiring may pass through the bulkhead only if connectors or other means are provided to prevent or retard fire propagation through the firewall. Engine access panels in the firewall shall be fabricated of fireproof material and secured with fireproof fasteners. These panels, their fasteners, and the firewall shall be constructed and reinforced to minimize warping of the panels during a fire that will compromise the integrity of the firewall.

5.4.1.7 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 and service doors. Static conditions shall 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.

5.4.2 STRUCTURE

5.4.2.1 GENERAL

5.4.2.1.1 Design

The structure of the bus as defined in Section 5.1.2 (25), shall be designed to withstand the transit service conditions typical of an urban duty cycle throughout its service life. The Design Operating Profile defined in Section 5.1.2 shall be considered for this purpose.

θ Baseline: No additional requirements for structure.

θ Alternative: Use for additional requirements for durability and corrosion resistance of structure.

The vehicle structural frame shall be designed to operate with no maintenance throughout a minimum 12-years under the Design Operating Profile. The vehicle shall be constructed using only inherently corrosion-resistant materials and fasteners to minimize deterioration. The structure shall not require corrosion-preventive coatings or after-treatments either during construction or through the service life of the vehicle.

5.4.2.1.2 Altoona Testing

Prior to acceptance of first bus, the structure of the bus shall have undergone appropriate structural testing and/or analysis, including FTA required Altoona testing, to ensure adequacy of design for the urban transit service. 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 Procuring Agency. [Reference Section 2.10.2, Bus Testing]

5.4.2.2 TOWING

Towing devices shall be provided on each end of the bus. Towing devices should accommodate flat-bedding or flat-towing. Each towing device shall withstand, without permanent deformation, tension loads up to 1.2 times the curb weight of the bus within 20 degrees of the longitudinal axis of the bus. The rear towing device(s) shall not provide a toehold for unauthorized riders.

<table>
<thead>
<tr>
<th>θ Baseline: Front tow only.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The front towing devices shall allow attachment of adapters for a rigid tow bar and shall permit lifting of bus until the front wheels are clear off the ground in order to position the bus on the towing equipment by the front wheels.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>θ Alternative: Front lift and tow of bus required.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The front towing devices shall allow attachment of adapters for a rigid tow bar and shall permit lifting and towing of the bus, at curb weight, until the front wheels are clear off the ground.</td>
</tr>
</tbody>
</table>

The rear towing devices 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 Procuring Agency. Each towing device shall accommodate a crane hook with a 1-inch throat.

5.4.2.3 JACKING

It shall be possible to safely jack up the bus, at curb weight, with a common 10-ton floor jack with or without special adapter, when a tire or dual set is completely flat and the bus is on a level, hard surface, without crawling under any portion of the bus. Jacking from a single point shall permit raising the bus sufficiently high to remove and reinstall a wheel and tire assembly. Jacking pads located on the axle or suspension near the wheels shall permit easy and safe jacking with the flat tire or dual set on a 6-inch-high run-up block not wider than a single tire. Jacking and changing any one tire shall be completed by a 2M mechanic helper in less than 30 minutes from the time the bus is approached. The bus shall withstand such jacking at any one or any combination of wheel locations without permanent deformation or damage.

Jacking pads shall be painted safety yellow or orange for ease of identification.

5.4.2.4 HOISTING
The bus axles or jacking plates shall accommodate the lifting pads of a 2-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.

5.4.2.5  FLOOR

5.4.2.5.1  Design

The floor shall be essentially a continuous flat plane, except at the wheel housings and platforms. The floor height shall be as specified in Section 5.1.5.1.3, to eliminate steps and facilitate boarding and de-boarding of passengers.

*Baseline: Use for 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 approximately 18 inches above the lower level. An increase slope shall be allowed on the upper level not to exceed 3½° off the horizontal.

*Alternative: Use for 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 5½° off the horizontal.

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 1 inch. Similarly, a molding or cove 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° to allow for drainage.

5.4.2.5.2  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. The use of adhesives to secure the floor to the structure shall be allowed only in combination with the use of bolt or screw fasteners and its effectiveness shall last throughout life of the coach. Tapping plates, if used for the floor fasteners, shall be no less than the same thickness as a standard nut and all floor fasteners shall be secured and protected from corrosion for the service life of the bus. The floor deck shall be reinforced as needed to support passenger loads. At GVWR, the floor shall have an elastic deflection of no more than 0.60 inches from the normal plane. The floor shall withstand the application of 2.5 times gross load weight without permanent detrimental deformation. Floor, with coverings applied, shall withstand a static load of at least 150 pounds applied through the flat end of a ½-inch diameter rod, with 1/32-inch radius, without permanent visible deformation.
5.4.2.5.3 Construction

The floor shall consist of the subfloor and the floor covering (See 5.4.4.5 Floor Covering). The floor, as assembled, including the sealer, attachments and covering shall be waterproof, nonhygroscopic, 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.

If plywood is used, it shall be certified at the time of manufacturing by an industry approved third-party inspection agency such as APA- The Engineered Wood Association (formerly the American Plywood Association). Plywood shall be of a thickness adequate to support the design loads, manufactured with exterior glue, satisfy the requirements of a Group I Western panel as defined in PS 1-95 (Voluntary Product Standard PS 1-95, Construction and Industrial Plywood) and be of a grade that is manufactured with a solid face and back. Plywood shall be installed with the highest-grade veneer up. Plywood shall be pressure-treated with a preservative chemical that prevents decay and damage by insects. Preservative treatments shall utilize no EPA listed hazardous chemicals. The concentration of preservative chemical shall be equal to or greater than required for an above ground level application. Treated plywood will be certified for preservative penetration and retention by a third party inspection agency. Pressure-preservative treated plywood shall have a moisture content at or below fifteen percent. A barrier shall be installed to prevent contact by road salt with the plywood panels.

5.4.2.6 PLATFORMS

5.4.2.6.1 General

Platform height shall not exceed 12 inches. Trim shall be provided along top edges of platforms unless integral nosing is provided. Except where otherwise indicated, covering of platform surfaces and risers shall be same material as specified for floor covering.

- **Baseline:** No trim material specified.
- **Alternative:** Stainless steel trim.

Trim installed along edges of platforms shall be constructed of stainless steel.

Other raised areas such as for providing space for under-floor installation of components shall be limited. Such raised areas shall be constructed in accordance to these specifications.

5.4.2.6.2 Operator’s Platform

The operator's platform shall be of a height that, in a seated position, the operator can see an object located at an elevation of 42" above the road surface, 24" from the leading edge of the bumper. Notwithstanding this requirement, the platform height shall not position the operator such that the operator's vertical upward view is less than 15 degrees (see Standard Bus Procurement Guidelines/Low Floor Specification section 5.4.7.2 -WINDSHIELD) A warning decal or sign shall
be provided to alert operator to the change in floor level. The following schematic diagram illustrates a means by which the platform height can be determined, using the Critical Line of Sight.
5.4.2.6.3 Farebox

If the driver’s platform is higher than 12 inches, then the farebox is to be mounted on platform of suitable height to provide accessibility for operator without compromising passenger’s access.

5.4.2.6.4 Intermediate Platform

If the vehicle is of a bi-level floor design, an intermediate platform shall be provided along the center aisle of the bus to facilitate passenger traffic between the upper and lower floor levels. This intermediate platform shall be cut into the rear platform and shall be approximately the aisle width, 18 inches deep and approximately one half the height of the upper level relative to the lower level. The horizontal surface of this platform shall be covered with yellow Hypalon ribbed rubber or skid-resistant material 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.

5.4.2.7 WHEEL HOUSING

5.4.2.7.1 Design

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. See Section 5.1.2(20).

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 requirements of Section 5.1.5.6, Noise.

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

The exterior finish of the front wheel housings shall be scratch-resistant, meeting requirements of Section 5.4.4.1, Interior Panels and Finishes, 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 12 inches above floor shall be equipped with additional more resistant coating or stainless steel trim.

5.4.2.7.2 Construction

Wheel housings shall be constructed of corrosion-resistant, fire-resistant material. Wheel housings, as installed and trimmed, shall withstand impacts of a 2-inch steel ball with at least 200 foot-pounds of energy without penetration.
5.4.3 EXTERIOR PANELS AND FINISHES

5.4.3.1 PEDESTRIAN SAFETY

Exterior protrusions greater than 1/2 inch and within 80 inches of the ground shall have a radius no less than the amount of the protrusion. The exterior rearview mirrors and required lights and reflectors are exempt from the protrusion requirement. Advertising frames shall protrude no more than 7/8 inch from the body surface and shall have the exposed edges and corners rounded to the extent practicable. Grilles, doors, bumpers and other features on the sides and rear of the bus shall be designed to minimize the ability of unauthorized riders to secure toeholds or handholds.

5.4.3.2 REPAIR AND REPLACEMENT

Exterior panels below the lower daylight opening and within 35 inches above ground level 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).

θ Baseline: No requirement for anti-graffiti/vandalism surface treatments.

θ Alternative: Additional requirements for anti-graffiti/vandalism treatments for exterior surfaces.

Additional requirements for anti-graffiti/vandalism treatments for exterior surfaces are contained in attachments to Part 5: Technical Specifications.

θ Baseline: No requirements for easily replaceable, impact-resistant panels on lower exterior panels.

θ Alternative: Use for requirements for easily replaceable, impact-resistant panels on lower exterior panels.

Lower exterior panels within 28 inches above ground level shall be equipped with removable resilient, impact resistant panels for protection against minor impacts and scratches. The panels shall withstand impacts of 200 foot-pounds of energy from a steel-faced spherical missile no less than 9 inches in diameter without any visible damage to it or underlying panel and structure. The panels shall be no greater than 8 feet in length and shall be easily replaced by a 2M mechanic in less than 10 minutes. The panels shall be color impregnated to complement color and paint scheme as specified in Section 5.4.3.10.

5.4.3.3 RAIN GUTTERS

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

| Baseline: No requirements for rain gutter above passenger side windows. |
| Alternative: Rain gutter above passenger side windows. |

Rain gutter shall also be provided above passenger side windows.

### 5.4.3.4 LICENSE PLATE PROVISIONS

Provisions shall be made to mount standard size U.S. license plates per SAE J686 on the front and rear of the bus. These provisions shall direct mount or recess the license plates so that they can be cleaned by automatic bus washing equipment without being caught by the brushes. License plates shall be mounted at the lower center or lower street side of the bus and shall not allow a toehold or handhold for unauthorized riders.

### 5.4.3.5 RUBRAILS

| Baseline: No requirement for rubrails |
| Alternative: Requirement for rubrails |

Rubrails 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. Rubrails shall have vertical dimensions of no less than 2 inches or 50 mm with the centerline no higher than 35 inches above the ground between the wheelwells. The rubrails shall withstand 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, wider than the rubrail, and with 1/4-inch end radii, with no visible damage to the rubrail, retainer, or supporting structure. The rubrail may be discontinued at doorways and wheelwells. A damaged portion of the rubrail shall be replaceable without requiring removal or replacement of the entire rubrail.

Note: Installation of rubrails may preclude the installation and or size of exterior advertising signs or racks.

### 5.4.3.6 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.
5.4.3.7 SPLASH APRONS

Splash aprons, composed of 1/4-inch-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 4 inches of the road surface at static conditions. Apron widths shall be no less than tire widths, except for the front apron which shall extend across the width of the bus. 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. Other splash aprons shall be installed where necessary to protect bus equipment.

5.4.3.8 SERVICE COMPARTMENTS AND ACCESS DOORS

5.4.3.8.1 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. Doors with top hinges shall have safety props stored behind the door or on the doorframe. All access doors shall be retained in the open position by props or counterbalancing with over-center or gas-filled springs 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.
Baseline: Requirement for locks on access doors. Also see Section 5.4.4.8.

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

Alternative: Use for Procuring Agency defined locks for access doors. Also see Section 5.4.4.8.

Access doors larger in area than 100 square inches shall be equipped with locks. The locks shall be standardized as defined by the Procuring Agency in the attachments to Part 5: Technical Specifications so that only one tool is required to open all major access doors on the bus.

Alternative: Deletion of the requirement for locking access doors. Also see Section 5.4.4.8.

Access doors larger in area than 100 square inches shall be equipped with latches. The latches shall be standardized and shall be openable without the use of a key or tool.

5.4.3.8.2 Battery Compartment

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 in the stowed position.

The battery compartment or enclosure shall be vented and self-draining. It shall be accessible only from outside the bus. All components within the battery compartment, and the compartment itself, shall be protected from damage or corrosion from the electrolyte and gases emitted by the battery, and from snow, slush, salt spray, mud, etc. generated from environmental conditions outside the vehicle. 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 Master Battery Switch accessibility requirements are defined in Section 5.5.3.1.3.

5.4.3.8.3 Service Area Lighting

Lights 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. Sealed lamp assemblies shall be provided in the engine compartment and shall be controlled by a switch located near the rear start controls in the engine compartment. Necessary lights, located in other service compartments, shall be provided with switches on the light fixture or convenient to the light.

5.4.3.9 BUMPERS
5.4.3.9.1 Location

Bumpers shall provide impact protection for the front and rear of the bus with the top of the bumper being 28 + 2 inches above the ground. Bumper height shall be such that when one bus is parked behind another, a portion of the bumper faces will contact each other.

5.4.3.9.2 Front Bumper

No part of the bus, including the bumper, shall be damaged as a result of a 5-mpg impact of the bus at curb weight with a fixed, flat barrier perpendicular to the bus' 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 4,000 pounds parallel to the longitudinal centerline of the bus and 5.5-mpg impacts into the corners at a 30° 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 in Section 5.1.5.1.1 by no more than 7 inches.

5.4.3.9.3 Rear Bumper

No part of the bus, including the bumper, shall be damaged as a result of a 2-mpg 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 feet wide contacting the horizontal centerline of the rear bumper, the bumper shall provide protection at speeds up to 5 mph, over pavement discontinuities up to 1 inch high, and at accelerations up to 2 mph/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 4,000 pounds, at 4 mph parallel to, or up to a 30° 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 be independent of all power systems 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 in Section 5.1.5.1.1 by no more than 7 inches.

5.4.3.9.4 Bumper Material

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

5.4.3.10 FINISH AND COLOR

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 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 dirt and the following other imperfections:

A. Blisters or bubbles appearing in the topcoat film.
B. Chips, scratches, or gouges of the surface finish.
C. Cracks in the paint film.
D. Craters where paint failed to cover due to surface contamination.
E. Overspray.
F. Peeling
G. Runs or sags from excessive flow and failure to adhere uniformly to the surface.
H. Chemical stains and water spots.

To the degree consistent with industry standards for commercial vehicle finishes, painted surfaces shall have gloss and orange peel shall be minimized. 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. Colors and paint schemes shall be in accordance with the attachments to Part 5: Technical Specifications.

 Baseline: Standard exterior paint finish.
 Alternative: Use for maintenance free exterior finish.

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. In general, the exterior surfaces shall be white except as specified in attachments to Part 5: Technical Specifications. Durable, peel-resistant pressure sensitive appliques shall be used for any striping and coloring required.

5.4.3.11 NUMBERING AND SIGNING

Monograms, numbers and other special signing specified by the Procuring Agency 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 sealed with clear, waterproof sealant around all exposed edges if required by the decal supplier. Signs shall be provided in compliance with the ADA requirements defined in 49 CFR Part, Subpart B, 38.27. The exact wording, size, color, and locations for these signs are found with requirements for other special signs in attachments to Part 5: Technical Specifications.
5.4.3.12 EXTERIOR LIGHTING

All exterior lights shall be designed to prevent entry and accumulation of moisture or dust, and each lamp shall be replaceable in less than 5 minutes by a 2M mechanic helper. Commercially available LED (Light Emitting Diode)-type lamps shall be used wherever possible, excluding applications where white lights are used, such as for headlights. Lights mounted on the engine compartment doors shall be protected from the impact shock of door opening and closing. 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. Lights located on the roof and sides (directionals) of the bus shall have protective shields or be of the flush mount type to protect the lens against minor impacts.

Visible and audible warning 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.

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 feet outward from the outboard edge of the door threshold. The lights may be positioned above or below the lower daylight opening of the windows and shall be shielded to protect passengers' eyes from glare.

Turn-signal lights shall be provided on both sides of the bus. Specific number and mounting requirements are defined in attachments to Part 5: Technical Specifications.

5.4.4 INTERIOR PANELS AND FINISHES

5.4.4.1 GENERAL

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

Interior surfaces more than 10 inches below the lower edge of the side windows or windshield shall be shaped so that objects placed on them fall to the floor when the coach is parked on a level surface. The entire interior shall be cleanable with a hose, using a liquid soap attachment. Water and soap should not normally be sprayed directly on the instrument and switch panels.
Baseline: No requirement for anti-graffiti/vandalism surface treatments.

Alternative: Additional requirements for anti-graffiti/vandalism treatments for interior surfaces.

Additional requirements for anti-graffiti/vandalism surface treatments for interior surfaces are contained in attachments to Part 5: Technical Specifications.

5.4.4.2 FRONT END

The entire front end of the bus shall be sealed to prevent debris accumulation behind the dash and to prevent the operator's feet from kicking or fouling wiring and other equipment. The front end shall be free of protrusions that are hazardous to passengers standing or walking in the front of the bus during rapid decelerations. Paneling across the front of the bus and any trim around the operator's compartment shall be formed metal or plastic material. Formed metal dash panels shall be painted and finished to the quality described in Section 5.4.3.10 or may be carpeted or vinyl covered. Plastic dash panels shall be reinforced, as necessary, vandal-resistant, and replaceable. All colored, painted, and plated parts forward of the operator's barrier shall be finished with a dull matte surface to reduce glare. (See Section 5.4.6.1.1)

5.4.4.3 REAR END

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, plastic, or carpeting and trimmed with stainless steel, aluminum, or plastic. Colors, patterns, and materials are defined in attachments to Part 5: Technical Specifications.

5.4.4.4 INTERIOR PANELS

5.4.4.4.1 General

Interior side trim panels and operator's barrier shall be textured stainless steel, anodized aluminum, plastic, melamine-type material, or carpeting. 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. Untrimmed areas shall be painted and finished to the quality described in Section 5.4.3.10. All materials shall comply with the Recommended Fire Safety Practices defined in FTA Docket 90, dated October 20, 1993. Colors, patterns, and materials for the interior trim are defined in attachments to Part 5: Technical Specifications.

5.4.4.4.1.1 Operator's Coat Hanger

A suitable hanger shall be installed in a convenient approved location for the operator's overcoat.
5.4.4.4.1.2 Operator's Drink Holder

- **Baseline:** No Drink holder.
- **Alternative:** Drink holder.

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

5.4.4.4.2 Operator Barrier

A barrier or bulkhead between the operator 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.

- **Baseline:** Standard configuration of operator’s barrier.

The barrier shall extend from below the level of the passenger or operator's seat cushion, whichever is lower, to above the level of the seated operator's head and shall fit the bus side windows and wall to prevent passengers from reaching the operator or the operator’s personal effects.

- **Alternative:** Full-height configuration of operator’s barrier.

Operator's Barrier shall extend continually from floor to ceiling and from the bus wall to first stanchion immediately behind the Operator to provide security to the Operator and limit passenger conversation.

- Location and shape must permit full seat travel possibilities and accommodate the shoulders of a 95th percentile male.
- Partition shall have a side return and stanchion to prevent passenger from standing behind the Operator's seat; lower area between seat and panel must be accessible to the Operator.
- Partition must be strong enough in conjunction with entire partition assembly for mounting of such equipment as flare kits, fire extinguishers (1.2kg), microcomputer, public address amplifier, etc.
- Partition shall start 25mm (1") above floor.
- Dark or black panels preferred
- Panel should be attached with rubber grommets
5.4.4.4.2.1 Operator Storage Box

θ **Baseline: No storage box.**

θ **Alternative: Storage box.**

An enclosed Operator storage area shall be provided with a positive latching door and lock; minimum approximate size: 355 mm x 355 mm x 355 mm (14" x 14" x 14")

5.4.4.4.3 Modesty Panels

Sturdy divider panels constructed of durable, unpainted, corrosion-resistant material complementing the interior trim shall be provided to act as both a physical and visual barrier for seated passengers. Modesty panels shall be located at doorways to protect passengers on adjacent seats, and along front edge of rear upper level. Design and installation of modesty panels located in front of forward facing seats shall include a handhold/grabhandle 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 no higher than the lower daylight opening of the side windows and those forward of transverse seats shall extend downward to a level between 1-1/2 and 1 inches 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 2-1/2-inch clearance between the modesty panel and the opened door to protect passengers from being pinched. Modesty panels installed at doorways shall be equipped with grab rails (see Section 5.4.5.2). The modesty panel and its mounting shall withstand a static force of 250 pounds applied to a four-inch by four-inch area in the center of the panel without permanent visible deformation.

5.4.4.4 Rear Bulkhead

The rear bulkhead paneling shall be contoured to fit the ceiling, side walls, and seat backs so that any litter, such as a cigarette package or newspaper, will tend to fall to the floor or seating surface when the bus is on a level surface. Any air vents in this area shall be louvered to reduce airflow noise and to reduce the probability of trash or litter being thrown or drawn through the grille. If it is necessary to remove the panel to service components located on the rear bulkhead, the panel shall be hinged or shall be able to be removed and replaced by a 3M mechanic in 5 minutes. Grilles where access to or adjustment of equipment is required shall be heavy duty and designed to minimize damage.

5.4.4.5 Headlining

Ceiling panels shall be textured stainless steel, anodized aluminum, melamine-type material, carpeting, or material suitable for exterior skin painted and finished to exterior quality. 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. Colors, patterns, and materials for the headlining are defined in attachments in Part 5: Technical Specifications.

5.4.4.4.6  Fastening

Interior panels shall be attached so that there are no exposed unfinished or rough edges or rough surfaces. Panels and fasteners shall not be easily removable by passengers. Interior trim fasteners, where required, shall be rivets or cross-recessed head screws.

5.4.4.4.7  Insulation

Any insulation material used between the inner and outer panels shall be sealed or self-sealing to minimize 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. All insulation materials shall comply with the Recommended Fire Safety Practices defined in FTA Docket 90, dated October 20, 1993. 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 of Part 5: Technical Specifications. The bus body shall be thoroughly sealed so that the operator or passengers cannot feel drafts during normal operations with the passenger doors closed.

5.4.4.5  FLOOR COVERING

The floor covering shall have a non-skid walking surface that remains effective in all weather conditions and complies with all ADA requirements. 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. The standee line shall be at least 2 inches wide and shall extend across the bus aisle. This line shall be the same color as the outboard edge of the entrance/exit areas. Color/pattern shall be consistent throughout the floor covering. Color and material of the floor covering is defined in attachment to Part 5: Technical Specifications.

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

The floor in the operator's compartment shall be easily cleaned and shall be arranged to minimize debris accumulation.

A one-piece center strip shall extend from the vertical wall of the rear settee between the aisle sides of transverse seats to the standee line. If the floor is of a bi-level construction, then center strip shall be one-piece at each level. The covering between the center strip and the wheel housings may be separate.
pieces. At the rear door, however, a separate strip as wide as the door shall extend from the center strip to the outboard edge of the rear/exit area.

The floor under the seats shall be covered with smooth surface flooring material. The floor covering shall closely fit the sidewall cove or extend to the top of the cove.

5.4.4.6 PASSENGER INTERIOR LIGHTING

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

Step lighting for the intermediate platform between lower and upper floor levels shall be provided and shall illuminate in all engine run positions. The step lighting shall be low-profile to minimize tripping and snagging hazard for passengers and shall be shielded as necessary to protect passengers’ eyes from glare.

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. Fluorescent tubes shall be a maximum 6-foot length, single-pin, T-12 type. (with exception granted for extinguishing or dimming fixtures as noted below)

Lens material shall be clear polycarbonate. Lens shall be designed to effectively "mask" the fluorescent tube. Lens shall be sealed to inhibit incursion of dust and insects yet are easily removable for service. If threaded fasteners are used they must be held captive in the lens. Access panels shall be provided to allow servicing of components located behind light panels. If necessary, the entire light fixture shall be hinged.

Individual ballast units shall be provided for each light fixture. Ballast shall have a fireproof housing, minimum operating frequency of above audible range, reverse polarity protection, integrated circuit breaker/automatic thermal protection, and rebuildable.
Baseline: Use for first light modules dim/extinguish when front door opens.

When the master switch is in the RUN or NITE/RUN mode, the first light module on each side of the coach shall automatically extinguish or dim when the front door is in the closed position and illuminate when the door is opened. This shall be accomplished through use of a ballast specifically designed for this type application without diminishing the life of the fluorescent tubes.

Alternative: Use for no dimming/extinguishing of first light modules when front door opens.

No dimming/extinguishing feature of first light modules is required and shall not be provided.

The light system may be designed to form part or the entire air distribution duct.

Baseline: Farebox light

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

5.4.4.7 FARE COLLECTION

Space, as far forward as practicable, and structural provisions shall be made for installation of currently available fare collection device(s). 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 operator to easily reach the farebox controls and to view the fare register. The fare box shall not restrict access to the operator area, shall not restrict operation of operator controls and shall not, either by itself or in combination with stanchions, transfer mounting, cutting, and punching equipment and route destination signs, restrict operator’s field of view per SAE Recommended Practice J1050 (See Section 5.4.7.2.) Location and mounting of the fare collection device shall allow use, without restriction, by passengers. 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 electric and electronic requirements of the fare box are described in Section 5.5.5.4.3.12.

Transfer mounting, cutting, and punching equipment shall be located in a position convenient to the operator. The fare box, including make, model, size, weight and meter locations and transfer equipment, is defined in attachments to Part 5: Technical Specifications.
5.4.4.8 ACCESS PANELS AND DOORS - INTERIOR
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. Panel fasteners shall be standardized so that only one tool is required to service all special fasteners within the bus.

Baseline: Door actuator access doors that do not require tools or keys to open.

Access doors for the door actuator compartments shall be secured with hand screws or latches, and shall prevent entry of mechanism lubricant into the bus interior. All fasteners that retain access panels shall be captive in the cover.

Alternative: Requirement for locking access doors. Also see Section 5.4.3.8.1

Access doors for the door actuator compartments shall be secured with locks, and shall prevent entry of mechanism lubricant into the bus interior. The locks shall be standardized so that only one tool, as required in Section 5.4.3.8.1, is required to open access doors on the bus. All fasteners that retain access panels shall be captive in the cover.

Access openings in the floor shall be sealed to prevent entry of fumes and water into the bus interior. Flooring material shall be flush with the floor and shall be edge-bound with stainless steel, or other material that is acceptable to the Procuring Agency, 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.

5.4.5 PASSENGER ACCOMMODATIONS

5.4.5.1 PASSENGER SEATING

5.4.5.1.1 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. The Procuring Agency recognizes that ramp location, foot room, hip-to-knee room, doorway type and width, seat construction, floor level type, seat spacing requirements, etc. ultimately affect seating capacity and layout.
Baseline: Forward facing seat configuration

Passenger seats shall be arranged in a transverse, forward facing configuration, except at the wheel housings 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).

Passenger seating capacity with this arrangement shall be no less than 37 not including the operator, with the specified seating arrangement.

Alternative: Perimeter seating arrangement.

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. Longitudinal seating shall meet the requirements in Section 5.4.5.1.3 except that armrest shall be provided between every other seating position at the same location as vertical passenger assists defined in Section 5.4.5.2.6. Each seat shall have a minimum width of 17 inches, not including the armrest.

Seating capacity with this arrangement shall be no less than ___ [Procuring Agency to fill-in] seated passengers, not including the operator, with the specified seating arrangement.

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. Longitudinal seating shall meet the requirements in Section 5.4.5.1.3 except that armrest shall be provided between every other seating position at the same location as vertical passenger assists defined in Section 5.4.5.2.6. Each seat shall have a minimum width of 17 inches, not including the armrest.

Seating capacity with this arrangement shall be no less than ___ [Procuring Agency to fill-in] seated passengers, not including the operator, with the specified seating arrangement.

Note: This minimum capacity may be reduced when accommodations for more than two wheelchairs are required in Section 5.4.5.4
<table>
<thead>
<tr>
<th>Baseline</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>No bid evaluation factor for maximized seating capacity.</td>
<td>Use for inclusion of bid evaluation factor for maximized seating capacity.</td>
</tr>
</tbody>
</table>

A bid evaluation factor for maximized seating capacity is included in attachments to Part 5: Technical Specifications.

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rearward facing seats not allowed.</td>
<td>Allow minimum rearward facing seats</td>
</tr>
</tbody>
</table>

A limited number of rearward facing seats will be allowed, with the expressed approval of theProcuring Agency. *Note that hip-to-knee and foot room requirements may also need to be addressed for this.*

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-padded inserts</td>
<td>Padded inserts</td>
</tr>
</tbody>
</table>

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

<table>
<thead>
<tr>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Padded inserts</td>
</tr>
</tbody>
</table>

The passenger seats shall be equipped with vandal-resistant padded inserts throughout the bus. Note that all applicable seat dimensions specified below shall be measured with pad fully depressed.

<table>
<thead>
<tr>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fully cushioned seats</td>
</tr>
</tbody>
</table>

The passenger seats shall be fully cushioned throughout the bus. Note that all applicable seat dimensions specified below shall be measured with cushion fully depressed.

<table>
<thead>
<tr>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>Combination padded and non-padded inserts</td>
</tr>
</tbody>
</table>

The passenger seats in the front section shall be equipped with padded inserts and those in the rear (aft of the rear/exit door) shall be equipped with non-padded inserts. Note that all applicable seat dimensions specified below shall be measured with pad fully depressed.

<table>
<thead>
<tr>
<th>Baseline</th>
<th>Alternative</th>
</tr>
</thead>
<tbody>
<tr>
<td>No requirements for drain hole/provision in seat inserts.</td>
<td>Requirement for drain hole/provision in seat inserts</td>
</tr>
</tbody>
</table>

Provision, such as a small grommeted hole, to allow drainage shall be incorporated into seat insert.
Baseline: Hip-to-knee room.

Hip-to-knee room measured from the front of one seat back horizontally across the highest part of the seat to the seat or panel immediately in front, shall be no less than 26 inches. At all seating positions in paired transverse seats immediately behind other seating positions hip-to-knee room shall be no less than 26.5 inches.

Alternative: Increased hip-to-knee room.

Hip-to-knee room measured from the front of one seat back horizontally across the highest part of the seat to the seat or panel immediately in front, shall be no less than 28 inches. At all seating positions in paired transverse seats immediately behind other seating positions hip-to-knee room shall be no less than 28 inches.

Alternative: Allow variations in limited areas

In order to maximize seating capacity without unduly affecting passenger comfort, minor variations in the required hip-to-knee room will be allowed in limited areas. All such areas shall be identified to the Procuring Agency prior to bid for approval.

Baseline: 14 inch foot room

Foot room, measured at the floor forward from a point vertically below the front of the seat cushion, shall be no less than 14 inches. Seats immediately behind the wheel housings and modesty panels may have foot room reduced, provided the wheelhouse is shaped so that it may be used as a footrest or the design of modesty panel effectively allows for footroom.

Alternative: Reduced 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 10 inches. Seats immediately behind the wheel housings and modesty panels may have foot room reduced, provided the wheelhouse panel is shaped so that it may be used as a footrest or design of modesty panel effectively allows for footroom.

Alternative: Hip-to-knee and foot room for rearward facing seats

At seating positions with rearward facing seats, the distance as measured from the front edge of the rearward facing seat to the front edge of the immediately opposite forward facing seat shall be no less than 24 inches.

Thickness of the transverse seat backs shall be minimized at the bottom to increase passenger knee room and passenger capacity. The area between the longitudinal seat backs and the attachment to the bus sidewalls shall be designed to prevent debris accumulation.
The aisle between the seats shall be no less than 20 inches wide at seated passenger hip height. Seat backs shall be shaped to increase this dimension to no less than 24 inches at standing passenger hip height.

Raised platforms for passenger seats shall not be allowed without Procuring Agency’s approval. If vehicle is of a sloped floor design, then raised platforms for passenger seats may be provided in the rear sloped section.

All bidder(s) shall submit in accordance to requirements of Section 1.1.2.2, Offeror Communications and Requests, a copy of his proposed seat layout consistent with these specifications showing hip-to-knee and footroom dimensions, stanchion layout and wheelchair maneuverability layout prior to bid for Procuring Agency review and approval. The bidders shall also indicate on this layout the Free Floor Space available to standees as defined in Section 5.1.2 and include the calculation of the Free Floor Space area.

5.4.5.1.2 Dimensions

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

The width, \( W \), of the seat shall be 35 inches.

The length, \( L \), shall be \( 17 \pm 1 \) inches.
The seat back height, B, shall be a minimum of 15 inches.

The seat height, H, shall be $17 \pm 1$ inches. 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 $18 \pm 2$ inches will be allowed. This shall also be allowed for limited transverse seats, but only with expressed approval of the Procuring Agency.

The foot room, F, shall be specified in 5.4.5.1.1

The seat cushion slope, S, shall be between 5° to 11°.

The seat back slope, C, shall be between 8° to 17°.

The hip to knee room, K, shall be as specified in 5.4.5.1.1.

The pitch, P, is shown as reference only.

### 5.4.5.1.3 Structure and Design

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

The transverse seat structure shall be fully cantilevered from the sidewall with sufficient strength for the intended service. The lowest part of the seat assembly that is within 12 inches of the aisle shall be at least 10 inches above the floor. Folding seats used in wheelchair securement areas, as well as, transverse seats mounted in locations at which cantilevered installation is precluded by design and/or structure, need not be cantilevered.

#### Alternative: Allow use of Pedestal-mounted seats.

In order to reduce cost and/or maximize seating capacity, the Procuring Agency will allow pedestal mounted transverse seats. For these type seats, the structure shall be attached to the sidewall and supported by a pedestal attached to the floor. The lowest part of the seat assembly that is within 12 inches of the aisle, excluding the pedestal, shall be at least 10 inches above the floor.

The underside of the seat and the sidewall shall be configured to prevent debris accumulation and the transition from the seat underside to the bus sidewall to the floor cove radius shall be smooth. 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 1,000 pounds onto the femur of passengers ranging in size from a 5-th-percentile female to a 95-th-percentile male during a 10g deceleration of the bus. This deceleration shall peak at $.05 \pm .015$ seconds from initiation. Permanent deformation of the seat resulting from two 95-th-percentile males striking the seat back during this 10g deceleration shall not exceed 2 inches, measured at the aisle side of the seat frame at height H. Seat back should not
deflect more than 14 inches, measured at the top of the seat back, in a controlled manner to minimize passenger injury. Structural failure of any part of the seat or sidewall shall not introduce a laceration hazard.

The seat assembly shall withstand static vertical forces of 500 pounds applied to the top of the seat cushion in each seating position with less than 1/4-inch permanent deformation in the seat or its mountings. The seat assembly shall withstand static horizontal forces of 500 pounds evenly distributed along the top of the seat back with less than 1/4-inch permanent deformation in the seat or its mountings. The seat backs at the aisle position and at the window position shall withstand repeated impacts of two 40-pound sandbags without visible deterioration. One sandbag shall strike the front 40,000 times and the other sandbag shall strike the rear 40,000 times. Each sandbag shall be suspended on a 36-inch pendulum and shall strike the seat back 10,000 times each from distances of 6, 8, 10, and 12 inches. Seats at both seating positions shall withstand 4,000 vertical drops of a 40-pound sandbag without visible deterioration. The sandbag shall be dropped 1,000 times each from heights of 6, 8, 10, and 12 inches. Seat cushions shall withstand 100,000 randomly positioned 3-1/2-inch drops of a squirming, 150-pound, smooth-surfaced, buttocks-shape 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 7/8 inch in diameter for standees and seat access/egress. The handhold shall not be a safety hazard during severe decelerations. The handhold shall extend above the seat back near the aisle so that standees shall have a convenient vertical assist, no less than 4 inches long that may be grasped with the full hand. This handhold shall not cause a standee using this assist to interfere with a seated 50th-percentile male passenger. The handhold shall also be usable by a 5th-percentile female, as well as by larger passengers, to assist with seat access/egress for either transverse seating position. The upper rear portion of the seat back and the seat back handhold immediately forward of transverse seats shall be padded and/or constructed of energy absorbing materials. During a 10g deceleration of the bus, the HIC number (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 vertical assist is provided in accordance with Section 5.4.5.2. Armrests shall not be included in the design of transverse seats.

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 operator's barrier, or a modesty panel and 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 1-1/2 to 3-1/2 inches of the end of the seat cushion. Armrests shall be located from 7 to 9 inches above the seat cushion surface. The area between the armrest and the seat cushion shall be closed by a barrier or panel. The top and sides of the armrests shall have a minimum width of 1 inch and shall be free from sharp protrusions that form a safety hazard.

Seat back handhold and armrests shall withstand static horizontal and vertical forces of 250 pounds applied anywhere along their length with less than 1/4-inch permanent deformation. Seat back handhold and armrests shall withstand 25,000 impacts in each direction of a horizontal force of 125 pounds with less than 1/4-inch permanent deformation and without visible deterioration.
At the Procuring Agency’s request, a test report shall be provided by the Contractor, fully documenting compliance with all the requirements defined above upon request. The test report shall contain a record of all testing activities, test diagrams, testing equipment, as well as test data related to loads, deflections and permanent deformation of the seat assembly. The report shall include a statement of compliance with the requirements of this section of Part 5: Technical Specifications.

5.4.5.1.4 Construction and Materials

Seat shall be constructed with materials that comply with the physical test. Selected materials shall minimize damage from vandalism and shall reduce cleaning time. The seats shall be attached to the frame with tamperproof fasteners. Coloring shall be consistent throughout the seat material, with no visually exposed portion painted. All visually exposed metal of the standard seat structure including mounting brackets and other components shall be aluminum or 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.


**Baseline: Non-padded seat configuration**

The seat back thickness shall not exceed 1/2 inch in the knee room area.

**Alternative: Padded seat configuration. Also see Section 5.4.5.1.1.**

Seating and interior trim shall have features to improve passenger comfort. The seat cushion and back shall be padded with a cellular foam product that complies with the physical test requirements cited in this document and is no less than 1/2-inch 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 employing a special tool so that they are easily removable by the maintenance staff but not by the 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. Also see Section 5.4.5.1.1.**

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 that complies with the physical test requirements cited in this document and is no less than 2 inches thick in areas contacted and loaded by passengers in the normal seated position and shall be upholstered with vinyl and/or fabric materials.

Armrests shall be padded with material that is the same as, or similar to, the seat back padding and handhold. Seats, back cushions and other pads shall be securely attached and shall be detachable by means of a simple release mechanism employing a special tool 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.

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 1/4-inch. Seat covering materials shall be selected on the basis of durability, ease of maintenance, and pleasing texture and appearance. 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 in accordance with the Knee Impact and Head Impact Criteria requirements of Section 5.4.5.1.3. Complete seat assemblies shall be interchangeable to the extent practicable. Additional construction details, color of the seat material and optional safety padding are defined in attachments to Part 5: Technical Specifications.

**5.4.5.2 PASSENGER ASSISTS**
5.4.5.2.1 **General**

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 (see Section 5.4.5.1.3) 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 stanchions at front doorway, around farebox, and at interior steps for bi-level designs shall be powder-coated in high contrast yellow color. The forward-most vertical stanchions on either side of the aisle immediately behind the operator's area, shall be

| powder-coated black | powder-coated yellow | plain stainless steel finish |

Excluding those mounted on the seats and doors, the assists shall have a cross-sectional diameter between 1-1/4 and 1-1/2 inches or shall provide an equivalent gripping surface with no corner radii less than 1/4 inch. All passenger assists shall permit a full hand grip with no less than 1-1/2 inches of knuckle clearance around the assist. Passenger assists shall be designed to minimize catching or snagging of clothes or personal items and shall be capable of passing the NHTSA Drawstring Test.

Any joints in the assist structure shall be underneath supporting brackets and securely clamped to prevent passengers from moving or twisting the assists. Passenger assists shall be designed to minimize glare in the Operator’s area to the extent possible (see Section 5.4.6.1.1). With the exception of seat and door handholds, all areas of the passenger assists that are handled by passengers including functional components used as passenger assists shall be of anodized aluminum or stainless steel. Seat handholds may be of the same construction and finish as the seat frame. Door mounted passenger assists shall be of anodized aluminum, stainless steel, or powder coated metal. Connecting tees and angles may be powder coated metal castings. Assists shall withstand a force of 300 pounds applied over a 12-inch lineal dimension in any direction normal to the assist without permanent visible deformation. All passenger assist components, including brackets, clamps, screw heads, and other fasteners used on the passenger assists shall be designed to eliminate pinching, snagging and cutting hazards and shall be free from burrs or rough edges.

5.4.5.2.2 **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 inches from the outside edge of the entrance step and shall be easily grasped by a 5th-percentile female boarding from street level. Door assists shall be functionally continuous with the horizontal front passenger assist and the vertical assist and the assists on the wheel housing or on the front modesty panel.

5.4.5.2.3 **Vestibule**

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

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

5.4.5.2.4 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 no less than 3/4 inch in width and shall provide at least 1-1/2 inches of knuckle clearance between the assists and their mounting. The assists shall be designed to permit a 5th-percentile female to easily move from one assist to another during the entire exiting process. The assists shall be located no farther inboard than 6 inches from the outside edge of the rear doorway.

5.4.5.2.5 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 convenient to standees anywhere in the bus and shall be located over the center of the aisle seating position of the transverse seats. The assist shall be no less than 70 inches above the floor.

Baseline: No requirements for overhead grab straps/extensions.

Alternative: Requirement for overhead grab straps/extensions. Straps or other extensions as necessary shall be provided for sections where vertical assists are not available and for the use by passengers that can not reach to 70 inches. Procuring Agency shall provide details of type and locations at which such extensions are to be located.

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

5.4.5.2.6 Longitudinal Seats

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

5.4.5.2.7 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.

5.4.5.3 PASSENGER DOORS

5.4.5.3.1 General

Two doorways shall be provided in the curbside of the bus for passenger ingress and egress. The front doorway shall be forward of the front wheels and located so that the operator will be able to collect or monitor the collection of fares. Passenger doors and doorways shall comply with ADA requirements.

- **Baseline:** Use for standard location of rear door.

  The rear doorway centerline shall be rearward of the point midway between the front door centerline and the rearmost seat back.

- **Alternative:** Use for rear door located behind the rear axle.

  The rear doorway shall be located behind the rear axle. A stepwell shall be provided as required.

- **Baseline:** No specific requirements for allowable door styles.

- **Alternative:** Use for specifying allowable door styles.

  The door style for the front door shall be one slide glide or double (2 piece) pantograph.

  The door style for the rear door shall be one slide glide or double (2 piece) pantograph or outward opening (flip) or one single (one piece) pantograph.

  *(Procuring Agency to check appropriate box)*

  *Note: If Procuring Agency requires a minimum rear door clear width of 31.75 inches or greater (see Section 5.4.5.3.3 below), then the Agency CANNOT specify an outward opening door style.*

5.4.5.3.2 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. The doors, when fully opened, shall provide a firm support and shall not be damaged if used as an assist by passengers during ingress or egress. The front leaves of the passenger doors shall overlap the rear leaves.

5.4.5.3.3 Dimensions

[Diagram showing dimensions of a door opening]

TRANSIT BUS MINIMUM DOOR OPENING
Baseline: Use with 31.75-inch doorway clear width.

Front door clear width shall be no less than 31.75 inches with the doors fully opened.

Rear door opening clear width shall be no less than 24 inches with the doors fully opened. If a rear door ramp is provided, then the clear door opening width shall be no less than 31.75 inches with door fully opened.

Alternative: Use for doorway clear width greater than 31.75 inches. Also see Sections 5.1.5.3 and 5.4.5.1.1

The front door clear width shall be no less than _______ inches with the doors fully opened.
(Procuring Agency insert dimension)

The rear door clear width shall be no less than _______ inches with the doors fully opened.
(Procuring Agency insert dimension)

Note: Either or both doorways may be specified to have a clear width greater than 31.75 inches. The Procuring Agency should note that increased doorway width might result in a reduction of seating capacity.

When open, the doors shall leave an opening no less than 76 inches in height.

5.4.5.3.4 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.

The front door panel glazing material shall have a nominal ¼ inch or 6 mm thick laminated safety glass conforming with the requirements of ANSI Z26.1 Test Grouping 2 and the Recommended Practices defined in SAE J673.

Glazing material in the rear doorway door panels shall be the same material, thickness and color as the side windows defined in Section 5.4.7.4.2.

5.4.5.3.5 Door Projection

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 inches during the opening or closing cycles or when doors are fully opened. Projection inside the bus shall not exceed 21 inches. The closing edge of each door panel shall have no less than 2 inches of soft weather stripping. The doors, when closed, shall be effectively sealed and the hard surfaces of the doors shall be at least 4 inches apart. The combined weather seal and window glazing elements of the front door shall not
require exceed 10 degrees of binocular obstruction of the operator's view through the closed door. Requirements for sensitive door edges are defined in Section 5.4.5.3.7.

5.4.5.3.6 Door Height Above Pavement

It shall be possible to open and close either passenger door when the bus loaded to GVWR is not knelt and parked with the tires touching an 8-inch-high curb on a street sloping toward the curb so that the street side wheels are 5 inches higher than the right side wheels.

5.4.5.3.7 Closing Force

Closing door edge speed shall not exceed 19 inches per second. Power close rear doors shall be equipped with a sensitive edge or other obstruction sensing system such that if an obstruction is struck by a closing door edge, the doors will stop and/or reverse direction prior to imparting a 10-pound force on 1 square inch of that obstruction. Doors closed by return spring or counterweight-type device need not be equipped with an obstruction sensing device but shall be capable of being pushed to the point where the door starts to open with a force not to exceed 20 pounds applied to the center edge of the forward door panel. Whether or not the obstruction sensing system is present or functional it shall be possible to withdraw a 1-1/2 inch diameter cylinder from between the center edges of a closed and locked door with an outward force not greater than 35 pounds.

5.4.5.3.8 Actuators

Door actuators shall be adjustable so that the door opening and closing speeds can be independently adjustable to satisfy the requirements of Section 5.4.6.1.4. 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 air system and to muffle sound.

5.4.5.3.9 Emergency Operation

In the event of an emergency, it shall be possible to open the doors manually from inside the bus using a force of no more than 25 pounds after actuating an unlocking device at each door. The unlocking devices 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 entrance and exit areas. When the rear door emergency device is actuated, the door interlock throttle system shall return the engine to idle and the door interlock brake system shall apply to stop the bus. When the front door emergency device is actuated only the door interlock throttle system shall be actuated. Locked doors shall require a force of more than 100 pounds 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, engines, and complex mechanism.
5.4.5.4 Accessibility Provisions

5.4.5.4.1 General

The design and construction of the bus shall be in accordance with all requirements defined in 49 CFR, Part 38, Subpart B: ADA Accessibility Specifications for Transportation Vehicles - Buses, Vans and Systems. Space and body structural provisions shall be provided at the front or rear door of the bus to accommodate the wheelchair loading system. Specific requirements, including the number of wheelchairs to be accommodated, the tiedown and securement devices, and fold-down seats, are provided in attachments to Part 5: Technical Specifications. Prior to submission of bid, the Contractor shall provide a plan, including layout drawings for entry, maneuvering, parking, and exiting of wheelchair passengers, to show compliance with ADA regulations.

5.4.5.4.2 Loading System

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

<table>
<thead>
<tr>
<th>Baseline: Front door location of loading system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The wheelchair loading system shall be located at the front door.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative: Rear door location of loading system.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The wheelchair loading system shall be located at the rear door.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Baseline: Flip-out design ramp</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ramp shall be of a simple hinged, flip-out type design.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative: Telescoping design ramp</th>
</tr>
</thead>
<tbody>
<tr>
<td>The ramp shall be of a telescoping type design.</td>
</tr>
</tbody>
</table>

*Note: Telescoping ramp may reduce ground clearances and/or angle of approach.*

When the system is not in use, the passageway shall appear normal. In the stored position of the ramp, no tripping hazards shall be presented 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 operator. If the loading system and controls are at the rear doors, a switch shall be provided in the operator'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 wheelchair loading system shall not present a hazard, nor inconvenience any passenger. The loading system shall be inhibited from retracting or folding 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 5,000 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 20 lbs. of force. Hydraulic systems incorporated in the loading system mechanism shall comply with the requirements defined in Section 5.2.2.2.3 of Part 5: Technical Specifications. The ramp assembly components shall be replaceable within 30 minutes by 3M mechanic.

5.4.5.4.3 Wheelchair Accommodations

<table>
<thead>
<tr>
<th>θ Baseline: Two forward facing wheelchair securement locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>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.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>θ Alternative: Greater number of wheelchair securement locations</th>
</tr>
</thead>
<tbody>
<tr>
<td>_____ [Procurement Agency to fill-in quantity] forward-facing location(s), 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.</td>
</tr>
</tbody>
</table>

Additional equipment, including passenger restraint seat belts, shoulder harnesses and wheelchair securement devices shall be provided for each wheelchair passenger. All belt assemblies must stow up and out of the way when not in use.

5.4.5.4.4 Interior Circulation

Maneuvering room inside the bus shall accommodate easy travel for a passenger in a wheelchair from the loading device through the bus to the designated parking area, and back out. No portion of the wheelchair or its occupant shall protrude into the normal aisle of the bus when parked in the designated parking space(s). As a guide, no width dimension should be less than 34 inches. Areas requiring 90-degree turns of wheelchairs should have a clearance arc dimension no less than 45 inches and in the parking area where 180-degree turns are expected, space should be clear in a full 60-inch-diameter circle. A vertical clearance of 12 inches above the floor surface should be provided on the outside of turning areas for wheelchair footrest.
5.4.5.4.5 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 as required in Section 5.4.9.5 of Part 5: Technical Specifications.

Requirements for a stop-request passenger signal in accordance with 49 CFR, Part 38.37 shall be provided as required in Section 5.4.9.3 of Part 5: Technical Specifications.

Requirements for exterior destination signs in accordance with 49 CFR, Part 38.39 shall be provided as required in Section 5.4.9.1 of Part 5: Technical Specifications.

5.4.6 OPERATOR PROVISIONS

5.4.6.1 OPERATOR’S AREA

5.4.6.1.1 General

The operator’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 operator’s area shall be avoided. Such objects include dash panels, switches and controls, cowlings, windshield wipers and arms, barriers and modesty panels, fare stanchions, access panels and doors, fasteners, flooring, ventilation and heating ducting, window and door frames, and visors. Interior lighting located ahead of the standee line shall be controlled by the operator. Additional provisions for operator’s area are included in attachments to Part 5: Technical Specifications.
5.4.6.1.2 Visors

θ Baseline: Requirements for sun visors.

Adjustable sun visor(s) shall be provided for the operator's windshield and the operator's side window. [Procuring Agency to choose one or both] 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 operator's field of view at angles more than 5 degrees above the horizontal.

θ Alternative: Use for operator's window sunscreens.

An adjustable roller type sunscreen shall be provided over the operator's windshield and/or the operator's side window. [Procuring Agency to choose one or both] The sunscreen shall be capable of being lowered to the midpoint of the operator's window. When deployed, the screen shall be secure, stable and shall not rattle, sway or intrude into the operator'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 operator.

5.4.6.1.3 Operator's Controls

All switches and controls necessary for the safe operation of the bus shall be conveniently located in the operator's area and shall provide for ease of operation. 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. Operational controls, instrumentation, switches, and other system controls shall not be mixed with ventilation diffusers and non-operational controls or readouts. Controls shall be located so that boarding passengers may not easily tamper with control settings.

The door control, kneel control, windshield wiper/washer controls, and run switch shall be in the most convenient operator locations. They shall be identifiable by shape, touch, and permanent markings. Doors shall be operated by a single control, conveniently located and operable in a horizontal plane by the operator's left hand. The setting of this control shall be easily determined by position and touch.

All panel-mounted switches and controls shall be marked with easily read identifiers. Text designating position (on/off) shall be a minimum of 9 points, identifying legends shall be a minimum of 11 points. Extremely condensed or italic type fonts shall not be used. Graphical 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. Red type on a black or gray field (or vice versa) shall not be used. Mechanical switches and controls shall be replaceable, and the wiring at these controls shall be serviceable from the vestibule or the operator's seat. Switches, controls, and instruments shall be dust and water resistant consistent with the bus washing practice described in Section 5.4.4.1.

5.4.6.1.3.1 Normal Bus Operation

Operator Controls - The following list for Normal Bus Operation identifies bus controls used to operate the bus safely and efficiently. These controls are frequently used or they are critical to the operation of the bus. They should be located within easy reach of the operator. The operator should not be required to stand or turn his/her body to view or to actuate these controls that include:

- Engine Start Switch or Button
- Transmission Shift Select
- Door
- Turn Signals
- Defroster
- Windshield Wiper
- Four Position Master Run Switch
- Parking Brake
- High Beam
- Hazard Lights
- Kneel Ramp Control
- Instrument Panel Lighting Intensity

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

5.4.6.1.3.1.1 Master Run Switch

The run switch shall be a four-position rotary switch with the following functions:

<table>
<thead>
<tr>
<th>Position</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>OFF</td>
<td>All electrical systems off, except power available for the passenger interior lighting, stoplights, turn lights, hazard lights, radio, silent alarm, horn, fare box, fire detection equipment, engine compartment lights, auxiliary heater, if provided and electronic equipment that require continuous energizing. If the bus is not operated for a period of 3 days, the total electric load due to devices that require continuous energizing shall not cause the battery to be discharged below the level necessary to start the engine. Electrical loads resulting from the Procurement Agency’s devices, such as, fare box, GPS, radio, etc., shall not exceed 1.5 amps with the master run switch in the OFF position.</td>
</tr>
<tr>
<td>CL/ID</td>
<td>All electrical systems off, except those listed in OFF and power to destination signs, interior lights and marker lights.</td>
</tr>
<tr>
<td>RUN</td>
<td>All electrical systems and engine on, except the headlights, parking lights and marker lights. Daytime running lights (DRL), if provided, shall be on.</td>
</tr>
<tr>
<td>NITE/RUN</td>
<td>All electrical systems and engine on.</td>
</tr>
</tbody>
</table>
5.4.6.1.3.1.2 Door Control

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 of Section 5.4.5.3.7 and the adjustment requirements of Section 5.4.5.3.8. The door control shall be located on the street side of the operator’s area within the hand reach envelope described in SAE Recommended Practice, J287, Driver Hand Control Reach. The front door shall remain in commanded state position even if power is removed or lost.

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

<table>
<thead>
<tr>
<th>Baseline: Use for operator-controlled front and rear doors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of, and power to, the passenger doors shall be completely controlled by the operator.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Alternative: Use for operator-controlled front and passenger-controlled rear doors.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Operation of, and power to, the front passenger doors shall be completely controlled by the operator. Power to rear doors shall be controlled by operator. The opening of rear doors shall be controlled by passenger via touch-bars. An alarm shall sound whenever the rear door is opened or attempted to be opened when rear doors are not powered. Doors shall automatically close when touch-bars are released.</td>
</tr>
</tbody>
</table>

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

5.4.6.1.3.1.3 Operator Interior Lights

The operator's area shall have a light to provide general illumination and it shall illuminate the half of the steering wheel nearest the operator to a level of 10 to 15 foot-candles. This light shall be operator controlled by a toggle switch located on the operator's control panel or other approved location.

(1) A three-position toggle switch, labeled "Interior Lights; On (at top), Off, Normal" shall control the lights.
   - "On" turns on all lights in any Master Switch position
   - "Off" turns off lights except as noted in (2) and (3)
   - "Normal" turns on all lights in "Night Run" and "Night Park" except as noted in (2).

(2) The first light on each side (behind the Operator 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. (If non-extinguishing light modules are in effect as per Section 5.4.4.6, this requirement shall not apply.)

(3) 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.)

(4) All interior lighting shall be turned off whenever the transmission selector is in the reverse and engine run switch is in the "On" position. The interior lighting design shall require the approval of the Procuring Agency.

5.4.6.1.3.2 Special Controls

Operator Controls - The following list of Special bus controls identifies the controls to initiate system diagnostics, aid the physically handicapped passenger, and control mirrors and speakers, etc. They are less often used than those in Normal Bus Operation. These controls should be within easy reach for viewing and actuation by the operator:

- ABS Diagnostics Test
- Stop Engine Override
- Drivers Fan
- Mirror Heater (Opt.)
- Drivers HVAC
- Fire Suppression (Opt.)
- Hill Holder
- Retarder
- Heater Blower Interlock

- Engine Diagnostic Test
- Chime
- Fast Idle
- Public Address System
- Diagnostic Light Panel Test
- Destination Sign On/Off (Opt.)
- Remote Mirror Control (Opt.)
- Kneel/Ramp Control

5.4.6.1.3.3 Passenger Comfort Controls

Operator Controls - The following list of Passenger Comfort Controls identifies the bus controls for the interior bus temperature, lighting, air circulation, etc. The settings of these controls are changed infrequently. The operator should be able to see and actuate these controls with minimal effort.

- Climate Control
- Interior HVAC
- Interior Lights
- Aisle Lights

- Temperature Select
- Blower
- Dome Lights

5.4.6.1.3.4 Controls Location

Figure 1 below is provided as an illustrative guide to instrument and control grouping:
Area 1: Operational gauges - speedometer, air pressure (primary and secondary), voltmeter(s), fuel and diagnostics shall be located immediately in front of the operator's field of view.

Area 2: Operational controls and switches, including but not limited to emergency controls and flashers, transmission controls, and lighting switches, located adjacent the left side of the instruments.

Area 3: Operational controls and switches, including but not limited to washer controls, kneel and ramp switches, operator's climate controls, located adjacent the right side of the instruments.

Area 4: Secondary operating controls including door, mirror and engine controls, located to the left of the operator ahead of the Seat Reference Point (SRP) of the 5 percentile female.

Area 5: System function controls, including destination sign keypad, cabin climate controls, fire suppression, located on the operator's centerline, above the operator's upper sight cutoff line.
5.4.6.1.4 **Operator Foot Controls**

5.4.6.1.4.1 Accelerator

5.4.6.1.4.1.1 Accelerator Pedal Angle

The angle of the accelerator pedal shall be determined from a horizontal plane regardless of the slope of the cab floor.

The accelerator pedal shall be positioned at an angle of 27-35 degrees at the point of initiation of contact, and extend downward to an angle of 10-18 degrees at full throttle.

5.4.6.1.4.1.2 Accelerator Pedal Dimensions

The floor mounted accelerator pedal shall be 10" - 12" long and 3" - 4" wide.

5.4.6.1.4.1.3 Accelerator Pedal Force

The force to depress the accelerator pedal shall be measured at the midpoint of the accelerator. The accelerator force shall be no less than 7 foot pounds and no more than 9 foot pounds.

5.4.6.1.4.1.4 Accelerator Interlock

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 when the rear door control is activated. The braking effort shall be adjustable with hand tools. Rear doors shall not open until bus speed is below 2 m.p.h.

| Baseline: No requirements for accelerator interlock whenever front doors are open. |
| Alternative: Use for requiring accelerator interlock whenever front doors are open. |
| An accelerator interlock shall lock the accelerator in the closed position whenever front doors are open. |

5.4.6.1.4.2 Brake

5.4.6.1.4.2.1 Brake Pedal Angle

The angle of the brake pedal shall be determined from a horizontal plane regardless of the slope of the cab floor. The brake pedal shall be positioned at an angle of 27-35 degrees at the point of initiation of contact, and extend downward to an angle of 20-28 degrees at full depression.
5.4.6.1.4.2.2 Brake Pedal Dimensions
The floor mounted brake pedal shall be 10" - 12" long and 3" - 4" wide.

5.4.6.1.4.2.3 Brake Force
The force to depress the brake pedal shall be measured at the midpoint of the brake pedal. The brake pedal force shall be no less than 10 foot pounds and no more than 50 foot pounds.

5.4.6.1.4.2.4 Relative Position Between Accelerator Pedal and Brake Pedal
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".

5.4.6.1.4.2.5 Accelerator and Brake Pedal Location and Lateral Angle
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. The brake pedal shall have a 0-degree lateral angle, and the accelerator shall have a 12-degree lateral angle to coincide with the position of the operator's leg as it moves outward to operate the accelerator pedal.

5.4.6.1.4.3 Operator Foot Switches

5.4.6.1.4.3.1 Turn Signal 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 28 degrees. It shall be located no closer to the seat-front than the heel point of the accelerator pedal.

5.4.6.1.4.3.2 Turn Signal Controls
Turn signal controls shall be floor-mounted, foot-controlled, waterproof, heavy-duty, momentary contact switches.

5.4.6.1.4.3.3 High Beam, Hazard, and PA Controls
May be floor mounted (Optional) with the same requirements as the Turn Signal controls.
5.4.6.1.5 Instrumentation

The speedometer, air pressure gauge(s), and certain indicator lights shall be located in Area 1 Instrument Panel immediately ahead of the steering wheel. The steering wheel spokes or rim shall not obstruct the operator's vision of the instruments when the steering wheel is in the straight-ahead position. Illumination of the instruments shall be simultaneous with the marker lamps. Glare or reflection from the windshield, side window, or front door windows from the instruments, indicators, or other controls shall be minimized. Instruments shall be easily readable in direct sunlight or shielded in such a manner that sunlight does not adversely affect legibility. Instrument covers shall be non-reflective, without electrostatic qualities that attract and hold dust, and shall be resistant to scratching or hazing as a result of cleaning. Text shall be a minimum of 11 points. Extremely condensed or italic type fonts shall not be used. The color of the display field shall be dark with contrasting typography. Indicator lights or illuminated symbols or typography immediately in front of the operator shall be restricted to those concerned with the operation of the vehicle, as identified in the following table.

<table>
<thead>
<tr>
<th>Visual Indicator</th>
<th>Audible Alarm</th>
<th>Condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Back-Up</td>
<td>Backup Alarm</td>
<td>Reverse gear is selected</td>
</tr>
<tr>
<td>Hazard</td>
<td>Click</td>
<td>Four-way flashers activated</td>
</tr>
<tr>
<td>DRL</td>
<td>None</td>
<td>Daytime Running Lights</td>
</tr>
<tr>
<td>High Beam</td>
<td>None</td>
<td>Headlamp high beams activated</td>
</tr>
<tr>
<td>Kneel</td>
<td>Kneel Horn</td>
<td>Suspension kneeling system activated</td>
</tr>
<tr>
<td>Left Turn Signal</td>
<td>Click</td>
<td>Left turn signal activated</td>
</tr>
<tr>
<td>Parking Brake</td>
<td>None</td>
<td>Parking brake is activated</td>
</tr>
<tr>
<td>Rear Door</td>
<td>None</td>
<td>Rear passenger door is not closed and locked</td>
</tr>
<tr>
<td>Right Turn Signal</td>
<td>Click</td>
<td>Right turn signal activated</td>
</tr>
<tr>
<td>Stop Request</td>
<td>Chime</td>
<td>Passenger stop request has been activated</td>
</tr>
<tr>
<td>Wheelchair Request</td>
<td>Double Chime</td>
<td>Passenger wheelchair stop request has been activated</td>
</tr>
</tbody>
</table>

The instrument panel shall include an electronic speedometer indicating no more than 80 mph and calibrated in maximum increments of 5 mph. The speedometer shall be a rotating pointer type, with a dial deflection of 220 to 270 degrees and 40 mph near the top of the dial. The speedometer shall be sized and accurate in accordance with SAE Recommended Practice J678.
5.4.6.1.6 Visual and Audible Alarms

The bus shall be equipped with visual and audible alarms linked to an on-board diagnostic system that will indicate conditions that require immediate action by the operator to avoid an unsafe condition or prevent further damage to the bus. The indicator panel shall be located in Area 1 of the Instrument Panel. The intensity of visual indicators shall permit easy determination of on/off status in bright sunlight or shielded in such a manner that sunlight does not adversely affect legibility. Indicator illumination shall not cause a visibility problem at night. 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. Wherever possible, sensors shall be of the closed circuit type, so that failure of the circuit and/or sensor shall activate the malfunction indicator.

To avoid unnecessary confusion and anxiety on the part of the operator, on-board displays visible to the operator should be limited to indicating the status of those functions described herein that are necessary for the safe operation of the bus and protection of assets. All other indicators needed for diagnostics and their related interface hardware shall be concealed and protected from unauthorized access. Data communications requirements for Drivetrain diagnostics are identified in Section 5.5.5.2.2.

Malfunction and other indicators listed in the following table shall be supplied on all buses.
<table>
<thead>
<tr>
<th>Visual Indicator</th>
<th>Audible Alarm</th>
<th>Condition or Malfunction</th>
</tr>
</thead>
<tbody>
<tr>
<td>ABS</td>
<td>None</td>
<td>ABS System Malfunction</td>
</tr>
<tr>
<td>A/C Stop</td>
<td>None</td>
<td>Compressor stopped due to high/low pressure or loss of refrigerant</td>
</tr>
<tr>
<td>Check Engine</td>
<td>None</td>
<td>Engine Electronic Control Unit detects a malfunction</td>
</tr>
<tr>
<td>Check Transmission</td>
<td>None</td>
<td>Transmission Electronic Control Unit detects a malfunction</td>
</tr>
<tr>
<td>Fire</td>
<td>Bell</td>
<td>Over-temperature condition in engine compartment</td>
</tr>
<tr>
<td>Alternator Fail</td>
<td>None</td>
<td>Loss of alternator output</td>
</tr>
<tr>
<td>Hot Engine</td>
<td>Buzzer</td>
<td>Excessive engine coolant temperature</td>
</tr>
<tr>
<td>Low Air</td>
<td>Buzzer</td>
<td>Insufficient air pressure in either primary or secondary reservoirs</td>
</tr>
<tr>
<td>Low Oil</td>
<td>Buzzer</td>
<td>Insufficient engine oil pressure</td>
</tr>
<tr>
<td>Low Coolant</td>
<td>Buzzer</td>
<td>Insufficient engine coolant level</td>
</tr>
<tr>
<td>Wheelchair Ramp</td>
<td>Beeper</td>
<td>Wheelchair ramp is not stowed and disabled</td>
</tr>
<tr>
<td>Methane Gas Detection</td>
<td>Bell</td>
<td>Significant level of methane detected</td>
</tr>
<tr>
<td>Wheelchair Ramp Detection (optional)</td>
<td>Optional</td>
<td></td>
</tr>
</tbody>
</table>

### 5.4.6.2 WINDSHIELD WIPERS

The bus shall be equipped with a variable speed windshield wiper for each half of the windshield. For non-synchronized wipers, separate controls for each side shall be supplied. A variable intermittent feature shall be provided to allow adjustment of wiper speed for each side between approximately 5 to 25 cycles per minutes. If powered by compressed air, exhaust from the wiper motors shall be muffled or piped under the floor of the bus. No part of the windshield wiper mechanism shall be damaged by manual manipulation of the arms. At 60 mph, no more than 10 percent of the wiped area shall be lost due to windshield wiper lift. Both wipers shall park along the edges of the windshield glass. Windshield wiper motors and mechanisms shall be easily accessible for repairs or service and shall be removable as complete units. The fastener that secures the wiper arm to the drive mechanism shall be corrosion resistant.
5.4.6.3  WINDSHIELD WASHERS

The windshield washer system shall deposit washing fluid on the windshield and, when used with the wipers, shall evenly and completely wet the entire wiped area. If powered by compressed air, all fluid shall be purged from the lines after each use of the washers.

The windshield washer system shall have a minimum 3-gallon reservoir, located for easy refilling from outside of the bus and protected from freezing. Reservoir pumps, lines, and fittings shall be corrosion-resistant, and the reservoir itself shall be translucent for easy determination of fluid level.

5.4.6.4  OPERATOR’S SEAT
5.4.6.4.1  Dimensions

The operator's seat shall be comfortable and adjustable so that persons ranging in size from the 95th-percentile male to the 5th-percentile female may operate the bus. While seated, the operator 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. Graphical symbols shall conform to SAE Recommended Practice (Proposed) J1458, Universal Symbols for Seat and Suspension Adjustments.

5.4.6.4.1.1  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 more than 16.5” at its minimum length and no less than 20.5” at its maximum length.

5.4.6.4.1.2  Seat Pan Cushion Height

- **Baseline:** 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” to a maximum of 20”, with a minimum of a 6” range of adjustment

- **Alternative Measurement:** The reference point for seat height shall be determined by establishing the H-point.

- **Alternative Specification:** The seat shall have a minimum height adjustment range of 6”.

5.4.6.4.1.3  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).

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

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5.4.6.4.1.5 Seat Pan Cushion Width

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

5.4.6.4.1.6 Seat Suspension

The operator's seat shall be appropriately dampened to support a minimum weight of 380 pounds. The suspension shall be capable of dampening adjustment.

5.4.6.4.1.7 Operator Area Depth

The measurement is the horizontal distance from the heel-point to the barrier at the height at which the top of the seat back reclines. For all low-floor buses, the operator area depth shall be a minimum of 45" and be able to accommodate the full range of seat adjustment and travel (for a seat with the specifications as described in these guidelines). For all high-floor buses, the operator area depth shall be a minimum of 43".

5.4.6.4.1.8 Seat Back Width

Measurement is the distance between the outer-most 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".

5.4.6.4.1.9 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 in at least two locations, within a minimum range of 7" - 11".

5.4.6.4.1.10 Seat Back Angle Adjustment

The seat back angle shall be measured relative to a level seat pan, whereas 90 degrees is the upright position and 90 degrees-plus represents the amount of recline. The angle can be measured using a protractor (or its equivalent) with the X-axis being the horizontal plane of a level seat pan, and the Y-axis the upright plane of the seat back. The angle is created by the intersection of the two planes, with the upright plane parallel to the frame of the seat back.

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.
5.4.6.4.1.11 Seat Belt Adjustment

The Type I seat belt shall attach at a point that moves with the assembly.

- **Baseline: Standard (lap only) seat belt.**
  Required Type I seat belts shall be fastened to the seat so that the operator may adjust the seat without resetting the seat belt. Seat belts shall be stored in automatic retractors.

- **Alternative: Three-point (lap and shoulder) seat belt.**
  Seat belts shall be provided across the operator’s lap and diagonally across the operator’s chest. The operator shall be able to use both belts by connecting a single buckle on the right side of the seat cushion. The belts shall be fastened to the seat and/or the bus structure so that the operator may adjust the seat without resetting the seat belt. Seat belts shall be stored in automatic retractors.

- **Baseline: No requirement for extended length seat belts.**

- **Alternative: Requirement for extended length seat belts.**
  Seat belts shall be extended length to accommodate operators of all sizes.

5.4.6.4.2 Seat Structure and Materials

The operator's seat shall be contoured to provide maximum comfort for extended period of time. Cushions shall be fully padded with at least 3 inches of closed-cell polyurethane foam or material with equal properties, in the seating areas at the bottom and back. Upholstery shall be ventilated, transportation grade material.

All visually exposed metal on the operator's seat, including the pedestal, shall be unpainted aluminum or stainless steel.

The seat and seatbelt assemblies as installed in the bus shall withstand static horizontal forces as required in FMVSS 207 and 210. The seat shall withstand 10,000 impacts of a 40-pound sandbag dropped from a height of 12 inches without visible deterioration. The seat shall be tested in the lowest vertical position and repeated with the seat in the top vertical position.

The 40-pound sandbag shall be suspended on a 36-inch pendulum and shall strike the seat back 10,000 times from distances of 6, 8, 10, and 12 inches. Seat cushion shall withstand 100,000 randomly positioned 3-1/2-inch drops of a squirming, 150-pound, smooth-surfaced, buttocks-shape striker with only minimal wear on the seat covering.

At the request of the Procuring Agency, the Bus Manufacturer shall provide a certified test report fully documenting compliance with all the requirements defined above. The test report shall contain a record of all testing activities, test diagrams, testing equipment, as well as test data related to loads, deflections and permanent deformation of the seat assembly. The report shall include a statement of compliance with the requirements of this section of Part 5: Technical Specifications.

Color of the operator's seat is defined in the attachments to Part 5: Technical Specifications.
5.4.6.5 MIRRORS

5.4.6.5.1 Exterior Mirrors

The bus shall be equipped with a corrosion-resistant, outside rearview mirror on each side of the bus. Mirrors shall permit the operator to view the roadway along both sides of the bus, including the rear wheels. The curbside rearview mirror shall be mounted so that its lower edge is no less than 80 inches above the street surface.

θ Baseline: Use for mirrors on both sides
The bus shall be equipped with 2 outside mirrors of unit magnification (flat), each with not less than 50 sq. in. of reflective surface. The mirrors shall be corrosion-resistant and be installed with stable supports on each side of the bus. The mirrors shall be located so as to provide the operator 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 curbside rearview mirror shall be mounted so that its lower edge is no less than 80 inches above the street surface. The roadside rearview mirror shall be mounted lower on the bus body so that the operator's line of sight is not obstructed.

θ Alternative: Use of a closed circuit television camera and monitor in addition to required mirrors.
In addition to the required mirrors, a video camera shall be mounted on the curbside of the bus and connected to a monitor visible to the operator. The monitor image shall be not less than 8 inches when measured diagonally. The video system shall permit the operator to view to the rear along curb side of the bus. The location of the video camera and monitor shall be approved by the Procuring Agency.

θ Baseline: Standard curb-side mirror (without remote adjustment)

θ Alternative: Remote adjustment of curbside mirror.
The operator shall be able to adjust the curbside mirror remotely while seated in the driving position. The control for remote positioning of the mirror shall be a single switch or device.

θ Baseline: Non-heated exterior mirrors.

θ Alternative: Heated exterior mirrors.
All exterior mirrors shall be electrically heated. The heaters shall be energized whenever the operator’s heater and/or defroster is activated.

Mirrors shall be firmly attached to the bus to minimize vibration and prevent loss of adjustment, but not so firmly attached that the bus or its structure is damaged when the mirror is struck in an accident. Mirrors shall retract or fold sufficiently to allow bus washing operations. Additional details on external mirrors, including size, location and mounting, are contained in Attachments to Part 5: Technical Specifications.
5.4.6.5.2 **Interior Mirrors**

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

Additional details on external mirrors, including size, location and mounting, are contained in Attachments to Part 5: Technical Specifications.

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5.4.7 **WINDOWS**

5.4.7.1 **GENERAL**

θ *Baseline: Use with 40-ft length.*

A minimum of 10,000 square inches of window area, including operator and door windows, shall be required on each side of the standard configuration bus.

θ *Alternative: Use with 35-ft length.*

A minimum of 8,000 square inches of window area, including operator and door windows, shall be required on each side of the standard configuration bus.

5.4.7.2 **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 15 degrees, measured above the horizontal and excluding any shaded band. The vertically downward view shall permit detection of an object 3-1/2 feet high no more than 2 feet 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 windshield shall not be used. The windshield glazing material shall have a 1/4-inch or 6-mm nominal thickness laminated safety glass conforming to the requirements of ANSI Z26.1 Test Grouping 1A and the Recommended Practices defined in SAE J673. The glazing material shall have single density tint. The upper portion of the windshield above the operator's field of view shall have a dark, shaded band with a minimum luminous transmittance of 6 percent when tested in accordance to ASTM D-1003.
5.4.7.3 OPERATOR’S SIDE WINDOW

The operator’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 seated operator to easily adjust the street side outside rearview mirror. When in an open position, the window shall not rattle or close during braking. The entire assembly shall be hinged and have a single release for Emergency Egress. 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.

- **Baseline:** Design must prevent sections from freezing closed in the winter. Light transmittance shall be 75% on the glass area below 53" from the operator platform floor.
- **Alternative:** The glazed area above 53" may have maximum 5% light transmittance.

The operator's view, perpendicular through operator's side window glazing, should extend a minimum of 840 mm (33 inches) 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 560 mm (26 inches) above the operator's floor to ensure visibility of an under-mounted convex mirror. Operator's window construction shall maximize ability for full opening of the window.

The operator’s side window glazing material shall have a 1/4 inch nominal thickness laminated safety glass conforming with the requirements of ANSI Z26.1 Test Grouping 2 and the Recommended Practices defined in SAE J673.

5.4.7.4 SIDE WINDOWS
### 5.4.7.4.1 Configuration

**Baseline:** Fixed side windows.

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

**Alternative:** Use for all openable side window configurations.

All side windows, except windows in passenger doors and those smaller than 500 square inches, shall have window panels that are openable by passengers. Openable window panels shall be equipped with latches that secure the window in the fully open and fully closed positions. The requirements for stops limiting the window opening travel and the window opening area are defined in Attachment to Part 5: Technical Specifications.

*Procuring Agency shall then specify one of the following options:*

- **Openable windows with inward-opening transom panels:**

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

- **Openable windows with sliding transom panels.**

  Each openable side window shall incorporate an upper transom portion. The transom shall be between 25 and 35 percent of the total window area. The lower portion of the window shall be fixed. The transom portion shall consist of two horizontally sliding panels.

- **Openable windows with a fixed transom panel and sliding lower panels.**

  Each openable side window shall incorporate an upper transom portion. The transom shall be between 25 and 35 percent of the total window area. The transom portion of the window shall be fixed. The lower portion shall consist of two horizontally sliding panels.

- **Openable windows with openable transom panel and sliding lower panels.**

  Each openable side window shall incorporate an upper transom portion. The transom shall be between 25 and 35 percent of the total window area. The transom portion of the window shall be hinged at lower edge and open inward. The lower portion shall consist of two horizontally sliding panels.

- **Openable windows with full-height sliding panels.**

  Each openable side window shall consist of two full-height horizontally sliding panels.
All side windows 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.

The windows shall be designed and constructed to enable a 3M mechanic to remove and replace two windows in less than 10 minutes.

<table>
<thead>
<tr>
<th>Baseline:</th>
<th>No requirements for cyclone cleaner.</th>
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<tbody>
<tr>
<td>Alternative:</td>
<td>Requirement for cyclone cleaner.</td>
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</table>

An opening in the rear of the bus shall be provided to accommodate a cyclone cleaner. An openable rear window may be used if the window cannot be accidentally closed during the cleaning operation. Minimum size of this opening is defined in attachment to Part 5: Technical Specifications.

5.4.7.4.2 Materials
Baseline: Use for safety glass glazing panels.

Side windows glazing material shall have a 1/4-inch nominal thickness tempered safety glass. The material shall conform to the requirements of ANSI Z26.1 Test Grouping 2 and the Recommended Practices defined in SAE J673.

Alternative: Use for polycarbonate glazing panels

Side window glazing material shall have a 1/4-inch nominal thickness. The material shall conform with 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: Use for acrylic glazing panels.

Side window glazing material shall have a 1/2-inch nominal thickness. The material shall conform with 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 cell cast acrylic sheet with an abrasion resistant coating on both sides of the window.

Alternative: Use for laminated glazing panels.

Side windows glazing material shall have 1/4-inch nominal thickness laminated safety glass. The material shall conform to applicable requirements of ANSI Z26.1 and the Recommended Practices defined in SAE J673.

Alternative: Use for 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 mil 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 ultra violet rays. The film shall withstand normal cleaning operations.

Alternative: Use for Anti-vandalism sacrificial liner (“storm window type”).

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 material shall be clear and shall have minimal effect the transmittance of the underlying glazing. This material shall not be adversely affected by ultra-violet rays and shall withstand normal cleaning practices. The installation of the liner shall prevent clouding or fogging. A mechanic without the use of any specialized tools shall be able to easily remove and replace the acrylic liner in 5 minutes or less.
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. Windows over the destination signs shall not be tinted.

5.4.7.5 REAR WINDOW

- **Baseline:** No requirement for rear window.

- **Alternative:** Use for Rear Window requirement. Note that requirement for a rear-mounted HVAC unit will preclude a rear window.

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 pushout type to meet FMVSS 217. If pushout type, it shall be one-piece, rugged sash design, meeting specifications for side windows.

5.4.8 HEATING VENTILATING AND AIR CONDITIONING

5.4.8.1 CAPACITY AND PERFORMANCE

The Heating, Ventilation and Air Conditioning (HVAC) climate control system shall be capable of maintaining the interior of the bus at the temperature and humidity levels defined in the following paragraphs.

- **Baseline:** HVAC equipped. (See below for configuration)

- **Alternative:** No requirements for cooling. All requirements relevant to the HVAC cooling mode contained in this section as well as throughout this Specification need not apply.
Baseline: Allow either roof or rear-mounted HVAC unit. Note that a rear-mounted unit will preclude a rear window and that the term “roof-mounted unit” includes units mounted on top of beneath the roof surface.

The HVAC unit may either be roof or rear-mounted.

Alternative: Require roof-mounted HVAC unit. Note that the term “roof-mounted unit” includes units mounted on top or beneath the roof surface.

The HVAC unit shall be roof-mounted.

Alternative: Require rear-mounted HVAC unit.

The HVAC unit shall be rear-mounted.

Accessibility and serviceability of components shall be provided without requiring maintenance personnel to climb-up 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 maintain an average passenger compartment temperature within a range between 65°F and 80°F, while controlling 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°F 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°F to 115°F, the interior temperature of the bus shall be permitted to rise one degree for each degree of exterior temperature in excess of 95°F.

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

System capacity testing, including pulldown/warm-up, stabilization and profile, shall be conducted in accordance to the APTA Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System. Temperature measurements shall be made in accordance to this document with the following modifications:

The three primary locations used for temperature probes are (1) 6 inches aft of front wheelhousing, (2) centered between the two axles and (3) 6 inches aft of rear wheelhousing. At each primary location, the nine (9) temperature sensing devices shall be (A) 72 inches above floor level, (B) 6 inches above top surface of seat cushion and (C) 6 inches above floor.

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 immediate path of 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.

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<tr>
<th>0</th>
<th>Baseline: Capacity and performance requirements</th>
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<td></td>
<td>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 that may be activated by an operator-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 inches 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.</td>
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<th>0</th>
<th>Alternative: For hotter ambient conditions</th>
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<td></td>
<td>The test procedure as described in Section 8 of the APTA document, “Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System,” shall be used for the purposes of the following pulldown requirements. The air conditioning portion of the HVAC system shall be capable of reducing the passenger compartment temperature as defined in the referenced test procedure from 110° to 70°F ± 3°F in less than 30 minutes after start-up of A/C system. A greater variance may be allowed for the sensor closest to the return air vent. During the cool-down period the refrigerant pressure shall not exceed safe high-side pressures and the condenser discharge air temperature, measured 6 inches 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.</td>
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<th>0</th>
<th>Alternative: For cold ambient conditions</th>
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<td>The pullup 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.</td>
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Additional HVAC system and performance requirements are contained in Attachments to Part 5: Technical Specification. The air conditioning system shall meet these performance requirements using:

θ HFC R22 θ HFC R134a θ HFC R407c θ Other (Specify)____________

The climate control blower motors and fan shall be designed such that their operation complies with the interior noise level requirements as specified in Section 5.1.5.6.1.

5.4.8.2 CONTROLS AND TEMPERATURE UNIFORMITY

The HVAC system excluding the operator's heater/defroster shall be centrally controlled with an advanced electronic/diagnostic control system with provisions for extracting/reading data.

<table>
<thead>
<tr>
<th>θ Baseline: Use for manual mode selection of climate control system.</th>
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<tr>
<td>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.</td>
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<tr>
<th>θ Alternative: Use for fully automatic climate control system.</th>
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<tbody>
<tr>
<td>The climate control system shall be fully automatic and control the interior average temperature to within ±2°F of specified temperature control set-point.</td>
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<th>θ Baseline: Use for single control set point at 70°F</th>
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<tr>
<td>The temperature control set-point for the system shall be 70°F.</td>
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<tr>
<th>θ Alternative: Use for dual temperature control set-point</th>
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<tr>
<td>The temperature control set-point for the system in the cooling mode shall be ___°F [Procuring Agency to fill-in] and ___°F [Procuring Agency to fill-in] in the heating mode.</td>
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<tr>
<th>θ Alternative: Manually adjustable temperature control set-point</th>
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<tr>
<td>The climate control system shall have the provision to allow operator 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 operator.</td>
</tr>
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</table>

The operator shall have full control over the defroster and operator's heater. The operator shall be able to adjust the temperature in the operator'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 inches to 72 inches 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 to APTA 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.

5.4.8.3 AIR FLOW

5.4.8.3.1 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 feet 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 feet per minute on any passenger. The ventilating mode shall provide air at a minimum flow rate of 20 cfm per passenger.

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

| Baseline: No “fresh air” requirements. Procuring Agencies who have type of operating profile where door opening cycle results in effectively providing an adequate “fresh air” mixture. |
| Alternative: Requirement for 20% “fresh air” mixture. |

The air shall be composed of no less than 20 percent outside air.

5.4.8.3.2 Operator's Area

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

5.4.8.3.2.1 Controls for the Climate Control System (CCS)

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

(1) 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 Procuring Agency, an "On-Off" switch shall be located to the right of or near the main Defroster switch.

(2) 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 Project Manager Procuring Agency.

5.4.8.3.2.2 Operator's Compartment Requirements

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

(1) The heater and defroster system shall provide heating for the operator and heated air to completely defrost and defog the windshield, operator'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 operator's feet. A minimum capacity of 100cfm shall be provided. The operator shall have complete control of the heat and fresh airflow for their area.

(2) The defroster supply outlets shall be located at the lower edge of the windshield. These outlets shall be unbreakable 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 shall be provided at the left of the driver's operator's position to allow direction of air onto the side windows. Two additional ball vents shall be located on the vertical front dash panel adjacent to the front door to allow direction of air onto the door windows and/or entrance area.

A ventilation system shall be provided to ensure operator comfort and shall be capable of providing fresh air in both the foot and head areas. Vents shall be controllable by the operator from the normal driving position. Decals shall be provided indicating "operating instructions" and "open" and "closed" positions as well. When closed, vents shall be sealed to prevent the migration of water or air into the bus.
5.4.8.3.2.3 Operator's Cooling

☐ **Baseline: Requirements for operator's cooling shall be consistent with specifications noted in section 5.4.8.1**

☐ **Alternative: Separate Dedicated Evaporator**

Using a separate, dedicated evaporator, the CCS shall be designed to maintain the operator'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. A separate fan unit shall provide 100cfm of air to the operator's area through directionally adjustable nozzles and an infinitely variable fan control, both of which shall be located above and ahead of the operator.

5.4.8.4 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 gram per 1,000 cfm cell. More efficient air filtration may be provided to maintain efficient heater and/or evaporator operation. Air filters shall be easily removable for service.

- **Baseline: Requirement for cleanable filters.**

  Air filters shall be cleanable.

- **Alternative: Disposable type filters.**

  Air filters shall be of disposable type.

5.4.8.5 ROOF VENTILATORS

- **Baseline: One roof ventilator required**

  One ventilator shall be provided in the roof of the bus approximately over the rear axle.

- **Alternative: Two roof ventilators required**

  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 by a 50th percentile female. If roof ventilator(s) cannot be reached by a 50th percentile female, then a tool shall be provided to allow this.
When open with the bus in motion, this ventilator shall provide fresh air inside the bus. Ventilator shall cover an opening area no less than 425 square inches and shall be capable of being positioned as a scoop with either the leading or trailing edge open no less than 4 inches, or with all four edges raised simultaneously to a height of no less than 3-1/2 inches. An escape hatch shall be incorporated into the roof ventilator. Roof ventilator(s) shall be sealed to prevent entry of water when closed.

5.4.8.6 MAINTAINABILITY

Manually controlled shutoff 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 inches of floor level shall be constructed to resist damage and corrosion.

Note: The Procuring Agency may include the following sections if Alternative for colder ambient performance is specified above.

5.4.8.7 ENTRANCE/EXIT AREA HEATING

θ Baseline: No requirements for entrance/exit area heating.

θ Alternative: Entrance/exit area heating.

Heat shall be supplied to the entrance and exit areas to prevent accumulation of snow, ice, or slush with bus operating under design operating profile and corresponding door opening cycle.

5.4.8.8 FLOOR LEVEL HEATING

θ Baseline: No requirements for floor level heating.

ρ Alternative: Floor level heating.

Sufficient floor level heaters shall be provided that 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 floor and ensure temperature uniformity shall be included. Control of the floor level heating shall be through the main heating system electronic control.
5.4.9 SIGNAGE AND COMMUNICATION

5.4.9.1 DESTINATION SIGNS

If selected in section 5.5.5.4.3, a destination sign system shall be furnished on the front, on the right side near the front door, and on the rear of the vehicle.

The sign located near the front door shall not block the operator’s critical horizontal line of sight. Display areas of destination signs shall be clearly visible in direct sunlight and/or at night. Signs shall be installed to allow replacement by a 3M mechanic within 30 minutes. Parts shall be commercially available.

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 operator in Area 5 of the Operator’s Workstation Control and Instrument Array, mounted in such a manner that will not pose any safety hazard.

The destination sign compartments shall be designed to meet the following minimum requirements:
1. Prevent condensation and entry of moisture and dirt.
2. Prevent fogging of both compartment window and glazing on unit itself.
3. Access shall be provided to allow cleaning of inside compartment window and unit glazing.
4. Front window shall have an exterior display area of no less than 8.5”h by 56”w.

5.4.9.2 PASSENGER INFORMATION AND ADVERTISING

5.4.9.2.1 Interior Displays

Provisions shall be made on the rear of the operator’s barrier for a frame to retain information that is sized (Procuring Agency to specify width) inches wide and (Procuring Agency to specify height) inches high posted by the Procuring Agency, such as routes and schedules. Advertising media 11 inches high and 0.09 inches thick shall be retained near the juncture of the bus ceiling and sidewall. The retainers may be concave and shall support the media without adhesives. The media shall be illuminated by the interior fluorescent light system.

Additional requirements for interior advertising and passenger information displays are defined in the Attachments to Part 5: Technical Specifications.

5.4.9.2.2 Exterior Displays

Provisions shall be made to integrate advertising, which may be specified by the Procuring Agency, into the exterior design of the bus. Advertising media, frames, or supporting structures shall not detract from the readability of destination signs and signal lights, and shall not compromise passenger visibility. Advertising provisions shall not cause pedestrian hazards or foul automatic bus washing.
equipment, and shall not cover or interfere with doors, air passages, vehicle fittings, or in any other manner restrict the operation or serviceability of the bus.

Additional requirements for exterior advertising are defined in the attachments to Part 5: Technical Specifications.

5.4.9.3 PASSENGER STOP REQUEST/EXIT SIGNAL

**Baseline: Use for touch tape 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 touch tape, chime, and interior sign message. The touch tape shall be located the full length of the bus on the sidewalls, towards the ceiling. It shall be easily accessible to all passengers, seated or standing. Vertical touch tape shall be provided at each window mullion and adjacent to each wheelchair parking position and priority seating positions.

**Alternative: Use for 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, height of pull cable shall approximate this transom level and shall be no greater than 63 inches as measured from floor surface. It shall be easily accessible to all passengers, seated or standing. Pull cable(s) shall activate a solid state or magnetic proximity switch(es). At each wheelchair parking position and priority seating positions additional provisions shall be included to allow a passenger in a mobility aid to easily activate “Stop Requested” signal.

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 above rear door on the rear door actuator compartment access panel. Button shall be clearly identified as “Passenger Signal.”

**Baseline: No requirements for additional Stop Request button on rear door stanchion.**

**Alternative: Use for requirements for 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 rear door and clearly identified as “Passenger Signal.”

A single "Stop Requested" chime shall sound when the system is first activated. A double chime shall sound when the system is first activated from wheelchair passenger areas.
Exit signals located in the wheelchair parking area shall be no higher than 4 feet above the floor. Instructions shall be provided to clearly indicate function and operation of these signals.

5.5 ELECTRICAL, ELECTRONIC AND DATA COMMUNICATION SYSTEMS

5.5.1 GENERAL REQUIREMENTS

This section encompasses electrical, electronic and data communication systems installed on-board the vehicle.

General requirements for the electrical system shall be as specified in Subsection 5.5.3. The Electrical System consists of the vehicle batteries and all other equipment that generate, distribute and use battery power throughout the vehicle (e.g., generator, voltage regulator, wiring, relays, and connectors).

General requirements for electronics shall be as specified in Subsection 5.5.4. Electronics are those components of the electrical system made up of discrete solid-state devices such as transistors, resistors, capacitors and diodes that are part of individual vehicle systems. Electronics also include the integrated circuits that are part of microprocessors that allow individual vehicle systems to process and store data.

Data Communication Systems shall be as specified in Subsection 5.5.5. These systems consist 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.

Data Communications Systems are divided into three levels to reflect the use of multiple data networks.

1) Drivetrain Level – Components related to the drivetrain including the engine, transmission, and anti-lock braking system (ABS), which may include traction control.

2) Multiplex Level – Electrical 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, and heating, ventilation, air conditioning (HVAC) systems.

3) Information Level – Components whose primary function is the collection, control or display of data that is not necessary to the safe driveability of the vehicle (i.e., those functions, that when inoperable, will still allow the vehicle to operate). 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.
Central Data Access, a concept where all on-board data is made available at one location, is detailed in Subsection 5.5.6.

Responsibilities for system integration and testing by the Procuring agency, vehicle manufacturer, and the sub-system supplier or other third party integrator shall be as specified in Subsection 5.5.7.

5.5.1.1 MODULAR DESIGN

Design of the electrical, electronic and data communication systems shall be modular so that each major component, apparatus panel, or wiring bundle is easily separable with standard hand tools or by means of connectors. Each module, except the main body wiring harness, shall be removable and replaceable in less than 1 hour by a 3M mechanic. Power plant wiring shall be an independent wiring module. Replacement of the engine compartment wiring module(s) shall not require pulling wires through any bulkhead or removing any terminals from the wires.

5.5.2 ENVIRONMENTAL AND MOUNTING REQUIREMENTS

The electrical system and its electronic components shall be capable of operating in the area of the vehicle in which they will be installed as recommended in SAE J1455, except as modified by the temperature requirements provided in the table “Temperature Extreme Summary Heavy – Duty Transit Bus” and figure “Heavy – Duty Transit Bus”, found in the Appendix A.

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. No vehicle component shall generate, or be affected by, electromagnetic interference or radio frequency interference (EMI/RFI) that can disturb the performance of electrical/electronic equipment as defined in SAE J1113.
The Procuring Agency shall follow recommendations from bus manufacturers and subsystem suppliers regarding methods to prevent damage from voltage spikes generated from welding, jump starts, shorts, etc.

5.5.2.1 MOUNTING

All electrical/electronic hardware shall be accessible and replaced by a 3M mechanic in 30 minutes. It shall be mounted on an insulating panel to facilitate replacement. 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.

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.

5.5.3 GENERAL ELECTRICAL REQUIREMENTS

5.5.3.1 BATTERIES

5.5.3.1.1 Main Power Supply
Baseline: Two 8D Battery Units

Two 8D battery units conforming to SAE Standard J537 shall be provided. Each battery shall have a minimum of 1150 cold cranking amps. 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 Procuring Agency.

Alternative: 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 700 cold cranking amps. Each battery shall have a purchase date no more than one year from date of release for shipment to the Procuring Agency.

Positive and negative terminal ends on the Baseline 8D batteries shall have different size studs to prevent incorrect installation. 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. Battery cables shall be flexible and sufficiently long to reach the batteries with 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 or SGX and SAE Recommended Practice J541.

Baseline: No requirements for jump-start connector.

Alternative: Use for requirements for jump-start connector.

Jump-start connector shall be provided in the engine compartment equipped with dust cap and adequately protected from moisture, dirt and debris. See Attachments to Section 5 for details on type of connector required.

5.5.3.1.2 Dedicated Electronic Power Supply

If required, gel-pack, or any form of encased batteries used for auxiliary power, are allowed to be mounted on the interior of the vehicle if they are contained in an enclosed, non-airtight compartment and accessible only to maintenance personnel. This compartment shall contain a warning label prohibiting the use of lead-acid batteries.

5.5.3.1.3 Master Battery Switch

A single master switch shall be provided near the battery compartment for the disconnecting of all battery positives (12V & 24V) except for safety devices such as 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 de-activation, 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 not damage any component of the electrical system. The master switch shall be capable of carrying and interrupting the total circuit load. Any equipment that requires power with the master battery switch “OFF” shall be listed in attachments to Part 5: Technical Specifications.

- **Baseline: Single switch**

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

- **Alternative: Separate switches**

  The batteries shall be equipped with separate switches for disconnecting 12V & 24V power.

### 5.5.3.2 POWER GENERATION AND DISTRIBUTION

The power generating system shall maintain the charge on fully charged batteries, except when the vehicle is at standard idle with a total alternator load exceeding 70 percent of the alternator nameplate rating. Use of fast idle shall maintain a charge on fully charged batteries so long as the total alternator load does not exceed 90 percent of the alternator nameplate rating.

*NOTE: These percentages will typically allow operation of the HVAC, lights, wipers, and some selected additional systems at fast idle. Table 20 provides a representative value of various examples.*

The vehicle manufacturer shall provide to the procuring agency both at time of bid and actual production an analysis of the estimated electrical load for each system.
TABLE 20 – REPRESENTATIVE EXAMPLES OF STATIC ELECTRICAL LOADS
(With batteries fully charged)

<table>
<thead>
<tr>
<th>Footnote</th>
<th>Components</th>
<th>24V Load</th>
<th>12V Load</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Interior Lights (all)</td>
<td>22.8 Amps</td>
<td>8.5 Amps</td>
</tr>
<tr>
<td>1</td>
<td>Intercom (inside and outside)</td>
<td>8.5 Amps</td>
<td>6.6 Amps</td>
</tr>
<tr>
<td>1</td>
<td>Turn Signal (right)</td>
<td>10.6 Amps</td>
<td>10.4 Amps</td>
</tr>
<tr>
<td>1</td>
<td>All Hazard Flashers</td>
<td>12.7 Amps</td>
<td>12.9 Amps</td>
</tr>
<tr>
<td>2</td>
<td>Radio, Farebox, Destination Signs, Rear Camera, and Step Well Lights</td>
<td>26.1 Amps</td>
<td>11.8 Amps</td>
</tr>
<tr>
<td>3</td>
<td>HVAC and all applicable devices</td>
<td>150.0 Amps</td>
<td>N/A</td>
</tr>
</tbody>
</table>

1 - Engine off and Master Run Switch in the “day run” position
2 - Engine off and Master Run Switch in the “night run” position
3 - Engine running and Master Run Switch in the “day run” or “night run” position

Alternator over-voltage output protection shall be provided.

Power distribution to all equipment requiring dedicated power and ground wiring to the batteries shall be accomplished by using power bus bars consisting of either a solid copper bar or heavy-duty terminal strip. One bus bar for each voltage potential, including ground, shall be located as close to the source of the potential as possible. Cabling from the bus bars to the equipment must be sized to supply the total current requirements with no greater than a five percent volt drop across the length of the cable.

5.5.3.3 CIRCUIT PROTECTION

All branch circuits, except battery-to-starting motor and battery-to-generator/alternator circuits, shall be protected by circuit breakers or fuses sized to the requirements of the load. Electronic circuit protection for the cranking motor shall be provided to prevent engaging of the motor for no 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. Any manually re-settable circuit breakers shall provide visible indication of open circuits.

Circuit breakers or fuses shall be sized to a minimum of 15 percent larger than the total circuit load current. The current rating for the wire used for each circuit must exceed the size of the circuit protection being used. Wire and cable ampacity for wire sizes 18 AWG and larger shall be in accordance with the Wire Ampacity Chart found in Appendix B.

5.5.3.4 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 connections shall be made per ground stud. Electronic equipment requiring an isolated ground
to the battery (i.e., electronic ground) shall not be grounded to the chassis.

5.5.3.5 WIRING AND TERMINALS

All power and ground wiring shall have double electrical insulation, shall be waterproof, and 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.

Wiring shall be grouped, numbered, and 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 points where wiring enters all 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 five feet long and containing at least five wires shall include 10 percent
(minimum one [1]) excess wires for spares. This requirement for spare wires does not apply to data
links and/or communication cables. Wiring length shall allow end terminals to be replaced twice
without pulling, stretching, or replacing the wire. Except for large wires such as battery cables,
terminals shall be cramped according to connector manufacturers recommendations for techniques and
tools to the wiring and may be soldered only if the wire is not stiffened above the terminal and no flux
residue remains on the terminal. Battery cable connectors shall be cramped and soldered.

Terminals shall be cramped, corrosion-resistant and full ring type or interlocking lugs with insulating
ferrules. When using pressure type screw terminal strips, stranded wire only shall be used. Insulation
clearance shall ensure wires have a minimum of “visible clearance” and a maximum of two (2) times
the conductor diameter or 1/16 “, 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.

For shielding and coaxial requirements refer to Section 5.5.4.1.2.

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: include a mechanical clamp in addition to solder on the splice; the
wire supports no mechanical load in the area of the splice; and the wire is 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.

For wiring harness connectors, pins shall be removable, crimp contact type of the correct size, and rated for the wire being terminated. All supply-side terminations shall end in a socket, not a pin. Unused pin positions shall be sealed with sealing plugs. Adjacent connectors shall either use opposing pin genders, different insert orientations, or different connectors to prevent incorrect connections. All cable connectors shall be placed to provide adequate space for ease of removal and disconnection. All electrical connectors subjected to environmental exposure outside the passenger compartment shall be corrosion resistant and splash proof.

5.5.3.6 ELECTRICAL COMPONENTS

All electrical components, including switches, relays, flashers, and circuit breakers, shall be heavy-duty designs with either a successful history of application to heavy-duty vehicles, or design specifications for an equivalent environment. These components shall be replaceable in less than 5 minutes by a 3M mechanic.

All electric motors shall be either heavy-duty brushless type where practical, or have a constant duty rating of no less than 40,000 hours (except cranking motors). All electric motors shall be easily accessible for servicing. All motors to be brushless are listed in attachments to Section 5: Technical Specifications.

5.5.3.7 ELECTRICAL COMPARTMENTS

All electrical components, including switches, relays, flashers, and circuit breakers, shall be heavy-duty designs with either a successful history of application to heavy-duty vehicles, or design specifications for an equivalent environment. These components shall be replaceable in less than 5 minutes by a 3M mechanic.

All electric motors shall be either heavy-duty brushless type where practical, or have a constant duty rating of no less than 40,000 hours (except cranking motors). All electric motors shall be easily accessible for servicing. All motors to be brushless are listed in attachments to Section 5: Technical Specifications.
5.5.4 GENERAL ELECTRONIC REQUIREMENTS

If an electronic component has an internal clock, it shall provide its own battery backup to monitor time when battery power is disconnected.

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 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.

5.5.4.1 WIRING AND TERMINALS

Kinking, grounding at multiple points, stretching, and exceeding minimum bend radius shall be prevented.

5.5.4.1.1 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. Labels shall be resistant to rubbing (hot stamped tubing and protected printing are service-proven examples of acceptable labels). 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 of each I/O terminal.

5.5.4.1.2 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 shall also 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.

5.5.4.1.3 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 other purpose other than communication between the system components, unless provided for in the network specifications. Further information on the physical wiring requirements associated with some available communication protocols in common use can be found in Appendix C.
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.

5.5.4.1.4 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, which 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. The corresponding component vendors shall be consulted for proper application of equipment including installation of cables.

5.5.4.1.5 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.

5.5.4.2 Multiplexing

5.5.4.2.1 General

All vehicles shall be equipped with a multiplexing system. 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. This system shall meet the network communications requirements of Section 5.5.5.3.

Versatility and future expansion shall be provided for by an expandable system architecture. The multiplex system shall be capable of accepting new inputs and outputs through the addition of new modules 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) at each zone location shall be designated as spares. Zone locations are: (1) behind the rear bulkhead; (2) forward of the bulkhead above the window line; and (3) forward of the bulkhead below the window line.
5.5.4.2.2 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. Both systems shall consist of several modules connected to form a control network.

5.5.4.2.3 I/O (Input/Output) 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 (4-20ma). 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.

5.5.5 DATA COMMUNICATIONS

5.5.5.1 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, or shall be published to the Procuring Agency with the following minimum information:

1. 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)
2. data definition requirements that ensure access to diagnostic information and performance characteristics
3. the capability and procedures for uploading new application or configuration data
4. access to revision levels of data, application software and firmware
5. the capability and procedures for uploading new firmware or application software.

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

All components on the Drivetrain network shall communicate data over the network as specified in Section 5.5.5.2. The Multiplex Level shall use a communications network that meets the requirements of Section 5.5.5.3. Components integrated on the Information Level shall communicate data over the network selected in Section 5.5.5.4.
5.5.5.2   DRIVETRAIN LEVEL

5.5.5.2.1   General

Drivetrain components, consisting of the engine, transmission, retarder, anti-lock braking system, and all other related components shall communicate data using a combination of the SAE Recommended Communications Protocols J1939 and/or J1708/J1587, or other open protocols as referenced in Section 5.5.5.1.

5.5.5.2.2   Diagnostics and Fault Detection

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.

5.5.5.2.3   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.

5.5.5.2.4   Programmability (Software)

The Drivetrain Level components shall be programmable by the Procuring Agency with limitations as specified by the sub-system supplier.

5.5.5.3   MULTIPLEX LEVEL

5.5.5.3.1   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 Procuring Agency in Worksheet 5.5.5.4.4.1. The communication port(s) shall be located as specified by theProcuring Agency in attachment to Part 5: Technical Specifications.

5.5.5.3.2   Diagnostics and Fault Detection
The multiplex system shall have a proven method of determining its status (system health and input/output status) and detecting either active (Online) or inactive (Offline) faults through the use of 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 (PC) or a hand held unit. Either unit shall have the ability to check logic function. The diagnostic data can be incorporated into the Information Level Network (5.5.5.4.3.1.2) or the Central Data Access System (5.5.6).

An optional Mock-Up Board can be used for diagnostics, design verification, and training.

| 0 Baseline: No requirement for Mock-Up Boards |
| 0 Alternative: 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. |

5.5.5.3  
Programmability (Software)

The multiplex system shall have security provisions to protect its software from unwanted changes. This shall be achieved through any or all of the following procedures: password protection, limited distribution of the configuration software, limited access to the programming tools required to change the software, and hardware protection that prevents undesired changes to the software.

Provisions for programming the multiplex system shall be possible through a PC/laptop. The multiplex system shall have proper revision control to insure that the hardware and software is 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; and software revision identification where all copies of the software in service displays the most recent revision number, and a method of determining which version of the software is currently in use in the multiplex system.

5.5.5.4  
INFORMATION LEVEL COMPONENT INTEGRATION

5.5.5.4.1  
General

The purpose of this section is to assist the Procuring Agency in specifying which Information Level components are to be installed, and provide a consistent integration interface.

Information Level components are those components whose primary function is the transmission of data to a system outside the vehicle; and/or the collection, control or display of data on the vehicle, none of which is necessary to the safe operation of the vehicle.
Information Level components can function independently of each other, or can be integrated with other components through a communications network to achieve greater functionality.

NOTE: Sub-section 5.5.5.4.2 is a guideline specification for the common functionality for all Information Level components. The remainder of the Information Level section is NOT to be considered as a specification, but is instead a series of checklists that the Procuring Agency can use to select a communications network, pre-wired cabling, and specific Information Level components with optional features.

The process of selecting Information Level components begins with a single checkbox found in sub-section 5.5.5.4.3. It provides an overall indication of the Information Level features and components that the Procuring Agency wants installed. Individual Worksheets in sub-section 5.5.5.4.4 are then used to indicate:

- components to be installed as part of this procurement, or into these vehicles at a later time by the Procuring Agency or third-part supplier;
- if the component is to be integrated on a communications network;
- if the Human Machine Interface (HMI) is to be a separate device or integrated with other networked components; and
- how the component is to be programmed.

5.5.5.4.2 General Component Specifications

All Information Level components selected by the Procuring Agency shall be networked on the Information Level, unless otherwise specified on the corresponding Worksheet, and have the capabilities as outlined in the following sub-sections.

5.5.5.4.2.1 Upgrade Ability

All programmable components shall be capable of upgrade without replacing the component. This is commonly done through EEPROM (flash), or replacement of EPROM(s). The flash upgrade shall be performed by either connecting a hand-held device, by contact-less device, PC Card, or via the network.

5.5.5.4.2.2 Mobile Data Terminal (MDT)

Note: The current practice is to use separate Human/Machine Interface (HMI) devices (e.g., keypads) for each component, which requires the operator to interact with many HMI devices and adds clutter to the operator’s workstation. The use of a single MDT, while not common today, is suggested to reduce the proliferation of distinct HMI devices.

Instead of using separate Human/Machine Interface (HMI) devices, the components shall share the MDT. This typically consists of both a display screen and a method of accepting operator input, usually via keypad and/or touch-screen.
5.5.5.4.2.3 Diagnostic Data

Component diagnostic data shall be available upon request of the network. If an error condition is self-detected on a component, then that condition, and any relevant diagnostic data, shall immediately be broadcast on the network.

5.5.5.4.2.4 Automatic/Manual Override

Any component that is controlled from the network shall have a means of providing an override. This override will then allow the operator to manually set/configure the device. This type of override is typically for disabling automatic update of route-displays and/or voice annunciation. If a Mobile Data Terminal (MDT) is specified, it shall provide this override functionality.

5.5.5.4.2.5 Power Requirements

To prevent battery drain, power shall not be supplied from the unswitched side of the Master Battery Switch. Unless otherwise specified, all components shall receive their power source from either a circuit enabled with the master-run switch, or have an internal timer that is configurable to place the component into a deep-sleep mode.

Unless otherwise specified, every component shall be designed to operate at 12V and 24V with required power filtering provided by the individual component.

When multiple microprocessor-based components require a minimum sustained voltage of 9V, and also a clean (filtered) power source, it may be more cost effective to specify a shared DC/DC converter and/or dedicated electronic power supply as specified in 5.5.3.1.2. Requirements for a shared DC/DC converter are contained in attachments to Part 5: Technical Specifications.

5.5.5.4.2.6 Real Time Clock

Any networked component that maintains its own time shall allow that time to be updated via the network.

5.5.5.4.3 Information Level Components

The Procuring Agency shall use the following checkbox to select the Information Level features and components to be installed. After selecting component(s), the Procuring Agency then completes the corresponding worksheet(s), which further define the options for each component.
### 5.5.5.4.3.1 Vehicle Area Network (VAN)

*If selected, complete Worksheet: 5.5.5.4.4.1.*

The Information Level network shall consist of an open and published data protocol that allows component manufacturers to interface to the network and communicate with other components.

*NOTE: The FTA recommended Vehicle Area Network is SAE J1708/J1587, which is used as the baseline in the corresponding worksheet. Alternative networks may be specified due to considerations such as component cost, compatibility, availability, and data transmission speeds. Any alternative network selected shall comply with the requirements of Section 5.5.5.1.*

*Due to the evolving nature of on-board communications networks and Intelligent Transportation System (ITS), Procuring Agencies are requested to keep informed of the most recent guidance concerning on-board communications networks.*

<table>
<thead>
<tr>
<th>Item</th>
<th>Section</th>
</tr>
</thead>
<tbody>
<tr>
<td>VEHICLE AREA NETWORK (VAN)</td>
<td>5.5.5.4.3.1</td>
</tr>
<tr>
<td>ELECTRONICS (RADIO) BOX</td>
<td>5.5.5.4.3.2</td>
</tr>
<tr>
<td>MOBILE DATA TERMINAL (MDT)</td>
<td>5.5.5.4.3.3</td>
</tr>
<tr>
<td>RADIO</td>
<td>5.5.5.4.3.4</td>
</tr>
<tr>
<td>EXTERNAL ROUTE DISPLAY (ERD)</td>
<td>5.5.5.4.3.5</td>
</tr>
<tr>
<td>VOICE ANNUNCIATION AND SIGNAGE SYSTEM (VASS)</td>
<td>5.5.5.4.3.6</td>
</tr>
<tr>
<td>PASSENGER STOP REQUEST SIGN</td>
<td>5.5.5.4.3.7</td>
</tr>
<tr>
<td>COVERT EMERGENCY ALARM</td>
<td>5.5.5.4.3.8</td>
</tr>
<tr>
<td>PUBLIC ADDRESS SYSTEM (PA)</td>
<td>5.5.5.4.3.9</td>
</tr>
<tr>
<td>AUTOMATIC VEHICLE LOCATION (AVL)</td>
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</tr>
<tr>
<td>AUTOMATIC PASSENGER COUNTER (APC)</td>
<td>5.5.5.4.3.11</td>
</tr>
<tr>
<td>AUTOMATED FARE COLLECTTON (AFC)</td>
<td>5.5.5.4.3.12</td>
</tr>
<tr>
<td>CLOSED CIRCUIT TV (CCTV)</td>
<td>5.5.5.4.3.13</td>
</tr>
<tr>
<td>TRANSIT SIGNAL PRIORITY (TSP)</td>
<td>5.5.5.4.3.14</td>
</tr>
<tr>
<td>WIRELESS AREA NETWORK (WAN)</td>
<td>5.5.5.4.3.15</td>
</tr>
</tbody>
</table>

*Other: _________________________________________________________________*
5.5.5.4.3.1.1 Network Cabling

*If selected, complete Worksheet: 5.5.5.4.4.1.*

The cabling shall be as required by the specifications of the selected VAN protocol. Pre-wiring the vehicle with data communications cabling will minimize the cost of installing the cabling and additional Information level components after delivery.

*Note: For the FTA recommended VAN protocol of SAE J1708/J1587, the cabling shall meet the requirements of SAE J2496.*

Network access points shall be located as specified by the Procuring Agency in the corresponding worksheet.

5.5.5.4.3.1.2 Integration With Other Networks

*If selected, complete Worksheet: 5.5.5.4.4.1.*

There shall be a gateway installed between the Information Level network and all other vehicle networks.

The gateway(s) shall provide a translation between network protocols of information specified in the worksheet; and a filter to prevent overloading of any network level, and to prevent network transmissions to the Drivetrain Level.

5.5.5.4.3.2 Electronics (Radio) Box

*If selected, complete Worksheet: 5.5.5.4.4.2.*

A location shall be provided for installing Information Level equipment, including the radio. The Electronics Box shall be located as agreed upon between the Procuring Agency and vehicle manufacturer. It shall be sealed against moisture from road spray or washing equipment if located in an exposed area. This location shall provide:

1) securable sliding mounting rack(s) that can accommodate a minimum of three (3) components with component dimensions of 17”x 24”x 6”
2) supplied “clean” power as specified in the corresponding worksheet
3) VAN network connection (if pre-wired)
4) keyed access as specified in the corresponding worksheet

5.5.5.4.3.3 Mobile Data Terminal (MDT)

*If selected, complete Worksheet: 5.5.5.4.4.3.*

The MDT shall consist of a display area, input keys, and shall be mounted in accordance with sections 5.4.6.1.3 and 5.4.6.1.5. The MDT shall be of sturdy construction and sealed against moisture from washing equipment.
5.5.5.4.3.4 Radio

*If selected, complete Worksheet: 5.5.5.4.4.*

The radio includes an operator speaker, handset and cradle, and shall be programmable with multiple channels. A location convenient to the operator shall be provided for the radio control head, speaker, handset, and cradle. The location shall conform to SAE Recommended Practice J287 “Driver Hand Control Reach.”

Provisions for attaching an antenna to the roof and routing an antenna lead to the radio compartment shall be provided. Antenna mounting shall conform to the electromagnetic suppression requirements of SAE J551. A roof mounted radio antenna requires a ground plane to prevent electronic noise being generated inside the vehicle. A metal roof can serve as a sufficient ground plane, however a fiberglass roof requires either a metallic surface, or an antenna with a virtual ground plane. To test and repair antenna connections, quick access shall be provided inside the vehicle at the point where the antenna is mounted to the roof and where the antenna cable attaches to the antenna.

5.5.5.4.3.5 External Route Display (ERD)

*If selected, complete Worksheet: 5.5.5.4.5.*

An ERD shall provide capabilities for front, side, and rear signs, and will meet all applicable Federal ADA requirements. The ERD shall be installed into the vehicle as specified in Section 5.4.9.1.

The front sign shall have a displayable area no less than 8”h by 50”w, and allow display of at least 12 alphanumeric characters of 7” height. The side sign shall have a displayable area no less than 2.7”h by 30”w, and allow display of at least 12 alphanumeric characters of 2.5” height. If optional curtain type signs are not selected, the rear sign shall have a displayable area no less than 6”h by 11”w, and allow display of at least 4 alphanumeric characters of 5” height.

An optional “Block” sign can be specified for placement on the dash. If selected it shall be capable of displaying at least four alphanumeric characters of 4” height.

A complete listing of sign messages, for initial configuration by the manufacturer, is provided in attachments to Part 5: Technical Specifications.

Baseline signs will be of electronic design, with the following requirements.

1. The bus “Master Run” switch shall control power to the ERD, and shall be operable in all switch positions except "Off". After the “Master Run” switch is placed in the “Off” position, all signs shall blank within 30 seconds, before powering down.

2. An emergency message may be specified by the Procuring Agency, which will only be displayed on exterior signs and not the HMI, initiated by method(s) specified by the procuring Agency, and reset by method(s) as specified by the Procuring Agency in Worksheet 5.5.5.4.4.8

3. Via the sign programming software, each sign shall be separately configurable, with an option for all signs to be consistently configured from a single alphanumeric message. Signs shall have alternating message capability with selectable transition effects.
4. The front sign shall have pixel elements of at least 16 rows by 105 columns. The side sign shall have pixel elements of at least 7 rows by 80 columns. The rear sign shall have pixel elements of at least 7 rows by 23 columns.

5. LEDs and LCDs shall not fade or discolor for the life of the coach, and shall have a rated life of at least 100,000 hours.

Optionally, signs can be of a curtain design. If curtain signs are selected, selections for front and side signs shall be powered and controlled with a switch conveniently located near the inspection window of each sign or shall be manually operated. The switch on the side sign shall be capable of being deactivated from the operator’s compartment. Each sign box or housing shall have an inspection window for the operator to monitor sign selection.

5.5.5.4.3.6 Voice Annunciation and Signage System (VASS)

*If selected, complete Worksheet: 5.5.5.4.4.6.*

The VASS system shall be capable of providing visual and audible announcements that meet all applicable “Federal ADA” requirements. There shall be a capability to make announcements both inside and outside the vehicle by utilizing the Public Address System (section 5.5.5.4.3.9). The Passenger Stop Sign (section 5.5.5.4.3.7) may be integrated with the VASS to minimize the number of onboard customer information displays. Automatic gain control shall be provided both internally and externally to adjust audio volume based on ambient noise levels. At least one internal sign shall be visible from any passenger area inside the vehicle.

The VASS usually requires some form of on-board AVL, and shall not duplicate this functionality if it is already provided by another on-board AVL system.

5.5.5.4.3.7 Passenger Stop Request Sign

*If selected, complete Worksheet: 5.5.5.4.4.7.*

Specific requirements for touch tape, pull cord and push button activated Passenger Stop Request Signs are defined in Section 5.4.9.3.

A "Stop Requested" message in red letters shall be illuminated when the passenger "Stop Requested" signal system is activated. The message shall remain visible until one or both passenger doors are opened. The message shall be visible to the seated operator and seated passengers. As an option, this sign could be integrated with other passenger displays.

The operator shall be able to deactivate the signal system from the operator’s area. A green light shall be mounted above the rear door, approximately on center of the rear door actuator compartment access panel, to indicate when the rear doors have been unlocked.

5.5.5.4.3.8 Covert Emergency Alarm

*If selected, complete Worksheet: 5.5.5.4.4.8.*
The Covert Emergency Alarm is for the operators use in dangerous situations. The alarm can be integrated with many of the Information Level components: the radio can transmit audio from a listen-in microphone as well as location data from the AVL; the External Route Display can signal an emergency; and the CCTV can tag and save recordings.

5.5.5.4.3.9 Public Address System (PA)

*If selected, complete Worksheet: 5.5.5.4.4.9.*

A public address system shall be provided that complies with the ADA requirements of 49 CFR, Part 38.35 and enables the operator to address passengers either inside or outside the bus. Inside speakers shall broadcast, in a clear tone, announcements that are clearly perceived from all seat positions at approximately the same volume level. A speaker shall be provided so announcements can be clearly heard by passengers standing outside the bus near the front door. An operator-controlled switch shall select inside or outside announcements. A separate volume control shall be provided for the outside system if volume adjustment would otherwise be necessary when switching from inside to outside. The system shall be muted when not in use. A provision shall be provided to secure the microphone in a stored position when not in use. An input jack and mounting clip shall be provided in the operator's area for a hand held microphone.

Additional requirements for the PA system are defined in attachments to Part5: Technical Specifications.

<table>
<thead>
<tr>
<th>θ Baseline: Flexible gooseneck microphone.</th>
</tr>
</thead>
<tbody>
<tr>
<td>The microphone shall be vandal resistant, mounted on a heavy-duty, flexible gooseneck, which is secured with tamper-proof fasteners and will allow the operator to comfortably speak into it without using his/her hands.</td>
</tr>
</tbody>
</table>

| θ Alternative: Built-in, hands-free microphone. |

5.5.5.4.3.10 Automatic Vehicle Location (AVL)

*If selected, complete Worksheet: 5.5.5.4.4.10.*

The on-board AVL system shall calculate current location data, and provide that information to the network at a specified interval, from the time a vehicle leaves the garage to when it returns to the garage. A Global Positioning Satellite (GPS) system shall be used as one source of location input. The AVL system should provide at least one other location referencing method, such as dead reckoning (odometer), gyroscope, and/or signposts. The system shall be able to provide accurate location data when traveling through all environments, including urban canyons and dense tree coverage.

*NOTE: All on-board AVL systems require an extensive back-end system to configure and update the scheduled route information. This should be a consideration in the selection of an AVL system.*
If more than one on-board system is location driven, only one shall be designated as the master.

5.5.4.3.11 Automatic Passenger Counter (APC)
*If selected, complete Worksheet: 5.5.4.4.11.*

The APC shall be capable of providing passenger counts, both ingress and egress, for every passenger doorway.

5.5.4.3.12 Automated Fare Collection (AFC)
*If selected, complete Worksheet: 5.5.4.4.12.*

An AFC system shall be capable of storing cash and/or electronic payment transaction data. In the case of electronic payment, the AFC shall be capable of reading from and writing to the fare media.

A 15-amp minimum, specified on Worksheet 5.5.4.4.12, DC, protected circuit shall be available to power the fare box. This power service shall include a grounded lead with both wires enclosed in a flexible conduit. Installation requirements for the AFC shall be as specified in Section 5.4.4.7.

5.5.4.3.13 Closed Circuit TV (CCTV)
*If selected, complete Worksheet: 5.5.4.4.13.*

The CCTV system shall include cameras, control system, and a recording storage device. The number of cameras and their location shall be specified in the Worksheet. The system shall have the capability of marking and saving an event as specified by the Procuring Agency. The system module shall be located in a secured location.

The vehicle shall be equipped with a sufficient number of cameras (no less than two) to allow continuous monitoring of the vehicle. The cameras shall be mounted to provide a clear view of the entire passenger compartment, and be protected to prevent tampering and vandalism.

The system shall have a recording capacity of no less than 72 hours and shall be programmable to automatically tag events, such as panic button activation or a hard deceleration/impact. Tagged events shall be stored, and when a recording is retrieved the tagged events shall be easily identifiable.

5.5.4.3.14 Transit Signal Priority (TSP)
*If selected, complete Worksheet: 5.5.4.4.14.*

The Procuring Agency must specify the TSP component model. TSP will only work in an area where the necessary equipment is specified and allowed by regional Traffic Engineers.
5.5.5.4.3.15 Wireless Area Network (WAN)

*If selected, complete Worksheet: 5.5.5.4.4.15.*

The Information Level network shall extend from the vehicle to a remote location. This is frequently done by using low-power radios, or by using an infrared communications system. The purpose of the WAN is to offload collected operational data and/or to upload new configuration data such as schedules and audio/visual messages. By definition, the WAN shall have no interfaces, except as a link between the Information Level network and the remote location.

5.5.5.4.4 Information Level Components Worksheets

*Note: The specification of brand name and model is for the purpose of illustrating the functionality required, and shall be in all cases deemed to include the phrase "Or Approved Equal."*
5.5.5.4.4.1 Vehicle Area Network (VAN)

**Baseline:** SAE J1708/J1587

**Alternative:** CAN based networks (select one)
- DeviceNet (IEC – 62026)
- LonWorks (IEEE – 1473-L)
- SAE J1939
- SAE J2284 High Speed CAN
- SAE J2411 Single Wire CAN

**Alternative:** TCP/IP

**Other Alternative:** Specified: __________________________

**Baseline:** SAE J2496 cabling with Device Access Boxes (DABs) at the following specified locations (check only those required):
- Inside Radio/Electronics Box
- Inside Dash Area
- Front Overhead Sign Compartment
- Above Front Door
- Above Rear Door
- Others: ____________________________________________

**Alternative:** Other pre-wired.

Specify cable type: ____________________________________________

With connections at the following specified locations:
- Inside Electronics Box
- Inside Dash Area
- Front Overhead Sign Compartment
- Above Front Door
- Above Rear Door
- Others: ____________________________________________

**Alternative:** Not pre-wired

**Baseline:** Gateway(s) between Information Level and
- Multiplex Level (Attach translation requirements)
- Drivetrain Level (Attach translation requirements)

**Alternative:** No gateway(s) installed
5.5.5.4.4.2 Electronics (Radio) Box

<table>
<thead>
<tr>
<th><strong>Baseline:</strong></th>
<th>Interior Location</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Alternative:</strong></td>
<td>Exterior Location. Corrosion and weather-proof</td>
</tr>
</tbody>
</table>

**Power:**

- 0 12V required
- 0 24V required
- 0 Either 12V and 24V

**Ignition-run switch:**

- 0 battery

AND

<table>
<thead>
<tr>
<th><strong>Baseline:</strong></th>
<th>Keyed</th>
</tr>
</thead>
</table>

- Specify model and key number:

**Alternative:** Not Keyed

5.5.5.4.4.3 Mobile Data Terminal (MDT)

<table>
<thead>
<tr>
<th><strong>Specified Name &amp; Model:</strong></th>
<th>_____________________________</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Or Specifications Attached:</strong></td>
<td></td>
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</tbody>
</table>

AND

<table>
<thead>
<tr>
<th><strong>Provided by Procuring Agency:</strong></th>
<th></th>
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</thead>
<tbody>
<tr>
<td><strong>Or Provided by Vendor:</strong></td>
<td></td>
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</tbody>
</table>
5.5.5.4.4.4 **Radio**

<table>
<thead>
<tr>
<th>Specified Name &amp; Model</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Or Vendor Provided</td>
</tr>
</tbody>
</table>

**Baseline:** The radio is controlled by a networked component

**Alternative:** The radio is not controlled by a networked component

**Antenna**

<table>
<thead>
<tr>
<th>Specified Name &amp; Model</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Or Vendor Provided</td>
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</table>

**Antenna Cable**

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<thead>
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</tr>
</thead>
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<tr>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Or Vendor Provided</td>
</tr>
</tbody>
</table>

**Baseline:** Human Machine Interface (HMI) provided by other networked component

**Alternative:** Separate HMI

<table>
<thead>
<tr>
<th>Specified Name &amp; Model</th>
<th>Or Additional Specifications Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>AND</strong></td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Or Provided by Vendor</td>
</tr>
</tbody>
</table>

**Alternative:** No HMI
5.5.5.4.4.5 External Route Display (ERD)

- Specified Name & Model: ____________________________
- Or Specifications Attached

AND

- Provided by Procuring Agency
- Or Provided by Vendor

- **Baseline:** The ERD is networked
- **Alternative:** The ERD is not networked
- **Alternative:** Curtain style ERD

- **Baseline:** Electronic Block Number Sign
- **Alternative:** Manual Block Number Sign
- **Alternative:** No Block Number Sign is required

- **Baseline:** Programmable via network messages and also via plug-in module

- **Alternative:** Programmable via specified: (Choose all that are required)
  - Network
  - Contact-less Device
  - PC Card
  - Plug-In Device
  - Chip replacement

- **Baseline:** Vendor provided plug-in devices for programming and/or diagnosing
  - Quantity: ____________________________

- **Alternative:** No required devices
5.5.5.4.4.6 Voice Annunciation And Signage System (VASS)

<table>
<thead>
<tr>
<th>Specified Name &amp; Model:</th>
<th>Other networked component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline:</td>
<td>Alternative:</td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Provided by Vendor</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Voice Annunciation And Signage System (VASS)</th>
<th>Specified Name &amp; Model:</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline: The VASS is networked</td>
<td>Or Specifications Attached</td>
</tr>
<tr>
<td>Alternative: The VASS is not networked</td>
<td>Provided by Procuring Agency</td>
</tr>
<tr>
<td>Provided by Vendor</td>
<td>Or Provided by Vendor</td>
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<table>
<thead>
<tr>
<th>Human Machine Interface (HMI) provided by other networked component</th>
<th>Manual Network Override</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline:</td>
<td>Alternative:</td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Provided by Vendor</td>
</tr>
<tr>
<td>Or Provided by Vendor</td>
<td>Or Provided with VASS</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Separate HMI</th>
<th>Specified Name &amp; Model:</th>
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<td>Provided by Procuring Agency</td>
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<tr>
<td>Provided by Vendor</td>
<td>Or Provided by Vendor</td>
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</table>

<table>
<thead>
<tr>
<th>No HMI</th>
<th>Provided by Procuring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative:</td>
<td>Provided by Vendor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Programmable via network messages and also via plug-in module</th>
<th>Provided by Procuring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline: Programmable via specified: (Choose all that are required)</td>
<td>Alternative: No required devices</td>
</tr>
<tr>
<td>Network</td>
<td>Provided by Procuring Agency</td>
</tr>
<tr>
<td>Contact-less Device</td>
<td>Or Provided by Vendor</td>
</tr>
<tr>
<td>PC Card</td>
<td>Or Provided with VASS</td>
</tr>
<tr>
<td>Plug-In Device</td>
<td>Or Provided with VASS</td>
</tr>
<tr>
<td>Chip replacement</td>
<td>Or Provided with VASS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Vendor provided plug-in devices for programming and/or diagnosing</th>
<th>Provided by Procuring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline:</td>
<td>Alternative:</td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Provided by Vendor</td>
</tr>
<tr>
<td>Or Provided by Vendor</td>
<td>Or Provided with VASS</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Quantity</th>
<th>Provided by Procuring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative:</td>
<td>Provided by Vendor</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>No required devices</th>
<th>Provided by Procuring Agency</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alternative:</td>
<td>Provided by Vendor</td>
</tr>
</tbody>
</table>

| Provided by Procuring Agency | Or Provided by Vendor |

| Or Provided with VASS | Or Provided with VASS |

| Or Provided with VASS | Or Provided with VASS |
5.5.5.4.4.7  Passenger Stop Request Sign

θ Specified Name and Model: ________________________________
θ Or Specifications Attached

AND

θ Provided by Procuring Agency
θ Or Provided by Vendor

θ Baseline: Is networked
θ Alternative: Is not networked

5.5.5.4.4.8  Covert Emergency Alarm

θ Specified Name & Model: ________________________________
θ Or Specifications Attached

AND

θ Provided by Procuring Agency
θ Or Provided by Vendor

θ Baseline: Is networked
θ Alternative: Is not networked

Specify other components to respond to Covert Emergency Alarm:

______________________________________________________

Specify the method and/or sequence of events required to enable/activate an emergency alarm.

______________________________________________________

Specify the method and/or sequence of events required to disable an activated emergency alarm.

______________________________________________________
5.5.5.4.4.9 Public Address System (PA)

<table>
<thead>
<tr>
<th>Specified Name &amp; Model: ________________________________</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>AND</td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Provided by Vendor</td>
</tr>
</tbody>
</table>

**Baseline:** The PA is networked

**Alternative:** The PA is not networked

**Baseline:** Human Machine Interface (HMI) provided by other networked component

| Manual Network Override |

**Alternative:** Separate HMI

<table>
<thead>
<tr>
<th>Specified Name &amp; Model: ________________________________</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
<tbody>
<tr>
<td>AND</td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td>Provided by Vendor</td>
</tr>
</tbody>
</table>

**Alternative:** No HMI

**Baseline:** Programmable via network messages and also via plug-in module

**Alternative:** Programmable via specified: (Choose all that are required)

- Network
- Contact-less Device
- PC Card
- Plug-In Device
- Chip replacement

**Baseline:** Vendor provided plug-in devices for programming and/or diagnosing

Quantity: ________________________________

**Alternative:** No required devices
5.5.5.4.4.10  Automatic Vehicle Location (AVL)

<table>
<thead>
<tr>
<th>Specified Name &amp; Model: ____________________________</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
</table>

**AND**

<table>
<thead>
<tr>
<th>Provided by Procuring Agency</th>
<th>Or Provided by Vendor</th>
</tr>
</thead>
</table>

**Baseline:** The AVL is networked

**Alternative:** The AVL is not networked

<table>
<thead>
<tr>
<th>Human Machine Interface (HMI) provided by other networked component</th>
</tr>
</thead>
<tbody>
<tr>
<td>Manual Network Override</td>
</tr>
</tbody>
</table>

**Baseline:** Separate HMI

**Alternative:** Separate HMI

<table>
<thead>
<tr>
<th>Specified Name &amp; Model: ____________________________</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
</table>

**AND**

<table>
<thead>
<tr>
<th>Provided by Procuring Agency</th>
<th>Or Provided by Vendor</th>
<th>Or Provided with AVL</th>
</tr>
</thead>
</table>

**Baseline:** Programmable via network messages and also via plug-in module

**Alternative:** Programmable via specified: (Choose all that are required)

- Network
- Contact-less Device
- PC Card
- Plug-In Device
- Chip replacement

**Baseline:** Vendor provided plug-in devices for programming and/or diagnosing

| Quantity: ____________________________ |

**Alternative:** No required devices
5.5.5.4.4.11  Automatic Passenger Counter (APC)

<table>
<thead>
<tr>
<th>Specified Name &amp; Model:</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
</table>

AND

<table>
<thead>
<tr>
<th>Provided by Procuring Agency</th>
<th>Or Provided by Vendor</th>
</tr>
</thead>
</table>

**Baseline:** The APC is networked

**Alternative:** The APC is not networked

**Baseline:** Human Machine Interface (HMI) provided by other networked component

- Manual Network Override

**Alternative:** Separate HMI

<table>
<thead>
<tr>
<th>Specified Name &amp; Model:</th>
<th>Or Specifications Attached</th>
</tr>
</thead>
</table>

AND

<table>
<thead>
<tr>
<th>Provided by Procuring Agency</th>
<th>Or Provided by Vendor</th>
<th>Or Provided with APC</th>
</tr>
</thead>
</table>

**Alternative:** No HMI

**Baseline:** Programmable via network messages and also via plug-in module

**Alternative:** Programmable via specified: (Choose all that are required)

- Network
- Contact-less Device
- PC Card
- Plug-In Device
- Chip replacement

**Baseline:** Vendor provided plug-in devices for programming and/or diagnosing

<table>
<thead>
<tr>
<th>Quantity:</th>
</tr>
</thead>
</table>

**Alternative:** No required devices
5.5.5.4.4.12 Automated Fare Collection (AFC)

- Specified Name & Model: ________________________________
- Or Specifications Attached
- 12V required
- 24V required
- 12 and 24V DC

AND

- Provided by Procuring Agency
- Or Provided by Vendor

Baseline: The AFC is networked

Baseline: Human Machine Interface (HMI) provided by other networked component
  - Manual Network Override

Alternative: Separate HMI
  - Specified Name & Model: ________________________________
  - Or Specifications Attached

AND

- Provided by Procuring Agency
- Or Provided by Vendor
- Or Provided with AFC

Alternative: No HMI

Baseline: Programmable via network messages and also via plug-in module

Alternative: Programmable via specified: (Choose all that are required)
  - Network
  - Contact-less Device
  - PC Card
  - Plug-In Device
  - Chip replacement

Baseline: Vendor provided plug-in devices for programming and/or diagnosing
  Quantity: ________________________________

Alternative: No required devices
5.5.5.4.4.13 Closed Circuit TV (CCTV)

- Specified Name & Model: ____________________________
- Or Additional Specifications Attached

AND

- Provided by Procuring Agency
- Or Provided by Vendor

- **Baseline:** The CCTV is networked
- **Alternative:** The CCTV is not networked

**Baseline:** Human Machine Interface (HMI) provided by other networked component
- Manual Network Override

**Alternative:** Separate HMI
- Specified Name & Model: ____________________________
- Or Specifications Attached

AND

- Provided by Procuring Agency
- Or Provided by Vendor
- Or Provided with CCTV

**Alternative:** No HMI

**Baseline:** Programmable via network messages and also via plug-in module

**Alternative:** Programmable via specified: (Choose all that are required)
- Network
- Contact-less Device
- PC Card
- Plug-In Device
- Chip replacement

Specify the number of cameras, and for each camera provide a description of the desired view or provide a sketch showing the camera location.

- **Baseline:** An adequate number of decals/signs notifying passengers of surveillance cameras on-board shall be installed in plain view throughout the bus.

**Alternative:** No decals/signs installed.
<table>
<thead>
<tr>
<th><strong>Baseline:</strong> Vendor provided plug-in devices for programming and/or diagnosing</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Quantity:</strong></td>
<td></td>
</tr>
</tbody>
</table>

| **Alternative:** No required devices |  |
### 5.5.5.4.4.14 Transit Signal Priority (TSP)

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Specified Name &amp; Model:</td>
<td>____________________________</td>
</tr>
<tr>
<td>Or Specifications Attached</td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td></td>
</tr>
<tr>
<td>Or Provided by Vendor</td>
<td></td>
</tr>
</tbody>
</table>

- **Baseline:** The TSP is networked
- **Alternative:** The TSP is not networked

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline: Human machine Interface (HMI) provided by other networked component</td>
<td></td>
</tr>
<tr>
<td>Manual Network Override</td>
<td></td>
</tr>
<tr>
<td>Alternative: Separate HMI</td>
<td></td>
</tr>
<tr>
<td>Specified Name &amp; Model:</td>
<td>____________________________</td>
</tr>
<tr>
<td>Or Specifications Attached</td>
<td></td>
</tr>
<tr>
<td>AND</td>
<td></td>
</tr>
<tr>
<td>Provided by Procuring Agency</td>
<td></td>
</tr>
<tr>
<td>Or Provided by Vendor</td>
<td></td>
</tr>
<tr>
<td>Or Provided with TSP</td>
<td></td>
</tr>
<tr>
<td>Alternative: No HMI</td>
<td></td>
</tr>
</tbody>
</table>

- **Baseline:** Programmable via network messages and also via plug-in module
- **Alternative:** Programmable via specified: (Choose all that are required)
  - Network
  - Contact-less Device
  - PC Card
  - Plug-In Device
  - Chip replacement

<table>
<thead>
<tr>
<th>Specification</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Baseline: Vendor provided plug-in devices for programming and/or diagnosing</td>
<td></td>
</tr>
<tr>
<td>Quantity:</td>
<td>____________________________</td>
</tr>
<tr>
<td>Alternative: No required devices</td>
<td></td>
</tr>
</tbody>
</table>

*Technical Specifications - 07/03/01*
5.5.5.4.4.15 Wireless Area Network (WAN)

| Specified Name & Model: ____________________________ | Or Specifications Attached |

AND

| Provided by Procuring Agency | Or Provided by Vendor |

| Baseline: Programmable via network messages and also via plug-in module |

| Alternative: Programmable via specified: (Choose all that are required) |
| Network |
| Contact-less Device |
| PC Card |
| Plug-In Device |
| Chip replacement |

| Baseline: Vendor provided plug-in devices for programming and/or diagnosing |
| Quantity: ____________________________ |

| Alternative: No required devices |
### 5.5.6 CENTRAL DATA ACCESS

#### 5.5.6.1 GENERAL

Central Data Access is a concept where data from several on-board communications networks and non-networked devices are accessible at one location. Making data available at a single location assists the Procuring Agency in uploading and downloading data/software, simplifies the process of sharing data between electronic systems and devices, and assists with fault detection and diagnostics.

Central Data Access could be accomplished in one of two ways. One option is through the use of physical connector port(s) where individual networks/devices are accessed at one location. The other is accomplished through a centrally located microprocessor-based device such as an on-board personal computer.

*NOTE: Central Data Access is a new concept in its early stages of development. It is not a proven practice. As a result, it is not feasible to describe in detail the specifications that could be used by a Procuring Agency. Instead, this section will serve as a knowledge platform to help promote the design and implementation of a future system that will simplify access to data and help facilitate electronic integration. This section addresses known parameters without limiting the application of new technology. Additional information on centralized data access can be found in Appendix D.*

The figure below illustrates the concept of Central Data Access.
5.5.6.2 CONNECTOR PORT OPTION

The connector port option is an extension of what is already provided on transit vehicles today. Presently, all vehicles have a large assortment of connector ports in multiple locations throughout the vehicle with which to access diagnostic and online information (i.e., from the engine, transmission, multiplexing, HVAC, doors, etc.). This option is capable of bringing all of the connector ports to a central location for easy access. This could be achieved by replacing the existing ports, or by running another set of parallel ports to one central location. Once positioned at a central location, the ports could remain as individual ports or be merged into one standardized connector adopted by the industry. A laptop computer or diagnostic reading device could then be used to access the required diagnostic or logged data/information from this one location.

5.5.6.3 MICROPROCESSOR-BASED OPTION

In a physical sense, the microprocessor-based approach is an extension of the connector port option, where the microprocessor-based device (i.e., PC) is connected to all communications ports on-board the vehicle. Most electronic devices and systems provide some type of computer interface; therefore, implementing a microprocessor-based device becomes an extension of what is already provided today. The device could be a ruggedized computer with or without a monitor, keyboard and mouse.

5.5.7 RESPONSIBILITIES FOR SYSTEMS INTEGRATION & TESTING

5.5.7.1 GENERAL

This section identifies the responsibilities of the Procuring agency, vehicle manufacturer and subsystem supplier or other third party integrator concerning the integration and testing of electronic equipment.

Upon bid award, the vehicle manufacturer shall provide to the Procuring Agency, preferably in PDF format, a representation of the multiplex logic program. The Procuring Agency will return to the vehicle manufacturer any required markups or corrections to the multiplex logic not later than 90 days prior to the start of production. The vehicle manufacturer shall bear the responsibility of ensuring that the Procuring Agency’s logic requirements will result in the safe operation of the vehicle, and shall make the Procuring Agency aware of any inconsistencies regarding normal vehicle operations.
5.5.7.2  PROCURING AGENCY'S RESPONSIBILITIES

The Procuring Agency shall provide softcopy of the complete Section 5 technical specification to the vehicle manufacturer in PDF format. Hardcopy is optional.

Upon request from the vehicle manufacturer, the Procuring Agency shall be responsible for providing, at least 30 days prior to bid closure, technical specifications that contain a clear and concise description of the operational and functional requirements expected from the multiplex system and the integration of Procuring Agency-specified electronic systems and components. Any changes to such electronic systems or components shall be communicated to the vehicle manufacturer not less than 120 days before start of production (including initial production, subsequent lots, or exercise of options). If needed, the Procuring Agency shall ensure that contact information is provided to both the subsystem supplier and the vehicle manufacturer.

5.5.7.3  MANUFACTURER'S ROLE AND RESPONSIBILITY

5.5.7.3.1  Specification Adherence

The vehicle manufacturer shall analyze and become familiar with the Procuring Agency's specifications, functional requirements and vehicle operational characteristics, as described in Section 5, herein.

When the integration requirements and specifications requested by the agency have not been engineered into a previous vehicle configuration, the vehicle manufacturer shall inform the agency. The vehicle manufacturer shall then create for its own purposes the necessary design requirements and performance specifications that will insure integration of the product(s) needed to achieve the functional requirements as specified by the Procuring Agency.

5.5.7.3.2  Requirement Analysis

Based upon the analysis of the Procuring Agency's requirements, the vehicle manufacturer shall provide the subsystem requirements to the subsystem supplier as may be needed to ensure proper functioning of those subsystems and their integration with other vehicle subsystems. (i.e., Procuring Agency specifications and/or manufacturer’s specific requirements)

Upon request by the subsystem supplier, the vehicle manufacturer shall provide a complete softcopy (hardcopy is optional) specification, PDF format.
5.5.7.3.3 Inspection & Approval

Prior to inspection, approval and installation of the subsystem integration, the vehicle manufacturer shall obtain the written approval from all subsystem suppliers that their products meet, and are being installed in accordance with, all applicable integration and interface requirements and that the product(s) installed will function properly as intended.

The vehicle manufacturer shall demonstrate proper integration of all on-board subsystems in accordance with the Procuring Agency's specification requirements.

Should manufacturing requirements and/or additional changes requested by the Procuring Agency that affect the installation and integration of the subsystem occur after initial approval, the sub-system supplier or third party integrator shall be notified and again have the opportunity to inspect such changes, and sign off and approve changes that may effect their systems.

5.5.7.4 SUBSYSTEM SUPPLIER OR OTHER THIRD PARTY INTEGRATOR RESPONSIBILITIES

5.5.7.4.1 Qualification Testing and Specification Adherence

The subsystem supplier or third party integrator is responsible for providing products that have been qualified or validated to meet current applicable standards as incorporated in the specification by reference, and for designing the product to integrate into basic vehicle configurations as defined by the vehicle manufacturer.

The subsystem supplier shall be responsible for providing to both the Procuring Agency and the vehicle manufacturer, at least 30 days prior to bid closure, technical specifications that contain a clear and concise description of the operational and functional requirements provided by their system. Any changes to such electronic systems or components shall be communicated to the Procuring Agency and vehicle manufacturer not less than 120 days before start of production (including initial production, subsequent lots, or exercise of options).

The subsystem supplier or other third party integrator shall provide to the Procuring Agency and the vehicle manufacturer the testing and interface information required regarding system integration, or shall be required to demonstrate how system integration was performed.

5.5.7.4.2 Interface Information

Not later than 120 days prior to the start of production, the subsystem supplier or third party integrator shall provide the vehicle manufacturer with the communications interface specifications and installation requirements. The subsystem supplier or third party integrator shall:

1) ensure that the vehicle manufacturer has all necessary documentation, drawings, and/or product information necessary to review product integration
2) provide product samples upon the vehicle manufacturer's request for testing and integration purposes
3) work with vehicle manufacturer on any design changes required to integrate the system into vehicle configuration

5.5.7.4.3 Installation Approval / Sign-Off

Prior to inspection, approval and installation of the subsystem integration, the subsystem supplier shall provide to the vehicle manufacturer written approval that their products meet, and are being installed in accordance with, all applicable integration and interface requirements and that the product(s) installed will function properly as intended.

5.6 ATTACHMENTS TO PART 5, TECHNICAL PROVISIONS

PROCURING AGENCY SPECIFICATIONS

The following is a list of those subsections of Part 5, Technical Specifications, which call for each Procuring Agency to attach additional detail
5.1 GENERAL

5.1.2 Definitions

(20) Design Operating Profile [Procuring Agency can provide additional operating characteristics to expand on the above Design Operating Profile definition]

(21) Class of Failures In attachments to Part 5: Technical Specifications, the Procuring Agency may relate the skill levels and ratings of mechanics in its operation to the above definitions.

(22) Maintenance Personnel Skills In attachments to Part 5: Technical Specifications, the Procuring Agency may relate the skill levels and ratings of mechanics in its operation to the above definitions.

5.1.5 Overall Requirements

5.1.5.4.2.1 Maintenance and Inspection Equipment Any special tools required to maintain the bus shall be provided in quantities as specified in attachments to Part 5: Technical Specifications. Additional requirements for Maintenance and Inspection Equipment are also provided in these attachments. [Shown below is a sample list of such equipment. Items and quantities are suggested. Procuring Agency shall identify additional equipment as required.]

<table>
<thead>
<tr>
<th>Item</th>
<th>Quantity*</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compartment access door keys (5/16&quot; square key)</td>
<td>one per bus</td>
</tr>
<tr>
<td>Radio Box Key (#CH751)</td>
<td>one per bus</td>
</tr>
<tr>
<td>W/C Belt Box Key (#WN03)</td>
<td>one per bus</td>
</tr>
</tbody>
</table>

A minimum of 3 of the following special tools shall be provided plus the number shown on the right.

- Towing adapters 1 per 100 buses
- Jacking adapters 1 per 100 buses
- Break out boxes for engine 1 per 100 buses
- Break out boxes for transmission 1 per 100 buses
- Destination sign PCMCIA programming cards 1 per 100 buses
- Engine tune up kit including belt tension gauge, seal installers/removers, injector timing gauge, valve lash gauges, etc 1 per 100 buses
- Wheel alignment tools 1 per 100 buses
- Handheld diagnostic readers w/ printers for engine 1 per 50 buses
- Handheld diagnostic readers for transmission 1 per 50 buses
- Diagnostic readers for HVAC system 1 per 50 buses
- Portable hand held readers for troubleshooting of the multiplex system 1 per 50 buses

*Fractional quantities shall be rounded up to nearest whole number.

5.1.5.5 Operating Environment Procuring Agency may include additional details of operating environment including climatic and service/duty conditions.

PROPULSION SYSTEM

5.2.2 Drivetrain

5.2.2.1 Power Plant
5.2.2.1.1 Engine: The requirements for specific cold weather starting aids are included in attachments to Part 5: Technical Specifications

5.2.2.2 Mounting

5.2.2.2.1 Service: An oil sampling and fill provision compatible with the Procuring Agency’s equipment and defined in attachments to Part 5: Technical Specifications, shall be included in the engine compartment.

5.2.2.2.3 Hydraulic Systems (Alternative): Specific systems for which low hydraulic fluid level sensors are required are included in attachments to Part 5: Technical Specifications.

5.3 CHASSIS

5.3.1 Suspension

5.3.1.2.3 Lubrication: Additional requirements for lubrication are contained in Attachments to Part 5: Technical Specifications.

5.3.4 Pneumatic System

5.3.4.1 General: A quick disconnect fitting specified in attachments to Part 5: Technical Specifications shall be easily accessible and located in the engine compartment and near the front bumper area for towing.

5.4 BODY

5.4.1 General

5.4.1.4 Corrosion: Additional requirements for corrosion protection are contained in attachments to Part 5: Technical Specifications.

5.4.3 Exterior Panels and Finishes

5.4.3.1 Alternative: Additional requirements for anti-graffiti/vandalism treatments for exterior surfaces are contained in attachments to Part 5: Technical Specifications

5.4.3.2 Access Doors (with locks): The locks shall be standardized as defined by the Procuring Agency in the attachments to Part 5: Technical Specifications so that only one tool is required to open all major access doors on the bus.

5.4.3.10 Finish And Color: Colors and paint schemes shall be in accordance with the attachments to Part 5: Technical Specifications.

5.4.3.11 Numbering And Signing: The exact wording, size, color, and location for these signs are found with requirements for other special signs in attachments to Part 5: Technical Specifications.

5.4.3.12 Exterior Lighting: Specific number and mounting requirements are defined in attachments to Part 5: Technical Specifications.

5.4.4 Interior Panels and Finishes

5.4.4.1 Alternative: Additional requirements for anti-graffiti/vandalism treatments for interior surfaces are contained in attachments to Part 5: Technical Specifications.
5.4.4.3 Rear End: Colors, patterns, and materials are defined in attachments to Part 5: Technical Specifications.

5.4.4.4 Interior Panels

5.4.4.4.1 General: Colors, patterns, and materials for the interior trim are defined in attachments to Part 5: Technical Specifications.

5.4.4.4.5 Headlining: Colors, patterns, and materials for the headlining are defined in attachments in Part 5: Technical Specifications.

5.4.4.5 Floor Covering: Color and material of the floor covering is defined in attachment to Part 5: Technical Specifications.

5.4.4.7 Fare Collection: The fare box, including make, model, size, weight, and meter locations, is described in attachments to Part 5: Technical Specifications. Transfer equipment is also defined in attachments to Part 5: Technical Specifications.

5.4.5 Passenger Accommodations

5.4.5.1 Passenger Seating

5.4.5.1.1 Bid Evaluation Factor Procuring Agency may include bid evaluation factor here. Suggested wording is shown below:

A bid evaluation factor in the amount of $________ per seated passenger position will be considered to encourage maximized seating. For each seated passenger position provided above the required minimum capacity specified above, $________ will be deducted from the bidder’s proposed price per bus so long as seating layout and installation is in conformance to all requirements stated herein. Note that this shall only be for purposes of bid evaluation.

5.4.5.1.4 Construction and Materials: Color of the seat material and optional safety padding is defined in attachments to Part 5: Technical Specifications.

5.4.5.4 Accessibility Provisions

5.4.5.4.1 General: Specific requirements, including the number of wheelchairs to be accommodated, the tiedown and securement devices, and fold-down seats, are provided in attachments to Part 5: Technical Specifications.

5.4.6 Operator Provisions

5.4.6.1 Operator’s Area

5.4.6.1.1 General: Additional provisions for operator’s area are included in attachments to Part 5: Technical Specifications.

5.4.6.5.2 Structure and Materials: Color of the operator’s seat is defined in the attachments to Part 5: Technical Specifications.

5.4.6.6.1 Additional details on exterior mirrors, including size, location and mounting, are contained in Attachments to Part 5: Technical Specifications.
5.4.6.6.2 Additional details on interior mirrors, including size, location and mounting, are contained in Attachments to Part 5: Technical Specifications.

5.4.7 Windows

5.4.7.4.1 Dimensions (Cyclone cleaner opening): Minimum size of this opening is defined in attachment to Part 5: Technical Specifications.

5.4.8 Heating, Ventilating, and Air Conditioning

5.4.8.1 Additional HVAC system and performance requirements are contained in Attachments to Part 5: Technical Specification.

5.4.9.2.1 Interior Displays: Additional requirements for interior advertising are defined in the attachments to Part 5: Technical Specifications.

5.4.9.2.2 Exterior Displays: (Additional requirements for exterior advertising may be defined in the attachments to Part 5: Technical Specifications.)

5.5 ELECTRICAL, ELECTRONIC AND DATA COMMUNICATION SYSTEMS

5.5.3.1.1 Main power supply: provide details of Jump Start connector if required.

5.5.3.1.3 Master Battery Switch: Any equipment that requires power with the master battery switch "off" shall be listed in attachments to Part 5: Technical Specifications.

5.5.3.6 Electrical Components. Procuring Agency to list specific brushless motor requirements.

5.5.3.8 Data Access. Procuring Agency to specify location of communication port(s).

5.5.4.2.5 Power requirements. Specify requirements for a shared DC/DC converter.

5.5.4.3.5 External Route Display (ERD) A complete listing of destination sign readings for initial sign programming by the manufacturer are provided in attachments to Part 5: Technical Specifications. Also complete Worksheet 5.5.5.4.4.8 and 5.5.54.4.5.

5.5.4.3.9 Public Address System: Additional requirements for the PA system are provided. Also see Worksheets 5.5.5.4.4.6 and 5.5.5.4.4.9.

5.5.4.3.13 Closed Circuit TV (CCTV): Complete Worksheet 5.5.5.4.4.13.
5.7 **OFFEROR VEHICLE TECHNICAL INFORMATION**

The Offeror shall submit for review by the Procuring Agency a completely filled-in Vehicle Technical Information form below to confirm his proposed vehicle and components are in compliance with the requirements of Part 5: Technical Specifications.

A. **BUS MANUFACTURER**
   Bus Model ____________________________

B. **UNDERSTRUCTURE MANUFACTURER**
   Model Number _______________________

C. **BASIC BODY CONSTRUCTION**
   1. Type ________________
   2. Tubing or frame member Thickness & Dimensions
      a. Overstructure _____________
      b. Understructure ___________
   3. Skin Thickness and Material
      a. Roof ________________
      b. Sidewall ________________
      c. Skirt Panel ______________
      d. Front End _______________
      e. Rear End _______________

D. **DIMENSIONS**
   1. Overall Length
      a. Over Bumpers _______ Ft. _______ In.
      b. Over Body _______ Ft. _______ In.
   2. Overall Width
      a. Over Body excluding Mirrors _______ In.
      b. Over Body including Mirrors - driving position _______ In.
      c. Over Tires Front Axles _______ In.
      d. Over Tires Rear Axles _______ In.
   3. a. Over all Height (maximum) _______ In.
      b. Overall Height (main roof line) _______ In.
   5. Breakover Angle _______ Deg.
6. Angle of Departure _______Deg.

7. Doorway Dimensions

<table>
<thead>
<tr>
<th></th>
<th>Front</th>
<th>Rear</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Width Between Door Posts</td>
<td>_____ in</td>
<td>_____ in</td>
</tr>
<tr>
<td>B. Door Width Between Panels</td>
<td>_____ in</td>
<td>_____ in</td>
</tr>
<tr>
<td>C. Clear Door Width</td>
<td>_____ in</td>
<td>_____ in</td>
</tr>
<tr>
<td>D. Doorway Height</td>
<td>_____ in</td>
<td>_____ in</td>
</tr>
<tr>
<td>E. Knuckle Clearance</td>
<td>_____ in</td>
<td>_____ in</td>
</tr>
</tbody>
</table>

8. Step Height from Ground (measured at center of doorway)

9. Interior Head Room (center of aisle)
   a. Front Axle Location           _____ In.
   b. Drive Axle Location           _____ In.

10. Aisle Width Between Transverse Seats (minimum)   _____ In.

11. Floor Height Above Ground (centerline of bus)
    a. at Front door                  _____ In.
    b. at Front Axle                  _____ In.
    c. at Drive Axle                  _____ In.
    d. at Rear door                   _____ In.

12. Minimum Ground Clearance (between bus and ground, with bus unkneeded)
    a. Excluding Axles                _____ In.
    b. Including Axles                _____ In.
13. Horizontal Turning Envelope (see diagram below)
   a. Outside Body Turning Radius, TR0 (including bumper) __________ Ft. __________ In.
   b. Front Inner Corner Radius, TR1 __________ Ft. __________ In.
   c. Front Wheel Inner Turning Radius, TR2 __________ Ft. __________ In.
   d. Front Wheel Outer Turning Radius, TR3 __________ Ft. __________ In.
   e. Inside Body Turning Radius, TR4 (including bumper) __________ Ft. __________ In.

14. Wheelbase __________ In.

15. Overhang, Centerline of Axle Over Bumper
   a. Front __________ Ft. __________ In.
   b. Rear __________ Ft. __________ In.

16. Floor
   a. Interior Length __________ Ft. __________ In.
   b. Interior Width (excluding coving) __________ Ft. __________ In.
   c. Total Standee Area __________ Sq. Ft.
   d. Minimum distance between Wheelhouses:
      Front: __________ In.
      Rear: __________ In.
   e. Maximum interior floor slope (from horizontal) __________ Deg.

17. Passenger Capacity Provided
a. Total Maximum Seating
b. Standee Capacity
c. Minimum Knee to Hip Room
   _______In.
d. Minimum Foot Room
   _______In.

E. WEIGHT OF BUS

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<th>No. of People</th>
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<th>Rear Axle</th>
<th>TOTAL BUS</th>
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<tr>
<td>Full Fuel and Farebox</td>
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<td></td>
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</tr>
<tr>
<td>Fully Seated</td>
<td>_______</td>
<td>+ Driver</td>
<td></td>
</tr>
<tr>
<td>Full Fuel and Farebox</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Fully Loaded</td>
<td>_______</td>
<td>+ Driver</td>
<td></td>
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<td>Standee and Fully Seated</td>
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<tr>
<td>Fully Loaded</td>
<td>_______</td>
<td>+ Driver</td>
<td></td>
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<tr>
<td>Full Fuel and Farebox</td>
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<tr>
<td>Crush Load (1.5xFully Loaded)</td>
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<td>GAWR</td>
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<td></td>
<td></td>
</tr>
</tbody>
</table>

F. ENGINE, MAIN

1. Manufacturer

2. Type

3. Model Number

4. No. of Cylinders

5. Bore
   _______In.

6. Stroke
   _______In.

7. Displacement
   _______Cu. In.

8. Compression Ratio

9. Injector Type and Size

10. Net S.A.E. Horsepower
    _______HP at _______RPM

11. Net S.A.E. Torque
    _______lb. ft. at _______RPM

12. Crankcase Oil Capacity
    a. New Engine, dry
       _______gals.
    b. New Engine, wet
       _______gals.

13. Turbocharger, Make & Model

Technical Specifications - 07/03/01
14. Maximum Speed, no load  __________RPM

15. Maximum Speed, full load  __________RPM

16. Speed at Idle  __________RPM
17. Speed at Fast Idle  __________RPM
18. Engine Information/graphs to be attached with this form:

   Engine speed vs. road speed
   Torque vs. engine speed
   Horsepower vs. engine speed
   Fuel consumption vs. engine speed.
   Vehicle speed vs. time  (both loaded and unloaded)
   Vehicle speed vs. grade (both loaded and unloaded)
   Acceleration vs. time
   Change of acceleration vs. time.

G. TRANSMISSION
1. Manufacturer
2. Type
3. Model Number
4. Speeds
5. Gear Ratios  Forward  ___________  Reverse  ___________
6. Shift Speeds
   a. 1st - 2nd  ___________ mph
   b. 2nd - 3rd  ___________ mph
   c. 3rd - 4th  ___________ mph
   d. 4th - 5th (if applicable)  ___________ mph
   e. 5th - 6th (if applicable)  ___________ mph
7. Fluid Capacity  [Including heat exchanger and filter(s)]
                      ___________________________________________________________________

H. VOLTAGE REGULATOR
1. Manufacturer
2. Model

I. VOLTAGE EQUALIZER
1. Manufacturer
2. Model
### J. ALTERNATOR
1. Manufacturer
2. Type
3. Model
4. Output at Idle
5. Output at Maximum Speed
6. Maximum Warranted Speed
7. Speed at Idle
8. Drive Type

### K. STARTER MOTOR
1. Manufacturer
2. Type
3. Model

### L. AIR COMPRESSOR
1. Manufacturer
2. Type
3. Rated Capacity
4. Capacity, at Idle
5. Capacity, at Maximum Speed
6. Maximum Warranted Speed
7. Speed Idle
8. Drive Type
9. Governor
   a) Cut-in Pressure
   b) Cut-Out Pressure

### M. AXLE, FRONT
1. Manufacturer
2. Type
3. Model Number
4. Gross Axle Weight Rating
5. Axle Load
**N. AXLE, REAR**
1. Manufacturer
2. Type
3. Model Number
4. Gross Axle Weight Rating
   __________________ lbs.
5. Axle Load
   __________________ lbs.
6. Axle Ratio

**O. SUSPENSION SYSTEM**
1. Manufacturer
2. Type:
   - Front
   - Rear
3. Springs:
   - Front
   - Rear

**P. WHEELS AND TIRES**
1. Wheels
   a. Make
   b. Size
   c. Capacity
      __________________ lbs.
   d. Material
2. Tires
   a. Manufacturer
   b. Type
   c. Size
   d. Load Range/Air Press.
      __________________ lbs/p.s.i.

**Q. STEERING, POWER**
1. Pump
   a. Manufacturer & Model No.
   b. Type
   c. Relief Pressure
      __________ psi
2. Booster/Gear Box
   a. Manufacturer & Model No.
   b. Type
   c. Ratio
3. Power Steering Fluid Capacity
   __________________ gals
4. Maximum Effort at Steering Wheel
   __________________ lbs
   (unloaded stationary coach on dry asphalt pavement)
5. Steering Wheel Diameter
   __________ in.
R. BRAKES
1. Make of Fundamental Brake System
2. Brake Chambers Vendor's Size & Part No.
   a. Front
   b. Rear
3. Brake Operation Effort
4. Slack Adjuster's Vendor's Type & Part No.
   a. Front
      1) Right
      2) Left
   b. Rear
      1) Right
      2) Left
   c. Length
      1) Front Take-up
      2) Rear Take-up
5. Brake Drums/Discs
   a. Front
      1) Manufacturer
      2) Part Number
      3) Diameter
   b. Rear
      1) Manufacturer
      2) Part Number
      3) Diameter
6. Brake Lining Manufacturer
   Type
7. Brake Lining Identification
   a. Front
      1) Forward
      2) Reverse
   b. Rear
      1) Forward
      2) Reverse
8. Brake Linings Per shoe
   a. Front
   b. Rear
9. Brake Lining Widths
   a. Front
   b. Rear
10. Brake Lining Lengths
    a. Front
    b. Rear
11. Brake Lining Thickness
12. Brake Lining Area Per Axle
a. Front
   ____________Sq. In.
b. Rear
   ____________Sq. In.

S. COOLING SYSTEM
1. Radiator/Charge Air Cooler
   a. Manufacturer
      ____________/___________
   b. Type
      ____________/___________
   c. Model Number
      ____________/___________
   d. Number of Tubes
      ____________/___________
   e. Tubes Outer Diameter
      ____________In./__________In.
   f. Fins Per Inch
      ________ Fins/__________ Fins
   g. Fin Thickness
      ________In./__________In.
2. Total Cooling and Heating System Capacity
   ____________Gals
3. Radiator Fan Speed Control
   ____________Type
4. Surge Tank, Capacity
   ____________Qts.
5. Engine Thermostat Temperature Setting
   a. Initial Opening
      ____________° F
   b. Fully Closed
      ____________° F
6. Overheat Alarm Temperature Sending Unit Setting
   ____________° F
7. Shutdown Temperature Setting
   ____________° F

T. AIR RESERVOIR CAPACITY
1. Supply Reservoir
   ____________Cu. In.
2. Primary Reservoir
   ____________Cu. In.
3. Secondary Reservoir
   ____________Cu. In.
4. Parking Reservoir
   ____________Cu. In.
5. Accessory Reservoir
   ____________Cu. In.
6. Other Reservoir Type
   ____________Cu. In.
## HEATING, VENTILATING AND AIR CONDITIONING EQUIPMENT

1. Heating System Capacity
   
2. Air Conditioning Capacity

3. Ventilating Capacity

4. Compressor
   - Manufacturer & Model
   - No. of Cylinders
   - Drive Ratio
   - Maximum Warranted Speed
   - Operating Speed
   - Weight
   - Oil Capacity
     1. Dry
     2. Wet
   - Refrigerant

5. Condenser
   - Manufacturer & Model
   - No. of Rows
   - No. of Fins/In.
   - O.D. of Tube
   - Fin Thickness

6. Condenser Fan
   - Manufacturer & Model
   - Fan Diameter
   - Speed Maximum
   - Flow Rate (maximum)

7. Receiver
   - Manufacturer & Model
   - Capacity

8. Condenser Fan Drive Motors
   - Manufacturer
   - Model
   - Type
   - Horse Power
   - Operating Speed

9. Evaporator Fan Drive Motors
   - Manufacturer
   - Model
   - Type
   - Horse Power
   - Operating Speed
10. Evaporator(s)
   a. Manufacturer & Model
   b. Number of Rows
   c. No. of Fins/In.
   d. Outer Diameter of Tube
   e. Fin Thickness
   f. Number of Evaporator

11. Expansion Valve
    Manufacturer & Model

12. Filter-Drier
    Manufacturer & Model

13. Heater Cores
    a. Manufacturer & Model
    b. Capacity
    c. Number of Rows
    d. Number of Fins/In.
    e. Outer Diameter of Tube
    f. Fin Thickness
    g. Number of Heater Cores

14. Floor Heater Blowers
    a. Heater Blower Motors
       1) Manufacturer & Model
       2) Horsepower
       3) Speed(s)
    b. Heater Blower Wheel
       Manufacturer & Model
       Capacity
       ___________cfm
    c. Cores
       Manufacturer & Model
       Capacity
       ________B.T.U.
       Number of Rows
       ________
       Number of Fins/In.
       ________Fins
       Outer Diameter of Tube
       ________In.
       Fin Thickness
       ________In.
       Number of Heater Cores
       ________

15. Controls
    a. Manufacturer & Model
    b. Type
16. Driver's Heater
   a. Manufacturer _______________________________________
   b. Model No. _______________________________________
   c. Capacity ______ B.T.U.

17. Ventilation System
   Type _______________________________________

18. Coolant Heater
   Make & Model _______________________________________
   Capacity(B.T.U) _______________________________________

V. INTERIOR LIGHTING
1. Manufacturer _______________________________________
2. Type _______________________________________
3. Number of Fixtures _____________
4. Size of Fixtures _____________
5. Power Pack _____________

W. DOORS
1. Front
   a. Manufacturer of Operating Equipment _______________________________________
   b. Type of Door _______________________________________
   c. Type of Operating Equipment
2. Rear
   a. Manufacturer of Operating Equipment _______________________________________
   b. Type door _______________________________________
   c. Type of Operating Equipment _______________________________________

X. PASSENGER WINDOWS
1. Manufacturer _______________________________________
2. Model _______________________________________
3. Type _______________________________________
4. Number: (Side) _____________
   (Rear) _____________
5. Sizes: _____________ _____________ _____________
6. Glazing: Type _______________________________________
   Thickness _______________________________________
   Color of Tint _______________________________________
   Light Transmission _______________________________________
### Y. MIRRORS

<table>
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<tr>
<th>Part</th>
<th>Size</th>
<th>Type</th>
<th>Manufacturer</th>
<th>Mfg. Part #</th>
<th>Model No.</th>
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<td>Right Side Exterior</td>
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<td>Center Rearview</td>
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<tr>
<td>Front Entrance Area</td>
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<tr>
<td>Upper-Right Hand Corner</td>
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<tr>
<td>Rear Exit Area</td>
<td></td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

### Z. SEATS

1. Manufacturer ____________________________
2. Model ________________________________
3. Type _________________________________

### AA. PAINT

- Manufacturer ____________________________
- Type _________________________________

### BB. WHEELCHAIR RAMP EQUIPMENT

1. Manufacturer & Model No. ____________________________
2. Type _________________________________
3. Capacity ____________ Lbs.
4. Dimensions
   - Width of Platform ________ In.
   - Length of Platform ________ In.
5. System Fluid Capacity ________ Qts.
6. Type Fluid Used ____________
7. Operating Hydraulic Pressure ____________
8. Hydraulic Cylinders ____________ psi
   - Size ____________
   - Number ____________

### CC. WHEELCHAIR SECUREMENT EQUIPMENT

1. Manufacturer & Model No. ____________________________
DD. DESTINATION SIGNS

1. Manufacturer ____________________________
2. Type ____________________________
3. Character Length
   Front Destination ___________ In.
   Front Run Number ___________ In.
   Side Destination ___________ In.
   Rear Route ___________ In.
4. Character Height
   Front Destination ___________ In.
   Front Run Number ___________ In.
   Side Destination ___________ In.
   Rear Route ___________ In.
5. Number of Characters
   Front Destination ___________ In.
   Front Run Number ___________ In.
   Side Destination ___________ In.
   Rear Route ___________ In.
   Rear ___________ In.
6. Message Width
   Front Destination ___________ In.
   Front Run Number ___________ In.
   Side Destination ___________ In.
   Rear Route ___________ In.

DD. ELECTRICAL

1. Multiplex System
   a. Manufacturer ____________________________
   b. Model No. ____________________________

12. Batteries
   a. Manufacturer ____________________________
   b. Model No. ____________________________
   c. Type ____________________________

EE. PASSENGER INTERIOR LIGHTING

Manufacturer ____________________________
Model No. ____________________________

FF. COMMUNICATION SYSTEM

1. GPS
   a. Manufacturer __________________
   b. Model No. __________________

2. P.A. System
   a. Amplifier Manufacturer Model No.
   b. Microphone Manufacturer Model No.
   c. Int. Speakers Manufacturer Model No. (number ___)
   d. Ext. Speaker Manufacturer Model No. (number ___)
APPENDIX A - OPERATING TEMPERATURES FOR HEAVY DUTY TRANSIT BUS COMPONENTS

TEMPERATURE EXTREMES SUMMARY - HEAVY-DUTY TRANSIT BUS (1)

<table>
<thead>
<tr>
<th>Location (2)</th>
<th>Operating Temperature (3, 4)</th>
<th>Storage Temperature (3, 4)</th>
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<tbody>
<tr>
<td></td>
<td>Temperatures MIN</td>
<td>Transit Bus MAX</td>
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<tr>
<td>ENGINE (5):</td>
<td></td>
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<tr>
<td>1a Underhood – Lower</td>
<td>-20 °F</td>
<td>185 °F</td>
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<tr>
<td>1b Underhood – Upper</td>
<td>-20 °F</td>
<td>212°F(5)</td>
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<tr>
<td>1c Underhood – Bulkhead</td>
<td>-20 °F</td>
<td>185 °F</td>
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<tr>
<td>INTERIOR, OCCUPIED:</td>
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</tr>
<tr>
<td>2a Floor (7)</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>2b Instrumental Panels</td>
<td>-20 °F</td>
<td>158 °F(6)</td>
</tr>
<tr>
<td>2c Headliner (7)</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>2d Doors (7)</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>INTERIOR, UNOCCUPIED:</td>
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<tr>
<td>3a Battery Box</td>
<td>-20 °F</td>
<td>158 °F</td>
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<tr>
<td>3b Signage Enclosure</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>3c Enclosure, Other</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>3d Enclosure, Near Engine</td>
<td>-20 °F</td>
<td>185 °F</td>
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<td>CHASSIS:</td>
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<tr>
<td>4a Forward (7)</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>4b Rear (7)</td>
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<td>185 °F</td>
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<td>EXTERIOR:</td>
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</tr>
<tr>
<td>5a Underfloor</td>
<td>-20 °F</td>
<td>158 °F</td>
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<td>5b Rear</td>
<td>-20 °F</td>
<td>158 °F</td>
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<tr>
<td>5c Doors (7)</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
<tr>
<td>5d Top</td>
<td>-20 °F</td>
<td>158 °F</td>
</tr>
</tbody>
</table>

NOTES:
1. This table is based on TABLE 1A in SAE J1455 (AUG94); The J1455 information has been revised for Transit Bus Applications by APTA Electrical Interface Working Group, 2000.
2. See following page for Pictorial Description of Locations.
3. If temperature characterization has been performed on the target vehicle, then the measured temperature may be substituted for the values in the Operating columns of the Table.
4. Maximum ambient temperature may reach 158 °F. Minimum ambient is –40 °F. The MAX Storage temperatures are based on the ambient and an estimate of the effects of thermal soakback.
5. Exhaust Manifold and Turbo surfaces can reach 1500 °F. Mount electronic control units and other electronics at least 18” away from these surfaces and at least 6” away from the Engine unless mounting instructions allow otherwise.
6. Direct Sunlight surface temperature can be 185°F.
7. Suggested limits for areas where no significant data is recorded. See notes above.
TEMPERATURE EXTREME LOCATIONS – HEAVY-DUTY TRANSIT BUS
AREA 1 IS IN ENGINE COMPARTMENT (BUT NOT ON THE ENGINE OR EXHAUST); AREA 2 IS THE OCCUPIED INTERIOR; AREA 3 IS THE UNOCCUPIED INTERIOR; AREA 4 IS THE VEHICLE CHASSIS; AND AREA 5 IS THE EXTERIOR OF THE VEHICLE.
### APPENDIX B - WIRE AMPACITY CHARTS

#### Wire Gauge 0000 - 0

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**Voltage Drop:** 1V

#### Wire Gauge 1 - 18

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**APPENDIX C - SELECTION OF A COMMUNICATION NETWORK**

Technical Specifications - 07/03/01  182
## Protocol Comparisons

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<td>Bus Wire</td>
<td>STP</td>
<td>UTP</td>
<td>UTP - Optional Shield</td>
<td>Single Unshielded</td>
<td>2 STP plus Shield</td>
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<td>Linear w/Stubs (3 pin unshielded)</td>
<td>Non-Linear</td>
<td>SAE J1962</td>
<td>Linear</td>
<td>See DeviceNet Specification</td>
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<td>Max. Bus Voltage</td>
<td>+16 volts</td>
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<td>+16 volts</td>
<td>+11 volt to +25 volt</td>
<td>Physical layer dependent</td>
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<td>(node input)</td>
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<td>Modules that support OBDII requirements must also support 29-bit</td>
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<td>Note 2a</td>
<td>Maximum distance between any two ECUs on the bus, including cable stubs and any off-board node (tool). The maximum distance between any two on-board ECUs is 25 meters (SAE J2284)</td>
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<td>Note 2b</td>
<td>SAE J2284 specifies a unique bus configuration for a single on-board ECU. The maximum distance from DLC (Data Link Connector) and the on-board ECU is 5 meters. Likewise, the maximum distance from the DLC and the off-board node (tester) is 5 meters</td>
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<td>High speed is 80 Kbps. SAE J2411 uses a normal operation baud rate of 40 Kbps. The high-speed mode for the test tool is 80 Kbps, for rapid downloading to modules. Manufacturing, however, may utilize more than one high-speed baud rate for programming various modules</td>
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<td>Note 4</td>
<td>Subnets/domain (255) times nodes/subnet (127) = 32,385 nodes/domain. Domain is a logical collection of nodes on one or more channels</td>
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<td>Note 5</td>
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<td>78Kbps</td>
<td>64/channel</td>
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Selecting a Communications Network

The Guideline Specification strongly encourages the use of an open communications network where the rules, or protocols, that define how messages are coded and transmitted on the network are documented to the public. Closed networks are proprietary in nature because most, if not all, of the communications protocols are restricted to licensed vendors.

The degree to which networks are open or closed depends upon how they interface with seven layers of an Open Systems Interconnection (OSI) reference model developed by the International Standards Organization (ISO). This model was developed to standardize the communication between computer-based systems. A fully open network is one where documentation for all layers is available to the public, while a completely closed network does not publish any of its interface protocols to the public.

The concept of pen networks is important because it allows components from several different manufacturers to be used on the network in a "plug-and-play" fashion, giving agencies a variety of products to choose from at competitive prices. Conversely, components integrated on a closed network may restrict choices and result in higher equipment costs. Additionally, the Procuring Agency may find itself with unsupportable equipment if the vendor should leave the market.

Prior to selecting a network, Procuring Agencies are advised to become aware of its capabilities and limitations. In particular, agencies should determine the extent to which a network is open, and if any network components are proprietary and only available through select vendors. Procuring Agencies are also advised to consider pre-wiring transit buses at time of manufacture with data/power cabling to facilitate future expansion of Information Level components.

The Protocol Comparison Chart shown on the preceding page provides information on essential characteristics of the more common communications networks available today.
APPENDIX D - CENTRAL DATA ACCESS

As described in Section 5.5.6, Central Data Access is a concept where data from several on-board communications networks and non-networked devices are accessible at one location. The intent of this concept is to simplify the process of sharing data between electronic systems and devices both onboard the vehicle and off. In the absence of a nationally recognized approach, the information below provides additional guidance to agencies seeking to implement the concept of Central Data Access.

General

Virtually all new electronic systems and devices are designed with a diagnostic/information connector port that allows connection to a portable device for diagnostics and programming. This portable device typically consists of a laptop computer or diagnostic reader that contains proprietary diagnostic software to provide real time diagnostics, and the ability to upload/download data or software. The objective of Central Data Access, using either the Connector Port Option or the Microprocessor Based Option, is to make data available at one vehicle location.

Connector Port Option

Advantages and Disadvantages

This is a low-cost solution that will aid in the development of the Single Port Microprocessor Based system. It does not, however, eliminate the need to purchase laptops and multiple connectors and cables, but allows the technician to access all required data without having to move about the vehicle to multiple locations.

When choosing this option the Procuring Agency must consider the following:

Location - what would be the most central and logical point to access this information? Keep in mind the technician must still access certain switches and controls while troubleshooting the vehicle.

Access Device - what will the technician use to access this information, a laptop or diagnostic data reader (DDR). Most systems provide a Windows Based diagnostic software package that will give the technician a user-friendly diagnostic tool. Additionally, some systems have developed emulating software packages that provide the technician with virtual system capabilities. The DDR is a very proven system with very limited capabilities. Most DDVs require multiple cards that must be plugged into the reader and only provide logged data that must be translated.
MICROPROCESSOR BASED OPTION

Advantages and Disadvantages

This system provides several opportunities for the Procuring Agency, manufacturer, and vendor. Using this system allows the Procuring Agency to perform multiple forms of historical data logging, upload/download new or stored information, a method of storing important vehicle information (licenses, serial numbers, etc.), and removes the need for a laptop computer in the shop. The manufacturer can design systems that can be remotely accessed from any location, which would provide immediate access to individual vehicles for troubleshooting or loading upgraded software. The vendor has a system it can access without having to provide a method or means of uploading/downloading their individual systems information, and can begin to standardize their diagnostic software packages.

When choosing this option the Procuring Agency must consider the following:

Location - what would be the most central and logical point to access this information. Keep in mind the technician must still access certain switches and controls while troubleshooting the vehicle.

Microprocessor-Based System - which one to use. It is not necessary to implement a complete computer system onboard the vehicle. However, implementing a system without a keyboard and monitor will require the technician to carry a keyboard and monitor with them in the shop. What size hard drive, how much RAM, what type of operating system, and is it upgradeable? These are all questions that the Procuring Agency should ask the manufacturer/vendor when considering this system.

System Elimination - Now that there is a permanently based Microprocessor Based System onboard the vehicle, the Procuring Agency and manufacturer/vendor can begin to assess what systems can be replaced using this new approach. The following are some examples of possible replacements:

The Onboard Multiplex Controller. Most multiplex systems are controlled using some form of a Microprocessor-Based System. Is this now necessary? Any historical data logging systems - many Procuring Agencies are currently implementing many forms of historical data logging system, Could this function be performed using the on-board system?

Remote Access Systems. Many vendors/Procuring Agencies are moving towards using a high-speed remote access system. Could this now be performed using the on-board system?

Video Surveillance Computers. This is just one example of a system that requires a computer to download stored data. Could this be a function of the new onboard system?

Summary
When implementing Central Data Access, it is important that all parties -- manufacturer, vendor, and Procuring Agency -- understand how this technology will effect their particular system. It is also imperative that all parties begin to work together to develop this concept in unison.