GENERAL

SCOPE

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 should have a minimum expected life of 12 years or 500,000 miles whichever comes first and is intended for the widest possible spectrum of passengers, including children, adults, the elderly, and persons with disabilities.

DEFINITIONS

The following are definitions of special terms.

(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 should 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 should 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 Human scale 1/2/3, N. Different, A. R. Tilley, J. C. Bardagjy, MIT Press.

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

 where:

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

 t1 and t2 = any two points in time during the impact.

(18) The destination sign reading list and other information should be provided by the agency after award.

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(19) Design Operating Profile. The operating profile for design purposes should 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.

Phase Stops/ Top Miles Accel. Accel. Cruise Cruise Decel. Decel. Decel. Dwell Cycle Total

 Mile Speed Dist. Time Dist. Time Rate Dist. Time Time Time Stops

 (mph) (ft.) (s) (ft.) (s) (fpsps) (ft.) (s) (s) (min-s)

CBD 7 20 2 155 10 540 18.5 6.78 60 4.5 7 9-20 14

Idle - - - - - - - - - - - 5-0 -

Arterial 2 40 2 1035 29 1350 22.5 6.78 255 9 7 4-30 4

CBD 7 20 2 155 10 510 18.5 6.78 60 4.5 7 9-20 14

Arterial 2 40 2 1035 35 1350 22.5 6.78 255 9 7 4-30 4

CBD 7 20 2 155 10 510 18.5 6.78 60 4.5 7 9-20 14

Commuter 1 stop for phase Max. or 55 4 5500 90 2 miles + 188 6.78 480 12 20 5-10 1

 4580 ft.

Total 14 47-10 51

Average Speed - 17.8 mph

The bus should be loaded to SLW and should average approximately 18 mph while operating on this duty cycle. Operation should continue regardless of the ambient temperature or weather conditions. The passenger doors should be opened and closed at each stop, and the bus should be knelt at each stop during the CBD phase. The braking profile should 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 should be evenly distributed over the three phases of the duty cycle. For scheduling purposes, the average deceleration rate is assumed.

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 should be reported by operating personnel.

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

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.

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

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.

Structure. The structure should 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.

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

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. O2 sensor, MAP sensor), spark and coil components, and air control devices (e.g. main throttle, wastegate).

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).

Burst Pressure. The highest pressure reached in a container during a burst test.

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

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.

Code. A legal requirement.

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

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

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.

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

Container Appurtenances. Devices connected to container openings for safety, control, or operating purposes.

Container Valve. A valve connected directly to a container outlet.

Defueling. The process of removing fuel from a CNG vehicle.

Defueling Port. Device which allows for, or point at which a vehicle is defueled.

Destroyed. Physically made permanently unusable.

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 should not exceed 125 percent of service pressure.

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.

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

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

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

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).

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.

Leakage. Release of contents through a defect or crack, see "Rupture".

Liner. Inner gas tight container or gas container to which the overwrap is applied.

Lower Explosive Limit. The lowest concentration of gas where, given and ignition source, combustion is possible.

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

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

 Metering Valve. A valve intended to control the rate of flow of natural gas.

Operating Pressure. The varying pressure which is developed in a container during service.

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.

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.

Rupture. Sudden and unstable damage propagation in the structural components of the container resulting in a loss of contents, see "Leakage".

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.

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.

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

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

Standard. A firm guideline from a consensus group.

Stress Loops. The "pig-tails" commonly used to absorb flexing in piping.

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 and that will permit propagation of flame away from them.

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 overpressure from improper charging practices.

Agency. The company purchasing the vehicle.

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 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 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 National Alternative Fuel Training Program

(28) NATEF/SAE 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

(38) TRC Texas Railroad Commission

(39) UL Underwriters Laboratories

(40) USDOT United States Department of Transportation

SPECIFICATIONS:

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

DIMENSIONS:

PHYSICAL SIZE

With the exceptions of exterior mirrors, marker and signal lights, bumpers, fender skirts, washers, wipers, ad frames and rub rails, the bus should have the following overall dimensions as shown in the figure “Transit Bus Exterior Dimensions” at static conditions and design height.

Thirty foot bus: Body Length: 30 feet ± 6 inches

Thirty-five foot bus: Body Length: 35 feet ± 6 inches.

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

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

UNDERBODY CLEARANCE

The bus should 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 should be no less than 8.5 degrees. Break over angle should be no less than 8 degrees. Departure angle should 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 should 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, should be no less than 5½ inches.

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

FLOOR HEIGHT

Height of the floor above the street should be no more than 15 ½ 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 should be less than 3 ½ Deg. off the horizontal except locally at the doors where 2o slope toward the door is allowed. All floor measurements should be with the bus at the design running height and on a level surface and with the standard 305 tires.

INTERIOR HEADROOM

Headroom above the aisle and at the centerline of the aisle seats should 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 should 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 should 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 should be provided on the overhead paneling.

WEIGHT

Curb weight of the bus, as defined in these Specifications, should not exceed 33,000 pounds.

CAPACITY

The vehicle should be designed to carry the Gross Vehicle Weight which should not exceed the bus GVWR.

SERVICE LIFE AND MAINTENANCE

Service Life

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

Maintenance and Inspection

Scheduled maintenance or inspection tasks as specified by the Contractor should require a skill level of 3M or less. Scheduled maintenance tasks should be related and should be grouped in maximum mileage intervals. Based upon the Design Operating routine scheduled maintenance actions, such as filter replacement and adjustments, should 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 should be provided in quantities as specified in Technical Specifications. Additional requirements for Maintenance and Inspection Equipment are also provided in these specifications.

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

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

CNG Cylinder Visual Inspection

A general visual inspection of all cylinders should 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 should occur every 3 years (NGV2) or every 3 years or 36,000 miles (FMVSS 304). This detailed visual inspection should 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.

Accessibility

All systems or components subject to periodic maintenance or that are subject to periodic failures should 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 should be unnecessary.

As a goal, relative accessibility of components, measured in time required to gain access, should be inversely proportional to frequency of maintenance and repair of the components.

The location of CNG cylinders should allow access for routine external surface cylinder cleaning and inspections. CNG cylinder labels should 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) should be easily accessible to allow for CNG fuel system shut-off or CNG cylinder isolation. Non-skid roof surfaces/walkways should be incorporated on buses when roof-top CNG cylinder access is provided.

Interchangeability

Components with identical functions should be interchangeable to the extent practicable. These components should include, but not limited to, passenger window hardware, interior trim, lamps, lamp lenses, and seat assemblies. Components with non-identical functions should not be, or appear to be, interchangeable. A component should 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 should 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.

OPERATING ENVIRONMENT

The bus should achieve normal operation in ambient temperature ranges of -10 to 115 F, 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 should be minimized at temperatures below -10 F, above 115 F, or at altitudes above 3,000 feet. Altitude requirements above 3,000 ft. 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 F without the engine in operation. Speed, gradability, and acceleration performance requirements should be met at, or corrected to, 77F, 29.31 inches Hg, dry air per SAE J1995.

NOISE

Interior Noise

The combination of inner and outer panels and any material used between them should provide sufficient sound insulation so that a sound source with a level of 80 dBA measured at the outside skin of the bus should have a sound level of 65 dBA or less at any point inside the bus. These conditions should 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 should not exceed 83 dBA and the operator should not experience a noise level of more than 75 dBA under the following test conditions. The bus should be empty except for test personnel, not to exceed 4 persons, and the test equipment. All openings should be closed and all accessories should be operating during the test. The bus should 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 should be at least 10 dBA lower than the bus under test. Instrumentation and other general requirements should conform to SAE Standard J366

Exterior Noise

Airborne noise generated by the bus and measured from either side should 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 should not exceed 83 dBA. The bus-generated noise at curb idle should not exceed 65 dBA. All noise readings should be taken 50 feet from, and perpendicular to, the centerline of the bus with all accessories operating. Instrumentation, test sites, and other general requirements should be in accordance with SAE Standard J366. The pull away test should begin with the front bumper even with the microphone. The curb idle test should be conducted with the rear bumper even with the microphone.

FIRE SAFETY

The bus should be designed and manufactured in accordance with all applicable fire safety and smoke emission regulations. These provisions should 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 should 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, should be exempt from this requirement.

Fire sensing and suppression systems as required in in this document should be provided.

ELDERLY AND DISABLED PASSENGERS

The contractor should 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.

PROPULSION SYSTEM

VEHICLE PERFORMANCE

POWER REQUIREMENTS

Propulsion system and drive train should 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.

TOP SPEED

The bus should be capable of a top speed of 68 mph. on a straight, level road at GVWR with all accessories operating.

GRADABILITY

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

ACCELERATION

The acceleration should meet the requirements below and should be sufficiently gradual and smooth to prevent throwing standing passengers off-balance. Acceleration measurement should commence when the accelerator is depressed (Idle Start.)

MAXIMUM IDLE START ACCELERATION TIMES ON A LEVEL SURFACE

(Vehicle weight = GVWR, 50-State Power Plant)

 SPEED

 (MPH) TIME

 (SEC)

 10 5.6

 20 11.0

 30 20.0

 40 31.0

OPERATING RANGE

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

DRIVETRAIN

POWER PLANT

Engine

Cummins ISL G 8.9L CNG or approved equal.

The HHDG engine should 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 should 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.

The engine should meet all requirements of 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 should be equipped with an electronically controlled fuel management system, compatible with multiplex wiring systems and either 12 or 24 volt electrical systems. The engine control system should be capable of receiving electronic inputs from the engine and other vehicle systems. Communication between these electronic systems should be made using the SAE J1939 Recommended Practice communication link. The engine's electronic management system should monitor operating conditions and provide instantaneous adjustments to optimize both engine and bus performance. The system should be programmable to allow optimization of engine performance.

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

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

The engine starter should 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 should be of the type recommended by the engine manufacturer and approved by the Central Oklahoma Transportation and Parking Authority.

The engine should be equipped with an operator-controlled fast idle device. The fast idle control should be a two-way toggle mounted on the dash or side console and should 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.

The engine control system should protect the engine against progressive damage. The system should monitor conditions critical for safe operation and automatically reduce power and/or speed and initiate engine shutdown as needed. The on-board diagnostic system should 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 should only occur when parameters established for the functions below are exceeded:

Coolant Level

Coolant Temperature

Exhaust Temperature

Oil Pressure

A control should 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

Cooling Systems

The cooling systems should 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 should be designed with a fail-safe mode of “fan on.” The cooling system in new condition should have an ambient capacity of at least 110° F with water as coolant and sea level operation.

Engine Cooling

The engine should 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 should be easily accessible for replacement. Shutoff valves should allow filter replacement without coolant loss. Valves should permit complete shutoff of lines for the heating and defroster units, and water booster pumps. The water boost pump should be a magnetically coupled, brushless design. All low points in the water-based cooling system should be equipped with drain cocks. Air vent valves should 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 should be provided and should 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 should be provided with both it and the water filler no more than 60 inches above the ground and both should be accessible through the same access door.

The radiator, and charge air cooler if integrated, should be of durable corrosion-resistant construction with bolted-on removable tanks. The radiator should 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 should not be used.

The radiator and charge air cooler should be designed to withstand thermal fatigue and vibration associated with the installed configuration.

The engine cooling system should 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

The cooling fan should be temperature controlled, allowing the engine to reach operating temperature quickly. The temperature-controlled fan should not be driven when the coolant temperature falls below the minimum level recommended by the engine manufacturer.

Charge Air Cooling

The charge air cooling system, also referred to as aftercoolers or intercoolers, should provide maximum air intake temperature reduction with minimal pressure loss. The charge air radiator should be sized and positioned to meet engine manufacturer's requirements. The charge air radiator should not be stacked ahead or behind the engine radiator and should be positioned as close to the engine as possible unless integrated with the radiator. Air ducting and fittings should be protected against heat sources, and should be configured to minimize restrictions and maintain sealing integrity.

Transmission Cooling

The transmission should 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 should be matched to retarder and engine cooling systems to ensure that all operating fluids remain within recommended temperature limits established by each component manufacturer.

Transmission

The transmission should be multiple speed, automatic shift with torque converter, retarder and electronic controls. Gross input power, gross input torque and rated input speed should be compatible with the engine. A 3M mechanic, with optional assistance, should be able to remove and replace the transmission assembly for service in less than 16 total combined man-hours. The transmission should be designed to operate for not less than 300,000 miles on the design operating profile without replacement or major service.

The electronic controls should be compatible with multiplex wiring systems, capable of receiving inputs from the throttle, shift selector, engine, and transmission. Communication between the transmission and other electronically controlled vehicle systems should be made using the SAE J1939 Recommended Practice communication link. Electronic controls should be compatible with either 12 or 24 volt systems, 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 should be required by the operator to engage forward or reverse range from the neutral position.

The electronically controlled transmission should have on-board diagnostic capabilities, able to monitor functions, store out-of-parameter conditions in memory, and communicate faults and vital conditions to service personnel. A diagnostic reader device connector port, suitably protected against dirt and moisture, should be provided in the operator’s area. The on-board diagnostic system should trigger a visual alarm to the operator when the electronic control unit detects a malfunction. The transmission should contain built-in protection software to guard against severe damage.

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

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

Retarder

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

The retarder should 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 should 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 should be activated when the retarder is engaged and the coolant temperature exceeds the maximum limit established by the engine and transmission manufacturers.

Jerk

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

MOUNTING

The power plant should be mounted in a compartment in the rear of the bus. All power plant mounting should be mechanically isolated to minimize transfer of vibration to the body. Mounts should 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.

Service

The power plant should be arranged so that accessibility for all routine maintenance is assured. No special tools, other than dollies and hoists, should be required to remove the power plant. Two 3M mechanics should 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 should be easily removable and independent of the engine and transmission removal. An engine oil pressure gauge and coolant temperature gauge should be provided in the engine compartment. These gauges should be easily read during service and mounted in an area where they should not be damaged during minor or major repairs.

Engine oil and the radiator filler caps should be hinged to the filler neck and closed with spring pressure or positive locks. All fluid fill locations should be properly labeled to help ensure correct fluid is added and all fillers should be easily accessible with standard funnels, pour spouts, and automatic dispensing equipment. All lubricant sumps should be fitted with magnetic-type, external, hex head, drain plugs.

The engine and transmission should 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 should be of the spin-on, disposable type or integral with the engine and transmission. All filters should be easily accessible and the filter bases should be plumbed to assure correct reinstallation.

An oil sampling and fill provision compatible with standard should be included in the engine compartment.

An air cleaner with a dry filter element and a graduated air filter restriction indicator should be provided. The filter should be removable by a 3M mechanic in 10 minutes or less. The location of the air intake system should be designed to minimize the entry of dust and debris and maximize the life of the air filter. The engine air duct should be designed to minimize the entry of water into the air intake system. Drainage provisions should be included to allow any water/moisture to drain prior to entry into air filter.

Accessories

Engine-driven accessories should be mounted for quick removal and repair. Accessory drive systems should operate without unscheduled adjustment for not less than 50,000 miles on the design operating profile. These accessories should 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 should be provided as required for safety and should be sturdy in design and installation and readily removable.

Hydraulic Systems

Any accessory may be driven hydraulically. The hydraulic system should demonstrate a mean time between repairs in excess of 50,000 miles. Hydraulic system service tasks should be minimized and scheduled no more frequently than those of other major coach systems. All elements of the hydraulic system should be easily accessible for service or unit replacement. Critical points in the hydraulic system should 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.

Hydraulic System Sensors

Sensors in the hydraulic system, excluding those in the power steering system, should 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.

Fluid Lines, Fittings and Clamps, and Charge Air Piping

All lines and piping should be supported to prevent chafing damage, fatigue failures, and tension strain. Lines passing through a panel, frame or bulkhead should 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 should be as short as practicable and should be routed or shielded so that failure of a line should not allow the contents to spray or drain onto any component operable above the auto-ignition temperature of the fluid.

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

Radiator

Radiator piping should be stainless steel or brass tubing and, if practicable, hoses should be eliminated. Necessary hoses should be a premium, silicone rubber type that is impervious to all bus fluids. All hoses should be as short as practicable. All hoses should be secured with premium, stainless steel clamps that provide a complete 360 seal. The clamps should maintain a constant tension at all times, expanding and contracting with the hose in response to temperature changes and aging of the hose material.

Oil & Hydraulic Lines

Oil and hydraulic lines should be compatible with the substances they carry. The lines should 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 should be capable of withstanding maximum system pressures. Lines within the engine compartment should be composed of steel tubing where practicable except in locations where flexible lines are specifically required by 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, should be tagged or marked for use on the hydraulic system only.

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 should be a minimum of seamless Type 304 stainless steel [ASTM A269 or equivalent]. Fuel lines and fittings should not be fabricated from cast iron, galvanized pipe, aluminum, plastic, or copper alloy with content exceeding 70 percent copper. Piping fittings, and hoses should be clear and free from cuttings, burrs, or scale. Pipe thread joining material that is impervious to CNG should be utilized as required.

Fuel lines should be securely mounted, braced, and supported every 24 inches, or as designed by the bus manufacturer to minimize vibration and should be protected against damage, corrosion, or breakage due to strain or wear.

Manifolds connecting fuel containers should be designed and fabricated to minimize vibration and should 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, should 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 should be pressure tested to a minimum of 125% of system working pressure prior to fueling. CNG or Nitrogen should be used to pressure test the lines/assembly. The bus manufacturer should have a documented procedure of testing the high pressure line assembly.

Charge Air Piping

Charge air piping and fittings should be designed to minimize air restrictions and leaks. Piping should be as short as possible and the number of bends should be minimized. Bend radii should be maximized to meet the pressure drop and temperature rise requirements of the engine manufacturer. The cross section of all charge air piping should not be less than the cross section of the intake manifold inlet. Any change in pipe diameter should be gradual to ensure a smooth passage of air and to minimize restrictions. Piping should 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 should 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 should be sealed with a short section of reinforced

FUEL SYSTEM

NOTE: CNG fueling and defueling station characteristics relating to the design and construction of the CNG bus fuel system will be provided as detailed this document.

Fuel Containers – Cylinders

Operating Range

The operating range of the coach, when run on the transit coach duty cycle, should be at least 350 miles with a gas settled pressure of 3600 psi (US) at 70 F.

Fuel Capacity

Should be sufficient to meet the required Operating Range stated without exceeding the estimated curb weight of this bus configuration/Specification.

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 Installation

Fuel cylinders should 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 3-3. In the case of a low floor transit bus, the placement of tanks should 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.

Labeling

CNG fuel systems should be labeled in accordance with NFPA 52, Compressed Natural Gas (CNG) Vehicular Fuel Systems Code, 1998 edition.

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, should be stainless steel.

Valves

Valves must be installed in accordance with ANIS/IAS NGV2 – 1998, Basic Requirements for Compressed Natural Gas Vehicle (NGV) Fuel Containers and NFPA 52, Standard for Compressed Natural Gas (CNG) Vehicular Fuel Systems.

Fuel Filler

The fuel filler should be located 7 to 38 feet behind the centerline of the front door on the curbside of the bus. The filler cap should be retained to prevent loss and should be recessed into the body.

Fuel system should be capable of being filled (for 350 mile range) from 500 psi to a settled pressure of 3600 psi in a maximum of five minutes.

CNG Fueling System

The CNG fueling port receptacle should be an ANSI/AGA NGV1 certified receptacle. The coach should be capable of being fueled by a nozzle (insert procuring agencies standard fueling nozzle). The fueling port receptacle location should be such that connection by fueling personnel can be performed without physical strain or interference. A Dust Cap should be permanently “tethered” to the fueling port receptacle. The fueling port receptacle access door should be equipped with an interlock sensor which disables the engine starting system when the access door is open, to prevent drive-away. The interlock should be of the type such that if the sensor fails the coach will not start.

Fueling port receptacle should be located on the curbside of the vehicle between the rear axle and the rear of the bus.

CNG De-Fueling System

The CNG de-fueling port should be an ANSI/AGA NGV1 certified receptacle. The CNG de-fueling port should be located on the curbside of the coach, in a location that is compatible with standard de-fueling station operations. The de-fueling system should incorporate the following characteristics:

• Dust Cap permanently “tethered” to the de-fueling port

• Device(s) to prevent inadvertent defueling. 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

FINAL DRIVE

The bus should 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 should be minimized. The drive axle should 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 should be magnetic type, external hex head. If a planetary gear design is employed, the oil level in the planetary gears should be easily checked through the plug or sight gauge. The drive shaft should be guarded to prevent it striking the floor of the coach or the ground in the event of a tube or universal joint failure.

EMISSIONS/EXHAUST

Exhaust Emissions

The engine should meet all applicable emission standards.

Exhaust System

Exhaust gases and waste heat should be discharged from the roadside rear corner of the roof. The exhaust pipe should be of sufficient height to prevent exhaust gases and waste heat from discoloring or causing heat deformation to the bus. The entire exhaust system should be adequately shielded to prevent heat damage to any bus component. The exhaust outlet should 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.

CHASSIS

SUSPENSION

GENERAL REQUIREMENTS

Both the front and rear suspensions should be pneumatic type. The basic suspension system should 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 should be replaceable by a 3M mechanic in 30 minutes or less. Adjustment points should be minimized and should not be subject to a loss of adjustment in service. Necessary adjustments should be easily accomplished without removing or disconnecting the components.

SPRINGS AND SHOCK ABSORBERS

Travel

The suspension system should 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 should be provided at the limit of jounce travel. Rebound travel may be limited by elastomeric bumpers or hydraulically within the shock absorbers. Suspensions should 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.

Damping

Vertical damping of the suspension system should be accomplished by hydraulic shock absorbers mounted to the suspension arms or axles and attached to an appropriate location on the chassis. Damping should be sufficient to control coach motion to 3 cycles or less after hitting road perturbations. Shock absorbers should maintain their effectiveness for at least 50,000 miles of the service life of the bus. Each unit should be replaceable by a 2M mechanic in less than 15 minutes. The shock absorber bushing should be made of elastomeric material that will last the life of the shock absorber.

Lubrication

All elements of steering, suspension, and drive systems requiring scheduled lubrication should be provided with grease fittings conforming to SAE Standard J534. These fittings should be located for ease of inspection, and should 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 should have its own grease fitting with a relief path. Lubricant specified should be standard for all elements on the bus serviced by standard fittings.

Kneeling

A kneeling system should 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 any time 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 should prevent movement when the bus is kneeled. The kneel control should be disabled when the bus is in motion. The bus should kneel at a maximum rate of 1.25 inches per second at essentially a constant rate. After kneeling, the bus should rise within 2 seconds to a height permitting the bus to resume service and should rise to the correct operating height within 7 seconds regardless of load up to GVWR. During the lowering and raising operation, the maximum acceleration should not exceed 0.2g and the jerk should not exceed 0.3g/sec.

An indicator visible to the driver should 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 should be provided that will blink when kneel feature activated. Kneeling should not be operational while the wheelchair ramp is deployed or in operation.

WHEELS AND TIRES

Wheels

Wheels and rims should be hub-piloted with polished aluminum rims and should resist rim flange wear. All wheels should be interchangeable and should be removable without a puller. Wheels should be compatible with tires in size and load-carrying capacity. Front wheels and tires should be balanced as an assembly per SAE J1986.

Tires

Tires should 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 should not exceed the tire supplier's rating

STEERING

FRONT AXLE

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

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

STRENGTH

Fatigue life of all steering components should exceed 1,000,000 miles. No element of the steering system should sustain a Class I failure when one of the tires hits a curb or strikes a severe road hazard.

TURNING RADIUS

Outside body corner turning radius for a standard configuration. The 35-foot long bus should have a turning radius not to exceed 39 feet and the 30-foot long bus should have a turning radius not to exceed 34 feet.

TURNING EFFORT

The steering wheel should be no less than 19 inches in diameter and should be shaped for firm grip with comfort for long periods of time. The steering wheel should be removable with a standard or universal puller. The steering column should have full tilt and telescoping capability allowing the operator to easily adjust the location of the steering wheel.

Hydraulically assisted power steering should be provided. The steering gear should be an integral type with flexible lines eliminated or the number and length minimized. Steering torque applied by the driver should not exceed 10 foot pounds with the front wheels straight ahead to turned 10 degrees. Steering torque may increase to 70 foot pounds when the wheels are approaching the steering stops. Steering effort should 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 should not result in loss of steering control. With the bus in operation the steering effort should not exceed 55 pounds at the steering wheel rim and perceived free play in the steering system should not materially increase as a result of power assist failure. Gearing should require no more than seven turns of the steering wheel lock to lock.

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

BRAKES

SERVICE BRAKE

Actuation

Service brakes should be controlled and actuated by a compressed air system. Force to activate the brake pedal control should be an essentially linear function of the bus deceleration rate and should 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) should be provided. The microprocessor for the ABS system should be protected yet in an accessible location to allow for ease of service. The total braking effort should be distributed between all wheels in such a ratio as to ensure equal friction material wear rate at all wheel locations

Actuation of ABS should override the operation of the brake retarder.

Friction Material

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

Hubs and Drums

Replaceable wheel bearing seals should run on replaceable wear surfaces or be of an integral wear surface sealed design. Wheel bearing and hub seals should not leak or weep lubricant for 100,000 miles when running on the design operating profile.

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

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

PARKING /EMERGENCY BRAKE

The parking brake should 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 should 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 should 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 should engage to hold the bus in place.

PNEUMATIC SYSTEM

GENERAL

The bus air system should operate the air-powered accessories and the braking system with reserve capacity. New buses should not leak down more than 5 psi as indicted on the instrument panel mounted air gauges, within 15 minutes from the point of governor cut-off.

Provision should 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, should be easily accessible and located in the engine compartment and near the front bumper area for towing. Retained caps should be installed to protect fitting against dirt and moisture when not in use.

Air for the compressor should be filtered through the main engine air cleaner system. The air system should be protected by a pressure relief valve set at 150 psi and should be equipped with check valve and pressure protection valves to assure partial operation in case of line failures.

AIR COMPRESSOR

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

AIR LINES AND FITTINGS

Air lines, except necessary flexible lines, should 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 should 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 should prevent movement, flexing, tension strain, and vibration. Copper lines should 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 should be pre-bent on a fixture that prevents tube flattening or excessive local strain. Copper lines should be bent only once at any point, including pre-bending and installation. Rigid lines should be supported at no more than 5-foot intervals. Nylon lines may be grouped and should be supported at 2-foot intervals or less.

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

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

AIR RESERVOIRS

All air reservoirs should meet the requirements of FMVSS Standard 121 and SAE Standard J10 and should be equipped with clean-out plugs and guarded or flush type drain valves. Major structural members should protect these valves and any automatic moisture ejector valves from road hazards. Reservoirs should be sloped toward the drain valve. All air reservoirs should 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.

AIR SYSTEM DRYER

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

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

BODY

GENERAL

DESIGN

The exterior and body features, including grilles and louvers, should be shaped to facilitate cleaning by automatic bus washers without snagging washer brushes. Water and dirt should 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 should 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 should be sufficiently stiff to minimize vibration, drumming or flexing while the bus is in service. When panels are lapped, the upper and forward panels should 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 should 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 should be minimized.

CRASHWORTHINESS

The bus body and roof structure should 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 should remain in place and should not open under such a load. These requirements must be met without the roof mounted CNG cylinders installed.

The bus should 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 should not result in sharp edges or protrusions in the bus interior.

Exterior panels below 35 inches from ground level should withstand a static load of 2,000 pounds applied perpendicular to the bus by a pad no larger than 5 inches square. This load should 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.

MATERIALS

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

CORROSION

The bus flooring, sides, roof, understructure, axle suspension components should resist corrosion or deterioration from atmospheric conditions and road salts for a period of 12 years or 500,000 miles whichever comes first. It should maintain structural integrity and nearly maintain original appearance throughout its service life, provided that it is maintained by the 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 should not require the complete reapplication of corrosion compounds over the life of the bus.

All exposed surfaces and the interior surfaces of tubing and other enclosed members below lower window line should be corrosion resistant.

All materials that are not inherently corrosion resistant should be protected with corrosion-resistant coatings. All joints and connections of dissimilar metals should be corrosion-resistant and should be protected from galvanic corrosion. Representative samples of all materials and connections should 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.

RESONANCE AND VIBRATION

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

FIRE PROTECTION

The passenger and engine compartments should be separated by a bulkhead(s) that should, by incorporation of fireproof materials in its construction, be a firewall. The engine compartment should include areas where the engine and exhaust system are housed including the muffler, if mounted above the horizontal shelf. This firewall should preclude or retard propagation of an engine compartment fire into the passenger compartment and should be in accordance with the Recommended Fire Safety Practices defined in FTA Docket 90, dated October 20, 1993. Only necessary openings should be allowed in the firewall, and these should be fireproofed. Any passageways for the climate control system air should be separated from the engine compartment by fireproof material. Piping through the bulkhead should 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 should be fabricated of fireproof material and secured with fireproof fasteners. These panels, their fasteners, and the firewall should be constructed and reinforced to minimize warping of the panels during a fire that will compromise the integrity of the firewall.

DISTORTION

The bus, loaded to GVWR and under static conditions, should not exhibit deflection or deformation that impairs the operation of the steering mechanism, doors, windows, passenger escape mechanisms and service doors. Static conditions should 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.

STRUCTURE

GENERAL

Design

The structure of the bus should be designed to withstand the transit service conditions typical of an urban duty cycle throughout its service life.

Altoona Testing

Prior to acceptance of first bus, the structure of the bus should 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 should be submitted to the agency.

TOWING

Towing devices should be provided on each end of the bus. Towing devices should accommodate flat-bedding or flat-towing. Each towing device should 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) should not provide a toehold for unauthorized riders.

The front towing devices should allow attachment of adapters for a rigid tow bar and should permit lifting and towing of the bus, at curb weight, until the front wheels are clear off the ground.

The rear towing devices should 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 a bus. Each towing device should accommodate a crane hook with a 1-inch throat.

JACKING

It should 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 should 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 should 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 should be completed by a 2M mechanic helper in less than 30 minutes from the time the bus is approached. The bus should withstand such jacking at any one or any combination of wheel locations without permanent deformation or damage.

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

HOISTING

The bus axles or jacking plates should accommodate the lifting pads of a 2 post hoist system. Jacking plates, if used as hoisting pads, should be designed to prevent the bus from falling off the hoist. Other pads or the bus structure should support the bus on jack stands independent of the hoist.

FLOOR

Design

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

The floor design should 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 should be allowed on the upper level not to exceed 3½° 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 should be blended with a circular section of radius not less than 1 inch. Similarly, a molding or cove should prevent debris accumulation between the floor and wheel housings. The vehicle floor in the area of the entrance and exit doors should have a lateral slope not exceeding 2deg to allow for drainage.

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 should not be used to retain the floor and all floor fasteners should be serviceable from one side only. The use of adhesives to secure the floor to the structure should be allowed only in combination with the use of bolt or screw fasteners and its effectiveness should last throughout life of the coach. Tapping plates, if used for the floor fasteners, should be no less than the same thickness as a standard nut and all floor fasteners should be secured and protected from corrosion for the service life of the bus. The floor deck should be reinforced as needed to support passenger loads. At GVWR, the floor should have an elastic deflection of no more than 0.60 inches from the normal plane. The floor should withstand the application of 2.5 times gross load weight without permanent detrimental deformation. Floor, with coverings applied, should 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.

Construction

The floor should 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 should be waterproof, nonhygroscopic, and resistant to mold growth. The subfloor should be resistant to the effects of moisture, including decay (dry rot). It should be impervious to wood destroying insects such as termites.

If plywood is used, it should 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 should 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 should be installed with the highest-grade veneer up. Plywood should be pressure-treated with a preservative chemical that prevents decay and damage by insects. Preservative treatments should utilize no EPA listed hazardous chemicals. The concentration of preservative chemical should 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 should have a moisture content at or below fifteen percent. A barrier should be installed to prevent contact by road salt with the plywood panels.

PLATFORMS

General

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

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

Other raised areas such as for providing space for underfloor installation of components, should be limited. Such raised areas should be constructed in accordance to these specifications.

Operator’s Platform

The operator's platform should be of a height to render the position of the operator with respect to the road surface the same as on standard floor buses. If the height of the operator's platform exceeds 12 inches, a step should be provided to allow for ease in boarding. A warning decal or sign should be provided to alert operator to the change in floor level.

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 this accessibility for operator without compromising passenger’s access.

Intermediate Platform

If the vehicle is of a bi-level floor design, an intermediate platform should be provided along the center aisle of the bus to facilitate passenger traffic between the upper and lower floor levels. This intermediate platform should be cut into the rear platform and should 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 should be covered with yellow Hypalon ribbed rubber or skid-resistant material and should be sloped slightly for drainage. A warning decal or sign should be provided at the immediate platform area to alert passengers to the change in floor level.

WHEEL HOUSING

Design

Sufficient clearance and air circulation should be provided around the tires, wheels, and brakes to preclude overheating when the bus is operating on the design operating profile.

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

Design and construction of front wheel housings should 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 should be scratch-resistant, 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 should be color-impregnated to match interior finishes. The lower portion extending to approximately 12 inches above floor should be equipped with additional mar-resistant coating or stainless steel trim.

Construction

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

EXTERIOR PANELS AND FINISHES

PEDESTRIAN SAFETY

Exterior protrusions greater than ½ inch and within 80 inches of the ground should 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 should protrude no more than ⅞ inch from the body surface and should 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 should be designed to minimize the ability of unauthorized riders to secure toeholds or handholds.

REPAIR AND REPLACEMENT

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

Rain gutters should 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 should not drain onto the windshield, or operator's side window, or into the door boarding area. Cross sections of the gutters should be adequate for proper operation.

Rain gutter should also be provided above passenger side windows.

RUBRAILS

Rubrails composed of flexible, resilient material should be provided to protect both sides of the bus body from damage caused by minor sideswipe accidents with automobiles. Rubrails should 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 should withstanding impacts of 200 foot-pounds of energy from a steel-faced spherical missile no less than 9 inches in diameter and of a 500-pound load applied anywhere along their length by a rigid plate 1 foot in length, 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 should be replaceable without requiring removal or replacement of the entire rubrail.

FENDER SKIRTS

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

SPLASH APRONS

Splash aprons, composed of 1/4-inch-minimum composition or rubberized fabric, should be installed behind and/or in front of wheels as needed to reduce road splash and protect underfloor components. The splash aprons should extend downward to within 4 inches of the road surface at static conditions. Apron widths should be no less than tire widths, except for the front apron which should extend across the width of the bus. Splash aprons should be bolted to the bus understructure. Splash aprons and their attachments should be inherently weaker than the structure to which they are attached. The flexible portions of the splash aprons should not be included in the road clearance measurements. Other splash aprons should be installed where necessary to protect bus equipment.

SERVICE COMPARTMENTS AND ACCESS DOORS

ACCESS DOORS

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

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

The battery compartment or enclosure should be vented and self-draining. It should be accessible only from outside the bus. All components within the battery compartment, and the compartment itself, should be protected from damage or corrosion from the electrolyte and gases emitted by the battery. The inside surface of the battery compartment's access door should 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.

SERVICE AREA LIGHTING

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

BUMPERS

LOCATION

Bumpers should 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 should be such that when one bus is parked behind another, a portion of the bumper faces will contact each other.

FRONT BUMPER

No part of the bus, including the bumper, should be damaged as a result of a 5-mph impact of the bus at curb weight with a fixed, flat barrier perpendicular to the bus' longitudinal centerline. The bumper should return to its pre-impact shape within 10 minutes of the impact. The bumper should 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-mph impacts into the corners at a 30 angle to the longitudinal centerline of the bus. The energy absorption system of the bumper should be independent of every power system of the bus and should not require service or maintenance in normal operation during the service life of the bus. The bumper may increase the overall bus length by no more than 7 inches.

REAR BUMPER

 No part of the bus, including the bumper, should be damaged as a result of a 2-mph impact with a fixed, flat barrier perpendicular to the longitudinal centerline of the bus. The bumper should 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 should 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 should 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 should be shaped to preclude unauthorized riders standing on the bumper. The bumper should be independent of all power systems of the bus and should not require service or maintenance in normal operation during the service life of the bus. The bumper may increase the overall bus length by no more than 7 inches.

BUMPER MATERIAL

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

FINISH AND COLOR

All exterior surfaces should be smooth and free of wrinkles and dents. Exterior surfaces to be painted should 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 should be made prior to cleaning, priming and painting to prevent corrosion. The bus should be completely painted prior to installation of exterior lights, windows, mirrors and other items which 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 should 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 should have gloss and orange peel should be minimized. All exterior finished surfaces should be impervious to diesel fuel, gasoline and commercial cleaning agents. Finished surfaces should resist damage by controlled applications of commonly used graffiti-removing chemicals. Colors and paint schemes should be in accordance with the attachments to Part 5: Technical Specifications.

NUMBERING AND SIGNING

Monograms, numbers and other special signing specified by the agency should be applied to the inside and outside of the bus as required. Signs should be durable and fade-chip , and peel-resistant; they may be painted signs, decals, or pressure-sensitive appliqués. All decals should be sealed with clear, waterproof sealant around all exposed edges if required by the decal supplier. Signs should 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.

EXTERIOR LIGHTING

All exterior lights should be designed to prevent entry and accumulation of moisture or dust, and each lamp should be replaceable in less than 5 minutes by a 2M mechanic helper. Commercially available LED (Light Emitting Diode)-type lamps should be used unless approved by the agency, excluding applications where white lights are used, such as for headlights. Lights mounted on the engine compartment doors should be protected from the impact shock of door opening and closing. Lamps, lenses and fixtures should be interchangeable to the extent practicable. Two hazard lamps at the rear of the bus should be visible from behind when the engine service doors are opened. Light lenses should 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 should have protective shields or be of the flush mount type to protect the lens against minor impacts.

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

Lamps at the front and rear passenger doorways should comply with ADA requirements and should activate only when the doors open. These lamps should 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 should be shielded to protect passengers' eyes from glare.

INTERIOR PANELS AND FINISHES

GENERAL

Materials should be selected on the basis of maintenance, durability, appearance, safety, flammability, and tactile qualities. Trim and attachment details should be kept simple and unobtrusive. Materials should be strong enough to resist everyday abuse and vandalism; they should be resistant to scratches and markings. Interior trim should 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 should be shaped so that objects placed on them fall to the floor when the coach is parked on a level surface. The entire interior should 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.

FRONT END

The entire front end of the bus should 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 should 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 should be formed metal or plastic material. Formed metal dash panels should be painted and finished or may be carpeted or vinyl covered. Plastic dash panels should be reinforced, as necessary, vandal-resistant, and replaceable. All colored, painted, and plated parts forward of the operator's barrier should be finished with a dull matte surface to reduce glare.

REAR END

The rear bulkhead and rear interior surfaces should 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.

INTERIOR PANELS

GENERAL

Interior side trim panels and operator's barrier should be textured stainless steel, anodized aluminum, plastic, melamine-type material, or carpeting. Panels should be easily replaceable and tamper-resistant. They should be reinforced, as necessary, to resist vandalism and other rigors of transit bus service. Individual trim panels and parts should be interchangeable to the extent practicable. All materials should comply with the Recommended Fire Safety Practices defined in FTA Docket 90, dated October 20,1993.

OPERATOR BARRIER

A barrier or bulkhead between the operator and the street-side front passenger seat should be provided. The barrier should minimize glare and reflections in the windshield directly in front of the barrier from interior lighting during night operation.

The barrier should extend from the floor or wheel housing to the ceiling and should fit the bus side windows, wall, and ceiling panels to effectively close off driver’s area and prevent passengers from reaching the operator or the operator’s personal effects.

MODESTY PANELS

Sturdy divider panels constructed of durable, unpainted, corrosion-resistant material complementing the interior trim should be provided to act as both a physical and visual barrier for seated passengers. Modesty panels should 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 should include a handhold/grabhandle along its top edge. These dividers should be mounted on the sidewall and should project toward the aisle no farther than passenger knee projection in longitudinal seats or the aisle side of the transverse seats. Modesty panels should extend no higher than the lower daylight opening of the side windows and those forward of transverse seats should extend downward to a level between 1-1/2 and 1 inches above the floor. Panels forward of longitudinal seats should extend to below the level of the seat cushion. Dividers positioned at the doorways should 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 should be equipped with grab rails. The modesty panel and its mounting should 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

REAR BULKHEAD

The rear bulkhead paneling should 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 should be louvered to reduce airflow noise and to reduce the probability of trash or liter being thrown or drawn through the grille. If it is necessary to remove the panel to service components located on the rear bulkhead, the panel should be hinged or should be able to be removed and replaced by a 3M mechanic in 5 minutes. Grilles where access to or adjustment of equipment is required should be heavy duty and designed to minimize damage.

HEADLINING

Ceiling panels should be textured stainless steel, anodized aluminum, melamine-type material, carpeting, or material suitable for exterior skin painted and finished to exterior quality. Headlining should be supported to prevent buckling, drumming, or flexing and should be secured without loose edges. Headlining materials should 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, should be stainless steel, aluminum, or plastic, colored to complement the ceiling material. Headlining panels covering operational equipment that is mounted above the ceiling should be on hinges for ease of service but retained to prevent inadvertent opening.

FASTENING

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

INSULATION

Any insulation material used between the inner and outer panels should be sealed or self-sealing to minimize entry and/or retention of moisture. Insulation properties should be unimpaired during the service life of the bus. Any insulation material used inside the engine compartment should not absorb or retain oils or water and should be designed to prevent casual damage that may occur during maintenance operations. All insulation materials should 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, wheelwells and ends of the bus, and any material used between these panels should provide a thermal insulation sufficient to meet the interior temperature requirements of Part 5: Technical Specifications. The bus body should be thoroughly sealed so that the operator or passengers cannot feel drafts during normal operation s with the passenger doors closed.

FLOOR COVERING

The floor covering should 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, should be smooth and present no tripping hazards. The standee line should be at least 2 inches wide and should extend across the bus aisle. This line should be the same color as the outboard edge of the entrance/exit areas. Color/pattern should be consistent throughout the floor covering.

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

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

A one-piece center strip should 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 should 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 should extend from the center strip to the outboard edge of the rear/exit area.

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

PASSENGER INTERIOR LIGHTING

The interior LED lighting system should 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 should be 7 foot-candles. Floor surface in the aisles should 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 should illuminate when the front door is open and master run switch is in the “Lights” positions. Rear exit area and curb lights should illuminate when rear door is unlocked.

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

The light source should 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 should be a maximum 6-foot length, single-pin, T 12 type. (with an exception granted for extinguishing or dimming fixtures as noted)

Lens material should be clear polycarbonate. Lens should be designed to effectively "mask" the fluorescent tube. Lens should 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 should be provided to allow servicing of components located behind light panels. If necessary, the entire light fixture should be hinged.

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

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

A light fixture should be mounted in the ceiling above the farebox location. The fixture should 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.

FARE COLLECTION

Space, as far forward as practicable, and structural provisions should be made for installation of currently available fare collection device(s). Location of the fare collection device should not restrict traffic in the vestibule, including wheelchairs if a front door loading device is used, and should allow the operator to easily reach the farebox controls and to view the fare register. The fare box should not restrict access to the operator area, should not restrict operation of operator controls and should not restrict operator’s field of view per SAE Recommended Practice. Location and mounting of fare collection device should allow use, without restriction, by passengers. Fare box location should permit accessibility to the vault for easy manual removal or attachment of suction devices. Meters and counters on the fare box should be readable on a daily basis. A 15-amp minimum, 12 -volt, DC, protected circuit should be available to power the fare box and a 15 amp 24-volt protected circuit should be available for transfer equipment. This power service should include a grounded lead with both wires enclosed in a flexible conduit. The floor under the fare box should be reinforced, as necessary, to provide a sturdy mounting platform and to prevent shaking of the fare box. The fare box, including make, model, mounting provisions, size, weight, and meter locations.

Transfer mounting, cutting, and punching equipment should be located in a position convenient to the operator. This equipment is defined in attachments to Part 5: Technical Specifications.

ACCESS PANELS AND DOORS - INTERIOR

Access for maintenance and replacement of equipment should be provided by panels and doors that appear to be an integral part of the interior. Access doors should be hinged with gas props or over-center springs, where practical, to hold the doors out of the mechanic's way. Panel fasteners should be standardized so that only one tool is required to service all special fasteners within the bus.

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

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

PASSENGER ACCOMMODATIONS

PASSENGER SEATING

ARRANGEMENTS AND SEAT STYLE

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

Passenger seats should 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).

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

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, should be no less than 28 inches. At all seating positions in paired transverse seats immediately behind other seating positions hip-to-knee room should be no less than 28 inches.

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 should be identified to the agency prior to bid for approval.

Foot room, measured at the floor forward from a point vertically below the front of the seat cushion, should 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 foot room.

Thickness of the transverse seat backs should 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 should be designed to prevent debris accumulation.

The aisle between the seats should be no less than 20 inches wide at seated passenger hip height. Seat backs should be shaped to increase this dimension to no less than 24 inches at standing passenger hip height.

Raised platforms for passenger seats should 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.

Dimensions

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

The width, W, of the seat should be 35 inches.

The length, L, should be 17 ±1 inches.

The seat back height, B, should be a minimum of 15 inches.

The seat height, H, should be 17 ± 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 ±2 inches will be allowed. This should also be allowed for limited transverse seats, but only with expressed approval of the agency.

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

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

The pitch, P, is shown as reference only.

Structure and Design

The passenger seat frame and its supporting structure should 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 should 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 should 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.

 The underside of the seat and the sidewall should be configured to prevent debris accumulation and the transition from the seat underside to the bus sidewall to the floor cove radius should be smooth. All transverse objects, including seat backs, modesty panels, and longitudinal seats, in front of forward facing seats should not impart a compressive load in excess of 1,000 pounds onto the femur of passengers ranging in size from a 5th-percentile female of a 95th-percentile male during a 10g deceleration of the bus. This deceleration should peak at .05  .015 seconds from initiation. Permanent deformation of the seat resulting from two 95th-percentile males striking the seat back during this 10g deceleration should 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 should not introduce a laceration hazard.

The seat assembly should 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 should 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 should withstand repeated impacts of two 40-pound sandbags without visible deterioration. One sandbag should strike the front 40,000 times and the other sandbag should strike the rear 40,000 times. Each sandbag should be suspended on a 36-inch pendulum and should strike the seat back 10,000 times each from distances of 6, 8, 10, and 12 inches. Seats at both seating positions should withstand 4,000 vertical drops of a 40-pound sandbag without visible deterioration. The sandbag should be dropped 1,000 times each from heights of 6, 8, 10, and 12 inches. Seat cushions should 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 should incorporate a handhold no less than 7/8 inch in diameter for standees and seat access/egress. The handhold should not be a safety hazard during severe decelerations. The handhold should extend above the seat back near the aisle so that standees should have a convenient vertical assist, no less than 4 inches long that may be grasped with the full hand. This handhold should not cause a standee using this assist to interfere with a seated 50th-percentile male passenger. The handhold should 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 should 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) should 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. Armrests should not be included in the design of transverse seats.

Longitudinal seats should be the same general design as transverse seats but without seat back handholds. Longitudinal seats may be mounted on the wheelhouses. Armrests should 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 should be located from 7 to 9 inches above the seat cushion surface. The area between the armrest and the seat cushion should be closed by a barrier or panel. The top and sides of the armrests should have a minimum width of 1 inch and should be free from sharp protrusions that form a safety hazard.

Seat back handhold and armrests should 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 should 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.

A test report should be provided by the Contractor fully documenting compliance with all the requirements defined above upon request. The test report should 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.

Construction and Materials

Seat should be constructed with materials which comply with the physical test. Selected materials should minimize damage from vandalism and should reduce cleaning time. The seats should be attached to the frame with tamperproof fasteners. Coloring should 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 should be aluminum or stainless steel. The seat, pads and cushions should be contoured for individuality, lateral support, and maximum comfort and should fit the framework to reduce exposed edges.

Seating and interior trim should have features to maximize passenger comfort. The seat cushion should be supported by springs. The seat cushion and back should 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 should be upholstered with vinyl and/or fabric materials.

Armrests should be padded with material that is the same as, or similar to, the seat back padding and handhold. Seats, back cushions and other pads should be securely attached and should 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 should be interchangeable throughout the coach bus. Materials should 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 should be a nominal 1/4-inch. Seat covering materials should 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 should 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. Complete seat assemblies should 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.

PASSENGER ASSISTS

General

Passenger assists in the form of full grip, vertical stanchions or handholds should be provided for the safety of standees and for ingress/egress. Passenger assists should 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 should be provided either as the vertical portion of seat back assist or as a separate item so that a 5th-percentile female passenger may easily move from one assist to another using one hand and the other without losing support. All handholds and stanchions at front doorway, around farebox, and at interior steps for bi-level designs should be powder-coated in high contrast yellow color. The forward-most vertical stanchions on either side of the aisle immediately behind the driver’s area, should be plain stainless steel finish to match the rest of vehicle.

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

Any joints in the assist structure should be underneath supporting brackets and securely clamped to prevent passengers from moving or twisting the assists. Passenger assists should be designed to minimize glare in the Operator’s area to the extent possible. 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 should 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 should be of anodized aluminum, stainless steel, or powder coated metal. Connecting tees and angles may be powder coated metal castings. Assists should 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 should be designed to eliminate pinching, snagging and cutting hazards and free from burrs or rough edges.

Front Doorway

Front doors, or the entry area, should be fitted with ADA compliant assists. Assists should be as far outward as practicable, but should be located on farther inboard than 6 inches from the outside edge of the entrance step and should be easily grasped by a 5th-percentile female boarding from street level. Door assists should 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.

Vestibule

The aisle side of the operator's barrier, the wheel housings, and when applicable the modesty panels should 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 should have sufficient clearance from the barrier to prevent inadvertent wedging of a passenger's arm.

A horizontal passenger assist should be located across the front of the bus and should 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 should provide support for a boarding passenger from the front door through the fare collection procedure. Passengers should be able to lean against the assist for security while paying fares. The assist should be no less than 36 inches above the floor. The assists at the front of the bus should 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.

Rear Doorway

Vertical assists that are functionally continuous with the overhead assist should 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 should be provided on modesty panels that are functionally continuous with the rear door assists. Rear doors, or the exit area, should be fitted with assists no less than 3/4 inch in width and should provide at least 1-1/2 inches of knuckle clearance between the assists and their mounting. The assists should be designed to permit a 5th-percentile female to easily move from one assist to another during the entire exiting process. The assists should be located no farther inboard than 6 inches from the outside edge of the rear doorway.

Overhead

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

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

Longitudinal Seats

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

Wheel Housing Barriers/Assists

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

PASSENGER DOORS

General

Two doorways should be provided in the curbside of the bus for passenger ingress and egress. The front doorway should 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 should comply with ADA requirements.

The rear doorway centerline should be rearward of the point midway between the front door centerline and the rearmost seat back. Rear doors should be operated by passenger push-to-exit.

Materials and Construction

Structure of the doors, their attachments, inside and outside trim panels, and any mechanism exposed to the elements should be corrosion-resistant. Door panel construction should be of corrosion-resistant metal or reinforced non-metallic composite materials. The doors, when fully opened, should provide a firm support and should not be damaged if used as an assist by passengers during ingress or egress. The front leaves of the passenger doors should overlap the rear leaves.

Dimensions

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

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

Door Glazing

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

The front door panel glazing material should have a nominal ¼ inch or 6 mm thick laminated safety glass conforming to 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 should be the same material, thickness and color as the side windows defined in Section 5.4.7.4.2.

Door Projection

Exterior projection of the doors should be minimized and should not exceed 13 inches during the opening or closing cycles or when doors are fully opened. Projection inside the bus should not exceed 21 inches. The closing edge of each door panel should have no less than 2 inches of soft weather stripping. The doors, when closed, should be effectively sealed and the hard surfaces of the doors should be at least 4 inches apart.

Door Height Above Pavement

It should 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.

Closing Force

Closing door edge speed should not exceed 19 inches per second. Power close rear doors should 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 should 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 should 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.

Actuators

Door actuators should be adjustable so that the door opening and closing speeds can be independently adjustable. Actuators and the complex door mechanism should be concealed from passengers but should be easily accessible for servicing. The door actuators should be rebuild-able. If powered by compressed air, exhaust from the door system should be routed below the floor of the bus to prevent accumulation of any oil which may be present in air system and to muffle sound.

Emergency Operation

In the event of an emergency, it should 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 should be clearly marked as an emergency-only device and should require two distinct actions to actuate. The respective door emergency unlocking device should be accessible from the entrance and exit areas. When the rear emergency device is actuated, the door interlock throttle system should return the engine to idle and the door interlock brake system should apply to stop the bus. When the front door emergency device is actuated only the door interlock throttle system should be actuated. Locked doors should require a force of more than 100 pounds to open manually. When the locked doors are manually forced to open, damage should be limited to the bending of minor door linkage with no resulting damage to the doors, engines, and complex mechanism.

ACCESSIBILITY PROVISIONS

General

The design and construction of the bus should 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 should 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 should provide a plan, including layout drawings for entry, maneuvering, parking, and exiting of wheelchair passengers, to show compliance with ADA regulations.

Loading System

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

The wheelchair loading system should be located at the rear door.

The ramp should be of a simple hinged, flip-out type design.

When the system is not in use, the passageway should appear normal. In the stored position of the ramp, no tripping hazards should be presented and any resulting gaps should be minimized. The controls should be simple to operate with no complex phasing operations required, and the loading system operation should be under the surveillance and complete control of the operator. If the loading system and controls are at the rear doors, a switch should be provided in the operator's area to disable the loading system. The bus should be prevented from moving during the loading or unloading cycle by a throttle and brake interlock system. The wheelchair loading system should not present a hazard, nor inconvenience any passenger. The loading system should be inhibited from retracting or folding when a passenger is on the ramp/platform. A passenger departing or boarding via the ramp should be able to easily obtain support by grasping the passenger assist located on the doors or other assists provided for this purpose. The platform should 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 should be covered with a replaceable or renewable, nonskid material and should be fitted with devices to prevent the wheelchair from rolling off the sides during loading or unloading. Deployment or storage of the ramp should require no more than 15 seconds. The device should 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 should permit unloading a wheelchair and storing the device in the event of a primary power failure. The manual operation of the ramp should not require more than 20 lbs. of force. The ramp assembly components should be replaceable within 30 minutes by 3M mechanic.

Wheelchair Accommodations

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

Additional equipment, including passenger restraint seat belts, shoulder harnesses and wheelchair securement devices should be provided for each wheelchair passenger. All belt assemblies must stow up and out of the way when not in use. Q’Straint Slide and Click or approved equal should be used to secure the wheelchair.

Interior Circulation

Maneuvering room inside the bus should 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 should 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.

Passenger Information

ADA priority seating signs as required and defined by 49 CFR, Part 38.27 should 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 should be provided.

Requirements for a stop-request passenger signal in accordance with 49 CFR, Part 38.37 should be provided.

Requirements for exterior destination signs in accordance with 49 CFR, Part 38.39 should be provided as required.

OPERATOR PROVISIONS

OPERATOR’S AREA

General

The operator’s work area should be designed to minimize glare to the extent possible. Objects within and adjacent to this area should 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 should 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 should be controlled by the operator.

Visors

An adjustable roller type sunscreen should be provided over the operator’s windshield and the operator’s side window. The sunscreen should be capable of being lowered to the midpoint of the operator’s window. To secure and stabilize the screen, it should be attached to thin metal rods on each side of the window. Once lowered, the screen should remain in the lowered position until returned to the stowed position by the operator.

Operator’s Controls

All switches and controls necessary for the operation of the bus should be conveniently located in the operator's area and should provide for ease of operation. Switches and controls should be essentially within the hand reach envelope described in SAE Recommended Practice, J287, Driver Hand Control Reach. Controls should be located so that boarding passengers may not easily tamper with control settings.

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

Controls for engine operation should be closely grouped within the operator's compartment. These controls should include separate master run switch and start switch or button. The run switch should be a four-position rotary switch with the following functions:

OFF - 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 should 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., should not exceed 1.5 amps with the master run switch in the OFF position.

 CL/ID - All electrical systems off, except those listed in OFF and power to destination signs, interior lights, and marker lights.

RUN - All electrical systems and engine on, except the headlights, parking lights and marker lights. Daytime running lights (DRL), if provided, should be on.

 NITE/RUN - All electrical systems and engine on.

The door control, kneel control, windshield wiper/washer controls, and run switch should be in the most convenient operator locations. They should be identifiable by shape, touch, and permanent markings. Doors should 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 should be easily determined by position and touch. Turn signal controls should be floor-mounted, foot-controlled, waterproof, heavy-duty, momentary contact switches.

All panel-mounted switches and controls should be marked with easily read identifiers and should be replaceable, and the wiring at these controls should be serviceable from the vestibule or the operator's seat. Switches, controls, and instruments should be dust- and water-resistant

Door Control

Doors should open or close completely in not more than 3.5 seconds from the time of control actuation and should be subject to a safe closing force as to not cause injury. The door control should be a lever that rotates around a vertical staff. The lever should be located on the street side of the operator’s area approximately 16 inches to the street side of the operator’s seat centerline, forward of the seat, and approximately 23 inches above the floor in the operator’s area. The front door should remain in commanded state position even if power is removed or lost.

Operation of, and power to, the passenger doors should be ultimately controlled by the operator. Passenger push-to-exit is an acceptable option.

A control or valve in the operator's compartment should 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 should close the doors, deactivate the door control system, release the interlocks, and permit only manual operation of the doors.

To preclude movement of the bus, an accelerator interlock should lock the accelerator in the closed position and a brake interlock should engage the service brake system when the rear door control is activated. The braking effort should be adjustable with hand tools. Rear doors should not open until bus speed is below 2 m.p.h.

An accelerator interlock should lock the accelerator in the closed position whenever front doors are open.

Instrumentation

The speedometer, air pressure gauge(s), and certain indicator lights should be located on the front cowl immediately ahead of the steering wheel. The steering wheel spokes or rim should not obstruct the operator's vision of the instruments when the steering wheel is in the straight-ahead position. Illumination of the instruments should be simultaneous with the marker lamps. Glare or reflection in the windshield, side window, or front door windows from the instruments, indicators, or other controls should be minimized. Instruments and indicators should be easily readable in direct sunlight. Indicator lights immediately in front of the operator are identified in the following table.

|  |  |  |
| --- | --- | --- |
| `Visual Indicator | Audible Alarm | Condition |
| Back-Up | Back-Up Alarm | Reverse Gear is Selected |
| Hazard | Click | Four-Way Flashers Activated |
| DRL | None | Daytime Running Lights |
| High Beam | None | Headlamp High Beams Activated |
| Left Turn Signal | Click | Left Turn Signal Activated |
| Parking Brake | None | Parking Brake is Activated |
| Rear Door | None | Rear Passenger Door is not Closed and Locked |
| Rear Turn Signal | Click | Right Turn Signal Activated |
| Stop Lights | None | Brake Lights Operational |
| Stop Request | Chime | Passenger Stop Request has been Activated |
| Wheelchair Request | Double Chime | Passenger Wheelchair Stop Request has been Activated |

The instrument panel should include an electronic speedometer indicating no more than 80 mph and calibrated in maximum increments of 5 mph. The speedometer should 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 should be sized and accurate in accordance with SAE Recommended Practice J678.

The speedometer should equipped with an odometer with a capacity reading no less than 999,999 miles.

The instrument panel should also include air brake reservoir pressure gauge(s) with indicators for primary and secondary air tanks and voltmeter(s) to indicate the operating voltage across the bus batteries. The instrument panel and wiring should be easily accessible for service from the operator's seat or top of the panel. Wiring should have sufficient length and be routed to permit service without stretching or chafing the wires.

On-Board Diagnostics

The bus should be equipped with 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. This diagnostic system should have visual and audible indicators. The diagnostic indicator lamp panel should be located in clear sight of the operator but need not be immediately in front of him. The intensity of indicator lamps should permit easy determination of on/off status in bright sunlight but should not cause a distraction or visibility problem at night. All indicators should have a method of momentarily testing the operation of the lamp. The audible alarm should be tamper resistant and should have an outlet level between 80 and 83 dBA when measured at the location of the operator's ear. Wherever possible, sensors should be of the closed circuit type, so that failure of the circuit and/or sensor should activate the malfunction indicator. Malfunction and other indicators listed in the following table should be supplied on all buses.

Space should be provided on the panel for future installation of 5 additional indicators as the capability of on-board diagnostic systems improves.

|  |  |  |
| --- | --- | --- |
| `Visual Indicator | Audible Alarm | Condition |
| ABS | None | ABS System Malfunction |
| A/C Stop | None | Compressor stopped due to High/Low Pressure or Loss of Refrigerant |
| Check Engine | None | Engine Electronic Control Unit detects a Malfunction |
| Check Transmission | None | Transmission Electronic Control Unit detects a Malfunction |
| Fire | Bell | Over-Temperature Condition in Engine Compartment |
| Generator Stop | None | Loss of Generator Output |
| Hot Engine | Buzzer | Excessive Engine Coolant Temperature |
| Low Air  | Buzzer | Insufficient Air Pressure in either Primary or Secondary Reservoirs |
| Low Oil | Buzzer | Insufficient Engine Oil Pressure |
| Low Coolant | Buzzer | Insufficient Engine Coolant Level |
| Wheelchair Ramp | Beeper | Wheelchair Ramp is not Stowed and Disabled |
| Methane Gas Detection |  Bell | Significant Level of Methane Gas Detected |
| Low Fuel | None | Less than 500 psi Fuel Pressure |

WINDSHIELD WIPERS

The bus should be equipped with a variable speed windshield wiper for each half of the windshield, with separate controls for each side. If powered by compressed air, exhaust from the wiper motors should be muffled or piped under the floor of the bus. No part of the windshield wiper mechanism should be damaged by manual manipulation of the arms. At 60 mph, no more than 10 percent of the wiped area should be lost due to windshield wiper lift. Both wipers should park along the edges of the windshield glass. Windshield wiper motors and mechanisms should be easily accessible for repairs or service from inside or outside the bus and should be removable as complete units. The fastener that secures the wiper arm to the drive mechanism should be corrosion resistant.

WINDSHIELD WASHERS

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

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

OPERATOR’S LIGHTING

The operator's area should have a light to provide general illumination and it should illuminate the half of the steering wheel nearest the operator to a level of 10 to 15 foot-candles. This light should be operator controlled through a switch on the front or side console.

OPERATOR’S SEAT

Dimensions

The operator's seat should be comfortable and adjustable so that persons ranging in size from the 95th-percentile male to the 5th-percentile female may operate the bus. The operator's seat cushion should have a minimum width of 18 inches, a length of 16 to 18 inches, and rearward slope of 0 to 10 degrees (non-adjustable.) The operator's seat back height, measured from the point of intersection of the uncompressed seat cushion with the seat back to the top of the back, should be 20 2 inches. The angle formed between the seat back and the seat cushion should be adjustable in the range of 95 to 110 degrees. Height of the seat should be adjustable so that the distance between the top of the uncompressed seat cushion and the floor may vary between 17 and 21 inches. The seat should be adjustable forward and rearward for a minimum travel of 7.5 inches. While seated, the operator should be able to make all of these adjustments by hand without complexity, excessive effort, or being pinched. Adjustment mechanisms should hold the adjustments and should not be subject to inadvertent changes.

Structure and Materials

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

The operator's seat should be cushioned supplementally by an air cylinder or air diaphragm. These devices may also provide the seat height adjustments. Damping should be provided as required.

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

Seat belts should be provided across the operator’s lap and diagonally across the operator’s chest. The operator should be able to use both belts by connecting a single buckle on the right side of the seat cushion. The belts should 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 should be stored in automatic retractors.

Seat belts should be extended length to accommodate operators of all sizes.

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

Two 40-pound sandbags should be suspended on a 36-inch pendulum and should strike the seat back 10,000 times each from distances of 6, 8, 10, and 12 inches. Seat cushions should 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.

The Contractor should provide a certified test report fully documenting compliance with all the requirements defined above upon request. The test report should 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.

MIRRORS

Exterior Mirrors

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

The operator should be able to adjust the curb-side mirror remotely while seated in the driving position. The control for remote positioning of the mirror should be a single switch or device.

All exterior mirrors should be electrically heated. The heaters should be energized whenever the operator’s heater and/or defroster is activated.

Mirrors should be firmly attached to the bus to prevent vibration and 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 should 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.

Interior Mirrors

Mirrors should be provided for the operator to observe passengers throughout the bus without leaving his seat and without shoulder movement. With a full standee-load, including standees in the vestibule, the operator should be able to observe passengers in the front/entrance and rear/exit areas, anywhere in the aisle, and in the rear seats. Inside mirrors should not be in the line of sight to the right outside mirror.

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

Radio

AM/FM/CD/AUX radio shall be provided and configured in a manner that does not transmit to the passenger compartment speakers, only the speakers in the driver’s area should be connected to this system.

WINDOWS

GENERAL

Buses that are 30 foot in length should have a minimum of 6,000 square inches of window area, including driver’s and door windows, should be required on each side of the standard configuration bus.

Buses that are 35 foot in length should have a minimum of 8,000 square inches of window area, including driver’s and door windows, should be required on each side of the standard configuration bus.

WINDSHIELD

The windshield should permit an operator's field of view as referenced in SAE Recommended Practice J1050. The vertically upward view should be a minimum of 15 degrees, measured above the horizontal and excluding any shaded band. The vertically downward view should permit detection of an object 3-1/2 feet high no more than 2 feet in front of the bus. The horizontal view should 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 should not exceed 10 degrees of binocular obscuration. The windshield should be designed and installed to minimize external glare as well as reflections from inside the bus.

The windshield should be easily replaceable by removing zip-locks from the windshield retaining moldings. Bonded-in-place windshield should not be used. The windshield glazing material should 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 should have single density tint. The upper portion of the windshield above the operator's field of view should have a dark, shaded band with a minimum luminous transmittance of 6 percent when tested in accordance to ASTM D-1003.

OPERATOR’S SIDE WINDOW

The operator's side window should open sufficiently to permit the seated operator to easily adjust the street side outside rearview mirror. This window section should slide rearward in tracks or channels designed to last the service life of the bus. The operator's side window should not be bonded in place and should be easily replaceable. The glazing material should have a single density tint.

The operator’s side window glazing material should 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.

SIDE WINDOWS

Configuration

All side windows, except windows in passenger doors and those smaller than 500 square inches, should have window panels that are openable by passengers. Openable window panels should 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.

Each openable side window should consist of two full-height horizontally sliding panels.

All side windows should be easily replaceable without disturbing adjacent windows and should be mounted so that flexing or vibration from engine operation or normal road excitation is not apparent.

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

Materials

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

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

HEATING VENTILATING AND AIR CONDITIONING

CAPACITY AND PERFORMANCE

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

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

Accessibility and serviceability of components should 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 should maintain an average passenger compartment temperature within a range between 65o and 80o F, while controlling the relative humidity to a value of 50 percent or less. The system should maintain these conditions while subjected to any outside ambient temperatures within a range of 10o to 95o F and at any ambient relative humidity levels between 5 and 50 percent.

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

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

System capacity testing, including pulldown/warm-up, stabilization and profile, should be conducted in accordance to the APTA Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System. Temperature measurements should 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 should 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 should be performed as necessary to ensure compliance to performance requirements stated herein.

The test procedure as described in Section 8 of the APTA document, “Recommended Instrumentation and Performance Testing for Transit Bus Air Conditioning System” should be used for the purposes of the following pulldown requirements. The air conditioning portion of the HVAC system should 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 should not exceed safe high-side pressures and the condenser discharge air temperature, measured 6 inches from the surface of the coil, should be less than 45 F above the condenser inlet air temperature. No simulated solar load should be used. There should be no passengers on board, and the doors and windows should be closed.

Additional HVAC system and performance requirements are contained in Attachments to Part 5: Technical Specification. The air conditioning system should meet these performance requirements using HFC R134a.

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

CONTROLS AND TEMPERATURE UNIFORMITY

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

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

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

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

Interior temperature distribution should be uniform to the extent practicable to prevent hot and/or cold spots. After stabilization, the temperatures between any two points in the passenger compartment same vertical plane, and 6 inches to 72 inches above the floor, should not vary by more than 5 F with doors closed. The interior temperatures, measured at the same height above the floor, should not vary more than ± 5oF, 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 ± 5oF will be allowed for limited, localized areas provided the majority of the measured temperatures fall within the specified requirement.

AIR FLOW

Passenger Area

The cooling mode of the interior climate control system should 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 should be evenly distributed throughout the bus with air velocity not exceeding 100 feet per minute on any passenger. The ventilating mode should 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 should not activate until the heating element has warmed sufficiently to assure at least 70oF air outlet temperature. The heating air outlet temperature should not exceed 120oF under any normal operating conditions.

Operator’s Area

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

AIR FILTRATION

Air should be filtered before discharge into the passenger compartment. The filter should meet the ASHRAE 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 should be easily removable for service.

Air filters should be of disposable type.

ROOF VENTILATORS

Two roof ventilators should 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 should 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 should be provided to allow this. When open with the bus in motion, this ventilator should provide fresh air inside the bus. Ventilator should cover an opening area no less than 425 square inches and should 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 should be incorporated into the roof ventilator. Roof ventilator(s) should be sealed to prevent entry of water when closed.

MAINTAINABILITY

Manually controlled shutoff valves in the refrigerant lines should allow isolation of the compressor and dehydrator filter for service. To the extent practicable, self-sealing couplings utilizing O-ring seals should 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 should be located to efficiently transfer heat to the atmosphere, and should 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 should preclude its obstruction by wheel splash, road dirt or debris. HVAC components located within 6 inches of floor level should be constructed to resist damage and corrosion.

ENTRANCE/EXIT AREA HEATING

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

FLOOR LEVEL HEATING

Sufficient floor level heaters should 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 should be included. Control of the floor level heating should be through the main heating system electronic control.

SIGNAGE AND COMMUNICATION

EXTERIOR ROUTE DISPLAYS

Destination Signs

An automatic electronic destination sign system shall be furnished on the front and on the right side near the front door. Display areas of destination signs should be clearly visible in direct sunlight and/or at night. The sign system should provide optimum visibility of the message display units for passengers and should meet applicable ADA requirements defined in 49 CFR, Part 38.39. Destination signs should be installed in such a manner as to facilitate easy access for replacement of the entire sign assembly, or components such as fluorescent lamps/LED’s and electronic control modules, from inside the bus within 30 minutes by a 3M mechanic. Lamps and associated parts should be commercially available.

Destination messages, route designations, and public relations messages should be independently selectable via a single Operator's Control Panel (OCP) which should include a display monitor. The rear route number sign should be controlled by the same OCP that operates the destination signs. The OCP display monitor readout should show the exact information displayed on the destination signs and route number sign. The OCP should be conveniently located for the bus operator and mounted in such a manner that will not pose any safety hazard. The OCP should utilize a durable weatherproof keypad with tactile feel for destination message control functions.

The destination sign system should be capable of programming 10,000 message lines. The number of public relations messages should be limited only by the remaining number of message lines not used for destination purposes. Sign displays should have alternating message capability with programmable blanking time between message lines as may be required. Variable blanking times should be programmable between 0.5 to 25 seconds in duration. Each line message or blanking time for each message should be individually programmable. The message display units should incorporate an automatic blanking feature that will cause the display area to blank within 30 seconds of the bus master power switch being turned off.

An emergency message should be initiated by the closure, or opening, of a dry contact switch or relay. The emergency message should be displayed on the exterior of the bus only. The OCP should not display the emergency message. The destination sign should automatically resume normal operation when the remote emergency switch is returned to its normal position.

Destination Sign Programming: The electronic sign system should be programmable via an integral connector located in the front destination sign area. Software should be furnished for programming the sign system via an IBM-compatible, laptop computer. Software should be capable of providing a high degree of flexibility to create, or select preprogrammed, fonts and graphic displays. The sign should have the capability of being programmed in the field using a PC or field programmer. Message program information should be transferable to and/or from the field programmer device as specified by the agency in attachments to Part 5: Technical Specifications.

The front destination sign should be full color and have no less than 1,792 LED dot pixels, 16 rows by 112 columns, with a message display area of not less than 8 inches high by not less than 56 inches wide.

The side destination sign should be full color and have no less than 648 LED dot pixels, having at least 9 rows and 72 columns with a message display area of not less than 2.7 inches high by not less than 36 inches wide.

The bus “Master Run” switch should control power to the sign system. The sign system should be operable in all switch positions except "Off".

The destination sign compartments should be designed to prevent condensation and entry of moisture and dirt. Additional provisions should be included, if necessary, to prevent fogging of both destination sign compartment window and glazing on unit itself. Access should be provided to allow cleaning of inside of destination sign compartment window and unit glazing.

A complete listing of destination sign readings for initial sign programming by the manufacturer are provided at a later date.

PASSENGER INFORMATION AND ADVERTISING

Interior Displays

Provisions should be made on the rear of the operator's barrier for a frame to retain information that is sized 11 inches wide and 17 inches high, such as routes and schedules. Advertising media 11 inches high and 0.09 inches thick should be retained near the juncture of the bus ceiling and sidewall. The retainers may be concave and should support the media without adhesives. The media should be illuminated by the interior fluorescent light system.

PASSENGER STOP REQUEST/EXIT SIGNAL

A passenger "Stop Requested" signal system that complies with applicable ADA requirements defined in 49 CFR, Part 38.37 should be provided. The system should consist of a heavy-duty pull cable, chime, and interior sign message. The pull cable should 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 should approximate this transom level and should be no greater than 63 inches as measured from floor surface. It should be easily accessible to all passengers, seated or standing. Pull cable(s) should activate a solid state or magnetic proximity switch(es). At each wheelchair parking position and priority seating positions additional provision should be included to allow a passenger in a mobility aid to easily activate “Stop Requested” signal.

An auxiliary passenger “Stop Requested” signal should 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 should be a heavy-duty push button type located above rear door on the rear door actuator compartment access panel. Button should be clearly identified as “Passenger Signal.”

A heavy-duty “Stop Request” signal button should be installed on modesty panel stanchion immediately forward of rear door and clearly identified as “Passenger Signal.”

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

A single "Stop Requested" chime should sound when the system is first activated. A double chime should sound when the system is first activated from wheelchair passenger areas.

A "Stop Requested" message in red letters should be illuminated when the passenger "Stop Requested" signal system is activated. The "Stop Requested" message should remain visible until one or both passenger doors are opened. The message should be visible to the seated operator and seated passengers. The operator should be able to deactivate the signal system from the operator's area. A green light should 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.

RADIO COMMUNICATION SYSTEM

Motorola XPR2500 or approved equivalent should be installed at a location convenient to the operator. The location should 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 should include a 3/4-inch inside diameter conduit with a pull wire. The antenna mounting and lead termination should be accessible from the bus interior. A compartment should be provided to accommodate a communication system. It should be located within 8 feet of the operator's seat and should be connected to the operator's area by waterproof, 2-1/4 inch inside diameter, metallic conduit. The radio area should be supplied with a 30-amp, 12-volt, DC, protected service with positive and negative leads.

PUBLIC ADDRESS SYSTEM

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

SECURITY CAMERAS

The bus should be equipped with an 8 Channel DVR unit with 8 cameras, three exterior and 5 interior. The DVR should be Mobile DVR X11-8CH or approved equal.

ELECTRICAL SYSTEM

GENERAL REQUIREMENTS

The bus should be equipped with a programmable logic control system that is computer based and completely modular. The programmable logic control collects information received from input devices throughout the bus and then communicates with its system components or other output devices in remote areas of the bus through multiplex wiring system. The entire system will reduce the amount of wiring over a conventional wiring/harness electrical system. Versatility and future expansion should be provided for by expandable system architecture. The system components should be capable of operating in an environment of between -20°F and 170°F while encountering mobile shock and vibrations. The system should store and retrieve data for the mechanical and electrical functions of the bus. All components in the system will be interchangeable. The multiplex power source should be isolated to avoid any ground noise.

The electrical system should provide and distribute power to ensure satisfactory performance of all electrical components. The system should supply a nominal 12 and/or 24 volts of direct current (DC), and employ alternating current up to 220 volts that does not present an electrical shock hazard. Electrical power provided for the fare collection device and the radio compartment should be 12 and/or 24 volts DC as specified in attachments to Part 5: Technical Specifications. Precautions should be taken to minimize hazards to service personnel. Transient voltages above 220 volts may be used in the fluorescent lighting system. The power generating system should be rated sufficiently higher than the total possible electrical load to maintain the charge on the batteries at all operating conditions including the engine at idle. All circuits, except for those involved in propulsion system start-up, should be protected by circuit breakers or fuses. Fuses should be used only where it can be demonstrated that circuit breakers are not practicable, and they should be easily accessible for replacement.

Redundant grounds should be used for all electrical equipment, except where it can be demonstrated that redundant grounds are not feasible or practicable. One ground may be the bus body and framing. Grounds should not be carried through hinges, bolted joints (except those specifically designed as electrical connectors), or power plant mountings. Electrical equipment should not be located in an environment that will reduce the performance or shorten the life of the component or electrical system. To the extent practicable, wiring should not be located under the bus floor. Wiring and electrical equipment necessarily located under the bus should be insulated from water, heat, corrosion, and mechanical damage.

MODULAR DESIGN

Design of the electrical system should 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, should be removable and replaceable in less than 1 hour by a 3M mechanic. Power plant wiring should be an independent wiring module. Replacement of the engine compartment wiring module(s) should not require pulling wires through any bulkhead or removing any terminals from the wires.

WIRING AND TERMINALS

All wiring between electrical components and terminations, should have double electrical insulation, should be waterproof, and should conform to specification requirements of SAE Recommended Practice J1127 and J1128. Except as interrupted by the master battery disconnect switch, battery and starter wiring should be continuous cables, grouped, numbered, and/or color-coded with connections secured by bolted terminals; and should conform to specification requirements of SAE Standard J1127-Type SGT or SGX and SAE Recommended Practice J541. Wiring harnesses should not contain wires of different voltages unless all wires within the harness are sized to carry the current and insulated for the highest voltage wire in the harness.

Double insulation should be maintained as close to the terminals as possible. The requirement for double insulation should be met by wrapping harnesses with plastic electrical tape or by sheathing all wires and harnesses with non-conductive, rigid or flexible conduit. Strain-relief fittings should be provided at points where wiring enters all electrical components. Grommets of elastomeric material should be provided at points where wiring penetrates metal structures outside of electrical enclosures. Wiring supports should be protective and non-conductive at areas of wire contact and should not be damaged by heat, water, solvents, or chafing.

All wiring harnesses over 5 feet long and containing at least 5 wires should include 10 percent excess wires for spares that are the same size as the largest wire in the harness excluding the battery cables. This requirement for spare wires does not apply to data links and/or communication cables. Wiring length should allow end terminals to be replaced twice without pulling, stretching, or replacing the wire. Except for large wires such as battery cables, terminals should be crimped 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. Terminals should be corrosion-resistant and full ring type or interlocking lugs with insulating ferrules. T splices may be used when there is less than 25,000 circular mills of copper in the cross section and a mechanical clamp is used 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 cable connectors should be locking type, keyed, and watertight, unless enclosed in watertight cabinets. Pins should be removable, crimp contact type of the correct size and rating for the wire being terminated. Unused pin positions should be sealed with sealing plugs. Adjacent connectors should either use different inserts or different insert orientations to prevent incorrect connections.

JUNCTION BOXES

All relays, controllers, flashers, circuit breakers, and other electrical components should be grouped according to voltage; and mounted in easily accessible junction boxes. The boxes should be sealed to prevent moisture from normal sources, including engine compartment cleaning, from reaching the electrical components and should prevent fire that may occur inside the box from propagating outside the box. The components and circuits in each box should be identified and their location permanently recorded on a schematic drawing glued to or printed on the inside of the box cover or door. The drawing should be protected from oil, grease, fuel, and abrasion. The front junction box should be completely serviceable from the driver's seat, vestibule, or from outside. A rear start and run control box should be mounted in an accessible location in the engine compartment.

ELECTRICAL COMPONENTS

All electrical components, including switches, relays, flashers, and circuit breakers, should be heavy-duty designs. These components should be longest lasting, commercially available, and should be replaceable in less than 5 minutes by a 3M mechanic. Sockets of plug-in components should be polarized where required for proper function and the components should be positively retained. Any manually resettable circuit breakers critical to the operation of the bus should be mounted in a location convenient to the driver and provide visible indication of open circuits. All electric motors, except cranking motors, should be heavy-duty brushless type, with a constant duty rating of no less than 40,000 hours. Electric motors should be located for easy replacement and except for the cranking motor should be replaceable in less than 15 minutes by a 3M mechanic. Electronic circuit protection for the cranking motor should be provided to prevent engaging of the motor for more than 30 seconds at a time to prevent overheating.

MULTIPLEX WIRING SYSTEM

The components of the multiplex system should be of modular design, thereby providing for ease of replacement by maintenance personnel. The modules should be easily accessible for troubleshooting electrical failures and performing system maintenance. Each module should be shielded to prevent interference by EMI and RFI; and should utilize LEDs to indicate circuit integrity and assist in rapid circuit diagnostics and verification of the load and wiring integrity. In conjunction with relays if necessary, each circuit should be capable of providing a current load of up to 10 Amperes. The internal controls should be a solid state device, providing an extended service life. Wiring for data bus and node module power should consist of three, 22 gage or larger, UL approved, shielded, twisted pairs.

Ten percent (10%) spare input and output should be provided at each I/O location. Wiring used for the multiplexing should be stamped with the address of the corresponding I/O location.

Protection to each individual circuit should be provided. An automatic test system, integral to the multiplexing, should be provided. The system should be hosted on an IBM-compatible personal computer as well as a hand held field diagnostic unit capable of reading the network data, control function and address data, or function code. The mechanic should be able to use either unit to check bus wire function.

BATTERIES

Batteries should be easily accessible for inspection and service from only the outside of the bus. The batteries should be securely mounted on a stainless steel tray that can accommodate the size and weight of the batteries. The battery tray should pull out easily and properly support the batteries while they are being serviced. The tray should allow each battery cell to be serviced and filled with either manual or automatic equipment. A positive lock should retain the battery tray in the stowed position.

Two 8D battery units conforming to SAE Standard J537 should be provided. Each battery should be fitted with threaded stud terminals and have a minimum of 1150 cold cranking amps. Each battery should have a purchase date no more than 60 days from date of release for shipment to the agency.

Positive and negative terminal ends should have different size studs to prevent incorrect installation. The battery terminal ends and cables should be color-coded with red for the primary positive, black for negative, and another color for any intermediate voltage cables. Battery terminals should be located for access in less than 30 seconds with jumper cables. Battery cables should be flexible and sufficiently long to reach the batteries with tray in the extended position without stretching or pulling on any connection and should not lie directly on top of the batteries. Battery cables must be of sufficient size to carry the load required by the starting motor.

A jump-start connector should be provided in the engine compartment equipped with dust cap and adequately protected from moisture, dirt and debris.

MASTER BATTERY SWITCH

A master switch on the battery positive (+) should be provided in the battery compartment near the batteries for complete disconnecting from all bus electrical systems except for safety devices such as fire suppression system and other systems as specified. The location of the master battery switch should be clearly identified on the access panel and be accessible in less than 10 seconds for activation. The master switch should be explosion proof and capable of carrying and interrupting the total circuit load. Any equipment that requires power without reference to the master battery switch should be listed in attachments to Part 5: Technical Specifications. Opening the master switch with the power plant operating should not damage any component of the electrical system. The location of the master battery switch should prevent corrosion from fumes and battery acid when the batteries are washed off.

FIRE SENSING AND SUPPRESSION SYSTEMS (FSS)

A Fire Sensing and Suppression System (FSS) should be provided to monitor the engine compartment and (optional) auxiliary area(s) where a significant fire hazard exists. Upon detection, the system will alert the operator with visual and audible signals and initiate automatic engine shutdown, fuel shut-off, and extinguisher discharge sequences.

FIRE DETECTION

Fire detectors can sense radiant or heat energy from a fire. Heat energy is detected thermally by immersion in hot air, such as in close proximity to a fire. Radiant energy is detected optically at some distance from the fire. Thermal fire detectors should be installed.

The thermal fire detectors should be spot (one-dimensional detection) or linear (two-dimensional detection) designed for use in engine compartments. Thermal fire detectors must be in close proximity to the fire in order to detect. Their mounting locations must be chosen per the installation instruction, certified by the manufacturer, and typically mounted so that airflow will act to move a fire in the protected area toward them. The thermal detector should respond to being immersed in a fire in less than thirty seconds. The thermal detection system in the engine compartment will be comprised of at least two each spot detectors or one linear detector of suitable length.

SYSTEM ACTION

The FSS will detect fires in the protected areas. Upon detection, the system will alert the operator with visual and audible signals and initiate automatic engine shutdown, fuel shut-off, and extinguisher discharge sequences.

Alarm Indication

Upon detection of a fire, the system will provide a visual and audible fire alarm to the operator.

System Status and Trouble Indication

The status of the FSS should be verified by inspection during maintenance.

Automatic Engine Shut-Down

After a fire is detected, the FSS should cause fuel flow to cease, and the engine to shut down.

Extinguisher Discharge

The system should provide a means for manually discharging the extinguisher with the control located in the driver’s area. The installation should be certified by the manufacturer of the suppression system

Operator Over-Ride of Automatic Engine Shut-Down and Extinguisher Discharge

The FSS should offer provision for the operator to over-ride the automatic action of the system. The over-ride will prevent the engine shutdown from occurring. The over-ride delay should require active input from the operator.

System Reset

After a fire alarm and complete system sequence, the FSS should have provision to be reset after the system is reconfigured per the instructions provided by the manufacturer.

FIRE SUPPRESSION SYSTEM

The fire suppression system should be pre-engineered and designed for vehicle applications. The system should have a minimum capacity of 20 pounds of BC or ABC dry chemical agent. System cylinder should have a minimum service pressure of 350 psi and be DOT rated. Nozzles and distribution should be installed in accordance with the installation manual. Stored pressure type extinguishing units should be provided with a gauge that can be visually inspected for pressure condition.

METHANE DETECTION SYSTEM (MDS)

A Methane Detection System (MDS) should be provided to monitor the engine compartment, each separate fuel storage area(s), and other areas where a leak is possible or gas may accumulate. See below for Methane Detection System details

METHANE DETECTION

GENERAL

The sensing technology selected should be configured for use in the protected area, e.g. the engine compartment, and allow for the required maintenance schedule.

SYSTEM ACTION

The MDS will detect potentially dangerous gas leaks in the protected areas. Upon detection, the system will alert the operator with visual and audible signals. If required, the MDS should (optionally) initiate engine shutdown and fuel shutoff sequences.

Alarm Indications

The MDS should automatically activate visible and audible alarms in the operator area when a significant leak is detected. The significant leak threshold should correspond to a maximum of 50% Lower-Explosive Limit (LEL) of methane. Optionally, a trace (20%) or moderate (30%) leak should be indicated visually and/or audibly.

System Status and Trouble Indication

The MDS should provide an active visual indication of the system status. An immediate visual Trouble indication will be provided if a fault occurs in any portion of the MDS circuit. An Indicator Test function should be provided at the panel.

Methane Detection System (MDS) Calibration

Standard requirement for a MDS not requiring field calibration.

Engine Shut-Down From MDS

After a significant level gas leak is detected, the MDS should cause the fuel flow to cease, and the engine to shut down. An optional automatic delay between the gas leak alarm and engine shutdown should not exceed 30 seconds.

Operator Engine Shut-Down Override

When the system is configured so that engine shut-down occurs after a pre-set delay following a significant gas leak alarm, the MDS provides for the operator to over-ride the automatic action of the system, further delaying the engine shutdown. The override delay should require active input from the operator.

Reset

After a gas leak alarm and complete system sequence, the MDS should reset automatically once the gas level has returned to a normal level. Once activated, the engine shut-down feature must be manually reset by input by qualified personnel.

RADIO NOISE ATTENUATION

Proper suppression equipment should be provided in the electrical system to eliminate interference with radio and television transmission and reception. This equipment should not cause interference