CITY AND COUNTY OF SAN FRANCISCO
SAN FRANCISCO MUNICIPAL TRANSPORTATION AGENCY

VOLUME 2

TECHNICAL SPECIFICATIONS

FOR

THE PROCUREMENT OF
30-FOOT, 40-FOOT AND 60-FOOT LOW FLOOR,
DIESEL HYBRID COACHES

CONTRACT PROPOSAL NO. CPT 713

1 OVERALL REQUIREMENTS

1.1 SCOPE

These specifications detail the technical requirements for the construction of new heavy-duty 30-foot, 40-foot and 60-foot Low Floor Diesel Hybrid Coaches for the San Francisco Municipal Transportation Agency (SFMTA). The new coaches are intended to provide superior performance in the unique San Francisco operating environment with improved reliability and reduced emissions compared to existing SFMTA equipment. These coaches are intended for the widest possible spectrum of passengers, including children, adults, the elderly, and the disabled.

The coach shall be designed to operate in transit service for at least

30 foot: 10 years or 300,000 miles

40 foot: 12 years or 500,000 miles

60 foot: 12 years or 500,000 miles

The Contractor shall be responsible for designing, fabricating, assembling, testing and finishing transit coaches, which are in all respects compliant with the requirements of the Contract Documents. Included with these requirements are specified components, equipment and systems usually accompanied by the phrase “or approved equal.” Such components, equipment and systems, or deviations and substitution items, specifically approved by SFMTA, shall be provided as part of the completed coaches by the Contractor.

1.1.1 Definition

The following are definitions of special terms used in the Technical Specifications:

ADA (Americans with Disabilities Act) – Federal mandates, which insure business and institutions, provide persons with disabilities access and communication in their daily life so they able to function as near as possible to normal.

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

APU (Auxiliary Power Unit) - Converts consumable fuel energy into mechanical and/or electrical energy.

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 four (4) decibels (dB) or more.

Battery Rated Ampere-hour Capacity - manufacturer-rated capacity of a battery in Ampere-hours obtained from a battery discharged at the manufacturer’s recommended discharge rate such that a specified minimum cut-off terminal voltage is reached.

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

Break over Angle - The angle is 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 coach can roll.

CL/ID - Clearance/Identification lights for vehicle not in motion.

Coach - The terms coach and vehicle are used interchangeably.

Controller - See definition of PCS (below).

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.

dBA - Decibels with reference to 0.0002 microbar as measured on the "A" scale.

Defect(s) - Patent or latent malfunctions or failure in manufacture or design of any component or subsystem.

Departure Angle - The angle is measured between a line tangent to the rear tire static loaded radius and the initial point of structural interference rearward of the rear tire to the ground.

DR - Diagnostic Reader

ECM - Engine Control Module

Electric Drive System - electric motor, system controller, generator, and energy storage system.

Electronic Parts Lists – This list shall be associated with an IPC assembly layout drawing. and provides all manufacturers part numbers for all the parts identified and shown on the layout drawing.

Electronics Schematic Diagram – This is a detailed drawing of the components and connections at a level detailing to the circuit boards and identifying those individual pieces, functions and connections.

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

Energy Storage System - A component or system of components that stores energy and for which its supply of energy is re-chargeable by an APU, an off-vehicle electric energy source, or both.

Failure Definitions - Classification of failures are described below:

- Bad Order: A failure that does not require removal of the coach from service during its assignments but does degrade coach operation. The failure shall be reported by operating personnel.
- MDBF (Mean Distance Between Failure): This measure of failure includes the definition of MDBSF as well as any incident, malfunction, intermittent condition, or failure of equipment or hardware, which prevents the vehicle from being deployed in revenue service.
- MDBSF (Mean Distance Between Service Failure): Any incident, malfunction, intermittent condition, or failure of equipment or hardware which in either actual or simulated revenue service causes a delay in excess of five (5) minutes and under normal operating conditions would cause passengers to be transferred to another vehicle.
- Physical Safety: A failure that could lead directly to passenger, operator or maintainer injury

Fireproof - Materials that will not burn or melt at temperatures less than 2,000°F.

Fire-Resistant - Materials that have a flame spread index less than 150 as measured in a radiant panel flame test per ASTM-E 162-75.

Free Floor Space - Floor area available to standees, excluding stepwells, area under seats, area occupied by feet of seated passengers, and the vestibule area forward of the standee line. Floor area of 1.5 square feet shall be allocated to be occupied by the feet of each standee.

Gross Load - 150 pounds for every designed passenger seating position, for the operator, and for each 1.5 square feet of free floor space.

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

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. The GVWR shall be greater than or equal to GVW.

High Voltage - 50-800 volts (AC and DC).

Human Dimensions - The human dimensions used in the Technical Specifications are defined in SAE Recommended practice J833.

Hybrid-electric Drive System - propulsion system comprised of an APU and corresponding electric drive system connected with the APU.

H&V (Heating and Ventilating) – The on-board system which provide the operator and passengers temperature comfort within the coach.

IPC (Illustrated Parts Catalog) – Layout drawings containing essential parts and part numbers which make up an assembly. These documents include the original manufacturers name part numbers, part quality, quantity, and sub-part and vendor information.

J1708 & J1939– An SAE standard defining a bi-directional, serial communication link among control modules containing microcomputers in heavy-duty vehicle applications.

Low Floor - Vehicle configuration primarily identified by the lack of steps at the front and rear doors.

Low Voltage - 50 volts or less.

Maintenance Personnel Skill Levels - Definitions of maintenance personnel skill levels are listed below:

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 Coach Servicer
e)	1M:	Cleaner, Fueler, Oiler, Hostler, or Shifter
f)	3E:	Assistant Supervising Electronics Maintenance Technician
g)	2E:	Electronics Maintenance Technician
h)	1E:	Assistant Electronics Maintenance Technician

Operator's Eye Range - The 95th percentile ellipse defined in the SAE recommended Practice J941, except that the height of the ellipse shall be determined from the seat at its reference height.

Parallel Hybrid - Electric motor and APU are both mechanically connected to the drive wheels.

PCB (Printed Circuit Board Assembly) - A PCB includes the printed circuit board and all of the individual electronic components and interconnections that make up the assembly.

PCS (Propulsion Control System) - The electronic controller regulates the amount of energy, (DC power in the case of batteries and capacitors), that is transferred (or converted to AC power by the inverter in AC motors) for acceleration. It also ensures that voltage is maintained within the specifications required for operating the motor(s). An electronic controller can also recover electrical energy by switching the motor(s) to a generator in order to capture the vehicle's kinetic energy through regenerative braking. The controller also ensures that the regenerative current does not overcharge the energy storage system and that regenerative energy is otherwise safely dissipated when not captured.

Power Density - The power of a battery cell in terms of its ability to discharge and accept energy at a given rate.

Propulsion System - System that provides propulsion for the vehicle in an amount proportional to what the driver commands.

Regenerative Braking - Deceleration of the coach caused by operating an electric motor-generator system. This act returns energy to the vehicle propulsion system and provides charge to the Energy Storage System.

Related Defect(s) - Damages inflicted on any component or subsystem as a direct result of a defect.

RFI - Radio Frequency Interference

Seated Load - 150 pounds for every designed passenger seating position and for the operator.

Series Hybrid - No mechanical connection between the APU and the drive wheels. The APU supplies electricity to motor(s) and energy storage system. There are three (3) basic variations: 1) a single electric motor or set of motors drives the wheels directly or 2) a single electric motor or set of motors drives the wheels through a mechanical transmission; or 3) an independent wheel motor drives each drive wheel. In each case, the electric motor(s) may draw energy from either the energy storage device or from the APU as determined by the controller. Subcategories of series hybrids include: engine-dominant and battery-dominant. These subcategories are generally linked to whether the hybrid system is charge sustaining or charge depleting.

SHOPS (Shop History and On-Line Parts System) – SFMTA's computerized maintenance system utilized for tracking vehicle history including but not limited to labor, parts, warranty, vendor activity, in addition to inventory of parts and supplies.

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

Standee Line - A line marked across the coach aisle in line with the front curbside modesty panel to designate the forward area, which passengers may not occupy when the coach is moving.

SOC (State of charge) - Quantity of electric energy remaining in the battery relative to the maximum rated Amp hour (Ah) capacity of the battery expressed in percent. This is a dynamic

measurement used for the energy storage system. A full SOC indicates that the energy storage system cannot accept further charging from the APU or the regenerative braking system.

Wheelchair - Mobility aid belonging to any class of three or four-wheel devices, usable indoors, designed for and used by individuals with mobility impairments, whether operated manually or powered. A "common wheelchair" is such a device, which 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.

Working Day - All 24-hour periods beginning and ending at midnight, Monday through Friday inclusive.

1.1.2 Abbreviation

The following is a list of abbreviations used in the Technical Specifications:

ABS	Anti-lock Braking System
ADA	Americans with Disabilities Act
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating, and Air Conditioning Engineers
ASTM	American Society for Testing and Materials
AWS	American Welding Society
CCR	California Code of Regulations
CFR	Code of Federal Regulations
DVD	Digital Versatile Disc
DTE	Diagnostic Test Equipment
DVAS	Digital Voice Annunciation System
EPA	Environmental Protection Agency
EPU	Emergency Propulsion Unit
FCC	Federal Communications Commission
FSRP	Field Service Repair Procedure
FMCSR	Federal Motor Carrier Safety Regulations
FMVSS	Federal Motor Vehicle Safety Standards
FTA	Federal Transit Administration
GVWR	Gross Vehicle Weight Rating
H&V	Heating and Ventilating
IPC	Illustrated Parts Catalog
ISO	International Organization for Standardization
JIC	Joint Industrial Council

LED	Light Emitting Diode
MIL-STD	Military Standard
NEC	National Electrical Code
NFPA	National Fire Protection Association
NHTSA	National Highway Traffic Safety Administration
OCU	Operator Control Unit
OEM	Original Equipment Manufacturer
PA	Public Address
PCB	Printed Circuit Board
PLC	Programmable Logic Controller
SAE	Society of Automotive Engineers
SOC	State of Charge
SPI	Society of the Plastics Industry
SDTS	Self Diagnostic Testing Software
SHOPS	Shop History and On-Line Parts System
SLW	Seated Load Weight
UL	Underwriters Laboratories
USDOT	United States Department of Transportation

1.1.3 Legal Requirements

A. The coach shall meet all applicable FMVSS in effect at the date of manufacture. The coaches and equipment must comply with all applicable federal, state, and local regulations. Local regulations are defined as those below the state level. In the event of any conflict between the requirements of these specifications and any applicable legal requirement, the legal requirement shall prevail.
B. Manufacturer shall certify to SFMTA that the vehicle complies with 49 U.S.C. § 5323(c) and FTA implementing regulations at 49 CFR Part 665 concerning coach testing.
C. Manufacturer shall test the prototype coach at the Altoona, PA Testing Facility and shall provide copies of all testing. If the coach proposed by the manufacturer has already been tested successfully at the Altoona, PA Testing Facility, then re-test of the prototype will not be necessary, subject to SFMTA's approval of the test results. The Contractor shall provide results from all Altoona Testing.
D. Manufacturer shall verify that the vehicle is certified by the California Air Resources Board for meeting both exhaust emissions and engine durability requirements as specified for use in heavy-duty, urban transit coaches. If manufacturer intends to emissions certify through vehicle testing, a detailed testing strategy and design review shall be approved by SFMTA prior to testing.
E. Manufacturer shall certify that the proposed coach meets the specifications set forth in the Americans with Disability Act (ADA).

1.2 DIMENSIONS

With the exceptions of exterior mirrors, marker and signal lights, flexible portions of the bumpers, and fender skirts, the coach shall have the following overall general dimensions:

TABLE 1.2

Length,, excluding bumpers	30’ +/- 1’	40’ +/- 1’	60’ +/- 1’
Width - exterior, excluding mirrors	102" max	102" max	102” max
Height Overall, without roof-mounted H&V system	125" max	125" max	125" max
Height Overall, with roof-mounted H&V system	140" max	140" max	140" max
Seating Capacity:	25 min	35 min	57 min
Width of Seat (one passenger)	18” min	18” min	18” min
Width of Seat (two passenger)	35" min	35" min	35" min
General Aisle Width	22" min	22" min	22" min
Headroom along Center Aisle, at Front Axle Wheelhouse	80" min	80" min	80" min
Headroom along Center Aisle, at Rear Axle Wheelhouse	77" min	77" min	77" min
Front Floor Height From Ground (normal)	15" max	15" max	15" max
Front Floor Height From Ground (kneeled)	10" max	10" max	10" max
Rear Floor Height From Ground (normal)	16" max	16" max	16" max
Body Ground Clearance	8" min	8" min	8" min
Approach Angle	9 degrees min	9 degrees min	9 degrees min
Break over Angle	9 degrees min	9 degrees min	9 degrees min
Departure Angle	9 degrees min	9 degrees min	9 degrees min
Turning Radius (Front Body Corners)	TBD	TBD	TBD

1.2.1 TURNING RADIUS

The outside body corner turning radius shall not exceed 45 feet with the coach at GVWR.

1.2.2 Underbody Clearance

The coach shall maintain the minimum clearance dimensions as shown in Table 1.2 and defined in SAE Standard J689, regardless of load, up to the GVWR. All components under the coach, engine including the oil pan, traction motor, generator, shall be protected from impacts.

Ramp Clearances: Approach and departure angles shall be no less than nine (9) degrees. Break over angle shall be no less than nine (9) degrees. Any encroachment into the approach or departure angle area shall encounter a structural member before any component. A wedge supplied by the Contractor shall verify the approach and departure angles.

Ground Clearance: Ground clearance shall be no less than eight (8) inches except within the axle zone and wheel area.

Axle Zone Clearance: Axle zone clearance (the axle zone is the projected area between tires and wheel on the same axial centerline) shall be no less than five (5) inches.

1.3 PROPULSION SYSTEM PERFORMANCE

All hybrid coaches shall be road tested and shall meet the following criteria with a full passenger load, and a full tank of fuel. Acceleration times begin when the accelerator pedal is depressed; lag time between depression of the accelerator pedal and movement of the coach should be minimized. Minimum actual vehicle acceleration requirements are:

TABLE 1.3.1 -Requirements

Speed on Grade

Grade	30-Foot / 40-Foot	60-Foot
0% Grade	63 mph (max)	63 mph (max)
2% Grade	55 mph	40 mph
5% Grade	25 mph	26 mph
10% Grade	15 mph	11 mph
16% Grade	10 mph	8 mph
23% Grade	8 mph	Not Applicable

Acceleration on Grade

Grade	mph	Time (seconds)	mph	Time (Second)
0% Grade	0-10	5	0-10	7
0% Grade	0-20	7	0-20	10
0% Grade	0-40	25	0-40	35
2% Grade	0-15	7	0-15	9
5% Grade	0-13	7	0-13	9
10% Grade	0-10	7	0-10	9
16% Grade	0-8	7	0-8	12

1.4 DUTY CYCLE

Coaches shall be designed to be compatible with the terrain and environment found in SFMTA's service area. Also, coaches shall be capable of running continuously with capacity load in the environmental conditions found in SFMTA's service area. These conditions include high humidity, rain, and occasional temperature extremes.

The propulsion and braking systems shall meet the performance requirements of the Duty Cycle. Braking application and performance shall remain consistent regardless of hybrid system SOC or other variances related to regenerative braking.

Jerk, the rate of change of acceleration, shall be minimized throughout acceleration and deceleration and shall average no greater than 3 mphs per second over any half-second interval. This requirement shall be achieved regardless of operator actions.

Coaches shall be capable of continuous operation at freeway speeds with GVWR and an ambient temperature of 115°F without overheating or degradation of any operating component. They shall operate in stop and go downtown traffic with no adverse effects. Coaches shall also be able to safely and efficiently negotiate the hilly conditions found in the City and County of San Francisco. SFMTA's service area includes grades of up to 23 percent..

The coach shall achieve normal operation in the environmental conditions of San Francisco with temperature ranges of 0 degree Fahrenheit (°F) to 115°F, at relative humidity between 5 percent and 100 percent, and at essentially sea level altitudes. Any exception to the above requirement shall be approved by SFMTA.

The following composite routes are typical routes the coach will take in normal revenue service. These include freeway and arterial travel.

Locations of Grades and Turns:

Sacramento Street -- Drum to Van Ness
Clay Street -- Van Ness to Drum
24 Divisadero Line -- 30th and Mission, 30th, R-Noe, L-26th, R-Castro, Divisadero to Geary (both directions)
Market and Clayton -- operate around turn onto Market and also from Market onto Clayton
DeHaro -- Mariposa to 23rd Street. *(*Note: this is a 21% grade.)
23rd Street -- Indiana to Pennsylvania (both directions - without contacting road with chassis) Note: this determines straight-on approach, break over, and departure clearances.
Mansell Street -- Mansell at San Bruno is the exact location. This determines departure angle clearance.
Rhode Is. & 26th St -- negotiate southbound turn onto 26th without contacting road with chassis. Note: this determines front-left side chassis clearance through left hand turn.
2nd Street at Folsom -- Negotiate westbound turn onto Folsom, as tight as possible, without contacting road with chassis. Note: this determines rear-right side chassis clearance through right hand turn.

1.5 AUDIBLE NOISE LEVEL CONTROL

SFMTA strongly prefers that each coach have a low level of exterior/interior noise and, as a design goal, that each coach be significantly quieter than the specification allows. Instrumentation and other requirements shall conform to SAE Standard J366, except that the two- (2) dBA tolerance is not allowed. If the noise level contains an audible discrete frequency, a penalty of five (5) dBA shall be added to the sound level. The contractor shall develop a test plan for validating the noise levels based on the following criteria. This plan shall be presented to SFMTA for review and approval. The tests shall be configured to be conducted with the coach loaded to SLW.

1.5.1 Interior Noise

The coach shall be empty except for test personnel, not to exceed four persons, and the test equipment. All openings shall be closed and all accessories shall be operating during the test, including the requirement that the cooling fan be locked in the full "ON" position. During the test, the ambient noise level in the test area shall be at least 10 dBA lower than the coach under test. In determining interior noise levels (dBA), the contractor shall not average results between locations.

TABLE 1.5.1

OPERATING MODE	Maximum Allowable At Any Seat Location in Passenger Area	Maximum Allowable at Operator Seat
(0-35 mph)	75 dBA	70 dBA

1.5.2 Exterior Noise

All noise readings shall be taken with all accessories operating and the cooling fan locked on. The pull-away test is measured with the throttle fully applied and the vehicle accelerating at maximum rate. It shall begin with the front bumper even with the microphone. The curb idle test shall be conducted in such a way that the APU is forced to operate at the maximum rpm possible while the vehicle is stationary (for example, simulating the re-charging of severely

depleted batteries). The curb idle test shall be conducted with the rear bumper even with the microphone.

TABLE 1.5.2

OPERATING MODE	MAXIMUM ALLOWABLE
Pull-away test	75 dBA
Curb idle test	65 dBA

1.6 ELECTRONIC NOISE CONTROL

Electrical and electronic sub-systems and components on the coaches shall not emit electromagnetic radiation that will interfere with on-board equipment, fare collection, telephone, radio, TV reception or be susceptible to R.F.I./E.M.I., and shall not be affected by external sources of R.F.I./E.M.I (Reference Section 7.13, Electrical and Electronic Noise).

1.7 COMPONENT PROTECTION AND OVER-RIDE

The engine and all major components of the propulsion system shall be monitored for proper operation, and shall be provided with automatic shut-down features that will protect the components from damage in the event of conditions such as over-speed, over-temperature, overload, or short circuit. Such shutdown features shall be tied to warning lights in the driver's area, and to fault codes logged in the diagnostic system. The components that must be protected in this way include: APU and its major subsystems (including engine, emissions control equipment, and propulsion system generator), traction motor(s), power electronics, and energy storage unit. Such automatic shut-down features shall be capable of being overridden in order to allow the vehicle to be safely moved a short distance (for example: out of the flow of traffic), unless overriding will pose a serious safety hazard (for example: a fire). The over-ride feature shall be activated by a guarded momentary contact switch located at the driver's position.

The control system shall be designed so that components that are mechanically connected to the rear wheels shall be prevented from over-speeding. This shall be accomplished automatically, without operator intervention, through a vehicle speed limiting control system. As an example, accelerator application shall be progressively reduced and/or regenerative braking shall be progressively applied to prevent the drive motor system from over-speeding.

1.8 SHOCK HAZARDS

Casual contact with components that have a sufficient voltage potential (emf) to cause bodily injury shall not be possible. No passenger, driver, or passerby shall be able to contact such equipment.

Electrical systems and equipment shall conform to the applicable SAE standards and/or recommended practices for electric/hybrid vehicles (including, J1673, J1718, J1742, J1766, J1797, J1798, J2344, J2293). The electrical system shall also conform to SAE standards for wiring (J1654 and J1673) and connectors (J1742).

There should be no high voltage areas within the passenger compartment. For maintenance purposes, all devices that contain high-voltage circuits (maximum circuit operating voltages above 50V) shall be contained within protective enclosures or enclosed coach body compartments that are either non-conductive or have been coated with SFMTA approved non-conductive insulation. All access covers for such enclosures and compartments shall be

permanently labeled with a warning and the voltage, for example "**DANGER-> 600 VOLTS DC**". All high voltage wiring and equipment shall be shielded by access covers, requiring the removal of at least one bolt, screw, or latch. It shall not be possible to contact high voltage devices with the access covers closed.

Appropriate warning signs and labels shall be used to alert maintenance personnel and/or emergency crews to the presence of high voltage batteries and cabling within the coach. All visible high voltage equipment or conductors shall be identified with a “HIGH VOLTAGE” marking. The diesel hybrid coach should be clearly marked “HYBRID VEHICLE” on the exterior.

Energy storage box enclosures shall be properly grounded and considered part of the chassis ground. Ground fault protection circuits shall be provided to ensure insulation integrity between the high voltage circuit components and the coach chassis. Circuit breakers and/or fuses (or accepted equal) shall be provided to effect electrical isolation of components and systems (including the energy storage unit) in the case of a short circuit and/or excessive current draw. In the case of battery isolation, the disconnecting contactors shall be located as close as possible to the positive and negative output of the energy storage unit. A means for informing the operator of the loss of high voltage ground isolation shall be provided by proper annunciation on the dashboard with visual and audible signals in a phased warning and shutdown.

High voltage cables and wires shall be installed in the dedicated harnesses, wire conduits, or raceways. High voltage wires and harnesses shall be permanently identified with the use of orange color per SAE specifications.

Low voltage systems should be independent of high voltage systems, so that emergency lighting, cameras, and all other accessories remain operable in the event of a high voltage system failure.

Interlocks shall be provided on doors and covers for inverters, converters and other energy storing devices to quickly de-energize primary power from these circuits when these doors and covers are opened. Doors and covers shall utilize square coach “door key” latches allowing for commonality among other doors on the coach.

The energy storage system enclosure, inverter(s), converter(s), main switch group, PCS and traction motor terminal covers shall all be labeled with “HIGH VOLTAGE WARNING” labels.

The energy storage system, inverter(s), converter(s), main switch group, PCS, traction motor and propulsion system generator shall be enclosed or covered to prevent casual contact. The PCS enclosure shall have a mechanical interlock to ensure that the high voltage connections are disconnected before the enclosure is opened. The energy storage unit shall be stored in a sealed container(s).

The traction (energy storage) batteries will remain a live power source when the traction battery storage box cover is removed. The distance between main terminals shall be beyond the mechanics reach to minimize potential problems. Energy storage modules shall be properly secured to withstand road vibrations and designed to ensure that their terminals do not come in contact with any part of the coach body or storage box and are not ejected, or leak, even under severe crash conditions. Module terminals shall under no circumstances be able to come into contact with the storage box lid.

The storage box must be sealed to the extent practical while being well ventilated and kept within acceptable operating temperatures by a thermal management system. If the low voltage battery is removed from the coach, all high voltage should be isolated within the battery boxes, regardless of the position of the master switch.

1.9 MASTER DISCONNECT

Coaches shall be equipped with a master disconnect switch that interrupts all high voltage power. If the master disconnect switch is in the "Off" position, there will be no high voltages present outside of the battery enclosures. The purpose and function of the switch shall be clearly and permanently marked so as to be easily understood by an individual unfamiliar with electric vehicles. The switch shall be readily accessible to maintenance and emergency service personnel but shall not be located in areas that can be readily accessed by passengers. The design of this switch shall provide for both remote operation and/or hand operation, and include physical lock-out/tag-out features for maintenance.

1.10 ELECTRO-MAGNETIC INTERFERENCE (EMI)

EMI requirements evaluation shall be performed to identify the following criteria:

1. Acceptable levels of radiated emissions from the coach both in low frequency (30Hz-30kHz) and RF frequency (30kHz-100mHz) ranges. Guidelines of MILSTD—461 and/or SAE-J551, as well as known properties of existing SFMTA approved devices, such as: portable/mobile radios, PA systems, fare collection, door control shall be considered.

2. RF susceptibility levels. Latest guidelines of MILSTD-461 and/or SAE-J551, as well as known properties of existing SFMTA devices, such as: radios, PA systems, fare collection, door control shall be considered.

3. Electromagnetic compatibility between the various electrical and electronic devices mounted on the hybrid coach shall be ensured by utilizing established EMC containment techniques, such as proper shielding, grounding, filtering, signal wiring separation, switching frequency management.

4. Adequate EMI/EMC testing shall be conducted on the individual components and on the finished coach to prove that design goals for EMI/EMC are met. The investigation of failure and structural analysis must be carried out by a reputable, independent party.

1.11 PROTOTYPE

The Contractor shall produce and deliver to SFMTA a prototype coach that is entirely representative of a production unit. The prototype shall undergo qualification testing in order to verify that the requirements of these specifications are being met. The format for qualification testing shall be determined by SFMTA. The testing shall include the utilization of worn SFMTA tires so as to simulate worst-case maneuverability conditions. SFMTA shall notify the Contractor in writing of change orders and the specific areas in which the prototype does not comply with the specification no later than 90 working days after the prototype has successfully completed its evaluation period.

Any failure by SFMTA to detect any defects or omissions in this review shall in no way relieve the contractor from fully complying with the contact document.

Prototype coach shall be brought up to the final production coach configuration in all respects at no additional cost to SFMTA, except as may be agreed by change orders. An emphasis will be placed on testing and evaluating new technologies, which may present challenges to the manufacturer and SFMTA.

1.12 ALTOONA TESTING

Prior to acceptance of first coach, the structure of the coach shall have undergone appropriate structural testing and/or analysis, including FTA required Altoona testing, to ensure adequacy of design for the urban transit service. Any items that required repeated repairs or replacement must undergo the corrective action with supporting test and analysis. A report clearly describing and explaining the failures and corrective actions taken to ensure any and all such failures will not occur shall be submitted to SFMTA.

A manufacturer whose coach is involved in a structurally related fleet failure in any transit property in the U.S. or Canada in the last ten years must have completed the detailed investigation of the failure and the detailed structural analysis of the complete coach structure to rule out any effect on any part of the structure.

All failures involving basic body, structure, axles, and suspension are considered structural related failures for purposes of this specification.

The investigation of failure and structural analysis must be carried out by a reputable, independent Transit Industry Consultant and shall not only be limited to finite element analysis but be confirmed by actual track test with suitable time concentration, to prove ability of modified structure to perform for the specified 500,000 miles in the SFMTA operating conditions. SFMTA reserves the right to approve the consultant prior to work performance.

The Engineering Report submitted to SFMTA must be detailed and must include proof of accuracy of the SFMTA’s operational conditions.

If the apparent responsive manufacturer's coach has been involved in a structurally related fleet failure, that manufacturer shall submit the aforementioned report to SFMTA project manager for review with the initial proposal.

A copy of the Altoona test shall be provided.

1.13 MATERIALS

All materials used in construction of the coach and all its parts shall conform in all respects to American Society of Testing Materials (ASTM), Society of Automotive Engineers (SAE), and industry recognized metric standards. Materials used shall be duplicated in manufacture, design, and construction on each coach (Reference Section 8.1, MATERIALS).

1.14 CORROSION RESISTANCE

The coach shall resist corrosion from atmospheric conditions, road chemicals, and other commonly encountered corrosive substances. It shall maintain structural integrity and maintain nearly original appearance throughout its service life, provided it is maintained by SFMTA in

accordance with the procedures specified in the service manual (Reference Section 2.1.8, Resistance to Corrosion).

1.14.1 Electrolyte Spills

Battery boxes shall be designed to prevent all battery fluids from entering the passenger compartment during a vehicle crash.

1.15 WORKMANSHIP

Workmanship shall be of the best grade and shall conform in all respects to the best practice in the industry. Welding procedures, welding materials, and qualifications of welding operators shall be in accordance with the standards of the ASTM and the AWS. Work performed outside the U.S. must conform to U.S. welding standards as approved by SFMTA (Reference Section 8.2, OVERALL WORK QUALITY).

All lines, cables, hoses shall be properly routed, supported and secured with adequate clearance to mitigate any potential rubbing, ruptures, shorts, etc.

1.16 MAINTAINABILITY

As a goal, relative accessibility of components, measured in time required to gain access, shall be inversely proportional to frequency of maintenance and repair of the components (Reference Section 11.6, MAINTAINABILITY).

1.16.1 Maintenance and Inspection

Scheduled maintenance or inspection tasks as specified by the Contractor shall be within the prevailing industry practices and subject to SFMTA approval (Reference Section 11.6.4, Maintenance And Inspection).

1.16.2 Electronic Components

Electrical subsystems shall consist of replaceable units so that each major component, apparatus panel, or wiring harness is easily repairable or replaceable with standard hand tools or by means of connectors (Reference Section 7.5, ELECTRICAL COMPONENTS). Contractors shall provide detailed drawings with part numbers detailing the manufacturer of electrical components, controls, in addition to testing and repair procedures. This should include but not be limited to schematics, PCB layout drawings, software listings, operation and maintenance (with detailed theory of operation) manuals.

The coach shall have a self-diagnostic system for the purpose of self-testing and fault isolation such that a 4M mechanic in the field should be able to isolate a failure to a single removable component in less than 30 minutes. Contractor shall identify during design review those systems that cannot be diagnosed in less than 30 minutes. The number of pieces of equipment required to locate a fault shall be minimized. All special test equipment required to locate a fault or test equipment function shall be supplied by the Contractor. Testers of each type shall be supplied in accordance with ATTACHMENT 13: Special Tools List.

Shop test equipment shall be supplied for the purpose of testing, trouble-shooting, and calibrating individual electrical assemblies. Test equipment shall be compatible with SFMTA's maintenance facilities. Testers shall be able to isolate a failure to a component or component grouping. Testers of each type shall be supplied in accordance with ATTACHMENT 13: Special Tools List.

All the supplied testers described above will be accompanied by documentation to allow SFMTA personnel to operate and repair them. This should include but not be limited to schematics, software listings, operation and maintenance manuals.

1.16.3 Interchangeability

Components with identical functions shall be fully interchangeable. These components shall include, but not be limited to, passenger window hardware, interior trim, step treads, lamps, lenses, and seat assemblies. Components with non-identical functions shall not be, or appear to be, interchangeable. Reference Section 5F, Part V, Agreement. Volume 1.

1.17 FIRE SAFETY

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

All materials used in the construction of the Passenger Compartment of the coach shall be in accordance with the Recommended Fire Safety Practices defined in FTA Docket 90, latest version or document superseding Docket 90. Materials entirely enclosed from the passenger compartment, such as insulation within the sidewalls, need not comply. In addition, smaller components and items, such as seat grabrails, switch knobs and small light lenses, shall be exempt from this requirement.

A fire retardant barrier or coating between the energy storage unit and storage box and the coach itself should be used to prevent, or at the very least delay, the spread of fire. A fire suppression system shall be installed. This system shall be a dry chemical suppression system.

An independently powered system of active thermal detection in the battery compartment that alerts the driver and/or personnel when the temperature is greater than 180°F shall be installed.

Battery box materials that are compatible and non-reactive with the battery electrolytes shall be used. Non-conductive storage box, or one coated with non-conductive materials, shall be used.

Battery overheat, fire or smoke conditions in the battery compartment shall actuate a visual and audible alarm at the operator's control panel. The specific type of alert shall be indicated to the operator. The alarm shall have a distinguishing audible level and configuration. The visual and audible alarm shall be approved by SFMTA.

A warning notice will be provided within the battery compartment and on the outside of the coach NOT to pour water on the battery equipment in case of fire. Appropriate instructions will be posted.

Fire detection / suppression systems shall be provided, including inside the battery box, to reduce the risk of the fire from spreading to other parts of the vehicle (Reference Section 5.11, FIRE DETECTION / SUPPRESSION).

1.18 NEW COMPONENTS

All components and product innovations not manufactured by the Contractor and required or selected by SFMTA that are not standard equipment on the coach shall have the design, installation, and integration certified by the component/subcomponent manufacturer to ensure proper installation of the unit. Contractor shall assume primary responsibility for systems

integration. SFMTA requires that a representative from the component/subcomponent manufacturer certify the design and installation. Certifications shall be provided to SFMTA prior to delivery of the prototype coach. Certifications shall clearly indicate that the installation and application of the component/subcomponent meets the installation and operational guidelines of the manufacturer and has been approved by the manufacturer's representative. In addition to all components, the component manufacturers shall certify the following major component installations:

- Engine
- Emission control devices
- Traction Motor
- Electric Drive System Generator
- Propulsion Control System
- Energy Storage and Management System
- Cooling System
- Axles
- Suspensions
- Wheel Chair Ramp
- Steering and Hydraulic System
- Brakes and Air System
- Destination Sign and Voice Annunciation System
- Heating and Ventilation System
- Fire Detection / Suppression System
- Video Surveillance System
- Paint
- Passenger Doors

2 BODY

2.1 BODY STRUCTURE

The coach shall have a clean, simple design, primarily derived from coach performance requirements and passenger service criteria established in these specifications. The body and under-structure shall be built as an integral unit reinforced at points of stress and concentration. The exterior and body features, including grilles and louvers, shall be shaped to allow complete and easy cleaning by SFMTA's automatic coach washers without snagging washer brushes or retaining water and dirt. The body and windows shall be sealed to prevent leaking of air, dust, or water under normal operating conditions and during cleaning in automatic coach washers for the service life of the coach. The windows, hatches, and doors shall be able to be sealed. Accumulation on any window of spray and splash generated by the coach wheels on a wet road shall be minimized.

The entire coach shall easily negotiate through all established SFMTA motor coach infrastructure (including but not limited to: fueling areas, coach maintenance and storage areas, body shop areas, and tire shop areas) without coming in contact with any part of the facilities or its attachments, or having any clearance issues.

Body materials shall be selected and the body fabricated for easy replacement and repair, to reduce maintenance, extend durability, and provide consistency of appearance throughout the service life of the coach. Fiberglass, plastic, or ABS type material shall not be used on the sidewalls, passenger doors, and equipment access doors unless approved by SFMTA. Side body panels shall be stainless steel or aluminum from the window down.

Detailing shall be kept simple. Add-on devices and trim shall be minimized and, where necessary, integrated into the basic design.

2.1.1 Strength and Fatigue Life

The basic structure shall be designed so that fatigue damage will not occur during the service life of the coach. The structure shall also withstand, without permanent deformation or damage, impact and inertial loads due to street travel during normal SFMTA service throughout the coach's service life. Contractor shall test the prototype coach at GVWR utilizing strain gauges to determine the weak points and fatigue life analysis of the basic structure. The strain gauges shall be placed in accordance with the indicated high stress areas predicted by the computerized Finite Element Analysis (FEA). The FEA testing procedure shall be approved by SFMTA. Copies of all analysis and testing shall be submitted to SFMTA for review and acceptance.

The Contractor may submit relevant test reports or previous FEA data, with similar coach structure, to SFMTA for review and approval. It is at the discretion of the SFMTA to relieve the Contractor's responsibility performing the strain gauge testing with the FEA.

2.1.2 Distortion

The coach, at GVWR and under static or dynamic conditions, shall not exhibit deformation or deflection that will damage panels or structural members or impair operation of doors, windows, or other mechanical elements. Static conditions include the vehicle at rest with any one wheel or dual set of wheels on a six (6) inches curb or in a six (6) inches deep hole. Dynamic

conditions include operation on a variety of road surfaces at prudent speeds up to the maximum for each type of coach and road irregularities such as chuckholes and railroad level crossing.

2.1.3 Crashworthiness

The coach body and roof structure shall withstand a static load equal to 150 percent of the curb weight evenly distributed on the roof with no more than a six (6) inches reduction in any interior dimension. Windows shall remain in place and shall not open under such a load, but shall be easily opened when used as emergency exits.

Exterior panels below 3 feet from the ground and their supporting structural members shall withstand a static load of 2,000 pounds applied perpendicular to the coach anywhere below the 3 feet height by a pad no larger than five (5) inches square. This load shall not result in deformation that prevents installation of new exterior panels to restore the original appearance of the coach. Components located behind these panels cannot be damaged by this test method.

The coach structure shall withstand a 25 mph impact by a 4,000 pounds automobile at any point with no more than three (3) inches of permanent structural deformation at seated passenger hip height. This impact shall not result in sharp edges or protrusions into the coach interior.

The Contractor shall demonstrate compliance by relevant test results or by dynamic FEA.

2.1.4 Resonance

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

2.1.5 Towing

Fixed towing devices shall be provided on each end of the coach. The towing devices shall withstand, without permanent deformation, tension loads up to 1.2 times the curb weight of the coach within 20 degrees of the longitudinal axis of the coach. The rear towing device(s) shall not provide a toehold for unauthorized riders. The front towing devices shall allow attachment of a rigid tow bar and shall permit lifting of the coach, at curb weight, by the towing devices and the tow bar until the front wheels are clear of the ground. The method of attaching the tow bar shall be approved by SFMTA. Each towing device shall accommodate a crane hook with a one (1) inch throat. Any specialized towing adapters for emergency road service and quick coach recovery by contracted towing companies shall be approved by SFMTA and the contracted towing company. All specialized towing adapters shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

2.1.6 Jacking and Hoisting

Jacking pads, located on the axle or suspension near the wheels, shall permit easy and safe jacking of the coach, at curb weight, with a common ten (10) inches high jack or a ten (10) ton floor jack. Such jacking shall occur, when the coach is on a level, hard surface, without the mechanic having to crawl under any portion of the coach. Jacking from a single point shall permit raising the coach sufficiently to remove and reinstall a wheel and tire assembly. Jacking and changing any one tire shall be completed by a 4M mechanic in less than 30 minutes. The coach shall withstand such jacking at any one or any combination of wheel locations without permanent deformation or damage.

The coach axles and/or jacking plates shall accommodate the lifting pads of SFMTA's hoist system. Jacking plates, if used as hoisting pads, shall be approximately 5 by 5 inches, with a turned-down flange not less than 1/2 inch deep on each side. The "turned-down" flange can be of welded, bent or cast construction. Other pads, or the coach structure, shall support the coach on jack stands independent of the hoist. Hoist adapters, if required, shall be supplied by the Contractor for each in-ground hoist in accordance with ATTACHMENT 13: Special Tools List.

2.1.7 Exclusion of Water

The coach shall be designed to assure that the underside, wheel houses, floor, exterior body, windows, passenger doors, roof ventilators, lamps, access doors, and other openings do not admit water into the interior of the coach or into any compartments covered by exterior doors during operation. Any equipment compartment located inside the coach shall be sealed to prevent water entry.

SFMTA requires that each coach be water tested before interior components and insulation are installed. The Contractor shall propose a water test method for SFMTA approval. The proposed water test shall include duration of test, rate of water flow, amount and placement of nozzles, and nozzle pressure/pattern. Each coach shall be water tested. Coaches, which fail any part of the test shall be repaired and fully re-tested until they pass. Use of sealers, externally applied to already attached components to meet the water test requirement, is prohibited. All exterior hardware must be installed. No temporary sealing methods can be used.

SFMTA will also water test all coaches prior to final acceptance. Any leaks found during this test shall be repaired by the Contractor, who will also make appropriate corrections in the assembly line and factory water test.

2.1.8 Resistance to Corrosion

The coach shall resist corrosion from atmospheric conditions, road chemicals, graffiti removal chemicals, commercial cleaning solutions, and other commonly encountered corrosive substance. It shall maintain structural integrity and maintain nearly original appearance throughout its service life, provided it is maintained by SFMTA in accordance with the procedures specified in the service manual. Materials exposed to the elements and all joints and connections of dissimilar metals shall be either corrosion proof or protected from galvanic corrosion. The corrosion inhibitor shall be non-flammable and the application shall be approved by SFMTA. All interior and exterior stainless steel hardware shall be of approved grades. Representative samples shall withstand a 2-week salt spray test in accordance with ASTM Procedure B-117 with no visual or structural detrimental effects and no significant structural degradation or weight loss over one (1) percent for other members or components.

2.2 EXTERIOR

Exterior protrusions greater than 1/2 inch and within 80 inches of the ground shall have a radius no less than the amount of the protrusion. The right side and left side mirrors, required lights and reflectors are exempt from this requirement. Grilles, doors, bumpers, and other features on the sides and rear of the coach shall be designed to minimize the ability of unauthorized riders to secure toeholds or handholds.

2.2.1 Strength and Installation
Exterior panels that are 3 feet above the road may be structural components. Exterior panels below 3 feet shall be divided into sections that are repairable (excluding painting) or replaceable by a 4M mechanic in less than 30 minutes for a section up to five (5) feet long.

2.2.2 Rain Gutters
Gutters shall be provided to prevent water flowing from the roof onto side windows and doors. When the coach decelerates, accelerates, coasts, or stops, the gutters shall not drain onto the windshield or operator's side window, or into the door boarding area. Cross sections of the gutters shall be no less than 1/4 square inch. Contractor shall demonstrate compliance with this section during prototype review.

2.2.3 License Plate Holders
Provisions shall be made to mount standard U.S. license plates on the front and rear of the coach. License plates shall be mounted so that they can be cleaned by SFMTA's automatic coach washing equipment without being caught by the brushes. License plates and mountings shall not provide toeholds or handholds for unauthorized riders. The rear license plate shall be illuminated.

2.2.4 Bicycle Rack
The Contractor shall install a Sportworks type wide profile 2-bicycle rack on the front bumper of the coach. These shall be of the front-loading type. The mounting of the bicycle rack to the coach shall be designed in a manner that the rack can be easily removed in the event the vehicle needs to be towed. The Contractor shall submit details of installation to SFMTA for approval during design review. A dash mounted bike rack deployment indicator light, clearly visible to the operator at all times shall be installed.

2.2.5 Articulation Cover
The contractor shall provide a Hubner, or approved equal articulation joint for an articulated 60-foot bus. The articulation area shall be covered by a flexible accordion-type structure, of sturdy, durable weatherproof, fire-retardant and vandal-resistant material- with vulcanized seams. Trim and fasteners shall be stainless steel and vandal-proof. Bulkhead couplings, for ease of maintenance, shall be provided for all hoses and wirings on each side of the articulation joint.

2.2.6 Finish and Color
Coach exterior shall be painted in silver (Colors and Paint Specifications are given in ATTACHMENT 5: Material, Colors, and Finishes.). Top portion of the bus shall be paint, not decal. The Contractor shall furnish anti-graffiti/vandalism treatment for SFMTA approval.

All exterior surfaces shall be smooth and free of visible fasteners, wrinkles and dents. Exterior surfaces shall be properly prepared as required by the paint system supplier prior to application of paint to assure a proper bond between the basic surface and successive coats of original paint for the service life of the coach. Body filler materials may be used for surface dressing, but not for repair of damaged or improperly fitted panels. Exterior shall be finished with lead-free Dupont Imron 6000 3.5 VOC basecoat/clearcoat system, PPG Delta DBHS 3.5 VOC or approved equal in accordance with the paint manufacturers recommendations. All paint used shall be lead free.

Paint shall be coated with an anti-graffiti mask or shield from the rear doors around the back to the parallel location on the street side.

2.2.7 Fender Skirts

Fender skirts of flexible rubber shall be included in wheel housing. Fender skirts shall be unbreakable and easily replaceable. Wheels and tires shall be removable with the fender skirts in place.

2.2.8 Splash Aprons

Splash aprons composed of composition or rubberized fabric at least 1/4 inch thick shall be installed behind each wheel and shall extend downward to within three (3) inches of the road surface. Apron widths shall be no less than tire widths. Splash aprons shall be bolted to the coach under structure. Splash aprons and their attachments shall be inherently weaker than the structure to which they are attached. Splash aprons and their attachments shall not be included in the road clearance measurements. Additional splash aprons shall be installed where necessary to protect coach equipment, including but not limited to the full width of the coach immediately behind the front and rear axles

2.2.9 Windshield Wipers and Washers

The coach shall be equipped with a Sprague or approved equal, electric powered, continuously variable speed windshield wiper for each half of the windshield, with separate controls for each side. No part of the windshield or wiper mechanism shall be damaged by manual manipulation of the arms. At 50 mph, no more than ten (10) percent of the wiped area shall be lost due to windshield wiper lift. Both wipers shall park along the center divider of the windshield. Windshield wiper motors and mechanisms shall be easily accessible for repairs or service, mounted with mechanical fasteners, and removable as individual units from the exterior of the coach. The information supplied for service and repair shall encompass the individual sub-assemblies to the lowest point of detail including the printed circuit boards of the sub-assemblies.

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

The windshield washer system shall have a minimum of two (2) gallons reservoir located for easy refilling. A location inside the coach near the front step is permissible. Access shall be provided through a spring-loaded paddle door. Reservoir pumps, lines, and fittings shall be corrosion resistant, and the reservoir itself shall be translucent for easy determination of fluid level. No equipment shall be located beneath the reservoir.

2.2.10 Service Compartments and Access Doors

SFMTA prefers conventional doors with stainless steel piano hinges for access to the engine compartment (APU and propulsion system) and all auxiliary equipment compartments. Access openings shall be sized for easy performance of tasks within the compartment, including tool-operating space. All handles shall be flush with, or recessed into, the body contour and shall be sized to provide an adequate grip for opening. Springs and hinges shall be corrosion resistant and shall last for the coach's service life. Keys for all exterior service access shall have a square male end which matches the door locking mechanism.

2.2.10.1 Access Doors

Access doors shall be of rugged, corrosion-resistant metal construction and shall maintain mechanical integrity and function under normal operations throughout the service life of the coach. They shall close flush with the body surface, and be prevented from coming loose or opening during transit service or coach washing operations. Access doors when open, shall not restrict access for servicing other components or systems. The curbside and roadside engine compartment access doors shall be mounted to horizontal hinges so that they will fold up and out of the way; no vertical hinges will be permitted. All other doors shall be hinged at the top or on the forward edge.

Access doors shall be retained in the open and close positions with over-center gas-filled springs, without the use of latches except for electrical and radio compartments. Doors smaller than 36 square inches shall be retained in the open and close positions by over-center springs. A thumbhole shall be provided on such doors to facilitate opening and closing.

2.2.10.2 Engine Compartment

The rear maintenance door, and both rear side maintenance doors shall be easily opened by one person. Engine oil, and traction motor fluid shall be checked and added through the maintenance compartment doors. Engine, and traction motor coolant shall be checked and added through a paddle door located on the roadside of the coach. All maintenance access doors shall be locked with 5/16-inch square tool.

SFMTA prefers that an access door be installed which allows easy maintenance access to engine exhaust after-treatment devices. The access door should be designed to minimize labor time related to periodic servicing of the after-treatment device.

2.2.10.3 Low Voltage Battery Compartment

The low voltage or auxiliary battery compartment shall be constructed of 304 stainless. The battery shall be located under the floor on the street side of the coach, vented and self-drained, and prevent accumulation of debris on top of the batteries. It shall be accessible only from the outside of the coach. All components within the battery compartment, and the compartment itself, shall be protected from damage or corrosion from the electrolyte. The inside surface of the battery compartment's access door shall be electrically insulated. Battery terminals shall under no circumstances be able to come into contact with the storage box lid. Batteries shall be properly secured to withstand road vibrations and designed to ensure that their terminals do not come in contact with any part of the coach body or storage box and are not ejected, or leak, even under severe crash conditions. Batteries shall be mounted in trays that are constructed of 304 stainless to resist corrosion and shall easily slide out of the body for service or replacement. Low voltage systems should be independent of high voltage systems, so that emergency lighting, cameras, and all other accessories remain operable in the event of a high voltage system failure. If the low voltage battery is removed from the coach, all high voltage should be isolated within the battery boxes, regardless of the position of the master switch.

2.2.10.4 Radio Compartment

The radio compartment box (minimum 14 in. high, 26 in wide & 21 in deep) shall be lockable, waterproof, dustproof, and accessible through an unlocked skirt panel door, and shall be split with vertical hinges on either side of the radio box. These doors will fold out of the way for ease of access to the interior of the radio box. Contractor shall submit drawings to SFMTA for approval.

2.2.11 Bumper System

Bumpers shall be Romeo Rim High Energy Level Polymer (HELP) bumpers or approved equal, adapted to the coach provided, and installed to meet the performance requirements of these Technical Specifications. Bumpers shall provide impact protection for the front and rear of the coach up to 26 inches above the ground. The bumpers shall wrap around the coach without exceeding allowable coach width. Bumper material shall be corrosion resistant. Visible surfaces shall be black. These qualities shall be sustained throughout the service life of the coach. Support and backing of the resilient portion of the bumper shall be made from materials and mounted in a manner, which protects the coach in the event of an accident. A steel or reinforced aluminum sub-frame shall be used.

2.2.11.1 Front Bumper

No part of the coach, including the bumper, shall be damaged as a result of a five (5) mph impact of the coach at curb weight with a fixed, flat barrier perpendicular to the coach's longitudinal centerline. The bumper shall return to its pre-impact shape within ten (10) minutes of the impact. The energy absorption system of the bumper shall be independent of every power system of the coach and shall not require service or maintenance in normal operation during the service life of the coach. The flexible portion of the bumper may increase the overall coach length specified in (Section 1.2, DIMENSIONS) by no more than six (6) inches.

2.2.11.2 Rear Bumper

No part of the coach, including the bumper shall be damaged as a result of a two (2) mph impact with a fixed, flat barrier perpendicular to the longitudinal centerline of the coach. The bumper shall return to its pre-impact shape within ten (10) minutes of the impact. When using a yard tug with a smooth, flat plate bumper two (2) feet wide contacting the horizontal centerline of the rear bumper, the bumper shall provide protection at speeds up to five (5) mph, over pavement discontinuities up to two (2) inches high, and at accelerations up to two (2) mph/sec.

The rear bumper or bumper extensions shall not offer footholds to unauthorized riders. The bumper extensions shall not hinder service and shall be faired into the coach body with no protrusions or sharp edges. The bumper shall be independent of all power systems of the coach and shall not require service or maintenance in normal operation during the service life of the coach. Any flexible portion of the bumper may increase the overall coach length specified in Section 1.2, DIMENSIONS, by no more than six (6) inches.

2.3 INTERIOR TRIM, PANELING AND ACCESS

Materials shall be selected on the basis of ease of maintenance, durability, appearance, safety, flammability, and tactile qualities. Trim and attachment details shall be kept simple. Trim shall be secured to avoid resonant vibrations under normal operational conditions. Panels shall be reinforced to resist buckling, flexing, drumming, vandalism, and other rigors of SFMTA coach service. They shall permit easy removal of paint, greasy fingerprints, and ink from felt-tip pens, resistant to scratches and markings, and easily replaceable and tamper resistant.

All interior surfaces below the lower edge of the windows or windshield shall be shaped so that objects placed on them fall to the floor when the coach is parked on a level surface. The entire interior shall be cleanable with a hose, using a liquid soap attachment. Interior mullion trim, moldings, and trim strips shall be textured stainless steel or anodized aluminum. Individual trim panels and parts shall be interchangeable. Untrimmed areas shall be painted and finished to

the quality described in Section 2.2.6, Finish and Color. The Contractor shall furnish samples of anti-graffiti/vandalism treatment for SFMTA approval.

2.3.1 Divider and Side Trim Panel

Divider panels of 1/4 inch melamine or approved equal material that matches the sidewalls shall be provided as required at the rear of the entry stepwell and at the front and rear of the exit stepwell(s). Surfaces of the divider panels shall be per ATTACHMENT 5: Materials, colors and Finishes.

These dividers may be mounted on the sidewall or floor, and shall project toward the aisle no farther than passenger knee projection in longitudinal seats, the aisle side of the transverse seats, or the edge of a stepwell. Divider panels shall extend no higher than the lower daylight opening of the passenger windows, and that forward of transverse seats shall extend to within 1-1/4 inches $\pm$ 1/4 inch of the floor. Panels forward of longitudinal seats shall extend to below the level of the seat surface. Dividers positioned at the doorways shall provide no less than 2-1/4 inches of clearance between the divider panel and the opened door. The divider panel and its mounting shall withstand normal kicking, pushing, and pulling loads from 200 pound passengers without permanent visible deformation. The bottom 12 inches of each side of each divider panel shall be stainless steel.

Interior side wall panels shall be premium grade melamine-type paneling, backed with a durable, moisture-resistant material no less than 1/10 inch thick. The material shall permit easy removal of paint, greasy fingerprints, and ink from felt-tip pens. Panels shall be easily replaceable without removing the window(s) and tamper resistant. They shall be reinforced, as necessary, to resist buckling, flexing, drumming, vandalism, and other rigors of transit coach service.

2.3.2 Rear Bulkhead

The rear bulkhead shall be paneled with premium grade melamine-type material, at least 1/16 inch thick, and trimmed with aluminum or stainless steel. The panels above the seat shall be contoured to fit the ceiling, sidewalls, and seatbacks. Any air vents in this area shall be designed to reduce trash or litter being thrown or drawn through the grille and shall be reinforced to prevent bending by passengers. The air vents shall meet the requirements of Section 2.3.6, Access Doors, if components requiring service are located behind the grille.

2.3.3 Headlining

Ceiling panels and the trim between the passenger windows and in the front end down to the level of the lower daylight opening shall be premium grade 1/16-inch melamine. For ease of graffiti removal, the surface shall be smooth and matte. The Contractor shall provide a proposal of graffiti-resistant materials and also the graffiti removal solution. The specific color and surface type shall be approved by SFMTA prior to production. Headlining shall be supported to prevent buckling, drumming, or flexing, and shall be mechanically secured without loose edges. Headlining materials shall be treated or insulated to prevent marks due to condensation where panels are in contact with metal members. Moldings and trim strips, as required to make the edges tamper-proof, shall be aluminum or stainless steel.

2.3.4 Front End

The entire front end of the coach shall be sealed to prevent debris accumulation behind the dash and to prevent the operator's feet from kicking or fouling wiring and other equipment. The

front end shall be free of hazardous protrusions. Paneling across the front of the coach and any trim around the operator's area shall be formed metal or reinforced fiberglass.

Formed metal dash panels shall be vinyl coated or painted and finished to the quality described in Section 2.2.6, Finish and Color. Plastic dash panels shall be reinforced as necessary, resistant to age discoloration and cracking, vandal resistant, and easily replaceable. All colored, painted, and plated parts forward of the operator's barrier and below the upper daylight opening shall be finished with a smooth, dull matte surface in a flat black color that matches or coordinates with the coach interior.

The dash will be constructed with metal support so components designated for dash mounting are securely mounted to an underside panel. Mounting areas shall be pre-drilled and tapped. The components shall be mounted to the underside panel using machine screws, or threaded nutserts. The components are radio head, speaker, and sign programming controller.

2.3.5 Fastening

Interior panels shall be attached so that there are no exposed edges or rough surfaces. Panels and fasteners shall not be easily removed by passengers but shall be easily replaceable when necessary Self-tapping screws are not permissible for attachment of interior panels.

2.3.6 Access Doors

Access for maintenance and replacement of equipment, shall be provided by panels and doors that appear to be an integral part of the interior. Removal of fixtures or equipment that is unrelated to the repair task to gain access should not be allowed. Access doors shall be hinged with props, as necessary, to hold the doors out of the mechanic's way. All door hinges shall be of stainless steel piano-style type. All interior access doors and panels except on the destination sign compartment and on the door actuator compartments shall be retained securely with latches with self-contained tamper proof fasteners approved by SFMTA.. Access doors for the destination sign compartment shall be secured with thumbscrews; access doors for the door actuator compartments shall be secured with latches and shall prevent entry of mechanism lubricant into the coach interior.

2.4 FLOOR

The floor deck shall be mounted securely on the structure to prevent chafing or horizontal movement. The floor shall be attached with either properly installed, hardened self-tapping bolts of adequate size or carriage bolts that are serviceable from the underside of the coach. Tapping plates used for the floor fasteners shall be no less than the thickness of a standard nut, and all floor fasteners shall be secured and protected from corrosion for the service life of the coach. The floor deck shall be reinforced as needed to support passenger loads. At GVWR, the floor should have an elastic deflection of no more than 0.60 inch from the normal plane. The floor shall withstand the application of 2.5 times gross load weight without permanent detrimental deformation. The floor and treads, with coverings applied, shall withstand a static load of at least 150 pounds, applied through the flat end of a 1/2 inch diameter rod with 1/32 inch radius, without permanent visible deformation.

The floor, as assembled, including the sealer, attachments, and coverings, shall be waterproof, non-hygroscopic, resistant to wet and dry rot, resistant to mold growth, and impervious to insects. All edges shall be sealed with a SFMTA approved sealer, and all gaps filled and ground flush with the floor. Sheets shall run the full width of the coach. Structural members

shall support all joints. Use of parallel joints shall be minimized to the extent practicable. Floor irregularities and joints shall not be visible after installation of floor covering.

Plywood is not considered acceptable flooring for this procurement. The flooring shall be composite material flooring, Coosa or approved equal.

2.4.1 Height

Height of the floor above the street shall be no more than 15 inches measured at the centerline of the doors. The floor shall be essentially level from the front door to the rear door. If the floor is raised at the rear axle, it shall have steps with risers no greater then 10-¾ inches. The step method is preferred however a ramp with a slope may be acceptable to SFMTA.

2.4.2 Edges

Where the floor meets the walls of the coach, the surface edges shall be blended with a circular section of radius not less than one (1) inch, and a molding or cove shall prevent debris accumulation between the floor and wheel housings.

2.4.3 Floor Covering

Floor covering shall be Altro Transflor D25-421 “Midnight”, or approved equal. Floor covering shall be nonskid, material that remains effective in all weather conditions and complies with all ADA requirements. The floor covering, as well as transition of flooring material to the center aisle and to the stepwell area, shall be smooth and present no tripping hazards. However, the artic trailer shall have rubber ribbed flooring.

The standee line shall be at least two (2) inches wide and shall extend across the coach aisle in line with the modesty panel behind the front door area; and at the exit door area in line with the inward edge of the opened door. This line shall be the same yellow color as the edge of the door area. Color shall be consistent throughout the floor covering.

The floor under the seats shall be covered with 1/8-inch think, smooth-surface flooring material except in the artic trailer area where it shall be rubber ribbed flooring. The floor covering shall closely fit the sidewall cove or extend to the top of the cove. The color of the floor covering in the passenger compartment shall be the same as that in the vestibule. All floor covering shall be secured at the edges with tightly fitted aluminum or stainless steel trim strips.

2.5 STEPS AND STEPWELLS

2.5.1 Steps

Interior step risers shall be no more than 10-3/4 inches.

2.5.1.1 Step Treads

Step treads shall be of uniform depth, which shall be no less than 11.75 inches. The plane of the step treads shall be essentially parallel to the plane of the floor, sloped only sufficiently to prevent water accumulation on the floor. All step treads shall be covered with the same nonskid floor covering material except for the artic trailer which shall be covered with rubber ribbed flooring, and shall remain effective in all weather conditions. The edge of the vestibule floor shall conform to ADA requirements and shall have a maximum of 5/16 inch overhang at the step riser. The outer edge of the step, just below the step nosing, at the rear door shall be covered with a stainless steel strip. The edge of the vestibule floor tread shall have a bright, contrasting

yellow band no less than two (2) inches wide on the full width of the opening. The color shall be permanently blended into the floor covering material.

2.6 WHEEL HOUSINGS

Wheel housings shall be constructed of 14-gauge or heavier stainless steel or equivalent strength fiberglass. Sufficient clearance and air circulation shall be provided around the tires, wheels, and brakes to prevent overheating when the coach is operating. Wheels and tires shall be removable when the coach is jacked by the axle or suspension, even with the air bags depleted. Interference between the tires and any portion of the coach shall not be possible in maneuvers up to the limit of tire adhesion with coach weights from curb to GVWR.

2.7 INSULATION

Any insulation material used between the inner and outer panels shall be fire resistant and installed to minimize entry and retention of moisture. The exhaust stack compartment/soffit shall be fire proof. Insulation properties shall not be impaired by vibration compacting or settling during the service life of the coach. The insulation material shall be non-hygroscopic and resistant to fungus and the breeding of insects. Any insulation material used inside the engine compartment and the exhaust area shall be fire proof and shall not absorb or retain oils or water. The material shall be physically retained to prevent tearing.

2.7.1 Thermal Insulation

The combination of inner and outer panels on the sides, roof, and ends of the coach, and any material used between these panels shall provide a thermal insulation sufficient to meet the interior temperature requirements of Section 3.4, INTERIOR CLIMATE CONTROL. The coach body shall be thoroughly sealed so that the operator or passengers during normal operations cannot feel drafts with the passenger doors closed.

2.7.2 Sound Insulation

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

3 FURNISHINGS

3.1 WINDSHIELD, DRIVER, AND PASSENGER WINDOWS

Opening shall be provided in the body structure to accommodate a windshield, driver's window, and passenger windows. All windows shall be supported by metal sub-structure. Tint shall be applied in the inter-layer. All designs and dimensions of windshield and windows shall be approved by SFMTA.

3.1.1 Windshield

The windshield requirements are given in Section 4.4.1, Windshield.

3.1.2 Driver's Side Window

The driver's side window requirements are given in Section 4.4.2, Side Window.

3.1.3 Passenger Windows

Windows shall be required on each side of the coach. Passenger windows shall be EXCEL-GARD Glazing Protection System by Excel or MV-70 series windows with protection sheet by Storm-Tite or approved equal. Contractor shall provide dimensions, specifications, drawings, and state of the art anti-etching technology for all windows.

3.1.3.1 Dimensions

At minimum, all passenger windows shall extend from the shoulder height of a 5th-percentile seated female passenger to the eye level of a 95th-percentile standing male passenger. Windows shall be divided horizontally. The bottom portions of the windows shall be fixed. The upper portion over the side destination sign shall be fixed. The upper portions of all other windows shall be 9 to 15 inches high and shall open by sliding forward or rearward up to approximately one-third of the length of each window. All windows shall be easily replaceable without disturbing adjacent windows and shall be mounted so that flexing or vibration from engine operation or normal road excitation is not apparent. All windows shall be the same size to the extent practicable. The replacement of the window should be done by two persons within 30 minutes.

3.1.3.2 Materials

All passenger windows and door windows shall be safety glass of minimum 1/4 inch thick and conform to the requirements of ANSI Z26.1 Standard for Type AS-3. All passenger windows and door windows shall be 55 percent luminous transmittance. Windows over the side destination signs shall not be tinted. Window sash shall be weather-protected, corrosion-resistant, and clear anodized aluminum. The tracks and seals shall be designed to be vandal resistant and to last the service life of the coach.

3.1.3.3 Anti-Vandalism Provision

The contractor shall apply 1/8-inch thick, scratch resistant, clear panels to all of the interior passenger windows and sliders. These panels shall protect the coach windows from etching and other forms of vandalism. The protective panels shall be undetectable and capable of being applied to any size or shape window, including sliding windows. The protective panels shall be resistant to SFMTA's coach wash bristles, detergents, and graffiti removers. No accumulation of moisture shall be allowed between the surfaces of the original windows and the protective panels. Each protective panel shall be capable of being removed and installed by a single 4M mechanic within three (3) minutes. This anti-vandalism provision shall be approved by SFMTA.

3.1.3.4 Emergency Exits

All coaches shall be provided with adequate exits for quick passenger escape during emergency conditions. All emergency exits shall comply with applicable codes and requirements and the best industry practice.

All passenger side windows shall open outward to provide an emergency exit. The upper window-mounting hinge shall be stainless steel. A simple red latch shall be provided on all passenger side windows that takes no more than 20 pounds of force to manipulate. This latch shall not pinch a person's fingers or hands when operating, and shall be designed so that it returns to its normally closed position. It shall not be possible for passengers to use the latch as an accessory hook. Latch design shall be approved by SFMTA. Each emergency exit window location shall be labeled with a metal instruction plate that is riveted in place (preferably close to the latch). Contractor shall provide emergency exit provision for SFMTA approval.

3.2 DOORS

Doors shall be double-stream, slide-glide inward opening type provided on curb side of the coach. The front entrance door shall be forward of the front wheels and located so that the operator is able to collect or monitor the collection of fares. The rear exit doors shall be located in front of the drive (rear) axle. Passenger entrance and exit doors and doorways shall comply with all requirements of the ADA.

The passenger exit (rear) doors shall have Vapor CLASS (Contact-Less Acoustic Sensing System). This allows the passenger to signal through the movement of their hand or body, the opening of the door after operator actuation. Operator actuation shall result in the illumination of a green light above the doors notifying the passenger the exit door can be opened. The door system will recognize the presence of passenger in the exit area or within 24 inches of the outside opening of the coach, and not close until the area is cleared of people. The system shall have a positive mechanical locking feature when the door control is in the "OFF" position. A door annunciator shall make digitally recorded messages (such as warnings, greetings, or service announcements) in the exit door area. The contractor shall present details of their methodology for entrance and exit door operation for SFMTA review.

3.2.1 Materials

Structure of the doors, their attachments, inside and outside trim panels, and any mechanism exposed to the elements shall be durable and corrosion resistant. Doors shall be constructed of aluminum. Top and bottom door seals shall be brush-type. The doors, when fully opened, shall provide a firm support and shall not be damaged if used as an assist by passengers.

3.2.2 Dimensions

Door openings shall be no less than 84.5 inches high. Front door free clear opening shall be able to accommodate a 32 inches wheel chair ramp as minimum but SFMTA prefers a 36 inches ramp if possible. The rear door shall have a free clear opening of 44 inches for the entire vertical height. The rear door clear opening width may be reduced to 41 inches in the areas of the passenger assists and the passenger head and foot areas, if these projections do not present hazards.

3.2.3 Door Glazing

The upper section (1/2 door height) of the front, and rear doors shall be glazed for no less than 45 percent of the door opening area. The lower section of the front door shall be glazed for no

less than 45 percent of the door opening area of the section. The lower section of the rear door shall not be glazed. The edge of a six (6) inches high curb shall be visible to the seated operator through the closed front door when the coach is more than 12 inches from the curb. Door glazing materials shall be the same as Section 3.1.3.2, Materials.

3.2.4 Door Projection

Exterior projection of the doors shall be minimized and shall not exceed 6-1/2 inches during the opening or closing cycles or when doors are fully opened. The closing edge of each door panel shall have no less than two (2) inches of soft weather-stripping. The doors when closed shall be effectively sealed and the hard edges of the doors shall be at least four (4) inches apart.

Inside the coach, the door mechanisms shall be recessed into the ceiling or paneled over so that no ledges are created.

3.2.5 Door Height Above Pavement

It shall be possible to open and close the passenger doors when the coach is loaded to GVWR and not knelt and parked with the tires touching an eight (8) inches high curb on a street sloping toward the curb so that the street side wheels are five (5) inches higher than the curb side wheels.

3.2.6 Actuator

Door opening and closing speeds shall be independently adjustable. Both door panels shall be operated by a single actuator for each door opening to guarantee synchronization of panels during opening and closing cycles. Actuators and the door mechanism shall be concealed from passengers but shall be easily accessible for servicing.

3.2.7 Emergency Operations

In the event of an emergency, it shall be possible to open each door manually from inside the coach using a force of no more than 25 pounds after actuating an emergency door-unlocking device just forward of or above each door. The unlocking devices shall be clearly marked as an emergency-only device and shall require punching in a small plastic window and activating a control. Concise instructions for emergency exits shall be posted near the device. Door emergency unlocking devices shall be accessible from the door areas. When any of the door emergency unlocking devices is actuated, the door interlock throttle system shall return the engine to idle, and the door interlock brake system shall apply, regardless of the position of the override switch described in Section 4.1.4.3, Interlock Override Switch.

Locked doors shall require a force of more than 300 pounds to open manually. When the locked doors are manually forced to open, damage shall be limited to the bending of minor door linkages with no resulting structural damage to the doors, motors, and complex mechanisms.

3.2.8 Sensitive Edges

The rear exit door shall be equipped with air-wave-type, sensitive edge sensor system in the meeting edge of the rubber weather stripping of the doors. Closing door edge speed shall not exceed 19 inches per second. If a wood block (1.5 inches thick by 2.0 inches wide) is struck by a closing door along the vertical edges with the 1.5 inches thickness between the rubber strips, the door shall stop and reverse direction prior to imparting a ten (10) pound force on a one (1) square inch on that wood block. The doors shall be reopened except when the wood block is placed within 2 inches of the top or bottom of the edges. Whether or not the obstruction sensing

system is present or functional it shall be possible to withdraw a 1-1/2 inches diameter cylinder from between the center edges of a closed and locked door with an outward force not greater that 35 pounds.

The sensitive edge system shall alert the coach operator by a visual and audible alarm if the doors completely close on any part of a person's body or any object. The system shall react to this obstruction within no more than a second.

3.2.9 Front Door Timing (Entrance Door)
Doors shall open or close completely within 2 - 4 seconds from the time of actuation.

3.2.10 Rear Door Timing (Exit Door)
Doors shall open or close completely within 2 - 4 seconds from the time of actuation.

3.3 LIGHTING
3.3.1 Exterior Lighting & Back-up Alarm
All exterior lights shall be sealed to prevent entry and accumulation of moisture or dust, and each lamp shall be replaceable in less than five (5) minutes. LED (Light Emitting Diode)-type with anti-scratch coating lamps shall be used wherever possible. Lights mounted on the APU compartment doors or adjacent panels shall be protected from the impact shock of door opening and closing. Lamps, lenses and fixtures shall be interchangeable to the extent practicable.

Turn signal lights shall be provided on both sides of the coach. Two (2) amber lights shall be mounted above each wheel opening and one (1) midway between each wheel opening. In addition to the amber lights, a right turn cornering lamp shall be installed between the rear wheel well and the rear door. The right turn cornering lamp shall be activated by the right turn signal switch during night runs only.

LED's shall have a minimum expected life of 50,000 hours of operation at 25^{o} C.

3.3.1.1 LED Lights
LED lights shall be Truck Lite, or approved equal. Wheelchair ramp and kneeling indicator lights shall be illuminated with LED's mounted flush with the coach exterior. The wheelchair ramp light shall be amber and the kneeling indicator light shall be red. Stop, turn, tail lights, and marker lights shall be flush-mounted without guards.

3.3.1.2 Courtesy Lights
Lamps mounted on each side of the front, and rear doors shall comply with ADA requirements and shall be activated only when the doors open and shall illuminate the street surface to a level of no less than one (1) foot-candle for a distance of three (3) feet outward from the step tread edge using LED lighting. Lighting shall provide a wide beam, with illumination spreading forward and rearward of the door opening. SFMTA prefers the exterior courtesy lights at the doors be flush or recess mounted and not prone to damage and should be located inside the coach if the performance specified can be met. Lamps shall have a minimum life of 5000 hours.

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

3.3.2 Interior Lighting

The LED passenger interior lighting system shall be DINEX or approved equal. The interior lighting system shall provide a minimum 15 foot-candle illumination on a 1 square foot plane at an angle of 45 degree from horizontal, center 33 inches above the floor and 24 inches in front of the seat back at each seat position. Allowable average light level for the rear bench seats shall be 7 foot-candles. Floor surface in the aisles shall be a minimum of 10 foot-candles, vestibule area a minimum of 4 foot-candles with the front doors open and minimum of 2 foot-candles with the front doors closed. The front entrance area and curb lights shall illuminate when the front door is open and master run switch is in the "Lights" positions. Rear exit area and curb lights shall illuminate when rear door is unlocked.

The light source shall be located to minimize windshield glare with distribution of the light focused primarily on the passengers' reading plane while casting sufficient light onto the advertising display. The brightness of each individual light fixture shall be software programmable to minimize glare. Photo sensor detects and adjusts light level automatically relative to ambient light for passenger comfort. The lighting system shall interface with vehicle multiplex control systems supplied by various vendors through J1939 gateway with serial data input or discrete inputs to automatically adjust the brightness of each individual light fixture to improve driver's visibility when the windshield wiper motor is set at high speed. High power 1 watt solid state LED strip shall be in approximately fourteen (14) inches increment with high power 1 watt LED manufactured by either Nichia or Philips or approved equal with expectation to maintain on average 60-70% of original brightness after 60,000 hours of operation.

Lens material shall be non-flammable polycarbonate in compliance with Doc 90A. Lens shall be designed to effectively "mask" all individual LED's to make them invisible and there shall be no visible "hot spot" or "dark spot". Lens shall be sealed to inhibit incursion of dust and insects yet are easily removable for service. If threaded fasteners are used they must be held captive in the lens. Access panels shall be provided to allow servicing of components located behind light panels.

Individual driver module shall be provided for each light fixture. Driver module shall have built-in self-protection of thermal shut-down and restart, PWM (Pulse Width Modulation) output to regulate light level, reverse polarity protect and rebuildable.

When the master switch is in the RUN mode, the first light module on each side of the coach shall slowly fades to darkness when the front door is in the closed position and light output shall gradually illuminate to reach maximum light level when the door is opened. Solid state LED lighting shall have unlimited on-off cycles.

Failure of any light fixture or driver module shall be broadcasted via telltale light panel or dashboard display. The system will look for supply current and lighting fixture temperature to be approximately the same for all of the driver modules, and will show which module(s) seem to have a problem.

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

Provisions for advertising in the coach interior shall be incorporated into the interior lighting fixtures,

3.3.3 Service Area Lighting

Lights shall be provided in the engine compartments to generally illuminate the area for night emergency repairs or adjustments. The lights shall be LED and be controlled by a conveniently located toggle switch near the rear start controls in the compartment. Necessary lights located in other service compartments shall be provided with toggle switches on the light fixture or conveniently near the light fixture. Adequacy of lighting shall be approved by SFMTA during prototype review.

3.4 INTERIOR CLIMATE CONTROL

The interior climate control system shall provide heating, and ventilation. The contractor shall provide to SFMTA all the essential information needed to test, troubleshoot and repair the Interior Climate Control Electronic Controllers. This information and equipment shall encompass the system on the coach and the repair of the individual sub-assemblies down to the components.

3.4.1 Controls

The control of the Interior Climate Control shall be hard-wired switches or display panel with AUTO, HEAT, and VENT modes located in a place that is convenient to the operator. Reference Section 4.1.12 Climate Control.

3.4.2 Air Flow

The ventilation mode of the interior climate control system shall introduce outside air into the coach at or near the ceiling height at a minimum rate of 1800 cubic feet per minute. Airflow shall be evenly distributed throughout the coach with air velocity not exceeding 60 feet per minute on any passenger.

Airflow may be reduced to 1500 cubic feet per minute when operating in the heating mode with full standee load. Heated air introduced into the coach shall contain no less than 20 percent outside air. The fans shall not activate until the heating element has warmed sufficiently to assure a 70°F air outlet temperature.

3.4.3 Air Intakes

Outside openings for air intake shall be 15 feet forward of the exhaust outlet and at least seven (7) feet above ground level, in a location to ensure cleanliness of air entering the climate control system, particularly with respect to exhaust emissions from the coach, adjacent traffic, and airborne dust generated by the rear wheels. All intake openings shall be baffled to prevent entry of water.

Except for roof-mounted ventilators, outside air shall be filtered before discharge into the passenger compartment. The filter shall meet the ASHRAE requirement for five (5) percent or better atmospheric dust spot efficiency, 50 percent weight arrestance, and a minimum dust holding capacity of 120 gram per 1000-cfm cell. More efficient air filtration may be provided to maintain efficient heater operation. Air filters shall be easily cleaned or removed for service. Moisture drains from air intake openings shall be located to prevent clogging from road dirt.

3.5 ROOF VENTILATORS

Roof ventilators shall be provided in the roof of the coach approximately over each axle or equally spaced at a location approved by SFMTA. Each ventilator shall be easily opened and closed manually by one person and shall also function as an emergency exit. When open, with

the coach in motion, these ventilators shall provide fresh air inside the coach. Each ventilator shall cover an opening area no less than 425 square inches. Each ventilator shall be capable of being positioned as a scoop with either the leading or trailing edge open no less than four (4) inches, or with all four edges raised simultaneously to a height no less than 3-1/2 inches.

3.6 WHEELCHAIR LOADING SYSTEM

An automatically-controlled, electrically-power operated loading system shall accommodate passengers on wheelchairs or using crutches, canes, walkers or persons with difficulty using steps ingress and egress from or to the street level or curb quickly, safely, and comfortably. The wheelchair loading system shall conform to all applicable ADA requirements.

3.6.1 Wheel Chair Ramp

The wheelchair ramp shall be a Lift-U, or approved equal, flip-out type design, self-contained, electrically-powered, which fully complies with ADA and FTA requirements and shall be provided at the front door of the coach. The driver shall be able to deploy the ramp from a seated position. In case of a power failure, driver shall be able to deploy the ramp manually. When the system is not in use, the passageway shall appear normal. In the stored position of the ramp, no tripping hazards shall be present and any resulting gaps shall be minimized. The ramp shall be capable of reaching a 1:6 maximum slope when deployed to the ground. All components of the ramp shall be accessible and serviceable through an interior access panel in the ramp. All drive chains shall be a minimum size #40 and constructed of corrosion resistant material. Ramp shall use only inductive proximity switches when required, the use of mechanical limit switches shall not be allowed. The loading platform shall be covered with replaceable or renewable, nonskid material and shall be fitted with devices to prevent the wheelchair from rolling off the sides during loading or unloading. During deployment or stowage, the ramp floor plate shall remain stationary at all times and shall not have any moving parts. Deployment or stowage of the ramp shall require no more than 15 seconds. The device shall function without failure or adjustment for 500 cycles or 5,000 miles in all weather conditions on the design operating profile when activated once during the idle phase. A manual override system shall permit unloading a wheelchair and storing the device in the event of a primary power failure, requiring no more than 10 lbs. to manually stow or deploy. The ramp assembly shall be replaceable within 30 minutes by a 4M mechanic without the need of any special tools or fixtures.

3.6.2 Wheel Chair Ramp Controls

The controls shall be simple to operate and conveniently located so the driver can operate and monitor the loading operation without leaving the driver's station. Control switches shall be of the momentary type, so that release of the control switch will stop the ramp immediately. All controls, and switch locations shall be approved by SFMTA. The coach shall be prevented from moving during the loading or unloading cycle by an accelerator and brake interlock system. The loading system shall be inhibited from retracting or folding when a passenger is on the ramp/platform and shall be equipped with an electronic current limiting feature to minimize damage if the ramp hits an obstruction during the stow/deploy functions. Whenever the ramp system is activated, an audible alarm shall sound and a visual signal shall illuminate with LED. One International Symbol of Accessibility, in blue and white, shall be provided near the ramp signal at the front door opening and one on the front of the coach, curbside visible to patrons in front of the oncoming coach. All wheel chair ramp maintenance controller shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

3.7 PASSENGER SEATS

Passenger seats shall be provided in each coach. The seatbacks shall be contoured to increase passenger knee room and coach capacity. The aisle between the transverse, forward-facing seats shall be no less than 38-1/2 inches wide at seated passenger hip height. Seatbacks shall be shaped to increase this dimension to no less than 42-1/2 inches at standing passenger hip height. Contractor shall be required to present to SFMTA for consideration seating layouts, which maximize the space in the passenger area while meeting clearances required for accessible ingress and egress. Seating layout shall be optimized to meet GVWR Capacity and shall be approved by SFMTA. A sample seating layout is provided in ATTACHMENT 7: SFMTA Typical Seating Layout.

All priority seating area seats, accommodating for wheelchair securement, passengers using crutches, canes, walkers or with difficulties in walking, shall be installed with blue color seat inserts.

SFMTA will require contractor to provide seating layouts for review and approval that utilize the available space efficiently while meeting ADA requirements for clearances and wheelchair maneuverability.

3.7.1 Dimensions

Seats shall have the dimensions shown in ATTACHMENT 8: Seating Dimensions and Standard Configurations). The hip-to-knee room shall be measured from the front of one seatback horizontally across the highest part of the seat surface to the seat or panel immediately in front. Wherever possible, the hip-to-knee room shall be no less than 29 inches at all seating positions. Floor room, measured at the floor forward from a point vertically below the front of the seat surface, shall be no less than 14 inches. Seats immediately behind the wheel housings may have foot room reduced, provided the wheelhouse is shaped so that it may be used as a footrest. Transverse seats accommodating two passengers shall have a minimum width of 35 inches, and seats accommodating one passenger shall have a minimum width of 18 inches.

3.7.2 Design

Passenger seats shall be baseline seats, American Seating #6468 with fiberglass insert, or approved equal, integrally molded with stainless steel drain holes and with full anti-graffiti treatment. The seat frame structure shall be a cantilever design that is mounted to the coach wall structure at three points and of the strength necessary to meet the energy-absorbing requirements. The passenger seat frame and its supporting structure shall be constructed and mounted so that space under the seat is maximized to increase wheelchair maneuvering room and is completely free of obstructions to facilitate cleaning. The lowest part of the seat assembly that is within 12 inches of the aisle shall be at least ten (10) inches above the floor. The underside of the seat and the sidewall shall be configured to prevent debris accumulation, and the transition from the seat underside to the coach sidewall to the floor cove radius shall be smooth. The seatback shall be contoured to maximize knee room. All transverse objects in front of forward facing seats, including seatbacks, modesty panels, and longitudinal seats, shall not introduce a laceration hazard as a result of structural failure.

3.7.2.1 Transverse Seat

The back of each transverse seat shall incorporate a stainless steel handhold. The handhold shall extend above the seatback near the aisle so that standees shall have a convenient vertical assist, no less than four (4) inches long that may be grasped with the full hand. This handhold

shall not cause a standee using this assist to interfere with a seated 40th-percentile male passenger. The handhold shall also be usable by a 5th-percentile female, as well as by larger passengers, to assist with seat access and egress for either transverse seating position. The seatback handhold may be deleted from seats that do not have another seat directly behind them and where vertical assist is provided in accordance with Section 3.9, (PASSENGER ASSISTS). Armrests shall not be included in the design of transverse seats.

3.7.2.2 Longitudinal Seat

Longitudinal seats shall be the same general design as transverse seats but without seatback handholds. Longitudinal seats may be mounted on the wheelhouses. Armrests shall be included on the ends of each set of longitudinal seats except on the forward end of a seat set that is immediately to the rear of a transverse seat, the operator's barrier, or a modesty panel where these fixtures perform the function of restraining passengers from sliding forward off the seat. Armrests are not required on longitudinal seats that fold up in the wheelchair parking area 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 surface. Armrests shall be located from seven (7) to nine (9) inches above the seat surface. The area between the armrest and the seat surface shall be open. The top and sides of the armrests shall have a minimum width of two (2) inches and shall be free from sharp protrusions.

3.7.2.3 Handholds and Armrest Strength

Seat back handholds and armrests shall withstand static horizontal and vertical forces of 250 pounds applied anywhere along their length with less than 1/4 inch permanent deformation. Seatback handholds and armrests shall withstand 25,000 impacts in each direction of a horizontal force of 125 pounds with less than 1/4-inch permanent deformation and without visible deterioration.

3.7.3 Structure

The seat assembly shall withstand static vertical forces of 500 pounds applied to the seat surface in each seating position with less than 1/4-inch permanent deformation in the seat or its mountings. The seat assembly shall withstand static horizontal forces of 500 pounds evenly distributed along the top of the seatback with less than 1/4-inch permanent deformation in the seat or its mountings. (Seatbacks shall withstand repeated impact of two 40-pound sandbags without visible deterioration. One sandbag shall strike the front 40,000 times and the other sandbag shall strike the rear 40,000 times. Each sandbag shall be suspended on a 36 inches pendulum and shall strike the seatback 10,000 times from distances of 6, 8, 10, and 12 inches respectively. Seat surfaces shall withstand 100,000 randomly positioned 3-1/2 inches drops of a squirming, 150 pounds, smooth-surfaced, buttocks-shaped striker with only minimal wear on the seat surface.)

3.7.4 Construction and Materials

Seat material shall be fiberglass and shall be attached to the frame without rivet fasteners. Back panel shall be diamond pattern stainless steel. Seat surface and back "inserts" shall be integrally molded fiberglass. Super tough-fabric glued directly to a steel pan is acceptable. Coloring shall be integrated with the seat material, with no visually exposed portion painted. The seat shall be American Seating with the seating shell being medium gray, color # 980 and the cushion and back inserts being medium red, color number 1781 and blue color number 989 consistent with existing SFMTA equipment. All visually exposed metal of the seat structure,

including mounting brackets and other components, shall be stainless steel. The seat shall be contoured for individuality, lateral support, and maximum comfort, and shall fit the framework to reduce exposed edges. The seatback thickness shall not exceed 1/2 inch in the knee room area. Seatbacks shall absorb energy in a severe crash by allowing the passenger's knees to deform them. Complete seat assemblies shall be interchangeable to the extent practicable. All materials and workmanship shall conform to SPI standards and specifications in testing for plastic materials.

3.7.5 Wheelchair Accommodation

Two forward or rear-facing wheelchair securement positions, one at 60 inches in length and one at 65 inches in length, as close to the front door as practical, shall be provided for each coach. Each wheelchair accommodation shall provide parking space and secure tie down for one passenger in a wheelchair. No portion of the wheelchair or its occupant shall protrude into the normal aisle when parked in the designated wheelchair parking space. Proposer shall submit wheelchair accommodation options for SFMTA review and approval as part of the general seating arrangement.

3.7.5.1 Maneuvering room

Maneuvering room inside the coach shall accommodate easy travel for a passenger in a wheelchair from the loading device through the coach to the designated parking area and back out. SFMTA prefers the maneuvering room of each coach to closely resemble the drawing shown in ATTACHMENT 12: Wheel Chair Maneuvering Room. No width dimensions shall be less than 34 inches; area requiring 90 degree turns of wheelchair shall have a clearance arc dimensions of no less than 35 inches; and in the parking area, where 180 degree turns are expected, space shall be clear in a full 60 inches diameter circle. Wheelchair footrest clearance of 12 inches above the floor surface shall be provided on the outside turning radius.

3.7.5.2 Wheelchair Securing Devices

A wheelchair-securing device, American Seating Reliant ® three point securement with clamp or approved equal, shall be provided at each wheelchair position. A hand or foot operated release lever shall be conveniently located to release the latching mechanism. The wheelchair latching mechanism shall not interfere with battery-operated wheelchairs. A bumper shall be provided at each wheelchair location. The wheelchair securing devices configuration and installation shall be approved by SFMTA.

3.7.5.3 Seat Belts

Four-point securement system shall be provided in the wheelchair parking area. Seatbelts shall be easily accessible for wheelchair users. On the curbside securement area, a shoulder belt should be attached to the sidewall of the coach. A belt-type securement system and shoulder strap seat belt shall be included. The latching mechanism and retracted belts shall be readily visible when seats are folded down. Wheelchair area accommodations shall comply with the latest ADA laws and federal safety requirements and have a retractable shoulder belt.

3.8 PASSENGER EXIT SIGNAL

A passenger chime and stop requested signal system that complies with applicable ADA requirements defined in 49 CFR, Part 38.37 or latest shall be provided. It shall be integrated with the Automatic Next Stop Passenger Information System in Section 3.11. “STOP REQUEST” sign shall be illuminated with LEDs. One stop request sign is to be located at a

position the operator has visible access to. The location shall be approved by SFMTA. The sign shall remain illuminated until any of the passenger doors is opened, at which point the chime and illumination systems shall reset. Whenever the sign is illuminated, the chime signal shall be muted, and it shall not disable the “STOP” pushbutton for a wheelchair passenger to request to disembark.

3.8.1 Exit Signal

This system shall consist of a vandal resistant pull cable, chime, and interior sign message. The pull cable shall be located the full length of the coach on the sidewall and no higher than the division bar between the upper and lower window sections. Vertical pull cable shall be provided at each window mullion and at each wheelchair user area. Eyelets shall be provided as necessary to prevent the cords from rubbing against the coach interior. In addition, "STOP" pushbuttons shall be provided on all vertical stanchions.

A digital “{CHIME} Stop Requested” and an analog CHIME shall announce when the system is activated from any pull cord or any “Stop” button on the vertical stanchion. Simultaneously, a "STOP REQUESTED" sign (Reference Section 3.11.4, Sign Requirement) shall illuminate. The digital Chime shall announce no later than 0.5 second after the cord is pulled. In the event the digital system fails, the analog chime system will remain functional.

3.8.2 Mobility Aid Passenger Exit Signal

This system shall consist of a vandal resistant push button, chime, and interior sign message. The “Stop” push button shall be mounted underneath the folding seat or in a position easily accessible to the patron in each of the wheelchair parking areas, and shall be no higher than 48 inches and no lower than 15 inches from the floor. The chime shall be distinct and distinguishable from the mobile passenger exit signal defined in Section 3.8.1, Exit Signal.

When this system is activated, a light on the dashboard shall be illuminated to alert the driver that a mobility aid passenger wishes to disembark. This shall also illuminate the “STOP REQUESTED” sign. Configuring the system so that coach stop, coach ID #, and time are announced upon activation is strongly encouraged.

Location of the “Stop” push button and the material shall be submitted to SFMTA for review & approval.

3.9 PASSENGER ASSISTS

Passenger assists in the form of full-grip vertical stanchions or handholds shall be provided for the safety of standees and for coach ingress and egress. Passenger assists shall be convenient in location, shape, and size for both the 95th-percentile male and 5th-percentile female standees. Starting from the entrance doorway and moving anywhere in the coach, full-length vertical assists shall be provided so that a 5th-percentile female passenger may easily move from one assist to another without losing support. Vertical assists shall be mounted on the aisle side of the seatback of every transverse seat. These assists shall be functionally continuous with the overhead assist. Stanchions and other assists shall be bolted or pinned at each end.

Excluding the seatback and doorway assists, the assists shall be between 1-1/4 and 1-1/2 inches in diameter or width with a radius no less than 1/4 inch. All passenger assists, including those along edges of modesty panels, shall permit a full handgrip with no less than 1-1/2 inches

of knuckle clearance around the assist. In addition, flexible woven fabric hand straps shall be mounted to the overhead assists, allowing passengers a grab handle when not gaining the opportunity for a seat (See 3.9.3, Overhead).

A crash resulting in a 1-foot intrusion shall not produce sharp edges, loose rails, or other potentially dangerous conditions associated with a lack of structural integrity of the assist. Any joints in the assist structure shall be underneath supporting brackets and securely clamped to prevent passengers from moving or twisting the assist. All areas of the passenger assists that are handled by passengers, including functional components used as passenger assists, shall be of stainless steel with yellow powder coated. Assists shall withstand a force of 300 pounds applied over a 12-inch linear dimension in any direction normal to the assist without permanent visible deformation. Brackets, clamps, screw heads, and other fasteners used on the passenger assists shall be free of rough edges.

3.9.1 Doorways

Assists shall be mounted in the doorway and on the doors to aid passengers in boarding and alighting. A 5th-percentile female shall be provided functionally continuous assists from the curb to the assists within the coach. For design purposes, use a six (6) inches curb height. These assists shall begin with a vertical element not less than 12 inches long and no more than 4 inches from the outside edge of the exit area tread and continue inward no less than the first inboard stanchion. Assists in the doorways shall be no less than 3/4 inch in width and shall provide at least 1-1/2 inches of knuckle clearance between the assists and their mountings. A full-size vertical assist that is functionally continuous with the overhead assist shall be provided on the aisle side of the modesty panels at the entrance and exit areas. A full-size assist no less than 36 inches above the floor tread surface shall be provided in the middle of the rear door area extending from the aisle to the outside edge of the exit area.

SFMTA will review door opening passenger assists and provide a final approval during the prototype coach development in an effort to maximize this aid to impaired and wheelchair passengers boarding the coach.

3.9.2 Vestibule

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

3.9.3 Overhead

Except forward of the standee line and at the rear door, a continuous full-closed-grip, overhead assist shall be provided along both sides of the coach. This assist shall be located at a height convenient to standees, directly over the aisle-side edge of the seats. The assist shall be no less than 70 inches above the floor and no less than 33 inches apart equally spaced from the coach centerline. Overhead assists shall be capable of supporting 150-pound loads at 12-inch intervals. No more than five (5) percent of the full-grip feature shall be lost due to assist supports.

3.9.4 Longitudinal Seats

Longitudinal seats shall have vertical assists located between each pair of seating positions, except for seats that fold up to accommodate wheelchair securement. Assists shall extend from near the leading edge of the seat and shall be functionally continuous with the overhead assist. Assists shall be staggered across the aisle from each other where practicable and shall be no more than 52 inches apart longitudinally. Vertical assists shall be attached by stainless steel receiver cups with isolators welded to the seat grabrail on one end, and "T" bracket attachments to the overhead horizontal assist at the other end.

3.9.5 Divider Panel

A horizontal passenger assist shall be mounted on the top of every divider panel forward of a transverse seat.

3.10 DESTINATION SIGNS

Contractor shall provide and install on each bus an automatic electronic sign system by Twin Vision or approved equal. The system shall conform to all applicable ADA requirements and shall function seamlessly with the Automatic Next Stop Passenger Information System specified in Section 3.11. All locations and mounting of equipment shall be approved by SFMTA.

The Master Run Switch shall control power to the sign system. The signs shall operate in all positions of this switch except in “OFF” position. The signs shall be internally protected against voltage transients and RFI interference to ensure proper operation in the SFMTA operating environment.

A Master Controller Board shall be mounted in the front sign. Independent Sign Driver Boards shall be mounted individually in each destination sign. The Master Controller Board and the Sign Driver Boards shall be capable of accepting updated firmware levels via direct programming using a USB key and loaded through the USB port located on the Operator Control Unit (OCU). Each sign circuit must be fused at the Master Control Panel with a visual indicator showing communication and power status. The Master Controller Board shall be capable of sending discrete outputs indicating system health to an onboard AVM system. The system shall be capable of communicating with additional information devices, such as interior information signs, Voice Annunciation devices, farebox, etc. The system shall provide for destination and/or Public Relations (P/R) message entry.

The system shall have the ability to sequentially display multi-line destination messages, with the route number portion remaining in a constant “on” mode at all times. It shall also be capable of accepting manual entry of Route Alpha/Numeric on any/all signs.

Flash memory integrated circuits shall be capable of storing and displaying up to 10,000 message lines. Message memory shall be changeable by the use of a “USB Key” sized according to the message listing noted herein. Download via a PCMCIA card or Memory Transfer Unit will not be accepted.

All sign programming tools shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

3.10.1 Display

The displays shall consist of pixels utilizing High Intensity Light Emitting Diode (LED). The LEDs shall be the only means of illumination of the displays. Each pixel shall have a dedicated LED for illumination of that pixel in any lighting conditions. The displays shall adjust intensity level automatically as a function of the ambient light conditions. No fan or special cooling shall be required for the displays. The LEDs will have a life expectancy of 100,000 hours and each LED shall consume no more than 0.02 watts. The LED's power circuit shall be protected against normal bus power surges. The LEDs shall be mounted such as to be visible directly to the observer positioned in the viewing cone, allowing for full readability 65 degrees either side of the destination sign centerline. Destination readings shall be furnished by SFMTA. The characters formed by the displays shall meet the requirements of the Americans with Disabilities Act (ADA) of 1990 Reference 49 CFR Section 38.39.

The sign enclosure shall inhibit dirt, dust, moisture, water, and insects during normal operation or cleaning with a cyclone cleaner. Access shall be provided to clean the inside of destination sign windows and to remove or replace the sign mechanism. The glass used in the signs shall be a glare-resistant type, minimizing the effects of other types of light reflecting on it. The vehicle manufacturer shall comply with the destination sign manufacturers recommended mounting configuration and installation procedures to assure optimum visibility of the sign display.

3.10.2 Front Destination Sign

The front destination sign shall be full color display and have no less than 16 rows by 160 columns of LEDs, with a message display area of not less than 7.9 inches high by not less than 63.0 inches wide. All service performed on this sign must be done through the sign access door.

3.10.3 Curb Side Designation

The curbside destination sign shall be full color display and have no less than 14 x 108 columns of LEDs, with a message display area of not less than 4.2 inches high by not less than 42.0 inches wide. The display must be easily read from the sidewalk level.

3.10.4 Street Side Destination Sign

The street side destination sign shall be full color display and have no less than 14 x 108 columns of LEDs, with a message display area of not less than 2.5 inches high by not less than 42.0 inches wide.

3.10.5 Rear Destination Sign

The rear destination sign shall be amber color display and have no less than 14 x 108 columns of LEDs, with a message display area of not less than 2.5 inches high by not less than 42.0 inches wide.

3.10.6 Run Number Sign-Dash Mounted

The integrated run number sign shall be amber color display and have no less than 14 rows by 36 columns of LEDs, with a display area of not less than 4.20 inches high by not less than 14.0 inches wide. The display area shall be able to display a minimum of 4 characters and each of the 4 characters shall be capable of displaying all 26 upper case letters as well as numbers 0 - 9. Run numbers to be displayed shall be input directly into the destination sign system's OCU (Reference Section 3.10.7, Operator Control Unit), and shall be independent of any destination

sign message code. The sign shall be mounted as low as possible on the dash on the right hand side of the bus.

3.10.7 Operator Control Unit (OCU)

The OCU shall be used to view and update display messages. It shall be recessed mounted in an area that is easily accessed by the vehicle operator. Location shall be approved by SFMTA. The OCU shall be capable of providing a single logon for all on-board electronics systems using network protocols to be approved by SFMTA. The OCU shall also control the operation of the voice annunciation system, reference Section 3.11, AUTOMATIC NEXT STOP PASSENGER INFORMATION SYSTEM. The OCU shall utilize a water resistant multi-key conductive rubber pad keyboard and be designed for transit operating conditions and a maximum depth of 1.25". The OCU keypad shall have a minimum of 28 keys within a sealed, elastomeric membrane.

The OCU Unit shall contain a display of at least two-lines of 20-character capability. The OCU shall contain an audio enunciator that beeps indicating that a key is depressed. The OCU shall continuously display the message associated with the selected destination readings.

The OCU shall contain a USB port which will accept the destination and/or voice announcement data upload/reprogram.

3.10.8 Emergency Message Display

An emergency button, in a location approved by SFMTA, shall activate an emergency message. The emergency message shall be displayed only on the front and rear signs facing outside the vehicle, while signs inside the vehicle, including the OCU display, remain unchanged. The emergency message shall be canceled by entering a new destination code, or by removing the emergency signal.

3.10.9 Message Memory Transfer and Wireless Upload/Download

The sign system shall be reprogrammable on the bus with the use of a USB Key. A key slot shall be provided on the OCU face for this purpose. The maximum reprogramming time for a 10,000 line listing shall be no more than 30 seconds.

The wireless Upload/Download Automated system shall transfer the new data from a local computer to the on-board memory or vice versa. After transfer is initiated, the system shall trigger an automated data update followed by "Signs Update Completed" type message on the Signs and the OCU Display. The system shall provide a software application to manage the fleet data deployment update and also the update completion status.

The Contractor shall be responsible to install the wireless infrastructure, including equipment, at SFMTA Flynn facility. The Contractor shall demonstrate to SFMTA for the wireless uploading/downloading and provide necessary training to SFMTA designated personnel.

3.11 AUTOMATIC NEXT STOP PASSENGER INFORMATION SYSTEM

The Automatic Next Stop Passenger Information System (ANSPIS) shall be a proven system and shall be compatible and function seamlessly with the Destination Sign System specified in Section 3.10. The system shall be capable of adding additional signs to the communications network without rewiring existing equipment.

A Digital Recorders DR600 stop announcement system or approved equal shall be installed on each vehicle. The system shall meet or exceed all ADA requirements found in 49CFR Parts

37.167 and 38.35 and shall provide different, simultaneous audio announcements to riders onboard and waiting curbside. The system shall also provide a control capability for integrating present and future electronics on the bus. In order to maximize the system's useful life and to ensure ease of integration with third party electronics on transit vehicles, the system shall provide a robust, open software and hardware architecture. The system shall have the capability of hardware and software extension to include new or additional features. The system shall also incorporate ease of programming and updates of all operating information.

The ANSPIS shall be capable of providing a single log-on for other in-vehicle electronics systems (e.g.; destination / head signs systems, fare collection systems, automatic passenger counters, etc.). The communications protocol to accomplish system integration shall be SAE J1587/J1939 communication protocols. The system shall include an easy-to-use means of specifying whether log-on and/or passwords are required, and what vehicle operator ID's and passwords are acceptable for each sub-system. The ANSPIS shall be capable of playing audio diagnostics for all integrated electronics and provide audio messages describing any failures.

The ANSPIS shall allow the operator to select the route and shall display the route and the next stop to be announced on the operator control unit. The operator shall have the ability to scroll forward or backward within the selected route's list of announcements. Internal announcements are intended for on-board riders and shall play either by manual activation by the operator or in response to signals received by an on-board Automatic Message Trigger (AMT). The Automatic Message Trigger function shall incorporate a Global Positioning System (GPS) receiver and dead-reckoning. External announcements shall play automatically when the door is opened for a stop.

The ANSPIS shall also provide the ability to define and play up to 99 special announcements and 200 announcements which play at pre-defined times of day, depending upon the amount of memory available. The system shall provide the ability to play external announcements on a repeating "loop" at regular time intervals until canceled by the operator.

The ANSPIS shall have dual channel audio capable of playing simultaneous internal and external announcements. Vendor shall provide all database programming and route mapping services necessary for the system to be fully functional.

The system shall include a noise-sensing device, an Automatic Gain Control (AGC) Microphone, for each audio channel and shall automatically and independently adjust each channel's audio volume as appropriate in response to ambient noise detected.

The ANSPIS shall provide an easy-to-use means of updating the programmed database, both the destination sign system and the voice annunciation system, via a USB data key and/or 802.11g protocol.

3.11.1 Operator Control Unit (OCU)

The same OCU for Destination Sign System shall be utilized to control the Automatic Next Stop Passenger Information System. Reference Section 3.10.7.

3.11.2 Programming

Each bus shall be delivered with a fully programmed, fully functioning voice annunciation system. The programming for the voice annunciation system shall include no less than sixty bus lines and four thousand unique bus stops. The trigger points for all voice announcements shall be user programmable. The supplier shall provide to SFMTA with all of the necessary hardware and software to maintain this Automatic Next Stop Passenger Information System and to collect data (including GPS coordinates & distances between stops), record announcements, program signs, and program routes for this Automatic Next Stop Passenger Information System.

This shall include as a minimum the following:

- 2 current IBM compatible desktop computers using Windows 2007 or newer operating system. Both with custom 32 bit digital audio PC boards installed.
- 2 current Tough Book Laptop PCs using Windows 2007 or newer for the Programmer's field use. Each in portable cases installed with ISCU and GPS systems hardware and software needed to perform/test field route mapping. Destination Sign programming software installed as well.
- Audio development system software package.
- Sign messages programming software package.
- Full Training documentation for the programming and development of Route Mapping, Sign Messages, and Audio Messages.
- On-Site training and support to fully train two SFMTA personnel on programming and use of the above equipment and software.
- Two years technical programming support by phone.
- Five years no cost software and firmware upgrades on all software and equipment.

Any other associated hardware shall also be supplied in accordance with ATTACHMENT 13: Special Tools List. All hardware and software shall be uniquely identified as SFMTA property with serial numbers.

3.11.3 Audio Announcement Sub-System

Audio announcements shall be initiated automatically at points along SFMTA motor coach routes. Each announcement shall be designated interior and/or exterior. The volume for each announcement shall be automatically set based upon analysis of the ambient noise level (this automatic volume adjustment needs to react in a range of 0.100 of a second to 1.000 second.) All volume settings shall be digitally set to ensure consistent volume throughout the fleet. At least 8 Exterior and 8 Interior Preset default settings, each with different volume and ambient AGC choices to be provided, as well as a enough memory for saving at least 10 of our own volume settings.

An Integrated Public Address (IPA) Sub-system shall use the vehicle's interior and exterior public address speakers. This system shall also provide the driver the capability to make his own interior and exterior announcements. The IPA shall include a driver's volume control (This should be a temporary volume setting {10db in range} that will go back to the default setting when the vehicle is shut off.) and speaker select, which shall only affect PA operation when the PTT (Push-to-Talk) button is depressed. The IPA Sub-system shall use the existing bus interior speakers. The exterior speaker and bracket shall be supplied. The design, location and position of speakers shall be shall be consistent from coach to coach and approved by SFMTA.

3.11.4 Sign Requirements

The internal display sign shall display coordinating text for next stop and other audio announcements. The sign shall meet all ADA requirements for internal signage. The sign shall be a Light Emitting Diode (LED) type sign with 16 characters per line with bright amber LEDs. Sign shall be no larger than 27" x 2 1/8" x 4 1/8" (single line) or 6 1/8" (double line). Messages can be shown streaming or by any of 3 single frame modes with automatic centering. Speed, delays, and looping shall be programmable. Busy/ready status shall be poll-able. Forced reset capability shall exist.

The internal LED display sign shall be used to display the words "Stop Requested" and shall be visible to passengers. When the passenger chime is activated and shall remain on until the front or rear door is opened. The internal LED display sign shall also be used to display "Ramp Requested" when the passenger chime is activated provided there are separate outputs on the vehicle to designate different chimes for Stop Requested and Lift Requested.

Enclosure shall be aluminum with welded and sanded seams, black powder paint finish and acrylic fascia with matte finish for reduction of reflected glare. Sign shall be constructed to withstand the harsh environmental conditions found in transit applications.

The interior information sign shall also function as a Stop Requested sign. This stop requested sign message should be automatically mixed with other active messages when applicable. The stop requested message shall be cleared when one or both of the passenger doors are opened.

The Contractor shall also install an independent analog passenger stop request display located on the front sign compartment door and shall function simultaneously with the electronic sign when a stop is requested by passengers.

3.11.5 GPS Vehicle Location Message Trigger

The GPS shall be capable of providing its positioning information to other onboard equipment. Such GPS information shall be made available for AVM and AVL applications. The system shall automatically determine adherence to the bus route and trigger the announcement of the next bus stop as it is approached. The system shall utilize GPS satellites signals, WAAS satellites, a heading sensor, and an odometer sensor to provide continuous location information and automatic correction.

Once initialized, the automatic announcement system shall not require Operator intervention or action in the event of off-route excursions. The system shall defect off-route excursions and remain silent when off route. The system shall detect reacquisition of the route, at any point along the route, and automatically determine and announce the next valid bus stop.

3.11.6 Data Transfer and Wireless Data Transfer

The voice announcement system shall be reprogrammable on the bus with the use of a USB Key. On-vehicle reprogramming shall also be accomplished in a single step process using a 802.11g or faster protocol.

The wireless Upload/Download Automated system shall transfer the new data from a local computer to the on-board memory or vice versa. After transfer is initiated, the system shall trigger an automated data update followed by "Voice Update Completed" type message on the

Signs and the OCU Display. The system shall provide a software application to manage the fleet data deployment update and also the update completion status.

The Contractor shall be responsible to install the wireless infrastructure, including equipment, at SFMTA facilities (Woods and Kirkland). The Contractor shall demonstrate to SFMTA for the wireless uploading/downloading and provide necessary training to SFMTA designated personnel.

3.12 PUBLIC ADDRESS SYSTEM

A public address system that complies with the ADA requirements of 49 CFR, Part 38.35 and enables the operator to address passengers either inside or outside the coach shall be provided in a location approved by SFMTA engineering. The public address system shall be activated by a floor-mounted momentary switch to permit driver to make internal announcement only or external announcement only - switching from inside to outside speakers shall not require volume adjustment. Switch shall be easily accessible to the operator. Six (6) inside speakers and one (1) outside speaker shall be installed. All speakers shall broadcast in a clear tone so that all announcements are clearly heard in all passenger locations. Interior speaker grills shall be metallic material and shall be secured by tamper-proof screws or rivets. The PA system shall be muted when not in use. A Stealth Mic hands-free digital microphone system, Digital Recorders Inc. or approved equal shall be provided. SFMTA shall approve all locations and installation for the public address system.

3.13 DIGITAL VIDEO RECORDING AND SURVEILLANCE CAMERA SYSTEM

The Contractor shall provide and install a digital video recording and surveillance system ("DVRS system") by DTI or approved equal, and shall demonstrate successful operation of the system on each vehicle. The DVRS system shall be approved by SFMTA during prototype review. The system shall include the following:

- 10 cameras (30-foot and 40-foot bus): 4 interior and 2 exterior Color CCD cameras, 2 HD cameras, and 2 Transit-Only Lane Enforcement (TOLE) cameras
- 11 cameras (60-foot bus): 5 interior and 2 exterior Color CCD cameras, 2 HD cameras, and 2 Transit-Only Lane Enforcement (TOLE) cameras
- 2 removable hard drives for separate video surveillance and TOLE storage
- 2 Microphone (with adjustable gain)
- System Status Panel in the security enclosure
- Security Enclosure (keyed alike with 1 key for each)
- Uninterruptible Power Source (30 minute minimum back-up capacity)
- Set of hardware and cabling connecting the system.
- Operator Control (pushbutton)

The DVRS shall be programmable to automatically tag events, or pre-programmed activities. Tagged and programmed events shall be stored, and when a recording is retrieved, the tagged events shall be easily identifiable.

The system shall be able to retain time, date and any user programmable data (i.e., coach number, route, run, etc.) without connection to the power source. The system shall have its own power supply connected to the 12 volt or 24 volt power of the coach. The system must be able to withstand all transients, surges, and dips in power from the vehicle’s electrical system without

any deterioration of system performance. The system shall not be affected by electro-magnetic interference (EMI) or radio frequency interference (RFI). The system shall meet all applicable rules and regulations of the Federal Communications Commission (including FCC Part 15 Rules and Regulations) and the Department of Transportation.

The contractor shall include in the vehicle maintenance manuals wiring diagrams clearly showing the interfacing coach wiring for the system as well as individual maintenance manuals for each piece of supplied equipment. These manuals shall include schematic diagrams and maintenance procedures including but not limited to operation, preventive maintenance, and troubleshooting.

The Contractor shall provide decals on all vehicles. There shall be six (6) decals in the coach. The purpose of the decal is to warn passengers that the vehicle is equipped with security camera system. Design and placement of decals shall be approved by SFMTA.

3.13.1 Camera

Contractor shall install 10 total cameras for 30-foot and 40-foot buses and 11 total cameras for 60-foot bus. 4 interior for 30-foot and 40-foot (5 interior for 60-foot) and 2 exterior Color CCD Cameras, 2 HD cameras with frame rate of 15fps facing forward and down the aisle, and 2 TOLE cameras located as specified by SFMTA . Exterior cameras shall not make any audio recordings outside of the transit vehicle including in the front of the vehicle or on the side of the vehicle.

The Transit-Only Lane Enforcement ("TOLE") cameras shall be positioned to capture an identifiable image of the vehicles in front of the transit vehicle, including the license plate, color, and other identifying characteristics of the vehicles. The TOLE cameras shall be positioned to capture the location of the vehicles illegally occupying the transit-only lanes in front of the transit vehicle.

The exterior camera outside the transit vehicle shall be pointed towards the rear and at the doors. It shall prevent damage to the lens from the transit vehicles washers or tree branches on the vehicle’s route.

All cameras supplied shall have a standard NTSC or IP color signal output. The NTSC cameras shall be capable of producing a 540 TVL high resolution undistorted wide dynamic image in all lighting conditions (auto back light compensation/auto or electronic iris or Pixim technology chip set required) without the need for manual adjustment to any equipment while the IP cameras shall be power over Ethernet (PoE) and capable of HD or greater resolution. The cameras shall also be capable of capturing face images with bright backgrounds within the transit vehicle. A Day/Night capability shall provide display images from 0.3 lux in day mode and 0.05 lux in night mode.

3.13.2 Digital Video Recorder

The digital video recorder (DVR) shall be capable of recording the outputs of the TOLE cameras and video surveillance cameras on internal separately removal hard drives. The video surveillance camera hard drive shall provide a minimum of one (1) month video retention with H.264 compression algorithm, and shall be a minimum 1 terabyte capacity SATA hard drive or an approved equal. The TOLE camera hard drive shall provide a minimum of three (3) days storage capacity, and shall be a minimum 250 gigabyte capacity solid state drive, or an

approved equal. All hard drives shall be “Hot Swappable” (i.e., the hard drives shall be removable without corrupting the data even with the DVR ON).The DVR shall record simultaneously at a speed of not less than five frames per second each at 2CIF, along with the two synchronous audio tracks and be identified with time, date, vehicle number, GPS location information, and time sync. The GPS information shall be able to relate to an address on a map.
The DVR shall have the ability to automatically download selected video events in user selectable increments via a wireless connection to the satisfaction of the SFMTA. Specific transit vehicle and specific times shall be selectable.
The DVR shall have the capability to be pre-programmed to download recorded incidents that have not been “tagged” by the operator up to one (1) hour in length from all cameras recorded in the transit vehicle when the vehicle returns to the yard to the satisfaction of the SFMTA. The download shall continue until complete even if the transit vehicle is powered down.
The DVR shall have the capability to transmit live video, from inside the transit vehicle, upon demand to a laptop or PDA while the transit vehicle is still in revenue service to the satisfaction of the SFMTA. The live video feed shall be transmitted up to a distance of 500 yards from the transit vehicle.

3.13.3 Silent Alarm Requirements

Upon activation of the silent alarm switch, the recording system must protect a window of recorded data that extends to a point, up to thirty (30) minutes, prior to the activation of the silent alarm and to a point, up to thirty (30) minutes, after activation and will not allow the recording to be erased. The software system shall allow the SFMTA to adjust the extent of the data to be saved through software without the need for contractor’s support. The activation of the silent alarm switch must be recorded on the video medium. Additional requirements for the silent alarm are given in Section 4.1.13, (Silent Alarm and Event Marker).

3.13.4 Health Monitor Tool ("HMT")

The contractor shall provide Health Monitor Tool ("HMT") application software for continuous monitoring of the health of remote DVRs. The DVR shall be capable of sending real time health checks and notification through e-mail or text of any defect noted during transit vehicle operation.

1. HMT shall be provided with the following:

    a. Automatically monitors multiple remote connected DVRs at set intervals.
    b. Ability to manually poll all DVRs for system health variables.
    c. Provide an on-line report of all results.
    d. Export reporting capability in 3 formats (Excel, HTML, and CSV).
    e. Email notification of events to multiple recipients.

2. Monitored Events:

    a. Connection: Network connectivity test.
    b. Failed Drive Access: Each drive shall be verified.
    c. Camera Failures during Defined Intervals: Cameras shall be continuously tested to ensure connectivity.
    d. Reboots anytime a DVR is restarted or shutdown.

e. Time Since Recording: Verification that recording is continuing up to current time.
f. Protected Capacity Used % shall monitor space remaining for protected video and displaying percentage utilized.
g. Days of Storage shall display the number of days currently retained on the DVR for unprotected recorded video.

3.13.5 Downloading Software

The downloading software shall have the capability to be programmed by a maintenance technician at the server to be able to download recently recorded video for QA checks of equipment functionality of each transit vehicle on a daily, weekly, and monthly basis. The downloading software shall have the ability to download the error/status log from the DVR every time the transit vehicle is back in the depot yard. It shall include a "GPS Search" feature that will allow SFMTA staff to video search the entire fleet based on specific or range of times and at or near specific locations of any incident. The use of Graphic User Interface (GUI) will be the preferred method of interface with the program.

The downloading software shall have fleet-wide software for viewing DVR and camera "health status" that are continuously updated and recorded in a log file accessible to the SFMTA Video Technicians and shall include real time health checks and notification that can send notifications to SFMTA staff via e-mail/text of any defect noted during operation.

The system shall have the capability to be pre-programmed to download recorded incidents that have not been "tagged" by the operator, up to one (1) hour in length from all cameras recorded on the transit vehicle when the vehicle returns to depot yard. The Contractor shall provide all support equipment needed to facilitate this (i.e., antenna, transmitter, receiver, and server)

3.13.6 Wireless System

The wireless system on the transit vehicle shall be the latest wireless bridge, currently 802.11N HauteSpot WRAPDXCi-MN or approved equal. The Contractor shall supply or use an existing antenna mounted on the roof of the transit vehicle of at least 3dbm gain, and if needed per the Contractor's power configuration, an external power supply to power the bridge may be installed. The wireless bridge shall have the capability to turn on and off the DVR via a wireless switch or IP relay.

3.13.7 Security Enclosure

The mobile DVR shall be encased in a vented, rugged metal chassis with shock absorbers to withstand exposure to extreme shocks, vibrations, and temperatures. A system status and event button indicator shall be provided on the outside of the enclosure. A pick resistant ACE-type lock or better shall be used. The lock shall be quarter turn lock and unlock. The internal and external assembly of the security enclosure shall be designed for ease of removal and repair of an internal subassembly and of the entire assembly. Ease of and convenience of maintenance, changing user parameters and media removal and replacement are also important functional requirements for the system. Design of the security enclosure shall be approved by SFMTA during prototype review.

3.13.8 Viewing Stations

The contractor shall provide complete viewing stations, in accordance with Attachment 12, Special Tools List, which will allow SFMTA personnel to review recorded video and audio data,

transfer data to long term storage media, or transfer to compact disk (CD) or DVD for court room viewing. The viewable and audible data shall meet all legal requirements for Rules of Evidence in the State of California's Courts of Law. The video shall be playable off the CD/DVD without the need of installing viewing software.

3.13.9 Documentation and Training

Documentation and Training are referenced in Section 9.2.7, (Surveillance Camera System Manuals) and Section 9.1.7, (Surveillance Camera System Training) respectively.

3.14 DRIVECAM

The Contractor shall provide a continuous battery powered DriveCam system on all vehicles. The DriveCam system ("DriveCam System") shall include the DC3 Cellular Event Recorder ("Event Recorder") with audio front and rear video views and internal IR, DriveCam GPS system with GPS antenna (internal or external), wiring bundle, electrical connects, securing tie down straps, mounting brackets, miscellaneous hardware and all associated equipment to provide an operational event recorder system that meets the written software and hardware related specifications DriveCam provided to SFMTA. The system design and installation shall be approved by SFMTA.

3.14.1 Hardware

A. DriveCam 3 Video Event Recorder – Cell – part number VER-DC3-0004 including:

   1 GPS Antenna – part number PER-GPS-0001 (not applicable for internal GPS)
   2 VER 6 Port Hub Installation Doc – part number DRC-302 (not applicable for 5-port hub)
   3 Instructions for Mounting Pushbutton Collar – part number DRC-929

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B. Torx Wrench DC3 – part number 1130-00101-0000

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C. Mounting hardware, accessories and power harness

3.14.2 Software

A. The Contractor shall provide the following software including any updates or patches:

   1. Initial Year Hindsight License – part number 3235-000HS -INIT
   2. ASP Hosting – part number 4230-00ASP-INIT

3.14.3 Services

A. The Contractor shall provide the following services:

   1. Cellular Transport Plan (Tier 3) – part number 4230-0CELL-INIT
   2. Managed Service (Tier 3) – part number 4230-000MS-INIT

3.14.4 Wires and Cables

A. All wire sizes and insulation shall be based on the current carrying capability, voltage drop, mechanical strength, temperature and flexibility requirements, as well as fire resistance requirements for vehicle applications in accordance with DriveCam specifications.

B. Wiring shall be uniformly color coded and tagged.

C. Wiring shall be prefabricated into standardized harnesses, wrapped and tied with “all weather UV type” nylon ties.

D. The power source wires must be sized appropriately to meet specified requirements for unit. Wherever there is a possibility of interference, wiring and interconnecting cables shall be properly shielded.

E. A protective plastic or rubber grommet must be installed in every hole that provides passage for conduit or wiring to avoid chaffing or cutting of the conduit or wiring.

F. Start up and normal operation should prevent unacceptable voltage drops

3.15 MOBILE RADIO SYSTEM

The bus manufacturer shall provide cable only installation for the future radio/CAD/AVL system that will be provided by Harris/Xerox for the SFMTA based on a system designed by Harris/Xerox and approved by the SFMTA Radio Project team.

The location of all radio and public address equipment shall be subject to SFMTA approval.

3.15.1 SFMTA-Supplied Equipment

The following radio equipment will be provided and installed by SFMTA:

1) Transmitter/receiver, Motorola Model No. T34SRA
2) Location processing unit, Motorola Model No. LPU-1200
3) Power line filter, Motorola Model No. TLN5277B
4) Fuse blocks and terminal strip
5) Mobile Data Terminal (MDT), Motorola Model No. T1941 (includes handset, speaker, mounting tray and box)
6) AVL Dasys cable, Motorola Part #TKN-8023B, (D-type connector to radio compartment, pin-type connector to front dash)

3.15.2 Contractor-Supplied Equipment

The Contractor shall provide and install the following equipment:

1) Silent alarm switch, Motorola Part #40-82608M03
2) Transmitter/receiver radio antenna and cable, Motorola Model Number RRA4739A
3) Location processing unit antenna and cable, Motorola Model Number RRA4455A
4) Interconnecting cable harnesses
5) Vertical wedge 11-1/2 inches by 7-3/8 inches with a removable back plate. SFMTA will supply a sample.

An 11/16-inch diameter hole on the side panel of the dash shall accommodate the Contractor-mounted silent alarm switch. The SFMTA Project Manager / Representatives will approve the layout. Contractor shall connect a coiled 3-foot length of #18 gauge two-wire to the switch. SFMTA will complete switch installation during installation of communication radio.

3.15.2.1 Radio Compartment and MDT

A radio compartment shall be provided to accommodate the first four listed items in 3.14.1, (SFMTA - Supplied Equipment). This compartment shall be in a convenient location to the driver's area. If installed outside of the operator's area, the radio compartment shall be connected to the operator's area by a waterproof, three (3) inches inside diameter, metallic conduit. The compartment shall include a clear space 12 inches high, 24 inches wide, and 18 inches deep for location of the radio. The compartment shall have a locked door that is accessible from outside the coach. It shall be watertight and equipped with a one-way drain. A location convenient to the operator shall be provided for the radio control head, speaker, and handset. The radio compartment shall be supplied with a nominal 12-volt, 30-amp direct current with positive and negative leads. This service shall be protected by a 30-amp circuit breaker located at the circuit breaker panel.

A 2-1/4 inches minimum inside diameter metallic conduit and mounting plate for the MDT, and a channel between the MDT and radio compartment to house the interconnecting cable harness, shall be supplied. The MDT shall be located conveniently to the operator.

The design, location and installation of the radio compartment and MDT shall be approved by SFMTA.

3.15.2.2 Radio Antenna

Contractor shall provide and install two Motorola low profile blade-type antennae, or approved equal. One Model No. RRA4739A shall be provided and installed at the forward location for the two-way radio, and the second Model No. RRA4455A shall be provided and installed at the second rearward location. Contractor shall provide and install type RG 58 coaxial from the under floor radio compartment to each antenna location.

Two reinforcement plates, 12 inches x 12 inches x 1/8 inch shall be mounted at two locations on the roof body panel at approximately four feet (4') to the rear from the front of the coach. The second plate shall be mounted at a location ten feet (10') to the rear of the first plate and be the location for the vehicle locator system external antenna. Both antenna locations shall have an access plate in the interior roof panel below the reinforcement for access to a transmitter/receiver antenna.

A concealed 3/4-inch conduit and pull wire from each reinforcement plate to radio compartment shall be provided. Conduit shall have no sharp or right angle bends.

3.15.2.3 Cable Harness Connection

The interconnecting cable harness and specific installation instructions are as follows:

- Each: DDU Cable, fused, Motorola Part #30-5827T01
- Each: Data head control cable, Motorola Part #8127A (bulk connector to radio compartment, pin connector end to front dash)
- Each: Data head alarm cable, Motorola Part #TKN-8130A (connector end to front dash, exposed cable end to radio compartment)
- Pair: (18AWG/Strand, color-coded red and black) from front dash to radio compartment
- Pair: (12 AWG/Strand, color-coded red and black) provided from the 12-volt battery source to the radio compartment
- Each: RG-58A/U radio coaxial cable provided from roof-mounted antenna to the radio compartment
- Each: Emergency alarm switch Motorola Part #40-8260M03
- A hole 2 inches in diameter punched on the front dash panel (about 1-1/2 foot distance from the operator's seat) with a 2-inch rubber grommet added for protection. All cable/wires terminated at the front dash panel.
- All cables and wires terminated at the front dash panel must have a minimum slack clearance of 1-foot length from the rubber grommet.
- All cables and wires terminated at the radio compartment must have a minimum slack clearance of 4-feet length into the radio compartment
- The rigid conduit leading into the radio compartment must be large enough to accommodate all cable runs with all connectors in place.
- Coaxial cables connecting to the roof antenna must have a minimum slack of 1-foot clearance for future maintenance applications. An interior access panel must be provided for antenna maintenance.

3.16 FARE COLLECTION

Provisions for mounting a fare box (10-1/2 inches by 10 inches footprint and 39-1/2 inches high) shall be provided as far forward and as deep into the floor as practicable. Location of the fare box shall not restrict traffic, including wheelchairs, in the vestibule and shall allow the operator to easily reach the fare box operational buttons and to view the deposited fares. The fare box shall not restrict access to the operator’s area and shall not restrict operation of operator controls. The passenger side of the fare box faces the front door of the coach shall provide sufficient clearance for easy access to the cash box/receiver system. The fare box must have sufficient clearance for easy removal of the Coin and Bill Modules, as well as the Master Controller Card. Meters and counters on the fare box shall be easily readable on a daily basis. The location of the fare box shall comply with ADA requirements. Wiring and mounting shall meet all clearance and access requirements, and shall accommodate installation of Cubic Electronic Fare boxes or approval equal.

3.16.1 Electrical

A 10-amp maximum, 24-volt, direct current protected circuit shall be available to power the fare box. This circuit shall be composed of three wires, +24VDC wire, 24VDC return, and a ground lead all enclosed in a protective flexible conduit. All wires are 14 AWG, stranded, oil/grease/abrasion resistant (Reference ATTACHMENT 10: POWER CABLE, FAREBOX). Where applicable, the Contractor shall install circuit breakers. A power-disconnect switch shall be provided inside the fare box for maintenance purposes.

3.16.2 Fare Box Mounting
SFMTA requires a reinforcing mounting support plate with nuts welded onto it. The support plate shall be mounted below the coach floor (Reference ATTACHMENT 11: FareBox Mounting Support Plate). The contractor shall place emphasis on the proposed placement of the fare box in order to meet space and maneuverability requirements for wheelchairs in addition to entrance and egress for the operator in an effort to minimize the possibility of industrial injury. The location of the fare box, installation procedures and rework procedures shall be approved by SFMTA.

3.16.3 Transfer Mounting Bracket
Transfer mounting, cutting, and punching equipment will be located in a convenient position on the right side of the instrument panel or on the fare box support. The mounting area shall be reinforced as required. A mounting bracket for this equipment shall be provided with the coach. Samples of this equipment shall be provided by SFMTA. Transfer mounting location shall be approved by SFMTA.

3.17 CLIPPER
Each coach shall be delivered with a fully programmed, fully functioning Clipper system. The Clipper system shall consist of one (1) DC (Driver Console) at the Operator Area and one (1) Customer Interface Device (CID) for each door. The DC shall not obstruct the view of the Operators and shall not interfere with Operator's Vent and Heater/Defroster in Section 4.3. Cables shall not be exposed and accessibility to wiring shall be a primary design consideration for ease of maintenance. The mounting locations of the DC and PD shall be approved by SFMTA.

The Clipper on-board equipment requires either 12VDC or 24VDC power from protected sources with voltage variations from 9VDC to 32VDC. The protection shall be a 5A manual resetting circuit breaker that visibly identifies an open circuit in the tripped state.

The Clipper system shall be equipped with wireless transmitting/receiving equipment to upload/download information between the Clipper system on the coach and the Clipper processing server. Contractor shall be responsible to demonstrate the Clipper system is fully functioning with the existing wireless network infrastructure at SFMTA.

3.18 AUTOMATIC PASSENGER COUNTING (APC)
Contractor shall furnish, install, and demonstrate successful operation of a proven system by a well-established APC company specializing in Automatic Passenger Counting (APC) systems. The APC system shall be a stand-alone system using its own Global Positioning System (GPS) and wireless (802.11g or faster protocol) upload and download data files. The APC system shall utilize optical image or optical thermo sensors and process the collected data. The system shall be capable to generate reports on the passengers load with bus stops information at the discretion of the user. Cables shall be mounted so as not to interfere with the operation and maintenance of the wheelchair ramp, or other vehicle systems. The installation will be heavy duty and able to withstand the stresses of urban transit operation in the SFMTA environment. Accessibility of wiring and ease of maintenance shall be primary design considerations. Automatic Passenger Counting shall be able to count bicycle and wheelchair users, as well as ambulatory passengers. The APC design and location shall be approved by SFMTA. All

specialized tools shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

The Contractor shall be responsible to install the wireless infrastructure, including equipment, at three (3) SFMTA facilities (Woods, Flynn & Kirkland). The Contractor shall demonstrate to SFMTA for the wireless uploading/downloading and provide necessary training to SFMTA designated personnel.

3.18.1 Electrical

The Master Run Switch shall control activation of the APC system. The APC system shall operate in all Run positions of this switch. Power to the APC system shall be on at all times, except when the battery has been shut off (this is to enable the Wireless download to operate at all times, as explained in Section 3.18.5).

The APC system shall have a very small current draw; it shall not drain vehicle battery below engine starting level for at least 4 full days.

The APC system shall have its own circuit breaker, and it shall be internally protected against voltage transients and RF interference to ensure proper operation in the SFMTA operating environment.

3.18.2 System Enclosure

The APC system shall be housed in its own sturdy vandal-resistant enclosure that includes a tamper and pick-resistant lock. The unit shall be installed in an area determined by SFMTA. This area must be easily and safely accessible to authorized personnel.

3.18.3 Passenger Counting Sensors

The Passenger Counting Sensor features shall be proven devices from a well-established APC company specializing in APC systems. They should include but not be limited to the following:

1) Acquisition of passenger counts by means of sensing devices at each vehicle door opening.
2) Fully adjustable detection zones that meet the requirements of the vehicle design.
3) Bicycle rack and wheelchair ramp switches that tabulate bicycle rack and wheelchair ramp users.
4) 95% counting accuracy that is not affected by normal variables, including but not limited to:
    a. The reasonable speed at which someone passes by sensors.
    b. Passengers carrying items such as backpacks, boxes, briefcases, etc.
    c. Obstructions to the sensors, such as passengers remaining immobile within the sensor field.
    d. The difference between passengers boarding and exiting the vehicle.
    e. Variations in light and temperature.

3.18.4 GPS (Global Positioning System)

The GPS shall provide accurate location of the vehicle while passengers board and exit. Location information will include but not be limited to route and bus stop/car stop identification.

The GPS shall include a Dead Reckoning system so that Stop ID's can be accurately recorded in poor GPS reception areas, and self-diagnostics with status lights for easy troubleshooting. These will include indications such as: "Power," "Boot Up Mode," "3-D Fix," and "Dead Reckoning in Use." The GPS system shall be provided with hardware and software to access status information and configuration settings in real time for the Electronics Shop Technicians to use as a troubleshooting and configuration tool.

3.18.5 Computer Data Logging System

The Computer Data Logging System shall be a proven device supplied by a well-established company specializing in Automatic Passenger Counting. It shall include, but not be limited to:

1) The GPS described in 3.18.4 GPS (Global Positioning System)
2) An onboard microcomputer that gathers and stores at least an average of 10-days of vehicle/route data that can be wirelessly downloaded to a local server via a RF Wireless System. Data shall also be stored on a non-volatile medium for onboard retrieval.
3) A RF Wireless Receiver System, stationed at each facility where the APC vehicles reside. Each RF Wireless Receiving Unit shall be installed in a secure area, determined by SFMTA.
4) An IBM PC server used for the Wireless System. It shall be installed in a secure area determined by SFMTA. The Server shall connect to our existing LAN for remote data retrieval.
5) Ability of the RF Wireless System and APC Server to run 24-hours a day, 365-days a year in order to provide authorized access to all APC data at any time.
6) Self-diagnostic capability of individual System units.

Microcomputer gathered data should consist of but not be limited to:

1) Route ID
2) Vehicle ID
3) Time and date stamp
4) Stop ID
5) GPS stop coordinates
6) Direction of travel
7) Minimum and maximum passenger numbers
8) Number of passengers boarding and exiting at each stop ID/GPS location
9) Passenger load count at any time
10) Bicycle rack user and wheelchair lift user data.

The above data and other variants shall be used with software described in 3.18.6 Computer Data Analysis Software.

3.18.6 Computer Data Analysis Software

The APC Vendor shall provide complete data analysis (PC Windows) software for use with downloaded APC computer-logged data, to generate Summaries, Reports, Analyses, Plots, and Graphs, such as but not limited to the following:

1) Route Summary Report

2) Route Productivity Plot
3) Trip Summary Report
4) Trip Report; Bus/Car Stop Summary
5) APC Mapping
6) Schedule Adherence Summaries and Reports

The software shall have the ability to adjust the parameters of the Reports and Summaries, such as dates, routes, addition of external data, etc. The Vendor shall provide 3 desktop PCs, all installed with a full version of APC software for converting the compiled data into useful information as outlined above. The Data Analysis Software will be part of the proven APC system supplied by a well-established APC company specializing in APC systems. The APC data/software shall be fully compatible with the Plan module of the Trapeze scheduling system.

3.19 PASSENGER INFORMATION HOLDER

Two frames shall be provided on the rear of the operator's barrier to retain information sized 17 inches wide and 11 inches high posted by SFMTA, such as routes and schedules.

One rack, constructed of durable plastic, shall be provided for displaying transit information. This rack shall be mounted on the top of the dash panel adjacent to the run number sign. The rack shall have four compartments, each 4-1/8 inches wide, 2-3/4 inches deep, and 5-1/2 inches high. The front face of each compartment shall be cut out with a "V" shape that is centered, Three (3) inches high, three (3) inches wide at the top, and two (2) inches wide at the bottom, with rounded corners.

Three "take-one" boxes shall be mounted inside the coach. Two boxes on the street side shall be mounted on the window pillars: one half-way between the operator's area and the space across from the rear door and one half-way between the rear door and the rear of the coach. One box shall be mounted on the rear door pillar. The "take-one" boxes shall be aluminum or stainless steel and shall retain a 1-1/4 inches stack of 4-1/4 inches-wide media. The boxes shall be four (4) inches deep.

Locations and placement of the passenger information holders are subject to SFMTA review and approval.

3.20 NUMBERING AND SIGNING

Coaches shall have four-digit fleet numbers counting upward in sequence with coach serial numbers. SFMTA will inform the Contractor of the fleet numbers. SFMTA logo and serial numbers shall be decals. The SFMTA common carrier number “CA 49819” shall be decals in three (3) inches high numbers on both the curbside and the road side of the coach. Coach numbers shall be decals on the roof in numerals 48 inches high. A bus fleet number plate shall be installed on the panel behind the operator seat. Fleet number style and locations shall be subject to the final approval by SFMTA.

The interior of the coaches shall have the four-digit fleet number in three-inch block style decal located on the panel or access door above the operators head and centered vertically from the windshield to the ceiling and horizontally between the coach interior walls. In addition, on the panel behind the operator’s station, a Braille vehicle number sign will be placed in accordance with ADA height and size requirements listed below.

Signing shall be applied to the inside and outside of the coach in compliance with the ADA requirements defined in 49CFR Part, Subpart B, 38.27. Signs shall be durable and resistant to fading, chipping, and peeling; they may be painted signs, decals, or pressure-sensitive appliqués. All decals shall be sealed with clear, waterproof sealant around all exposed edges if required by the decal supplier. Appliqués shall be 3M Scotchcal or approved equal. Signing listings are included in ATTACHMENT 2: Decal Listing. Contractor will be supplied with a sample of all decals and decal drawings at design review. Sign materials, location and placement shall be subject to the final approval by SFMTA.

3.21 SIGNAL PRIORITY EQUIPMENT

Contractor shall supply and install fully functional signal priority equipment by Opticom or approve equal. The signal priority equipment shall utilize standalone GPS antenna and LED emitter. The design and location of the equipment shall be approved by SFMTA during design review.

3.22 CHASSIS MOUNTED PEDESTRIAN BARRIER (S1 GUARD)

Contractor shall provide chassis mounted pedestrian barrier on the curbside in front of the rear axle wheel. The pedestrian barrier shall be adequate enough to push pedestrian away from the right rear wheel.

3.23 NEXTBUS

Contractor shall provide all equipment, provide installation and testing meeting the requirements for a fully functional NEXTBUS system. The coach system shall be the most current NEXTBUS technology, which is designed to interface and operate with current SFMTA equipment. All equipment installation locations and methods shall require approval from the SFMTA Project Manager. The SFMTA Project Manager and/or quality assurance inspector shall witness testing and provide approval as part of the vehicle acceptance.

4 OPERATOR'S AREA

The objective of designing the operator's area is to provide an environment for the driver to operate the coach safely and efficiently for long periods of time without injury and with minimal fatigue. The operator's area shall also be designed to minimize glare to the extent possible. The use of polished metal and light-colored surfaces within and adjacent to the operator's area shall be avoided. To the extent practicable, areas that are visible from outside the coach in the vicinity of the dash panel and cowl shall be configured to preclude use for storage of items. The

Contractor shall present the complete detailed layout of the operator's area at the design review for approval by SFMTA. The Contractor shall construct a mock-up of the operator's area for approval of the operator's area by SFMTA prior to the manufacture of each prototype coach.

The operator's area shall comply with the following SAE recommended practices:

TABLE 4.0

SAE J287	Driver Hand Control Reach
SAE J941	Motor Vehicle Driver Eye Range
SAE J1050	Driver's Field of View
SAE J1052	Motor Vehicle Driver and Passenger Head Position
SAE J1516	Accommodation Tool Reference Point
SAE J1522	Truck Driver Stomach Position
SAE J1834	Seat Belt Comfort, Fit and Convenience

4.1 CONTROLS

All switches and controls shall be marked with easily read backlit identifiers and shall be in convenient operator locations. All panel-mounted switches and controls shall be replaceable, and the wiring at these controls shall be serviceable from the vestibule or the operator's seat. Switches, controls, and instruments shall be dust and water resistant, consistent with the coach washing practice described in Section 2.3, INTERIOR TRIM, PANELING AND ACCESS. All operator controls shall be located in positions where the operator can activate and deactivate them without reaching below the dash level and shall be located in a position that the operators body cannot contact them while entering / existing the control station, or while operating the coach.

4.1.1 Operator Control

SFMTA Operations personnel will be heavily involved with the final approval and acceptance of the operator's area. All switches shall be waterproof or, if at SFMTA's approval, weatherproof. All control panels installed on to the Operator's area shall be sealed properly to prevent water intrusion. All switches and controls necessary for the operation of the coach shall be conveniently located in the operator's area and shall provide for ease of operation. They shall be identifiable by shape, touch, and permanent non-wear or fading identification markings Specific requirements for operator controls are summarized in Figure 4.1, (Operator Control Requirements). All required switches and controls are included in Figure 4-2, (Operator Switches and Controls) and shall be constructed and specified as heavy-duty automotive/industrial quality.

No wiring, equipment or housings shall interfere with the operation of foot-controlled switches or pedals. Controls and all dash features shall be designed so that the operator or passengers may not easily tamper with them. Layout of controls shall be approved by SFMTA.

4.1.2 Instruments

The speedometer, certain indicator lights, and air pressure gauge(s) with two needles and a minimum of 2-1/2 inches in diameter, shall be located on the front cowl immediately ahead of the steering wheel. Illumination of the instruments shall 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 shall be minimized. Instruments and indicators shall be easily readable in direct sunlight. Instrument and indicator light readability in all conditions will be approved by SFMTA during prototype evaluation.

The instrument panel shall include an electric analog-speedometer with a maximum possible indicating speed of no less than 80 mph and calibrated in maximum increments of five (5) mph. The speedometer shall be a rotating pointer type, with a dial deflection of 200 degrees to 270 degrees and 40 mph near the top of the dial and shall not include an odometer. The speedometer shall meet size and accuracy requirements of SAE Recommended Practice J678. The instrument panel shall include a fuel level gauge, an air pressure gauge with indicators for primary and secondary air tanks, and 12 volt and 24 volt voltmeter(s) (if space is available) to indicate the operating voltage across the coach batteries. The instrument panel lamp wiring shall be easily accessible for service from the operator's seat or from the top of the panel. Wiring shall have sufficient length and be routed to permit service without stretching or chafing the wires.

FIGURE 4-1 OPERATOR CONTROL REQUIREMENTS

SUBJECT	SPEC/DESIGN
Steering Wheel Adjustment	3" vertical; 6" Horizontal Steering
Steering Wheel	19" diameter
5th Percentile Acc. Pedal Angle at Rest	SAE J287-J941-J1052 and J1522
5th Percentile Brake Pedal Angle at Rest	SAE J1516
95th Percentile Acc. Pedal Angle at Rest	SAE J1516
95th Percentile Brake Pedal Angle at Rest	SAE J1516
Turn Signal Controls Left Foot	35 - 45 degrees platform
Control Handreach – Side	SAE J287
Control Handreach – Front	SAE J287
Seat Dimensions	Min. Width - 18" Slope - 5 +/- 5 degrees
Seatback to Cushion Angle	95 - 110 degrees
Seat Height Adjustment	13” – 19” from floor to top of uncompressed seat
Seat Adjustment Forward	Min. 9"
Object Detection	3.5' height at 2' in front of coach
Horizontal View	Min. 90 degrees
Obstruction – Divider	Less than 3 degrees
Obstruction – Pillar	Less than 10 degrees
Upward View	Greater than 15 degrees
Brake	Range of resistance 10 –50 lbs. Angle from the horizontal: 45; freeplay: 1.2 degrees; Pedal Travel: 0.5” – 2.5”; height above accelerator: 1.2”
Accelerator	Range of resistance: 4 – 10 lbs. Angle from the horizontal: 45; freeplay: 5 degrees Maximum travel: 20 degrees

FIGURE 4-2 OPERATOR SWITCHES AND CONTROLS

SWITCHES
Master Run Switch
Start button
Kneel switch (with cover) and over raise function
Hill holder switch, with extension arm
Interior lighting switch
Power door switch
Passenger Chime switch
Operator area lighting switch
Silent alarm switch
Hazard warning switch, with extension arm
Engine shutdown override switch (with cover)
Diagnostic light panel test switch
Master door switch
Street side/curb side door switch (with cover)
Foot-controlled turn signal switches
Horn button in steering wheel hub
Foot-controlled headlight dimmer switch
Fire suppression system manual activation switch
Sweeper Switch
Electric-only mode switch
Emergency shut down switch (with “tell tale” indicator)

CONTROLS
Accelerator pedal
Brake pedal
Rotary handle for Doors
Windshield wipers
Windshield washers
Interior climate control
Defroster control
Operator's heater controls
Parking brake control (also acts as direction control neutral actuator)
Wheelchair ramp controls
Destination sign controls
Rear throttle control
Instrument panel lighting intensity control

4.1.3 Indicators

Critical systems or components shall be monitored by a built-in diagnostic system with visible and audible indicators. The diagnostic indicator lamp panel shall be located in clear sight of the operator. The intensity of indicator lamps shall permit easy determination of "on"/"off" status in bright sunlight but shall not cause a distraction or visibility problem at night. All indicators shall have a method of momentarily testing the operation of the lamp. Whenever possible, sensors shall be of the closed-circuit type so that failure of the circuit or sensor shall activate the malfunction indicator. Sensors shall be accurate to +/- two (2) percent of the manufacturer's specified value. An audible alarm shall be loud enough for the operator to be aware of its operation and to be inclined to discontinue operation of the coach. Diagnostic indicators are

listed in Figure 4-3, (Onboard Diagnostic Indicators). Space shall be provided on the panel for future additions of no less than five indicators.

FIGURE 4-3 ONBOARD DIAGNOSTIC INDICATORS

VISIBLE INDICATOR	AUDIBLE ALARM	FUNCTION
Low Fuel	No	Clean diesel fuel level at or below 25 gallons
Low Oil	Yes	Engine oil pressure low
Hot Engine	Yes	Engine coolant temperature high
Low Air	Yes	Air system low in primary or secondary reservoir
Alternator stop	No	Alternator not charging
Kneel	Yes	Kneeling system activated
Wheelchair ramp	Yes	System activated
Fire	Yes- 75 dB (min)	Over temperature in engine compartment
Low Hydraulic Fluid	Yes	Hydraulic fluid low fluid level
Traction Motor	Yes	Over Speed and/or overheat
Mobility Aid Passenger Exit Signal	No	Mobility aid passengers want to get off
High headlamp	No	High headlamp is on
Right and Left turn	Yes	Indication of left-turn or right-turn
Hazard warning	No	Warning signal to other drivers. (may be common with turn indicators)
Rear doors open or enabled	No	Rear doors are opened
Parking brake not applied	Yes- 75 dB (min)	Parking brake is not applied and Master Run Switch is at “OFF” position
Parking brake applied	No	Parking brake is applied
Interlock is off	Yes	Interlock is turned off
Service brake applied	No	Service brake is applied. (may be common with parking brake indicator)
Check Engine	Yes	Engine interlocks
Stop Engine	Yes	Engine interlocks
Energy Storage Unit Temperature	Yes	Warning of high temperature and/or fire and/or smoke condition
Energy Use	No	Dynamic energy usage efficiency indicator(s)
GFCI	Yes	Progressive indicator of excessively high current condition within the high voltage system
Electric-only mode	No	APU manual off condition
Controller	Yes	Overheat
State of Charge (SOC)	No	Progressive low power indicator(s)

Adapter plugs for energy consumption meters or SFMTA approved alternative equivalent means shall be provided to monitor cumulative and instantaneous values of motor current draw and line current.

A total of three meters shall be provided. Access to the adapter plug or equivalent means shall be inside the coach, but shall be available to maintenance personnel only.

The instrument panel and wiring shall be easily accessible for service from the operator seat or top of the panel. Wiring shall have sufficient length and be routed to permit service without stretching or chafing the wires.

4.1.4 Door Controls

Controls for the front entrance and rear exit doors shall be a single 5-position master door switch, conveniently located and operable in a horizontal plane by the operator's left hand. The setting of this control shall be easily determined by position and touch. The 5-position master door switch shall also activate the hazard light whenever the switch is not in the “centered” position. The master door switch shall be a single 5-position control with the following settings shall be provided:

FIGURE 4-4

Second Position Forward	Front door open, rear doors enabled
First Position Forward	Front door open, rear doors disabled
Centered	Front door closed, rear doors disabled
First Position Rearward	Front door closed, rear doors enabled
Second Position Rearward	Front door open, rear doors enabled

Contractor shall provide Proof-Of-Payment (POP) push buttons on the outside of the vehicle by each of the exit door. Whenever the operator enabled the rear exit doors, passengers on the outside of the vehicle shall be able to push the POP button to open the door. Contractor shall provide the design for SFMTA approval.

4.1.4.1 Door Operations

The designs, configurations, locations, operations and mounting installations shall be approved by SFMTA. A separate switch, convenient to the operator, shall convert the rear doors to power doors with simultaneous opening and closing of both door valves controlled by the operator.

Operation of, and power to, the passenger doors shall be completely controlled by the operator. Doors shall open or close completely within 2 – 4 seconds from the time of actuation, and shall be subject to the adjustment requirements of Section 3.2.6, Actuator. Activation of the door mechanism can be accomplished using air power or electric power. Electric powered doors shall operate similarly to the following description for air-powered doors.

The rear exit door panels shall include a sensitive edge for the purpose of alarming and reversing door operation in the event an individual or an individual’s limb would be caught between the doors on closure. The sensitive edge will activate a toned alarm in the operator’s area, and immediately open the exit door. Once the obstruction is cleared, the operator will be required to recycle the door controller to the open position before being able to again activate closure of the doors. Detailed specifications are listed in 3.2.8 Sensitive Edges.

4.1.4.2 Interlock

When any door controls is activated, an accelerator interlock shall inhibit the acceleration of the vehicle, and a braking interlock shall engage the rear axle service brake system. The interlocks shall not release until the front and rear doors have closed and the operator has positioned the door control to the "all doors closed" position. If vehicle speed is above 1 mph when the interlock is engaged, a loud, momentary alarm will sound (Reference Section 6.4.5, Propulsion System Interlocks).

4.1.4.3 Interlock Override Switch

An interlock override switch, enclosed in the front destination sign compartment and accessible only through a horizontally-located adequately-sized finger hole beyond the reach of the seated

operator, shall, when set in the "off" position, release and deactivate the door interlocks, allowing the release of the inhibited throttle, and enabling the front and rear doors. An audible alarm shall be activated when the override switch is in the “off” position. The design and access to the interlock override switch shall be approved by SFMTA during design review.

4.1.5 Steering Wheel and Horn Button

The steering wheel shall last the life of the coach, and shall be constructed of a hard, smooth black material impervious to diesel or gasoline fuel, cleaning fluids, and body acids. The steering wheel shall be no less than 18 inches in diameter and shall be shaped with a soft rim grip for comfort for long periods of time. The steering wheel spokes or rim shall not obstruct the operator's vision of the instruments when the steering wheel is in the straight-ahead position. The steering column shall be capable of a minimum six (6) inch horizontal adjustment and a 3-inch vertical adjustment from the operator seat. Clearance requirements shall be met in all positions (Reference Section 5.2.3, Turning Effort).

Dual electric horns shall be provided, mounted to prevent entry of water and dirt into horn trumpets. The horns shall sound high and low notes (notes D & F) that are clearly audible over 80 dBA traffic noises at a distance of 300 feet. The horn button shall be located in the steering wheel hub and shall be protected from debris accumulation and shall not incorporate any manufacturers' logo.

The steering wheel shall be Vehicle Improvement Products, BKBL2024D47V, or approved equal and the horn assembly shall be Vehicle Improvement Products, HB9T, or approved equal.

4.1.6 Accelerator and Brake Pedal

Contractor shall install an adjustable pedal system by Kongsberg or approve equal. The adjustable pedal system shall simultaneously slide the brake and accelerator pedals for 3 inches both forward and rearward. The adjustment shall be made by use of a dash mounted toggle or rocker switch. The switch shall be clearly labeled to identify it as pedal adjustment and shall be within easy reach of the operator. The design and locations shall be determined at the design review.

Accelerator and brake pedals shall be designed for ankle motion and shall meet the requirements of SAE J1516. Foot surfaces of the pedals shall be faced with wear-resistant, nonskid, replaceable material. Force to activate the brake pedal control shall be an essentially linear function of the coach deceleration rate and shall not exceed 50 pounds at a point seven (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. Brake and accelerator design shall refer to Figure 4-1, (Operator Control Requirements).

4.1.7 Master Run Switch

Controls for engine operation shall be closely grouped within the operator's area. These controls include a separate master run switch and start switch or button. The master run switch shall be a three-position rotary switch located conveniently to the operator’s left.

TABLE 4.1.7

OFF	All electrical systems off, except power available for the stoplights, turn lights, hazard lights, silent alarm, horn, and fare box. The off switch shall not function unless the traction motor is in neutral.
RUN	All electrical systems, including headlights, parking lights, and marker lights, and engine on. The starter shall be inoperative when the engine is running and when the traction motor is not in neutral.
CL/ID	All electrical systems off, except those listed in "OFF," and power to passenger interior lighting, radio and marker lights.

4.1.8 Hill Holder
The contractor shall provide an automatic hill holding system, but if manual control is necessary, the hill holder control shall be conveniently located to the operator's left (Reference Section 5.3.8, Hill Holder).

4.1.9 Turn Signal
Turn signal controls shall be foot-controlled, waterproof, heavy-duty momentary contact switches, floor-mounted on a platform inclined at an angle between 35 and 45 degrees in a manner that precludes confusion among the left, right, and high-beam switches. Whenever the curbside turn signal control is activated, an external audible warning shall sound to warn other drivers that the coach is preparing to make a turn. The external audible curbside turn signal alarm, Mallory Sonalert SC628JR or approve equal, shall be located under the coach just forward of the rear door, shall sound whenever the turn signal is activated.

SFMTA required the Contractor to install two independent override toggle switches, one for left turn beeper and one for the right turn beeper, to be installed in a secured locking compartment, only accessible by 4M mechanics, on the vehicle. The location shall be review and approved by the SFMTA.

4.1.10 Destination Sign Control & Automatic Next Stop Passenger Information System
Reference Section 3.10, DESTINATION SIGNS, and Section 3.11, AUTOMATIC NEXT STOP PASSENGER INFORMATION SYSTEM.

4.1.11 Fare Collection Area Light Control
Reference Section 4.7, OPERATOR'S AREA LIGHTING.

4.1.12 Climate Control
The climate control shall provide switches or display panel on the instrument panel to control the heating, and ventilating. All switches or display panel locations shall be reviewed and approved by SFMTA (Reference Section 3.4, INTERIOR CLIMATE CONTROL, Section 3.5, ROOF VENTILATORS, and Section 4.3, OPERATOR'S VENT AND HEATER/DEFROSTER.

Operator Heater/Defroster: There shall be a 2-speed switch to control the Heater/Defroster.

4.1.13 Silent Alarm and Event Marker
Contractor shall install a silent alarm switch in a location to be determined at the design review. When the silent alarm switch is activated, the following events shall occur:

- The recording system must protect a window of recorded data that extends beyond the beginning and ending of an event (Reference Section 3.13.2, Silent Alarm Requirements).
- A help message (subject to SFMTA approval) shall display on all front and rear facing electronic signs.
- SFMTA Central Control shall be alerted to notify proper authorities.

At the discretion of the operator, a control event marker (pushbutton or equivalent) shall be available to mark an event in the same manner as specified for the silent alarm in Section 3.13.2.

4.2 OPERATOR SEAT

The operator seat shall be a USSC 9100 ALX, modified to meet the specifications listed below in Section 4.2.1, Dimensions and Adjustability, or approved equal. It shall be easily removable from the coach for service or repair. A non-removable headrest is required; however it shall be easily removed and installed by a mechanic. Installation shall be approved by SFMTA.

The Contractor shall install a parking alert alarm on the vehicle. The alarm shall sound if the Operator unbuckles the seatbelt and leaving the operator seat but the parking brake is not set. The Contractor may utilize the seat belt fastening as the sensing element. The Contractor is required to submit a proposal to SFMTA for review and approval.

4.2.1 Dimensions and Adjustability

The operator's seat shall be adjustable so that persons ranging in size from the 95th percentile male to the 5th percentile female may safely and comfortably operate the coach. A footrest shall be provided for the operator's left foot. The operator's seat cushion shall have a minimum width of 18 inches, a depth of 16 inches and a rearward slope with a total range of adjustability of 10 degrees. The operator seatback height, measured from the point of intersection of the uncompressed seat cushion with the seatback to the top of the back, shall be a minimum of 23 inches. The angle formed between the seat back and the seat cushion shall be adjustable in the range of 95 to 120 degrees. The height of the seat shall be adjustable so that the distance between the top of the uncompressed seat cushion and the floor shall vary between 12 and 20 inches. The height of the lumbar support from the seat shall vary between 9 and 12 inches. The seat shall be adjustable forward and rearward for a minimum travel of 12 inches and shall provide a minimum of 33.5 inches of horizontal distance between the seat reference point and heel of the driver on accelerator pedal. While seated, the operator shall be able to make all adjustments by hand, easily and conveniently. Adjustment mechanisms shall hold the adjustments and shall not be subject to inadvertent changes.

4.2.2 Structure and Materials

The operator's seat shall be contoured to provide maximum comfort and safety for extended periods of time. Cushions shall be padded with at least three (3) inches of closed cell molded self-skinning polyurethane on the seat cushion and back, and shall comply with FMVSS fire and smoke requirements. Supplementary cushioning shall be provided by air suspension of the seat assembly. The spring rate of the supplementary suspension and the seat height shall be independently adjustable by the operator. Seat suspension shall effectively dampen road shock, so the seat shall not oscillate excessively during normal driving conditions, including passing over potholes. Upholstery shall be H012 Hampton Black Vinyl, or approved equal, and

shall be approved by SFMTA during prototype review. All visually exposed metal on the operator seat, including the pedestal, shall be aluminum and stainless steel. The seat shall be adjusted without unfastening the seat belts. The seat shall be supplied with belt assemblies, lap belt system and shall accommodate all drivers in all positions of the seat. Seat belts shall be stored in automatic retractors. The color of the operator seat shall be black and the seat belt shall be orange.

4.3 OPERATOR'S VENT AND HEATER/DEFROSTER

A separate operator-controlled heater and blower shall be provided to heat the operator area and defrost the windshield. The unit shall be sized and designed to operate in the San Francisco environment providing a comfortable work area during normal transit operation. The blower shall have at least two speeds, with a minimum of 500 cubic feet per minute at the higher speed. Adjustments shall permit variable distribution or shutting off of the airflow. SFMTA prefers to have a manually opened vent door. This vent door shall provide unfiltered outside air to the lower portion of the operator area. The windshield defroster unit shall comply with the SAE recommended practices J382. Placement and operation of the vent shall be approved by SFMTA. Contractor shall demonstrate the operator's area heating and ventilation system's compliance with the specification.

4.4 OPERATOR WINDOWS

4.4.1 Windshield

The windshield shall permit an operator's field of view as specified in SAE Recommended Practice J1050. The vertically upward view shall be greater than 15 degrees, measured above the horizontal and excluding any shaded band. The vertically downward view shall permit detection of an object 3-1/2 feet high no more than two (2) feet in front of the coach. The horizontal view shall be a minimum of 90 degrees above the line of sight. Windshield pillars shall not exceed 10 degrees of binocular obscuration. The windshield shall be designed and installed to minimize external glare as well as reflections from inside the coach.

The windshield shall be laminated safety glass of minimum of 1/4 inch thick and conforms to the requirements of ANSI Z26.1-1983 Standard for Type AS-1. The windshield shall be easily replaceable by removing zip-locks from the windshield retaining moldings. Bonded-in-place windshields shall not be used. The glazing material shall have single-density tint. The upper portion of the windshield above the operator's field of view shall have a dark, shaded band with a minimum luminous transmittance of 6 percent when tested according to ASTM D-1003. SFMTA prefers windshields with flat glass.

4.4.2 Side Window

The operator's side-window shall be safety glass of minimum of 1/4 inch thick and conform to the requirements of ANSI Z26.1-1983 Standard for Type AS-2. The entire side window area shall be framed in a two-section sash. Each section shall slide horizontally and be glazed with float-type, single-density, tinted safety glass that is neutral gray with approximately 76 percent light transmission. The assembly shall have a ratchet mechanism to prevent uncontrolled sliding. The side window must include a lock that utilizes a common SFMTA "M" and "W" key. The window tracks, channels, and seals shall be designed to last the service life of the coach. Contractor shall provide glass dimensions and specifications. The side window shall be equipped with a solar screen and shall be USSC machine cassette or approved equal. The design of the operator's side window and locking arrangement shall be approved by SFMTA.

4.5 MIRRORS

4.5.1 Exterior

The coach shall be equipped with a pair of corrosion-resistant exterior rearview mirrors on each side of the coach. Both mirrors shall be remote adjustable with breakaway arm or approved equal. The mirrors shall be separately adjustable and replaceable. The mirrors shall permit the operator to view the highway along both sides of the coach, including the rear wheels. Both mirrors shall be mounted no less than 80 inches above the street surface.

Mirrors shall be firmly attached to the coach to prevent vibration and loss of adjustment, but not so firmly attached that the coach or its structure is damaged if the mirror is struck, and shall retract or fold sufficiently to allow coach-washing operations. All exterior mirrors electrical wiring shall utilize Quick Disconnect Connectors located as close as possible to the mirror for ease of maintenance. The mirrors shall be mounted on spring-loaded brackets and be guarded from hitting the coach sides in the retracted position. Mounting arms shall not protrude beyond the outside mirror edge. The mirrors, mirror bracket construction, mounting location and installation shall be approved by SFMTA.

4.5.2 Interior

Rear view mirrors shall be provided and arranged so that the operator can observe passengers throughout the coach without leaving the operator's seat and without shoulder movement. With a full standee load, including standees in the vestibule, the operator shall be able to observe passengers anywhere in the aisles, and in the rear seats. Interior mirrors shall not be in the line of sight to the exterior curbside mirror. Mountings shall be sturdy to resist flexing, vibration, and vandalism.

Interior observation shall be accomplished by a swivel-mounted convex rear view mirror of 4 inches by 10 inches attached above and to the right of the operator's head. The locations of mirror mountings shall be approved by SFMTA, including assurance the step well mirror does not encroach upon passenger doors during access/egress

4.6 PUBLIC ADDRESS SYSTEM

The public address system shall be activated by a floor-mounted momentary switch to permit driver to make internal announcement only or external announcement only - switching from inside to outside speakers shall not require volume adjustment. Switch shall be easily accessible to the operator. A Stealth Mic hands-free digital microphone system by Digital Recorders Inc. or approved equal shall be provided (Reference Section 3.12, PUBLIC ADDRESS SYSTEM).

4.7 OPERATOR'S AREA LIGHTING

The operator's area shall have a light to provide general illumination, and it shall illuminate the half of the steering wheel nearest the operator to a level of 10 to 15 foot-candles. This light shall be controlled by a switch convenient to the operator.

A high-intensity bullet light mounted in the ceiling shall spotlight the money receptacle of the fare box when the front door is open and the master run switch is in the "RUN" position.

4.8 OPERATOR BARRIER

A Dutch door style barrier in the operator's area shall be provided on all of the vehicles delivered. The barrier shall be designed to have no glare, reflection and rattle as design criteria. The barrier shall have an opening such that the lower half only or both halves can be closed or safely left opened at the operator's discretion. Where visibility is required, clear Lexan type material or laminated safety glass can be used to comply with all FMVSS visibility and safety requirements. The barrier shall extend to within one inch of the floor, ceiling and walls. The design of the operator barrier shall be approved during the design review and shall comply with all applicable regulations. The barrier color should match the 980 gray of the passenger seats. The barrier shall meet the strength requirements described in Section 2.3.1, Modesty and Side Trim Panel. The latching mechanism shall be easily accessible to all operator heights. The Contractor shall review the barrier on the existing SFMTA fleet prior to submitting a proposal for SFMTA to review and approve.

4.9 TRASH RECEPTACLE

A cylindrical plastic trash receptacle, 13 inches high and six (6) inches in diameter, shall be provided and installed by the Contractor. It shall be fastened to the vertical assist element of the operator barrier with a removable J clip and shall not rest on the coach floor. In addition, the Contractor shall provide a small capacity trash holder, minimum 28 in^3, on the side of the operator panel.

4.10 FARE COLLECTION EQUIPMENT

Refers to Section 3.16, FARE COLLECTION.

4.11 SUN VISOR AND SUN SHADES

An adjustable sun visor shall be provided for use on the operator's side of the windshield. The visor shall be shaped to minimize light leakage between the visor and windshield pillars. The visor shall store out of the way and shall not obstruct airflow from the climate control system or foul other equipment, such as the destination sign control. Deployment of the visor shall not restrict vision of the rearview mirrors. Visor adjustments shall be made easily by hand with positive locking and releasing devices and shall not be subject to damage by over tightening. Sun visor construction and materials shall be strong enough to resist breakage during adjustments. The visor, when deployed, shall be effective in the operator's field of view at angles more than 5 degrees above the horizontal. A spring-loaded clip not less than 3 inches wide shall be securely riveted to each side of the sun visor to retain operator's run sheet. Covering on the visor shall be black vinyl similar to that of the operator's seat.

A scissor-type pull down shades shall be provided for operator's side of the windshield, approximately half of the entire windshield, and on the operator's side window. Scissor-type pull down shades shall be capable to pull down and cover the entire vertical length of the windows. The scissor-type pull down shades shall have the solid vinyl at the lower segment and the mesh perforated screen on the upper segment. Sun visor and scissor-type pull down shades shall comply with all applicable regulations. Configurations and installations of sun visor and roll-curtain shall be approved by SFMTA.

4.12 STORAGE LOCKER

The contractor shall furnish and install one (1) storage locker. Location, design and materials shall be approved by SFMTA. A storage locker with a side-hinged and latch shall be provided in the operator area behind the operator seat. The locker shall be at least four (4) cubic feet.

4.13 OPERATOR'S PLATFORM

The operator's platform shall be finished with no sharp edges and shall not interfere or impede wheelchairs or other mobility aids. SFMTA prefers that the Contractor provide Operator's platforms similar to SFMTA's existing motor coaches.

The floor in the operator's area shall be easily cleaned and shall be arranged to prevent debris accumulation. Floor covering shall be Altro Transflor D25-421 "Midnight", or approved equal.

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5.1 SUSPENSION AND AXLES

5.1.1 General Requirement

All axle suspensions shall be pneumatic type and shall have a load rating compatible with that of the axles. The basic elements of the suspension system shall last the life of the coach without major overhaul or replacement. Suspension beams, weldments and structural members shall be considered as parts of the basic body structure. Items such as bushings and air springs shall be easily and quickly replaceable by a 4M mechanic in 30 minutes or less. Suspension pivots shall be replaceable. Bushings shall be permanently lubricated and interchangeable at all positions. Adjustment points shall be minimized and shall not be subject to a loss of adjustment in service. Necessary adjustment shall be easily accomplished without removing or disconnecting the components. Caster and toe-in adjustments shall be possible without removal of any component. Contractor shall provide axle tool kits which contain specialty tools required for axle nuts, flanges, bearing replacement, seal installation, service brake reline (s-cam and disc brake) / hardware replacement etc. in accordance with ATTACHMENT 13: Special Tools List.

5.1.2 Axles

All axles shall have a minimum load rating sufficient for the coach loaded to GVWR and shall operate for 300,000 miles on the design operating profile without repairs. The axle gearing shall be easily accessible for lubrication and all axles shall be approved by SFMTA.

The front axle suspension system shall be independent type, reverse Elliott Standard MAN, Rockwell, Meritor, or approved equal that incorporates Rockwell components from the steering knuckle through the entire brake assembly or approved equal.

The drive axle shall be heavy-duty full-floating type standard MAN or approved equal. End tubes shall be removable and shall be threaded to allow for adjustment of wheel bearing nuts.

Reusable axle hub bolts are preferred.

Minimum axle load ratings are encouraged to be rated so that GVWR is maximized.

5.1.3 Wheel Bearings

Wheel bearings shall provide smooth low friction rotation of the wheels under all operating conditions. The wheel bearings shall be easily accessible, maintainable, and replaceable. Wheel bearing inner grease seal shall run on a replaceable-chromed wiper ring or the tube. All bearings shall be sealed properly to prevent leakage of lubricant. An oil bath type seal shall lubricate the non-drive axle bearings by Stemco, Inc. or approved equal.

5.1.4 Air Bellows

The air suspension system shall consist of at least two, and preferably four, air bellows per axle. The system shall use leveling valves and bellows to maintain constant spring characteristics and coach body height, regardless of coach loading. Leveling valve exhaust ports shall be guarded to avoid plugging with road dirt.

Air bellows shall be removable, replaceable and serviceable without removal of any wheels while the coach is on standard in-ground hoists, above ground hoists or in a pit area. The type and manufacturer of the air bellows requires the approval of SFMTA.

5.1.5 Travel

The suspension system shall permit a minimum wheel travel of 3½ inches in jounce-upward travel of a wheel when the coach hits a bump (higher than street surface). And a minimum of 3 inches rebound–downward travel when the coach comes off a bump and the wheels fall relative to the body. Elastomeric bumpers shall be provided at the limit of jounce travel. Rebound travel may be limited by elastomeric bumpers or hydraulically within the shock absorbers. Suspensions shall incorporate appropriate devices for automatic height control, so that regardless of load the coach height relative to the centerline of the wheels does not change more than ±½ inch at any point.

5.1.6 Damping

Vertical damping of the suspension system shall be accomplished by multi-shock absorbers mounted to the suspension arms or axles and attached with replaceable bolts and nuts to appropriate locations on the chassis. Damping shall be sufficient to control coach motion to two cycles or less after hitting road perturbations. Shock absorbers shall maintain their effectiveness for at least 50,000 miles and each shock absorber unit shall be individually replaceable by a 4M mechanic in less than 15 minutes. Variations in passenger loading shall not adversely affect the handling characteristics of the coach sufficient to classify it as dangerous, unsatisfactory, and uncontrollable.

5.1.7 Kneeling

The coach must kneel evenly on both sides. The operator-actuated kneeling device shall lower the step at the front door to a height of no more than 10 inches, measured at the longitudinal centerline of the front door to the ground. Brake and throttle interlocks shall prevent movement when the coach is kneeled. A three-position, spring-loaded, normally centered switch located in the operator's area shall control kneeling of the coach. A downward force on the switch shall activate the kneeling function. The coach shall complete kneeling in a maximum of four (4) seconds from the time the switch is activated. During the lowering and raising operations, the maximum acceleration shall not exceed 0.2g, and the jerk shall not exceed 0.3g per second, measured on a front step tread. An indicator, visible to the operator, shall be illuminated whenever the coach is too low for safe street travel and the interlocks are engaged. An audible alarm and downward-pointing visual signal mounted near the door pillar shall operate when the coach's kneeler is in motion. The audible alarm shall be a different frequency than other alarms and beeper. The sound and operation of this alarm shall be approved by SFMTA at the design review. The coach shall remain kneeled when the control switch is released. An upward force on the switch shall be required to raise the coach. The coach shall rise to the correct operating height within 15 seconds.

The kneeling switch shall also provide over-raise feature for vehicle speed traveling under 5 mph. The design and operations shall be determined and approved by SFMTA at the design review.

5.1.8 Lubrication

All elements of steering, suspension, and drive systems requiring scheduled lubrication shall be provided with grease fittings conforming to SAE Standard J534. These fittings shall be located

for ease of inspection, and shall be accessible with a standard grease gun without flexible hose ends, from a pit or with the coach on a hoist. Each element that requires lubrication shall have its own grease fitting with relief path. The lubricant specified shall be standard for all elements on the coach. The manufacturer shall supply SFMTA with a maintenance schedule and protocol.

5.2 STEERING

The steering gear shall be either axle-mounted or frame-mounted and shall be a Sheppard steering gear, ZF steering gear, Ross Model #HFB70 steering gear, TRW TAS-85 steering gear, or approved equal. The steering column shall have telescoping and tilt column adjustments. The steering gear shall be an integral type with the number and length of flexible hydraulic fluid lines minimized.

5.2.1 Strength

Fatigue life of all mechanical steering components shall exceed the service life of the coach. No element of the mechanical steering system shall fail before suspension system components when one of the tires strikes a severe road hazard. The mechanical steering system shall be considered as part of the basic body structure.

The manufacturer shall provide SFMTA with certificates that validate the strength and security of the suspension and steering system along with any test documentation for tests, which have been conducted.

5.2.2 Turning Radius

The outside body corner turning radius shall not exceed 45 feet with the coach at Seated Load Weight, applicable to 30, 40 and 60 foot lengths.

5.2.3 Turning Effort

Steering torque applied by the operator shall 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 shall be measured with the coach at GVWR, stopped with the brakes released, and the engine at normal idling speed on clean, dry, level, commercial asphalt pavement and the tires inflated to recommended pressure. Power steering failure shall not result in loss of steering control. With the coach in operation, the steering effort shall not exceed 55 pounds at the steering wheel rim, and perceived free play in the steering system shall not materially increase as a result of power assist failure. Gearing shall require no more than seven (7) turns of the steering wheel lock-to-lock.

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

5.3 BRAKES

5.3.1 Description

Service brakes shall be air actuated disc type. The disc brake system and replacement parts shall be commercially available in North America. The Contractor shall provide and install a MUNI approved brake lathe, fixture, adapters and other necessary equipment to service these brake, in accordance with ATTACHMENT 13: Special Tools List.

The Contractor shall also install MGM E-Stroke, or approved equal, with the system status indicator. The indicator panel shall be mounted at a location approved by the SFMTA.

5.3.2 Actuation
Service brakes shall be compressed air operated and controlled with a single actuator at each wheel. Force to activate the brake pedal shall be as specified in Section 4.1.6, Accelerator and Brake Pedal.

Disc brakes shall have either axial or radial air actuation with a single floating caliper operation.

5.3.3 Friction Material
The entire service brake system, including friction materials, shall be designed to have an overhaul or replacement life of 30,000 miles with brake retardation through regenerative braking. Disc pad friction material shall be non-asbestos and bonded to the pad.

5.3.4 Rotors
Brake rotors shall be sized to the vehicle weight and wheel diameter and meet all FMVSS requirements. The brake rotors shall be able to be resurfaced in the field and have the minimum thickness size stamped in the casting.

Wheel bearing seals shall run on replaceable wear surfaces. Wheel bearing and hub seals shall not leak or weep lubricant for 50,000 miles when running on operating profile.

5.3.5 Brake Adjustment
Disc brakes shall not require in-service adjustment and have brake wear mechanical indicators for lining thickness on each brake assembly.

5.3.6 Parking Brake
The parking brake shall be spring applied and air released, controlled by manual valve (Bendix or approved equal) and shall be mounted on the left side of the driver's seat. The design and location shall be approves by SFMTA.

The parking brake system shall hold the coach loaded to GVWR in both forward and rearward directions on a 23 percent grade, and shall be capable of locking the braked wheels on a surface with a skid number of .75 at speeds up to 20 mph. This brake shall comply with FMVSS-121 requirements. A separate "Parking Brake Applied" (Reference Section 4.1.3, Indicators) indicator with audible alarm shall be provided on the panel and it shall:

- Activate an interior audible warning alarm and blinking warning lights if the parking brake is not applied and the Master Run Switch is set to the "Off" position.
- Illuminate the "Parking Brake Applied" indicator upon activation of the control.

5.3.7 Anti-Lock Braking System with Traction Control
The coach shall be equipped with all wheel anti-lock braking system (ABS) with Traction Control by Rockwell, Wabco or approved equal. The Contractor shall provide complete performance data and system design of the brake system with ABS. The design shall be approved by SFMTA. ABS brake diagnostic cartridge, if required, shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List). All essential information and equipment needed to test, troubleshoot, and repair the brake system controller shall be provided to SFMTA by the contractor. This information and equipment shall encompass the system on the coach

and the repair of the individual sub-assemblies down to the components on the printed circuit boards of the sub-assemblies.

5.3.8 Hill Holder

An automatic hill holder system incorporated in the propulsion system shall be provided. A conventional hill holder system shall be incorporated in to the braking system. If configured for manual operation, control of the hill holder shall be a spring-loaded, guarded switch, which is normally "off" located to the left of the operator. Activation of the switch shall engage the same rear service brake system as the interlock system described in 4.1.4.2, Interlock. Regardless of whether the hill holder is configured for automatic or manual operation, accelerator operation shall not be affected by activation of the hill holder. Activation of the hill holder shall light the brake lamps and prevent roll back.

5.3.9 Brake Jerk

Jerk, the rate of change of acceleration measured at the centerline, floor level of the coach shall be minimized throughout acceleration and regenerative braking or other methodologies of auxiliary braking and shall be no greater than 0.3 g/sec. for duration of a quarter-second or more.

5.4 REGENERATIVE BRAKING

Energy regeneration shall not cause the driver to lose control of the coach regardless of the surface coefficient (μ) that the coach is being operated on. Total brake rate shall be 3.5 mphps or otherwise approved by SFMTA.

Braking effort derived from energy regeneration or dynamic braking shall be blended with the standard air brake system such that the braking response of the vehicle is similar to that of a conventional diesel coach and requires no additional driver skill or training to operate than a conventional diesel coach. The regenerative brake controller shall be a full range control. Stepping controls are not permitted.

Regenerative braking force shall remain consistent and predictable to the operator. The system shall be designed in a manner to effectively dissipate excess energy while providing consistent auxiliary braking.

5.5 AIR SYSTEM

The coach air system shall operate all accessories and the braking system with reserve capacity. New coach shall not leak down more than five (5) psi as indicated on the instrument panel mounted air gauges, within 15 minutes from the point of governor cut-off. Air for the compressor shall be filtered through the main engine air cleaner system. The air system shall be equipped with check valve and pressure protection relief valve set at 150 psi to assure partial operation in case of line failures. Load and demand calculations shall be submitted to SFMTA for approval.

Provision shall be made to apply shop air to the coach air systems through Amflo CP2 female charging port or approved equal. These valves shall be conveniently located in the engine compartment, behind the front bumper, and just inside the front door and shall mount into a 3/8 –NPT fitting. Final locations of the valves shall be approved by SFMTA during prototype review.

5.5.1 Air Compressor

The air compressor shall be scroll type oilless compressor Powerex, model # SBS0507M or approved equal. The air compressor shall have the capacity to charge the air system from 40 psi to the governor cutoff pressure in less than three (3) minutes. The compressor output rating shall be dependent on the manufacturer's calculations of the required volumes necessary for normal transit operation including but not limited to braking, door operation, air suspension and all other components requiring pneumatic power. This calculation shall be presented and explained to SFMTA for approval during prototype review.

5.5.2 Air Lines and Fittings

Air lines, except necessary flexible lines, shall conform to the installation and material requirements of SAE Standard J1149 for copper tubing with standard brass flared or ball-sleeve fittings, or SAE Standard J844 for nylon tubing. The routing shall preclude the nylon tubing from being subjected to temperatures over 200°F. Air lines shall be cleaned and blown out before installation and shall be installed to minimize air leaks. All air lines shall be sloped toward a reservoir and routed to prevent water traps. Nylon tubing shall be installed in accordance with the following standard color coding:

TABLE 5.5.2

GREEN	Primary brakes and supply
RED	Secondary brakes
BROWN	Parking brake
YELLOW	Compressor governor signal
BLACK	Accessories

Nylon lines may be grouped and shall be continuously supported and prevented from any movement, flexing, tension strain, and vibration. Copper lines shall be supported by looms at intervals of no more than five (5) feet to prevent movement, flexing, tension strain, and vibration. Copper lines shall be prevented from touching one another or any component in the coach. To the extent practicable and before installation, the copper lines shall be pre-formed on a fixture that prevents tube flattening or excessive local strain. Copper lines shall be bent only once at any point, including pre-bending and installation, to avoid fatigue of the tubing.

Flexible hoses shall be as short as practicable and individually supported. They shall not touch one another or any part of the coach except for the supporting grommets. Flexible lines shall be supported at two (2) foot intervals or less. Grommets for bulkhead fittings shall protect the air lines at all points where they pass through under structure components.

The compressor discharge line between the air compressor and the bulkhead shall be flexible convoluted copper or flexible Teflon hose with a braided stainless steel jacket. The line between the bulkhead and the air dryer shall be rigid copper. These lines shall have a minimum inside diameter of one (1) inch. End fittings shall be standard SAE or JIC brass or steel flanged, reusable, swivel-type fittings.

All hoses and lines shall contain adequate separation to ensure no contact between lines.

5.5.3 Air Reservoirs

Air reservoir tanks shall supply air for the vehicle's air suspension system, windshield wipers, door operating mechanism and brake system. These air tanks can be mounted in the ceiling behind the interior LED lights, easily accessible for inspection and maintenance. The number of

tanks required with a 25% reserve, sizes, mounting and final locations shall be approved by SFMTA.

All air reservoirs shall meet the requirements of FMVSS Standard 121 and SAE Standard J10 and shall be equipped with clean-out plugs and guarded or flush type drain valves. The primary reservoir shall be equipped with an S.A.B. Auto Drain valve without heater, as well as a manual valve. Major structural members shall be provided to protect these valves from road hazards. Reservoirs shall be sloped toward the drain valve.

5.5.4 Air Dryer

A Graham White "SludgeBraker" Air Dryer, or approved equal, shall meet the following salient characteristics:

1) Dryer shall be sized for the air system volume and compressor capacity
2) Continuous flow capacity based on continuous inlet temperatures of 200*F
3) Twin tower desiccant style dryer capable of switching towers for regeneration
4) Dryer shall have an ambient operating temperature range from –40*F to 150*F
5) Dryer shall have a filtration package that conditions the air before the towers. This includes a pre-filter for bulk carbon, oil and water removal and a coalescing filter with a 99.9% efficiency rating in addition to removal of water and oil aerosols down to .03 micron, and dirt and carbon down to .3 micron.
6) An automatic discharge for accumulated contaminants.

5.6 HYBRID FUEL SYSTEM

All fuel system components shall be designed to be used with diesel fuels currently being distributed in California. SFMTA currently uses B20 Bio-Diesel and desires to move to B100 eventually. All fuel lines, connectors, and system components shall be marine grade or approved equal in order to be compatible with modern alternative diesel fuels.

5.6.1 Fuel Tank

The fuel tank shall be securely mounted with anti-squeak strips to prevent movement during coach maneuvers, but shall be capable of being removed and reinstalled by a 4M mechanic for cleaning or replacement in 4 hours or less. Fuel tank capacity shall meet the operating range specified in Section 6.2.7, Operating Range. The fuel tank shall be equipped with an external hex-head brass drain plug. The drain plug shall be at least 1-3/8 inch in size and shall be located at the lowest point of the tank. The tank shall have an inspection plate or removable filler neck to permit cleaning and inspection without its removal. The fuel tank shall be constructed of stainless steel.

The tank shall be baffled internally to prevent fuel-sloshing noise regardless of fill level. The baffles and fuel pick-up location shall assure continuous full power operation on a 16 percent upgrade for 15 minutes, starting with no more than 25 gallons of fuel over the unusable amount in the tank. The underside of the tank shall be protected from damage caused by road debris. The coach shall operate at idle on a six (6) percent downgrade for 30 minutes, starting with no more than 10 gallons of fuel over the unusable amount in the tank. Design and location shall be approved by SFMTA.

5.6.2 Fuel Filler

The fuel filler shall be Emco Wheaton Posi/SnapCap, Envirotech, or approved equal. It shall be provided approximately 18 feet behind the front edge of the front bumper on the curbside of the coach. The filler shall accommodate a 1½-inch diameter nozzle and a fill rate of 40 gallons per minute without spitting back or causing the nozzle to shut off before the tank is full. The fuel filler neck shall be a straight pipe mounted at an angle of 45 degrees. An audible signal shall indicate when the tank is essentially full. The fuel lines forward of the engine bulkhead shall be in conformance to SAE Standard J1149-Type 1 for copper tubing or SAE Standard J844 for nylon tubing, which shall be color-coded orange.

5.6.3 Fuel Control

Any control mechanisms for automatic shut-off of the fuel system shall be subject to SFMTA approval.

5.7 HYDRAULIC SYSTEM

All hydraulic systems shall demonstrate a mean time between repairs in excess of 50,000 miles. Hydraulic system service tasks shall be minimized, and scheduled no more frequently than those of other major coach systems. All elements of the hydraulic system shall be easily accessible for service or unit replacement. A priority system shall prevent the loss of power steering during operation of the coach if other devices are powered by the same hydraulic system.

Filtering shall be provided as recommended by the manufacturers of the hydraulically powered units. Spin-on filters are preferred. Filters shall be provided to protect the hydraulic systems down to 10-micron from contamination. Indicators on the reservoirs shall allow visual detection of low hydraulic fluid level. Permanent diagnostic quick-coupler ports, or approved equal, shall be installed at all locations necessary to provide complete troubleshooting of all hydraulic systems. Filtering system shall be approved by SFMTA.

5.7.1 Hydraulic Lines

Flexible lines shall be minimized in quantity and length. Necessary flexible hydraulic lines shall be Aeroquip 2807 except where the radii of the lines exceed the performance of the Aeroquip 2807 line. In those instances, Aeroquip FC 350 with replaceable ends will be permitted. Lines of the same size and with the same fittings as those on other piping systems of the coach, but interchangeable, shall be tagged or marked for use on the hydraulic systems only. It shall not be possible to connect the input lines to the output lines.

Hydraulic lines shall be individually and rigidly supported to prevent chafing damage, fatigue failures, and tension strain on the lines and fittings. Underbody lines shall be 304 stainless steel, rigidly mounted and routed separate from all other lines. Rigid tubing lines shall be continuous from the forward most bulkhead or cross member to rearmost bulkhead or cross member. Welded unions shall be permitted at maximum intervals of 20 feet for lines longer than 20 feet.

5.8 FLUID LINES

Fuel and oil lines within the engine compartment shall be rigidly and independently supported and shall be composed of steel tubing, where practicable. Flexible fluid lines shall be kept at a minimum and shall be as short as practicable. They shall be routed or shielded so that failure of a line shall not allow fuel or oil to spray or drain onto any component operable above the flash

point of the fluid. Flexible lines shall be Teflon hoses with braided stainless steel jackets, except in applications where premium hoses are required, and shall have standard SAE or JIC brass or steel reusable swivel end fittings. Hoses shall be individually supported and shall not touch one another or any part of the coach. The fuel suction line shall be equipped with a check valve to aid restarting after fuel filter changes. High-pressure hydraulic lines shall be Aeroquip FC395, Aeroquip FC300, or approved equal.

5.9 WHEELS AND TIRES

5.9.1 Wheels

Wheels and rims shall be hub piloted and shall be aluminum one piece, Alcoa Dura-Brite or approved equal. All wheels shall be machine finished and stamped with the following markings a) unique serial number, b) “Property of SFMTA on a non-stressed area. All wheels shall be interchangeable and shall be removable without a puller. Wheels shall be compatible with tires in size and load-carrying capacity. Front wheels and tires shall be spin balanced as an assembly utilizing weights specifically designed for aluminum wheels with disk-lock non-loosening fasteners. Contractor shall provide one (1) spare wheel per coach delivered, upon delivery of coach.

5.9.2 Tires

Transit-type tires, leased by SFMTA, will be furnished to the Contractor by SFMTA. Arrangements will be made for tire delivery directly to the Contractor's plant. The Contractor shall mount and balance these tires and shall pay any transportation, duty, or other charges. The Contractor shall provide "plain" valve stem caps with each mounted tire. No valve stem tool will be permitted on the valve stem cap. Current SFMTA Fleet equipped with Firestone 12R22.5 H City Transport Radial Model 281-611. Tires shall have a external air pressure monitoring system.

5.10 ELECTRONIC ODOMETER DATA RECORDER

Each coach shall be supplied with a bus-mounted data recorder unit or approved equal. The bus-mounted data recorder unit shall be suitable for mounting on the coach and connect directly to a J1708/1939 connector on the coach. Bus-mounted data recorders shall be programmable with vehicle number and codes for defining the set of data to be provided to allow for re-program the recorder unit at any time. The recorder shall be programmed to respond to a beacon signal sent from a Receiver Unit and upon receipt of such beacon signal; the recorder shall transmit via radio frequency the bus number and other defined data to the Receiver Unit. The bus-mounted data recorder unit shall be compatible with existing SFMTA system. The contractor is required to submit for SFMTA approval during design review.

The contractor shall provide equipment needed to test, troubleshoot and repair the bus-mounted data recorder in accordance with ATTACHMENT 13: Special Tools List.

5.11 FIRE DETECTION / SUPPRESSION

Contractor shall furnish and install fully automatic fire detection and complete dry chemical fire suppression system manufactured by Dual Spectrum, Ansul, Amerex, or approved equal.

The automatic detection and activation system shall provide twenty-four (24) hour fire protection for the engine compartment and areas of the coach to be wetted by leaking flammable fluids, including the articulation joint area The system shall also provide both a manual and automatic

means to pneumatically actuate the fire suppression system. The location of the manual actuation switch shall be approved by SFMTA. Fire suppression system testing kit, if required, shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

The system shall have a 30 pounds dry chemical agent or a 22 pounds purple “K” storage tank and an external expellant gas tank. Upon actuation of the system, pressurized gas shall be released from the expellant gas tank to pressurize and fluidize the dry chemical and propel it out to the hazardous area. Two or more linear detection wires shall be installed in the coach. Install sensor with audible alarm to detect approaching combustion range in the catalytic convertor department The system shall monitor the heat levels and activate an overheat warning light in the driver’s compartment without discharging the fire extinguisher, when the temperature returns to normal the overheated alarm shall be deactivated. Also provide appropriate status and warning lights on the driver’s dashboard and audible fire detection warning. This alarm shall sound in both fire and fault conditions. The system shall be false alarm immune from sunlight, flashlight, lightning (excluding a direct hit) and welding arc. The sensor shall have a suppression monitor to determine that each individual component is correctly installed. The system control module shall be fully programmable via laptop computer or PC. Programming features shall include at least the time delay cycles from fire detection to vehicle shutdown and from vehicle shutdown to fire suppression system actuation. If a fire is detected, the detection/suppression system shall automatically:

- Activate an audible warning alarm and warning lights.
- Shut off and close off the ventilation system.
- Shut off the engine fan.
- Shut off the flow of hydraulic fluids.
- Reduce engine power to slow the coach.
- Flood the engine with sufficient dry chemical agent to extinguish the fire when either the vehicle speed falls below 15 mph or after certain time delay, adjustable between zero (0) and 15 seconds
- Sufficient dry chemical agent to extinguish fire within the articulated joint section

6 HYBRID COACH PROPULSION SYSTEM

6.1 PROPULSION SYSTEM DESCRIPTION

The coach shall be powered by a hybrid-electric diesel propulsion system. Function and operation of the coach shall be transparent to the Coach Operator and passengers. The prime contractor shall assure that the coach structure can successfully accept the installation of the propulsion system and be operated on a San Francisco duty-cycle for a period of 12 years without a structural failure. At a minimum, APU shall comply with CCR, Title 13, section 1956.1 for both emissions and useful life requirements. The engine shall comply with 40 CFR section 86.094-25 (maintenance) and other applicable sections. The engine shall meet all requirements of the Technical Specifications. Durability of the engine and its components shall not be reduced and the performance requirements shall be met by operation on commercially available B100 fuel.

6.2 PROPULSION SYSTEM SERVICE

The propulsion system shall be arranged so that accessibility for all routine maintenance is assured. No special tools, other than dollies and hoists, shall be required to remove the APU or any subsystems. Two 4M Mechanics shall be able to remove, replace, and prepare the engine for service in less than 20 total combined man-hours. The exhaust system, air cleaner, air compressor, alternator, radiator, all engine accessories, and any other component requiring service or replacement shall be easily removable. Contractor shall provide all special tools and diagnostic equipment required for maintaining the Propulsion System in accordance with ATTACHMENT 13: Special Tools List.

6.2.1 APU GENERATOR AND TRACTION MOTOR

The engine generator and traction motor may be configured in a variety of methods dependent upon type of drive, series or parallel. The definition of motor in the context of this specification assumes the devices can provide or consume electrical energy as well as either can provide or retard mechanical motion. An independent fresh air plenum is required for providing air to the generator.

6.2.2 Energy Storage and Controller

The energy storage system shall include a voltage equalization system designed to provide automatic real-time equalization of voltage between individual energy storage devices within each module. Design and performance shall be approved by SFMTA. Energy storage shall be of a commercial design capable of operating in the San Francisco transit environment. Charging of the energy storage device shall be accomplished by on-board engine-generator and regenerative braking.

In the event external, stationary chargers are required, Contractor shall provide chargers and all special tools required for maintaining this requirement in accordance with ATTACHMENT 13: Special Tools List.

6.2.3 Propulsion Controller

The hybrid system controller shall monitor system inputs and execute outputs as appropriate to control the operation of all hybrid devices. This controller may include or directly control power electronics necessary for operation of the engine, generator, traction motor, energy storage and other related hybrid devices. The controller shall be capable of storing multiple (minimum 3)

configuration/calibration files in an effort to facilitate optimizing drive parameters to a variety of route profiles. The configuration default file shall be based upon operator route selection via destination sign code and further optimization "on the fly" by toggling between parameters in an effort to optimize via changing route duty cycle profiles.

6.2.4 Top Speed

The hybrid coach shall be capable of a top speed of 63 mph on a straight, level road at GVWR with all accessories operating (Reference Section 1.3, PROPULSION SYSTEM PERFORMANCE).

6.2.5 Gradability

Gradability requirements shall be met on grades with a dry commercial asphalt or concrete pavement (Reference Section 1.3, PROPULSION SYSTEM PERFORMANCE).

6.2.6 Acceleration

The minimum acceleration requirements are given in Section 1.3, PROPULSION SYSTEM PERFORMANCE).

6.2.7 Operating Range

The operating range of the coach in revenue service or equivalent operating cycle shall be in excess of 400 miles on a full tank of fuel (example: operating on the 38 GEARY).

6.3 HYBRID SYSTEM

Coaches shall have a Hybrid System unit, designed to last the life of the coach, which, coordinated with the engine and the rear axle drive ratio, enables the vehicle to achieve the required top speed, acceleration and hill climbing capability while still maintaining passenger comfort and providing a smooth ride. Hybrid System input torque rating shall exceed engine output torque. The Hybrid System shall be rated to operate at a minimum of the GVWR of the coach.

6.4 ENGINE

The coach shall be powered by an engine to meet or exceed the performance requirements of this specification for the strenuous service requirements of public transportation in San Francisco. The engine should be optimized for use in the Hybrid System arrangement as well as in the areas of reliability, emissions, audible noise, and vibration.

- The engine shall have diagnostic capability via a laptop computer. Remote communication is encouraged (Reference Section 9.3, VEHICLE SUB-SYSTEMS INTEGRATION AND DIAGNOSTIC TESTING REQUIREMENTS).
- Piping or hoses containing fuel, oil, or other flammable liquid shall not be routed through wheel housings or bundled with electric wires.
- Contractor shall provide all special tools required for maintaining and rebuilding the engine in accordance with ATTACHMENT 13: Special Tools List.
- An engine oil pressure gauge and coolant temperature gauge shall be provided in the engine compartment for ease of maintenance.
- "Check engine" and "stop engine" lights and an audible alarm shall be provided at the operator's dashboard area.

- The ECM shall be capable of being programmed for shut down in the event of extended idle periods. SFMTA will supply the coach manufacturer the time in minutes, which shall be programmed in the ECM to shut the engine off after extended idle.

6.4.1 Emissions

The coach shall meet or exceed all appropriate emission standards for use in transit service in the State of California, according to date of delivery, including any special circumstances requiring alternative regulatory compliance and/or testing. Complete vehicle or systems certification documentation shall be provided to SFMTA, based on the CCR, Title 13, section 1956.1. This documentation will specify the role and regulatory responsibilities of the coach manufacturer and subsystem manufacturer(s). Any requirements must be approved by SFMTA. Responsibility for all emissions and useful life requirements shall be born by the coach manufacturer or subsystem manufacturer(s) unless specifically detailed in the compliance plan and approved by SFMTA.

Contractor shall provide a CARB approved exhaust emission control system. The exhaust outlet shall be roof mounted and not increase the overall height of the coach. Exhaust gases and waste heat shall not be discharged on the curbside and shall be directed vertically away from the coach. Termination of the exhaust pipe shall comply with FMVSS 108. Regeneration shall be approved by SFMTA.

6.4.2 Engine Firewall

A fireproof bulkhead (firewall) shall separate the passenger and engine compartments; the bulkhead shall preclude or retard propagation of an engine compartment fire into the passenger compartment. Any passageways for the climate control system air shall be automatically separated from the engine compartment by fireproof material when a fire is detected. All piping, connectors, fittings, engine access panels, fasteners shall be fabricated of fireproof material. These panels, their fasteners, and the firewall shall be constructed and reinforced to minimize warping that would compromise the integrity of the firewall during a fire.

6.4.3 Mounting

All propulsion system mountings shall be mechanically isolated to minimize transfer of vibration to the body structure and mounted in a failsafe manner that eliminates the opportunity for a catastrophic failure in the event of a structural failure. No special tools, other than dollies and hoists, shall be required to remove the APU sub-systems. Two 4M mechanics shall be able to remove, replace, and prepare the engine, traction motor and traction generator assembly for service in less than 30 total combined hours. Such an installation shall incorporate quick-disconnects for wiring, piping, and all mounting hardware for ease of removal.

6.4.4 Engine Protection

All components specified within this section shall be housed within a weatherproof box. The engine shall be protected by an electronic control system recommended by the engine and Hybrid System manufacturers.

The Engine Control Module (ECM) shall be equipped with self-diagnostic system as well as engine system protection and engine performance diagnostic as a minimum. The ECM shall retain/record an engine failure and which can be uploaded to a PC, laptop, or a diagnostic reader (D.R.) for evaluation/analysis. Two (2) D.R. plug-ins shall be provided for the D.R., one shall be at the operator's dashboard and the second shall be at the engine run control box.

Locations shall be approved by SFMTA. Both plugs shall be permanently affixed to the coach for ease of plug-in. The option to include remote diagnostic communication is encouraged. All coaches shall complete all ECM programming prior to delivery.

6.4.5 Propulsion System Interlocks

The electronic foot pedal accelerator shall be interlocked (disabled) when:

- Any door of the coach is activated by the operator door control (4.1.4.2 Interlock)
- The coach kneeling system is activated
- The wheelchair ramp is activated, not stowed and locked completely or as indicated by Federal or California State Regulations.
- Propulsion system interlock arrangement and control shall be approved by SFMTA.

6.4.6 Engine Override Button

If the propulsion system cannot operate without the engine running, a stop engine override button will be provided, which enables the operator to receive 30 seconds warning that an engine failure has been sensed and that engine shutdown will occur. If the operator needs additional time the override system shall be capable of operating at least a second time after this. The override system shall be reset within 30 minutes. This override (with cover) shall incorporate a momentary switch that shall automatically return to the off position when released, or approved equal.

SFMTA prefers that the vehicle be capable of returning (without passengers) to a coach maintenance division without the use of an engine. The ability for the vehicle to operate in engine-off mode shall be appropriately optimized and subject to SFMTA approval.

6.4.7 Starter

The starting switch shall be controlled by an electric push button and shall only be activated when the Master Run Switch is in the on position. If a conventional engine starter is used, SFMTA requires an electric starter system; the starter shall have a pre-engaged drive, which will engage into the ring gear before the motor begins to turn. The electric start system shall be warranted for three (3) years or 150,000 miles. All mounting and cables locations shall be approved by SFMTA.

6.4.8 Lubrication

The manufacturer shall install a "Probalyzer", or approved equal, mini gauge oil sampling system on the engine. Location shall be approved by SFMTA.

6.4.9 Cooling System

The cooling system shall be lead free and shall operate using water-based fluids only. The cooling system shall be designed to maintain the radiator top tank inlet temperature below 205°F under the following combined-circumstances: a) the coach loaded to GVWR and ambient temperature up to 115°F, b) Maximum heat rejected from the engine, traction motor and traction generator, and all other liquid cooled subsystems, c) The radiator is 15% clogged. The pressure type cooling system shall not permit boiling or coolant loss during the operations described above. The Contractor shall submit an analysis verifying cooling system capabilities to SFMTA. Design and locations shall be approved by SFMTA. The cooling system shall include but not be limited to the following requirements:

- Engine thermostats shall be easily accessible for replacement.
- Equipped with a properly sized water filter with a spin-on, disposable, borate element filter.
- All shutoff valves shall be ¼ turn
- Filter replacement without coolant loss.
- Valves shall permit complete shutoff of lines for both the heating and defroster units.
- All low points in the water-based cooling system shall be equipped with drain cocks.
- All high points in the cooling system shall be vented to the surge tank.
- If an air to air after cooler is required, SFMTA specifies a side by side with the radiator design.
- The cooling system shall be filled with an approved non-ethylene-glycol rust inhibitor approved by the engine manufacturer.

- Coolant to be specified by SFMTA.

If climatic conditions require shipping coaches with ethylene-glycol-based antifreeze, the Contractor shall, off SFMTA property and prior to delivery, legally dispose of the antifreeze and replace it with the specified fluid.

The coach manufacturer shall test the design of the cooling system insuring it meets the requirements of the engine manufacturer for cooling capabilities along with de-aeration and maintainability of the system. SFMTA requires the engine manufacturer provide representation during the testing and documentation of the prototype coach. This installation and cooling system documentation should be reviewed and approved by the engine manufacturers engineering staff prior to manufacture of the first production coach.

6.4.9.1 Radiator

Radiator shall be EMP cooling system with full diagnostic capabilities, or approved equal. Drain cock location shall be such so that it will not sustain damage by road hazards while being easily accessible by a mechanic.

Radiator top and bottom brass (stress relieved) or stainless steel tanks shall be bolted using one-piece gaskets and finish with high heat prime & enamel paint. The radiator shall be of durable corrosion-resistant construction. An identification tag with the manufacturer's name, part number, and date of manufacture must be soldered to the face of the radiator core

Radiator piping shall be seamless stainless steel or brass tubing, and hoses if absolutely necessary shall be silicone. A tight fit between fins and tubes are required, zero clearance between the outer wall of the tube and elongated fin holes.

6.4.9.2 Surge Tank

A stainless steel surge tank with a sight glass shall be mounted above the radiator. The surge tank shall include a manual pressure relief valve, an automatic cooling system pressure control system, coolant filler, a low coolant sensor, and provisions for adequate de-aeration of the cooling system. A spring-loaded, push-button type valve to safely release pressure or vacuum in the cooling system shall be provided. The sight glass, coolant fill location, and the valve shall be accessible and clearly visible from the exterior of the coach through a separate access door without opening the main engine compartment door. The bottom of the surge tank shall be above all of the rest of the cooling system. The surge tank shall be certified by the engine manufacture.

6.4.9.3 Cooling Fan
A thermostatically controlled electric cooling fan shall be installed. The cooling fan and control system are subject to SFMTA review and approval.

6.4.9.4 Cooling System and Charge Air Hoses
Hoses shall be premium silicone-rubber type, impervious to all coach fluids. Hoses shall be secured with heavy- duty Oetiker clamps, Breeze, or approved equal, with one (1) or two (2) clamps per connection.

6.4.10 Engine Piping
Stainless steel piping shall be provided throughout the cooling and exhaust system. Aluminized steel piping shall be provided throughout the air intake charger system. All piping shall have adequate separation so as to not have chaffing or rubbing.

6.4.11 Service
The muffler, exhaust system, air cleaner, air compressor, starter (if used), alternator, radiator, cooling system surge tank, all accessories, and any other component requiring service or replacement shall be identified at the design review. Each coach shall be designed to facilitate the disassembly, re-assembly, servicing or maintenance by use of tools and items, which are normally available as commercial standard items. Any special tools must have the approval of SFMTA.

6.4.11.1 Fillers
Engine oil and coolant filler caps shall be hinged to the filler neck and closed with spring pressure or positive locks. All filler locations shall be approved by SFMTA and they shall be properly labeled. All fillers shall be accessible with standard funnels, pour spouts, and automatic dispensing equipment. All lubricant sumps shall be fitted with Femco Dripless Drain Plug or approved equal.

6.4.11.2 Filters
The engine, traction motor and traction generator shall be equipped with sufficient heavy-duty fuel and oil filters for efficient operation and for engine, traction motor and traction generator protection between scheduled filter changes. The filters shall be of the spin-on, disposable type. All filters shall be easily accessible and the filter bases shall be plumbed to assure correct reinstallation. The secondary fuel filter housing shall be fitted with a pipe plug to check the fuel pressure. The plug shall have an external hex head of standard size.

The engine air intake shall be equipped with a dry type air filter. The filter and housing shall be sized to meet the engine manufacturers recommendations for air volume in CFM. The housing shall have a one-way vented port to allow for the drain of moisture. The housing shall be isolator mounted and utilize a minimal amount of bends and angles either on the inlet or outlet hose and piping. A manually re-settable filter restriction gauge shall be mounted per the engine manufacturers recommendations in the delivery pipe. The pipe shall have a threaded boss welded in to accommodate the replacement of the threaded indicator.

The engine coolant system will have a coolant filter meeting the requirements of the engine manufacturer.

6.4.12 Accessories

Wherever appropriate, all engine-driven accessories shall be gear-driven, without adapters, directly from the engine and shall be unit-mounted for quick removal and repair. Accessory drive systems shall operate without failure or unscheduled adjustment for 50,000 miles. These accessories shall be driven at speeds sufficient to assure adequate system performance during extended periods of idle and low route speeds typical of SFMTA operation. Belt guards shall be provided for all belts.

6.5 DRIVE SHAFT

The drive shaft and universal joints shall be heavy-duty type. The drive shaft shall be guarded to prevent it from striking the floor of the coach or the ground in the event of a tube or universal joint failure. Universal joints and drive shaft slip joints shall have separate grease fitting accessible by a standard grease gun. The drive shaft assembly, mounting and components are required to be approved by SFMTA.

6.6 GEAR RATIO

The gear ratio shall provide the coach with the ability to maximize acceleration and climbing while still maintaining the ability to achieve the maximum specified speed and meets the performance of these specifications (Reference Section 1.3, PROPULSION SYSTEM PERFORMANCE). The final drive gear ratio requires SFMTA review and approval.

6.7 HEAT EXCHANGER

The traction motor and traction generator shall have an external, rebuildable, heat exchanger that utilizes coolant from the engine cooling system. The heat exchanger shall have removable ends, and shall be located in an accident-free area.

In the event the traction motor or generator is air-cooled, the cooling system ductwork, fans, filtration and control shall be constructed meeting the OEM motors recommendations.

6.8 LUBRICATION

Traction motor and traction generator shall have an oil sampling device compatible with the Probalyzer system or approved equal. The location of the sampling plug requires SFMTA review and approval.

7 ELECTRICAL

The coach shall be equipped with a Programmable Logic Control (PLC) system that is computer based and completely modular. All electrical components or equipment shall comply with all the following subsections.

7.1 POWER REQUIREMENT

The electrical power system shall supply a nominal 12 and 24 volts of direct current (DC). Consumable items such as, but not limited to, light bulbs and headlamps shall be supplied at a nominal 12 volts DC. An isolated and dedicated control circuit and an isolated and dedicated line feed circuit with a continuous load rating of at least 150% of the engine and propulsion system control system current demand shall be provided. Precautions shall be taken to minimize hazards to service personnel. The power-generating system shall 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.

7.2 CIRCUIT PROTECTION

Manual reset circuit breakers or fuses shall protect all circuits, except for those involved in propulsion system start-up. Fuses shall be used only where it can be demonstrated that circuit breakers are not practicable, and they shall be easily accessible for replacement. All fuses and circuit breakers shall be easily accessible for replacement or reset by being located in areas where special equipment (ladder or hoist) is not required for service or reset. . Precautions shall be taken to minimize hazards to service personnel. All manual reset circuit breakers shall provide visual trip indicators and manual on/off trip functions to aid in isolating circuits for troubleshooting.

All circuits and circuit branches (except starter solenoid, headlamp and battery 12 & 24-volt feeds to the driver's apparatus panel) shall be protected by manual reset circuit breakers. Manual reset circuit breakers that are critical to the operation of the coach shall be mounted with visible indication of open circuits. The exceptions shall be protected by automatic reset circuit breakers. All wire shall be rated as high as the protection (circuit breaker) for that circuit. Circuit breaker connections shall be crimped and soldered on both sides of the breaker -- rosin core electrical solder shall be used. All high voltage control (600 VDC) and power (1000 VDC) wiring shall have insulation protection rated for utilization in environments up to 125 degrees C.

7.3 GROUNDING

Redundant grounds shall 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 coach body and framing. Grounds shall not be carried through water piping, hinges, bolted joints (except those specifically designed as electrical connectors). Electrical equipment shall not be located in an environment that will reduce the performance or shorten the life of the component or electrical system. Major wiring harnesses shall not be located under the coach floor, and under-floor wiring shall be eliminated to the extent practicable. Wiring and electrical equipment necessarily located under the coach shall be insulated from water, heat, corrosion, and mechanical damage, and shall be contained in sealed conduit. Insulation of grounds shall in no way conflict with other vehicular operations.

7.4 SHIELDING

All wiring that requires shielding shall meet the following minimum requirements. A shield shall be generated by connecting to a ground, which is sourced from a power distribution coach bar or chassis. A shield shall be connected at one location only, typically at one end of the cable. However certain standards or special requirements, such as SAE J1939 or RF applications, have separate shielding techniques that shall also be used as applicable. Note: A shield grounded at both ends forms a ground loop, which can cause intermittent control or faults. When using shielded or coaxial cable, upon stripping of the insulation, the metallic braid shall be free from frayed strands, which can penetrate the insulation of the inner wires. To prevent the introduction of noise, the shield shall not be connected to the common side of a logic circuit.

7.5 ELECTRICAL COMPONENTS

All electrical components, including switches, relays, flashers, and circuit breakers, shall be heavy-duty designs. These components shall be longest lasting commercially available designed to last the service life of the coach and shall be replaceable in less than 5 minutes by a 4M mechanic. Any manual - reset circuit breaker critical to the operation of the coach shall be mounted in a location convenient to the operator and provide visible indication of open circuits. All electric motors, except cranking motors, shall be heavy-duty brushless type, with a constant duty rating of no less than 240,000 hours. Electric motors shall be located for easy replacement and except for the cranking motor shall be replaceable in less than 15 minutes by a 4M mechanic. Electronic circuit protection for the cranking motor shall be provided to protect engaging of the motor for more than 30 seconds at a time.

7.6 MODULAR DESIGN

Design of the electrical system shall be modular so that a major component, apparatus panel, or wiring bundle is easily separable with standard hand tools or by means of connectors. Each module, except the main body wiring harness, shall be removable and replaceable in less than 30 minutes by a 4M mechanic. Power plant wiring shall be an independent wiring module. Replacement of the engine compartment wiring module(s) shall not require pulling wires through any bulkhead or removing any terminals from the wires.

7.7 WIRING, TERMINALS

All lamp sockets shall be of two-wire design with Cannon-Shearson or equal disconnects to eliminate corrosion or ground problems. To facilitate servicing, all lamp wires shall have leaders of at least six (6) inches.

All wiring between major electrical components and terminations, shall have double electrical insulation, shall be waterproof, and shall conform to specification requirements of SAE Recommended Practice J1127 and J1128. Except as interrupted by the master battery disconnect switch, battery and starter wiring shall be continuous cables grouped numbered and/or color-coded with connections secured by bolted terminals, and shall conform to specification requirement of SAE Standard J1127-Type SGT or SGX and SAE recommended Practice J541. SFMTA prefers that a minimum of eight (8) colors be used and that no one color be repeated within a single harness. Wiring numbers shall be hot-stamped every six (6) inches. Installation shall permit ease of replacement. All wiring harnesses over five (5) feet long and containing at least five (5) wires shall include 15% excess wires for spares that are the same size as the largest wire in the harness, excluding the battery cables. Wiring harnesses shall 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. Ground harnesses, except for battery cables, shall be neutral or off-white in color.

Double insulation shall be maintained as close to the terminals as possible. The requirement for double insulation shall be met by sheathing all wires and harnesses with nonconductive rigid or flexible conduit. Strain-relief fittings shall be provided at points where wiring enters all electrical components. Grommets of elastomeric material shall be provided at points where wiring penetrates metal structure outside of electrical enclosures. Any clamps used throughout the electrical system shall be stainless steel and of aircraft-type quality and shall be "dipped". Wiring supports shall be nonconductive. Precautions shall be taken to avoid damage from heat, water, solvents, or chafing. Wiring length shall allow replacement of end terminals twice without pulling, stretching, or replacing the wire. Except for large wires such as battery cables, terminals shall 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 shall be corrosion-resistant 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, 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. Connectors shall be common, weather pack, AMP or Ameriline, aircraft quality, self-aligning, or approved equal.

7.8 JUNCTION BOXES

All relays, controllers, flashers, circuit breakers, and other electrical components shall be grouped according to voltage and mounted in easily accessible junction boxes. The boxes shall be sealed to prevent moisture from normal sources, including engine compartment cleaning, from reaching the electrical components and shall prevent what may occur inside the box from propagating outside the box. The components and circuits in each box shall be identified and their locations shall be permanently recorded on a schematic drawing glued to or printed on the inside of the box cover or door. The drawing shall be protected from oil, grease, fuel, and abrasion. The front junction box shall be completely serviceable from the street side exterior of the coach, or from inside the header over the operator's seat. It shall be replaceable as a unit in less than 15 minutes by a single 4M mechanic. A rear start and run control box shall be mounted in an accessible location in the engine compartment. The run control box shall contain: 1) a starter pushbutton, 2) engine oil pressure gauge, 3) traction motor oil temperature gauge, 4) traction generator oil temperature gauge 5) coolant temp gauge, 6) sealed, coach data port connector, 7) ignition switch (front/rear/disable options). The control box shall be stainless steel and waterproof.

7.9 MULTIPLEX WIRING SYSTEM

The electrical system shall be controlled by “MULTIPLEX” programmable logic controller, which shall be Dinex or approved equal and shall be located in a sealed compartment. Contractor shall provide complete details of the design of the PLC system during the design review. Versatility and future expansion shall be provided for by system architecture. Multiplex Wiring System shall provide and distribute power to ensure satisfactory performance of all electrical components. The system shall be capable of monitoring and recording all coach systems including, but not limited to, passenger counts, door operation, ramp operation, engine, energy storage system, traction motor and traction generator (Reference Section 7.6, MODULAR DESIGN). The system shall store and retrieve data for the mechanical and electrical functions of the coach. All electrical and all electronic devices sub-systems and components shall be

repairable and maintainable by SFMTA. SFMTA shall be granted a no cost license to utilize the software as long as the coach remains in service. SFMTA shall be provided with the ability to make configuration changes to the software such as adding, deleting, or re-characterizing devices on the multiplex system, without having to go back to the supplier for software changes. Any associated devices required for reprogramming the coach should be identified with special equipment, training, and manuals included as part of the coach purchase.

The components of the multiplex system shall be of modular design thereby providing for ease of replacement by maintenance personnel. The modules shall be easily accessible for troubleshooting electrical failures and performing system maintenance. Each module shall be shielded to prevent interference by EMI and RFI; and shall utilize LEDs to indicate circuit integrity and assist in rapid circuit diagnostics and verification of the load and wiring integrity. Each circuit shall be capable of providing a current a load of no less than 2 Amperes. The internal controls shall be a solid-state device providing an extended service life. Wiring for data coach node module power shall consist of three, 22 gage or larger, UL approved, shielded, twisted pairs.

Protection to each individual circuit shall be provided. An automatic test system integral to the multiplexing shall be provided. A single test button mounted on a panel at the driver's compartment area, upon activation, will provide a system check of the circuits. Failure points will be indicated by corresponding LED lights on the panel. The system shall 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 shall be able to use either unit to check coach wire function. Laptop computer programmer and maintenance reader shall be supplied by the Contractor in accordance with ATTACHMENT 13: Special Tools List.

The contractor shall provide SFMTA all essential information and identify equipment needed to test, troubleshoot and repair the Multiplex system controller. This information and equipment shall encompass the system on the coach and the repair of the individual sub-assemblies down to the components on the circuit board of the sub-assemblies.

7.10 BATTERIES AND ENERGY STORAGE SYSTEM

7.10.1 Traction Energy Storage System

The traction energy storage system shall be composed of batteries and/or other energy storage devices, along with associated power electronics interface and controls, diagnostic systems, and environmental controls. This system shall be designed to provide a load-leveling function for the engine/generator in the hybrid propulsion system. The energy storage devices used, and their arrangement shall be selected and sized to meet coach performance specifications and design goals, including: vehicle reliability, reduced exhaust emissions, improved vehicle fuel economy, long cycle life, low life-cycle cost, safety, maintainability, durability, and simple, robust diagnostics. The design and projected unit life of the energy storage system shall be optimized in order to reduce life cycle costs to a minimum while maintaining full system reliability throughout.

Individual energy storage devices (Lithium-Ion batteries) shall be packaged in one or more modules, which shall be mounted in an enclosure(s) that permits ease of servicing. The enclosure shall be double-hulled to prevent any leaked substance from escaping. The energy storage system and enclosure(s) shall be designed to minimize shock hazard to maintenance

personnel. Access to individual devices within each module shall be through two covers or panels. Hazard warnings shall be visible on the inner cover or panel and hazard warnings shall remain visible with both covers open. Individual devices within a module, or the entire module, shall be replaceable within 1 hour. Contractor and SFMTA shall perform hazard assessment and develop a procedure to replace individual devices within a module and entire modules.

The propulsion control system (PCS) shall include a management system to monitor and control the operating conditions within each energy storage system module, including voltage, current, and temperature. This system shall include an over-current and an over-temperature protection feature that disconnects current to and from the energy storage modules in the event of an over-temperature or over-current condition.

The energy storage system shall include a voltage equalization system that will provide real-time equalization of voltage between individual energy storage devices within each module. This equalization function shall be accomplished automatically, and shall not require manual intervention by the coach operator or maintenance personnel.

The propulsion system shall be designed so that the energy storage system shall not require regular external charging from the electric grid. Connection to the external electric grid is acceptable for periodic maintenance (not more frequently than once per month), if required. If such periodic maintenance is required, the energy storage system shall be designed so that the required maintenance tasks can be accomplished with minimal labor, without requiring a maintainer to access the roof of the coach and without requiring a maintainer to open the energy storage module enclosure(s). The contractor shall provide all special equipment required to perform these maintenance tasks. Such equipment shall be designed to be compatible with the electric service typically found in a coach depot (110v or 208v 3 phase; no more than 50 amp circuit; standard connectors). The contractor shall provide SFMTA all essential information and identify equipment needed to test, troubleshoot and repair the energy storage system. This information and equipment shall encompass the system on the coach and the repair of the individual sub-assemblies down to the components on the circuit board of the sub-assemblies.

7.10.2 Low Voltage Batteries

At least two DEKA 8A8D Absorbed Glass Mat (AGM) MagnaPower or approved equal shall be provided. Batteries shall be of premium construction and shall be fitted with threaded side-mounted stud terminals. They shall bear an initial warranty date no earlier than 60 days prior to coach manufacture. In the event of a temporary failure of the battery charging system, the low voltage batteries shall be able to maintain an adequate charge to operate the low voltage control system and the interior lighting system for a minimum of two hours. Positive and negative terminals shall have different size studs, or the battery terminals and cables shall be arranged to prevent incorrect installation. Battery terminals shall be located for access in less than 30 seconds with jumper cables. Battery cables shall be flexible and sufficiently long to reach the batteries in the extended tray position without stretching or pulling on any connection. Cables shall not lie on top of the batteries, and shall be sheathed and wrapped to prevent corrosion. The battery terminals and cables shall be color-coded with red for the primary positive and black for negative.

Battery terminals shall be located for access with jumper cables. Batteries shall be stamped with the date of manufacture and shall be translucent.

Batteries shall not be abused or quick-charged before delivery to SFMTA. Despite battery configuration, the Contractor shall be responsible for analysis and selection of a battery of adequate capacity to supply the load.

Battery cables shall be flexible and sufficiently long to reach the batteries without stretching or pulling on any connections when the tray is extended. The battery cables shall not lie on top of the batteries. The battery cables shall be color-coded with red for primary positive, black for negative, and any other color for intermediate voltage cables. Battery cables shall be a minimum 4/0.

The battery cable terminal connections shall be capable of withstanding the mechanical stress and vibrations commonly experienced during coach revenue service.

The batteries shall be sufficiently protected from over temperature or meltdown.

7.10.2.1 Battery Tray

The battery tray shall be made of 304 stainless steel and shall pull out easily and properly support the batteries during service. In the normal position, the battery tray shall not be supported by rollers. A positive lock shall retain the battery tray in the normal position. Batteries shall be easily accessible for inspection, serviceable only from outside the coach. The battery containment area shall be vented to the outside allowing for the mitigation of fumes from gassing batteries and provisions made for the drainage of cleaning liquid. The containment area access door shall be able to be opened without the use of a special key.

A polarized lug mating with Anderson power products #632062 or approved equal and manual release #919 shall be provided inside the battery compartment and adjacent to, but no further outboard than, the batteries. The plug shall be wired with 3/0 cable.

7.11 MASTER BATTERY SWITCH

A master battery switch shall be provided for complete disconnection from all coach electrical systems except systems that require 24-7 power supply. The master battery switch shall be located in an outside compartment, which requires no tool(s) to access. The location of the master battery switch shall be clearly identified on the access panel and be accessible in less than 10 seconds for activation. The master switch shall be capable of carrying and interrupting the total circuit load. Opening the master switch with the power plant operating shall not damage any component of the electrical system.

7.12 ALTERNATOR

The alternator shall be sized to supply the entire nighttime operating electrical load of the coach while providing at least 20 percent of its current output for battery charging when the battery is fully discharged. The alternator shall be a EMP air cooled alternator or approved equal. Cables shall be adequately mounted such that if the lug fails, the cable shall remain in place.

The Contractor shall provide an analysis, approved by SFMTA, demonstrating that the alternator supplied is adequate for coach operation in the service area of SFMTA. Alternator cooling methods shall be approved by SFMTA.

The Contractor shall provide evidence that an average 4M mechanic shall be able to replace the alternator in one (1) hour or less.

7.13 ELECTRICAL AND ELECTRONIC NOISE

Electrical and electronic subsystems and components shall not emit directly or indirectly electromagnetic radiation that will cause undesirable electrical and electronic noise interference on radio and television transmission and reception, radiation at unsafe levels, or radiation that will cause undesirable responses, degraded performance, or malfunction of equipment. This includes but is not limited to the following systems and equipment.

- Commercial radio and television transmission and reception
- FCC and official local and state radio and television transmission and reception
- Onboard equipment supplied by SFMTA or by the Contractor
- Pacemakers and other implanted medical devices.

The performance of the coach shall not be degraded by electromagnetic interference from external sources. The coaches shall meet all applicable FCC and FTA requirements in addition to the following standards and guidelines listed below:

- Federal Communications Commission (FCC) Procedure for Measuring RF Emissions from Computing Devices and meet part 15 of FCC regulations
- MIL-STD-461 - Requirements for the Control of Electromagnetic Interference Emissions and Susceptibility
- MIL-STD-462D - Measurement of Electromagnetic Interference Characteristics
- American Conference of Governmental Industrial Hygienists (ACGIH) (See ATTACHMENT 9:)
- UMTA-MA-06 0153-10 (DOT-TSC-UMTA-88-1) Radiated Interference in Rapid Transit Systems Volume I: Theory & Data
- UMTA-MA-06-0153-11 (DOT-TSC-UMTA-87-4) Radiated Interference in Rapid Transit Systems, Volume II: Suggested Test Procedures
- SAE J551 Performance Levels and Methods of Measurement of Electromagnetic Compatibility of Vehicles, Boats (up to 15m), and Machines (16.6 Hz to 18 GHz)
- SAE Recommended Practice ARP 1393: “Electromagnetic Compatibility and Interference Control for Rapid Transit Vehicles”

The Contractor shall develop and submit an EMI/EMC Control Plan for SFMTA review and approval prior to submittal of final drawings. The plan shall delineate the manner in which EMI and EMC will be mitigated and meet the requirements in this section.

8 MATERIALS AND OVERALL WORK QUALITY

8.1 MATERIALS

All materials used in the construction of the coach and all of its parts shall be in accordance with the stated specification or description unless written approval for substitution is obtained. All materials shall comply with the standards established by ASTM, SAE, or similar association standards. Materials used shall be duplicated in manufacture, design, and construction on each coach and be marked so as to be readily identified.

Whenever under the Contract Documents it is provided that the Contractor shall furnish materials or manufactured components or shall do Work for which no detailed specifications are set forth, the Work performed shall be in full conformity and harmony with the intent to secure the best standards of manufacture in the Work as a whole or in part. The Contractor shall not take advantage of the omission of any part or detail which goes to make the coach complete and ready for service, even though such part or detail is not mentioned in the Specifications or in the Contractor's approved design.

Foreign matter such as shavings, chips, etc., shall be completely removed from all parts of the coach whether hidden or exposed.

I. All painted aluminum sheets shall be thoroughly cleaned and coated on the inside and outside with zinc-chromate protective paint prior to assembly in coach.
II. All joints shall be protected by application of a zinc-chromate metallic compound at assembly.
III. All bolts, nuts, washers and exposed linkage shall be stainless steel or zinc plated (where applicable) to prevent corrosion. Contractor shall submit certification that all bolts on the coaches are in compliance with SAE Standard J429.

8.1.1 Hazardous Materials

It shall be the design objective to eliminate from the coaches all materials that are or may become hazardous to passengers, operators, or maintenance personnel. Of particular concern are materials that produce toxic smoke or gases when heated, possibly due to an accidental fire or when bodywork using welding equipment or cutting torches is necessary. No parts on the coach shall contain lead, asbestos or PCBs. The Contractor shall provide for SFMTA approval of the material safety data sheets (MSDS) of any hazardous materials or fluids that must be used in the construction, operation or maintenance of the vehicle. SFMTA has the option to reject the use of any hazardous materials proposed for use on the vehicles.

8.1.2 Consumables

The following list of consumable items shall be available in the United States from U.S. manufacturers:

- Engine air filters
- Ventilating air filters
- Fuel, water and oil filters
- Belts
- Lamps
- Fuses
- Brake lining material
- Hoses and lines – air, coolant and hydraulic
- Wire terminations and connectors
- Air bags
- Brake Rotors
- Suspension components
- Wiper blades
- Exhaust after treatment filters

Any similar items shall also meet the above requirements. Any exceptions require the prior approval of SFMTA.

8.2 OVERALL WORK QUALITY

Overall work quality shall be of the best grade and shall conform in all respects to the best practice in the industry.

Material and equipment shall be new and of a quality equal to that specified or accepted as the best industry practice. Mechanical, electrical and electronic equipment and components shall be the products of manufacturers of established good reputations regularly engaged in the fabrication of such equipment and components.

The work shall be executed in conformity with the best-accepted standard practice of the trade so as to contribute to maximum efficiency if operation, accessibility, pleasing appearance and minimum cost of maintenance.

The fit and finish of the exterior and interior components shall be to the best of the industry standards of the automotive trade.

8.2.1 Welding

Welding procedures, welding materials, and qualifications of welding personnel shall be in accordance with the current standards of the ASTM and AWS. Work performed outside or in the U.S. must conform to U.S. welding standards as approved by SFMTA. Where metal is welded to metal, the contact surfaces shall be free of scale, grease, and paint.

8.2.2 Mechanical Fastening

No protruding screws, mounting bolts, or similar items shall be permitted in the interior or the exterior of the coach. Fasteners not exposed to passengers on the inside of the coach shall be stainless steel or zinc-plated steel. Zinc plating shall conform to the latest revision of ASTM B633, TYPE II, SC3 or SC4. All fasteners used in the vehicle body exterior, even if not exposed

to passengers, shall be of stainless steel except where mechanical requirements impose graded steel fasteners, or to minimize galvanic corrosion. These fasteners shall be zinc-plated as per specification, with treatments to prevent hydrogen embrittlement if required. Where non-anodized metal is riveted or bolted to metal, contact surfaces shall be thoroughly cleaned and properly primed. The use of stretch to torque fasteners is discouraged.

8.2.2.1 Rivets

Rivets shall completely fill the holes. No blind rivets shall be used. All rivets shall be of the solid center type. External rivet heads shall be concentric with the body of the rivets and free from rings, pits, burrs and fins. Surfaces exposed to passengers, operator, or maintenance personnel shall be smooth and free of burrs, fins, sharp edges, and dangerous protrusions.

8.2.2.2 Screws

On the coach interior, all screws exposed to passengers shall be stainless steel with a flat or oval head. Exposed screws shall be of an approved tamper-proof type with the exception of the glazing mounting screws. Self-tapping screws shall not be used in areas requiring dismantling for servicing. At least 1-1/2 screw threads shall be visible beyond all nuts.

8.2.2.3 Bolts

All bolts or rods passing through composite flooring or exposed to the elements shall be an approved grade stainless steel or, with SFMTA's pre-approval, zinc-plated. All nuts and bolts exposed to passengers shall be an approved grade stainless steel unless otherwise specified. The design strengths for Grade 2 bolts and Class A nuts shall be used in sizing the mounting and attachment bolts for under floor mounted equipment, support structures, or brackets. However, all structural or load carrying bolts shall be domestic manufacture, grade 5 or better. Bolts or screws used for structural connections shall have full-size bodies in areas subjected to bearing and/or shear loads. For bolted joints subject to steady vibration, UNC bolts with appropriate locking arrangement shall be used. Nuts shall be a regular height, nylon insert, and self-locking type. Bolts smaller than 1/4 inch shall not project more than 1-1/2 threads plus 1/4 inch. Bolts 1/4 inch or larger shall not project more than eight (8) threads. All hardware is to be installed and torqued per ANSI guidelines.

8.2.3 Finishing

Special care shall be taken with the outside sheathing; roof, roof bonnets, and interior finish so that all kinks and buckles are removed before assembly to present a true and smooth finish. This shall be accomplished without excessive grinding, which may weaken the structure material. All painted surfaces shall have a true and smooth surface that will not show sanding or grinding marks after painting. All steel and aluminum body parts that are to be painted shall be thoroughly cleaned and treated before priming with a primer compatible with the paint system.

8.2.4 Electrical

All electrical connections shall be of the locking type. All electrical wiring harnesses should be tie-wrapped and supported at regular intervals. When wires, cables, hoses or tubes go through walls or panels, the bulkhead holes shall have protective grommets/molding and the wires, cables, hoses or tubes shall be clamped on both sides of the bulkhead hold. A 1/4-inch minimum clearance is required (Reference Section 7.7, WIRING, TERMINALS). All electrical wires shall be installed to as not to have any chaffing or rubbing with other components.

8.3 PROOF OF COMPLIANCE WITH CONTRACT

In order that SFMTA may attempt to determine whether the Contractor has complied with the requirements of the Contract Documents not readily determinable through inspection and test of equipment, components or materials utilized in the Work, the Contractor shall, at any time when requested, submit to SFMTA Project Manager properly authenticated test results, design documents or other satisfactory proof as to its compliance with such requirements.

8.4 DEFECTIVE WORKMANSHIP AND MATERIALS

When and as often as SFMTA determines that the Work done or being done under the Contract, or the kind or quality of components, equipment or materials supplied in connection therewith, is not fully and completely in accordance with any requirement of the Contract Documents, it may give notice of such noncompliance to the Contractor in writing and the Contractor shall immediately upon receipt of such notice do all things required to remedy such noncompliance at no additional cost to SFMTA.

9 TRAINING, PUBLICATION, DIAGNOSTICS TESTING SOFTWARE

9.1 TRAINING

Training shall be designed and presented to ensure that each participant will be able to perform specific tasks or be able to demonstrate specific knowledge in his/her working area. Training shall provide specific course goals and objectives outlined in the lesson plans with pre-course tests and post-course tests. Dates, hours, and locations of training shall be at the discretion of SFMTA. The training starting days and completion days shall refer to Section 13.1, PREFERRED DELIVERY SCHEDULE.

All manuals and lesson plans shall be provided on CD-ROM and hard copies to all participating trainees. All computer software programs shall be approved by SFMTA. SFMTA reserves the right to copy all computer information for future use. Six (6) copies of all training aids (such as videos, slides, and audiotapes) shall be provided to SFMTA Maintenance Training Department.

SFMTA Proposed Training Matrix (ATTACHMENT 14:) is an example of a training schedule by major category for each group of personnel. The total number of classroom training hours by qualified instructors shall be at least 1500 hours. The City reserves the right to make adjustments to the session structure shown in ATTACHMENT 14: SFMTA PROPOSED TRAINING SCHEDULE, while not increasing the total number of training hours. The proposer shall submit their recommendations for training hours and categories for consideration by SFMTA.

9.1.1 Training Plan

Contractor shall submit a training plan per the schedule in Section 13.1, PREFERRED DELIVERY SCHEDULE. The training plan shall delineate the manner in which the Contractor plans to meet the requirements of this specification. The plan shall include:

- Specific trainee performance objectives
- Draft lesson plans
- Specific topics to be covered including subsystem groupings for mechanics and electronic technician training
- Probable training aids and materials
- Training schedule
- Training facilities required.

9.1.2 Training Materials and Personnel

Contractor will provide detailed instructional guides, outlining training philosophy, and weighted areas of instruction based on Contractor's understanding of the complexity of the equipment from a maintenance performance standpoint. In addition, Contractor will identify recommended course length with basic electrical/electronic knowledge-driven instruction leading to a proficiency level suitable for new vehicle maintenance.

Instructors shall be totally familiar with the technical information being taught, shall use instructional materials properly, and shall possess the skills required to make effective presentations. Safety must be an integral part of all instruction. Instructors must be transit literate and factory certified to teach the specific system being taught. SFMTA prefers all training instructors are employees or technical representatives from the maker of the equipment to provide the training sessions.

Upon commencement of classroom instruction, instructor shall be dedicated to the task of teaching without a break in the continuity of the instruction to perform other duties. Instructor shall be fluent in English.

The Contractor shall provide all handouts, training aids, audio-visual equipment, and visual aids for each class. Training materials, including audio-visual hardware, slides, view graphs, mock-ups, charts, and other aids, will become the property of the City upon the completion of the training course. Mock-ups shall include as a minimum a door header with all operating equipment, a brake system (air components) and an air system. The City or its designee may use such materials in subsequent training sessions for any other purposes. A training manual shall be prepared for each personnel classification and distributed to personnel in training prior to or at class start up.

9.1.3 Operations Instructors, Maintenance Instructors, Street Operations, and Managers

The purpose of these training sessions shall be to provide the necessary information to SFMTA's operations instructors, maintenance instructors, and training management and operations managers so that they may train SFMTA operators, transit inspectors and maintenance personnel. This training shall cover all operational and maintenance aspects of the coach, with emphasis on features of the coach that are unique or may not have been encountered by SFMTA personnel. Separate training session shall be provided for street operation inspectors.

9.1.4 Maintenance Manager Training

These training sessions shall be geared to acquaint maintenance superintendents, general foremen, and foremen with the design, use, limitations, preventive maintenance, warranty periods, and special features of the coach. This training can be included in the general orientation, or used for specific in-depth training time.

9.1.5 Service Personnel Training

Service personnel shall be trained in basic daily servicing requirements, including cleaning, inspection, towing, trained first responders, and routine servicing and the preventive maintenance inspections.

9.1.6 Mechanic

These sessions shall provide the mechanics with the basic knowledge necessary to utilize the maintenance manuals and to safely perform preventive maintenance, troubleshooting, repairs, and overhauls. Sessions shall concentrate on individual subsystems and components, such as body, doors, propulsion, suspension, brakes, and operator controls. The Contractor shall include, as part of the training plan, a list of proposed subsystem groupings. Training shall include demonstrations of Time to Repair and Accessibility of coach components and subsystems. Training for shop technicians will cover test equipment and subassembly bench repair and calibration.

Maintenance engineer training shall focus on overall system design, maintainability, computer diagnostic techniques, control systems, data collection and retrieval, life cycle predictions, optimization programming, electronic maintenance techniques, and special tools.

The Contractor shall provide to SFMTA sufficient training and documentation needed to test, troubleshoot, maintain and repair all electronic systems and subsystems. The training shall

review all electronic schematic diagrams and shall provide troubleshooting flow charts and block diagrams.

Road Call sessions shall provide the mechanics with knowledge necessary to troubleshoot and fix, if possible, subsystems which may fail and cause service interruption. Mechanics shall be made to understand how to proficiently use all necessary troubleshooting equipment. Mechanics shall be provided with both hands-on and classroom training.

9.1.7 Surveillance Camera System Training

The contractor shall provide training classes on how to operate and maintain the surveillance camera system (the number of classes and hours are subjected to SFMTA approval and Contractor's recommendation). Test equipment and special tools required maintaining the system will be provided by the Contractor in accordance with ATTACHMENT 13:, Special Tools List. One test fixture will be provided which duplicates an entire vehicle system. The test fixture will easily allow for the substitution of individual components of the system for test and repair purposes. One viewing station (in addition to Section 3.13.6) will be provided. The viewing station shall be assembled in such as a manner as to allow for ease of component exchange.

9.1.8 Videos

SFMTA may require digital recordings of any or all of the Contractor's training sessions, at SFMTA's discretion, or at least one session of each discrete training class. These recordings will be transferred to DVD for distribution within SFMTA. In addition, the Contractor shall be required to provide a complete set of training discs to include a disc for each classroom training session on a specific topic and a disc for each vehicle "hands-on" training session on a specific topic. Discs shall be no longer than 30 minutes in length. Topics requiring more time to cover in complete detail shall be segmented into 30-minute modules. A single compilation disc (or minimal disc set) incorporating all of the training sessions shall also be produced. At minimum, Contractor shall cover the following topics:

- Propulsion and Energy Storage Systems
- Axle and suspension systems
- Auxiliary Electrical System
- Wheelchair ramp assembly
- Air and Brake systems
- Door system
- Power steering system
- Heating and Ventilating system
- Vehicle Body Components & repair techniques (e.g. special welding, interior panel replacement, etc.)
- Preventive Maintenance practices for all preventive maintenance required on each vehicle

A complete set of master recordings shall be submitted to SFMTA in DVD or approved equal format along with a complete set of training media. The Contractor shall maintain a complete set of reproducible recordings on file for a period of 12 years for use by SFMTA.

The Contractor shall provide two sample discs with the draft training plan. One disc shall be representative of a classroom instruction, and one disc shall be representative of a vehicle "hands-on" instruction. These sample discs shall be submitted for SFMTA approval and shall be

representative of the level of quality of the product that SFMTA can expect for the balance of the training discs to be delivered.

9.1.8.1 Video Quality

Contractor shall have in-house capability, or subcontract with a company approved by SFMTA, for the following requirements:

- All work associated with video recording and production shall be performed by the Contractor or subcontractor approved by SFMTA.
- The Contractor shall have script writing capabilities and be experienced with transit organizations and issues.
- Studio and/or field acquisition capabilities.
- CD-ROM and DVD for wide distribution shall have the ability to be viewed on any modern desktop or laptop computer equipment (possessing basic, modern multimedia software such as Windows Media Player) in a smooth video tape-like manner, without lagging, freezing, or stuttering, and without compromising or "crashing" the computer.

The Contractor may elect to utilize its own actors, or utilize SFMTA employees in actual classroom and vehicle "hands-on" sessions. However, if the Contractor chooses to use SFMTA employees at least two (2) sessions of each topic shall be filmed and proper editing performed to result in a quality product. Tapes shall be professionally edited to eliminate unnecessary and irrelevant sections that are common to live, on-location filming.

9.1.9 Training Charts

The Contractor shall provide three (3) copies of the following schematic charts used for training and working reference: 1) the electrical system, 2) the brake system and 3) the door system. The charts shall be 3 feet by 5 feet, clearly legible, and suitable for classroom viewing. Two rigid frames shall be provided for mounting the charts. Charts shall be consistent with those provided in the Maintenance Manual and subject to SFMTA approval, and available for use at commencement of the training course. Schematic charts shall be laminated.

9.1.10 Interactive Multimedia Training

Contractor shall provide a series of interactive training modules on coach maintenance procedures to be delivered using standard interactive CD-ROM or DVD technology. This training must be specific to the coach for this procurement, and to maintenance practices that are used by SFMTA. The interactive training should be CD-ROM formatted computer based training (CBT) or approved equal, and compatible with all modern computer windows-type operating systems, office programs, and latest multimedia software. The CD shall include video clips of component operation and critical adjustments.

Project milestones shall consist of the following:

- Detailed design document, to be developed with SFMTA participation and completed 10 months prior to delivery of first production coach
- Video production
- Completion and review of video editing
- Prototype module delivery (test, review, and feedback of first module)
- Pre-production module delivery (test, review, and feedback of all modules)
- Delivery of completed program, including Trainer's Manual and Guide shall be completed per the schedule in Section 13.1, PREFERRED DELIVERY SCHEDULE. (System setup and troubleshooting, program administration guidelines, and answers to test questions).

9.1.10.1 Training Module

The training module shall have on screen text as well as voice over descriptions of the procedure being demonstrated. The module shall have a complete demonstration of the maintenance procedure followed by a self-paced post examination of the student. Only the student and the Training Manager shall have access to the scores for each training module. In addition, SFMTA shall have all licensing rights to unlimited reproduction of the CD training module. The Contractor shall have the responsibility for providing all updates and revisions to the CD training modules until all engineering modifications and final engineering have been approved and acceptance of the last production coach.

The training modules shall address the most critical systems pertaining to coach maintenance. One module shall be produced on each of the following systems:

- APU and subsystems installation and maintenance
- Ramp installation and maintenance
- Door control maintenance
- Electrical systems control maintenance, including multiplexing
- Disc brake installation and maintenance

Each module shall include the following program elements:

- Overview on system components, operations and relationship with other relevant systems
- Step-by-step video demonstration of maintenance procedures (not more than 50 steps in the process), with random access to each step and multiple choice quiz questions on critical steps
- Interactive job simulation exercises using three-dimensional solid modeling to graphically represent job setting and function on critical steps
- Built-in user performance tracking for confidential review by Maintenance Training Supervisor
- Visual-based parts identification and ordering information system (using three-dimensional solid model and/or stills)
- Contractor shall demonstrate the ability to produce interactive multimedia training that contains each of the program elements for the critical subsystems as described above.

9.2 PUBLICATIONS: MAINTENANCE MANUALS, ILLUSTRATED PARTS MANUALS, OPERATOR'S MANUALS, & VEHICLE RECORD BOOKS

The Contractor shall provide maintenance, illustrated parts and operational manuals for each of the vehicle type according to the schedule in Figure 9-1. The Contractor shall provide all electronic copies of the vehicle drawings, frame structure of the vehicle, major electrical system and other subcomponent system in AutoCAD and PDF formats. The intent and purpose of all maintenance and operating documents provided to SFMTA by the Contractor shall be to facilitate the safe and reliable operation of the vehicle by SFMTA during the entire expected operational life of the vehicle. Using the information provided in the Contractor's maintenance documentation, SFMTA itself shall be able to perform any and all procedures necessary to ensure the safe and reliable operation and maintenance of the vehicle during its service lifetime. The Contractor shall submit a draft copy of each of the manuals for review and approval by SFMTA in accordance with the delivery schedule of the final contract. Release copies of the manuals shall reflect the most recent information available at the time of their release and shall be delivered to SFMTA on or before delivery of the last production coach. Manuals need to be updated in a timely manner whenever there is a FSRP issued.

FIGURE 9-1

Manuals	Qty/Vehicle type	Maintain up-to-date after the date of acceptance of the coaches
Maintenance Manual	30	12 years
Parts Manual	30	12 years
Operator's Manuals	400	12 years

The supplied manuals shall provide complete, concise and clear documentation for all equipment ordered on the vehicle and shall not include superfluous documentation for equipment that was not provided with the vehicle. As well as the printed copies of the manuals specified above, all maintenance operations and illustrated parts manuals shall be provided in digital format.

All such electronic documentation shall be viewable using modern, basic office and multimedia software such as Microsoft Office and Windows Media Player. In addition, all materials will be provided in a format that allows their use in the latest SPEAR Technologies software Image Manager and/or Document Manager modules. SFMTA reserves the rights to electronic reproduction of all such information mentioned herein for its own internal uses, where such electronic reproduction is not already specifically provided for by the Contractor as part of this contract. Within the relevant vehicle warranty period provided for by the Contractor, SFMTA will make no changes to the Contractor-provided documentation where such changes would compromise the intent of the Contractor's original documentation with respect to the safe operation or reliability of the vehicle, unless such change is agreed to in writing by both SFMTA and the vendor. Where such changes are made, both SFMTA and the Contractor shall maintain coordinated records of the changes, including the SFMTA contract number, manual part number, title, page number(s), date the change was made, who authorized the change, why the change was made, and before-and-after copies of the change. Contractor will provide such changes in the same digital format as used for the initial delivery of the manuals. At the expiration of the time periods specified above for Contractor maintenance of the documentation, or upon default of the Contractor in providing such document maintenance, SFMTA shall have

the right to reproduce copies of such documentation for internal use only, subject to the warranty concerns expressed herein.

All system modifications, retrofits, parts, defect and factory recalls done must include full documentation for recordation into the latest SPEAR Technologies software, plus all parts, service and engineering manuals must be updated regularly.

All maintenance documents in electronic form shall be generated for best readability on a current computer monitor. The default page setup for all printed maintenance and parts manuals shall be standard U.S. letter size (8.5" by 11") in portrait mode with a gutter suitable for use in a standard 3-ring binder. Wherever feasible, printed manuals should be organized so that updates or corrections to the manuals can be made with minimal impact to the overall document. Where drawings or other documents are too large to be easily legible in the default page size, such pages may be provided either as 11" tall by 14" (or longer) pages, or as 22" tall by 16" "four-up" pages. In both these cases of oversized pages, the printed page shall be capable of being neatly folded up into the default page size, and shall have suitable reinforcement at the 3-hole edge of the page. Major sections of the maintenance manuals shall be separated by 1/3- or 1/5-cut tabbed and labeled, reinforced index dividers. The printed Operator's Manual shall be a single softbound volume; with at least medium-weight, glossy-stock covers for durability, and may be smaller than the default 8.5" by 11" size, as dictated by the best compromise of readability and portability. An emphasis should be placed on durability and portability. In the interest of readability and clarity, SFMTA may dictate that the Operator's Manual be printed in color.

9.2.1 Maintenance Manuals

Maintenance manuals shall be integrated so that all subsystems of the coach are contained in a logically indexed, contiguous series of chapters and/or volumes. Manual organization shall be approved by SFMTA before work begins on the manuals. All standard and specialized maintenance or overhaul procedures which involve potential health and safety issues for the repair technician shall be clearly noted in the documentation with the international safety warning symbol appropriate to the level of potential danger involved. Procedures where the proper performance of the task is critical to the safe operation of the vehicle shall also be clearly marked for emphasis. Maintenance manuals shall contain the complete data required for routine and periodic maintenance of all parts of the coach, including as a minimum the following:

At the beginning of each manual, it shall contain a table of contents, a list of abbreviation, instructions on how to use the manual Special safety precautions for maintenance and/or overhaul procedures General overview / introduction to the vehicle and its systems and subsystems recommended required and/or specialized maintenance and overhaul tool lists, including electronic test equipment where appropriate. Main components of the manual shall include, but are not limited to, the following:

1) Detailed theory/principles of operation of each primary system (e.g., the braking system) on the vehicle and its relationship to and interactions with other primary systems on the vehicle and, where applicable, to any off-board systems.
2) Detailed theory/principles of operation of each subsystem (e.g., ABS) within its primary system, and the relationship and interactions of the subsystem to other subsystems within the primary system, and, where applicable, to other primary systems or the subsystems of those other primary systems.

3) Field and shop troubleshooting procedures for all systems and subsystems using a combination of text, flowcharts and images as best suits the procedure.
4) Shop overhaul procedures for all rebuildable or repairable systems on the vehicle.
5) Recommended preventive maintenance (e.g. lubrication and adjustment) requirements and schedule (Reference Section 9.2.2, Preventive Maintenance Manual).
6) Schematic and wiring location diagrams (including wire and cable size and rating schedules, where appropriate) for all electrical systems and subsystems on the vehicle.
7) Air and hydraulic system diagrams showing locations in the coach of air and hydraulic components.
8) Detailed, illustrated procedures for component change-out, and run-in information as required.
9) Body and structural information and materials specifications for major accident repairs.
10) Electronic systems and subsystems documentation including schematics and diagnostic procedures, where applicable (Reference Section 9.2.6, Electronic Systems Documentation.)

9.2.2 Preventive Maintenance Manual

Contractor shall provide a separate Preventive Maintenance (PM) Manual specifying the recommended preventive maintenance procedures and the scheduling of those procedures. The manual shall provide an outline PM program with checklist, which can be used to perform PMs. The PM checklist pages shall be formatted so that copies can be made to stand as individual SFMTA documents, including lined space at the end of the document for additions and notes. The preventive maintenance manual shall also include recommendations for the scheduled overhaul of major systems above and beyond the normal maintenance procedures, where such overhaul is known to significantly improve the long-term reliability, maintainability and/or useful life span of the vehicle.

In addition to the above requirements, the structure of the PM schedule must include at least the following elements for each required maintenance procedure within an overall PM program:

1) Interval between each procedure (calendar based, mileage based, hours based, other, i.e., every 30 days or 3,000 miles whichever comes first)
2) Allowable period for completion (i.e., considered on time if performed up to 5 days or 500 miles before or after the actual due date or mileage)
3) List of parts (Manufacturer Part #, Description, Quantity, UOM) Required for the procedure, and recommended but not required for the procedure
4) Estimated hours by craft to perform procedure

9.2.3 Illustrated Parts Manual

The Illustrated Parts Manuals shall be designed so that all systems and subsystems of the vehicle are broken down to the component level in a logically indexed, contiguous series of chapters and/or volumes. Page setup requirements for the parts manuals shall conform to the requirements in Section 9.2, PUBLICATIONS: MAINTENANCE MANUALS, ILLUSTRATED PARTS MANUALS, OPERATOR'S MANUALS, & VEHICLE RECORD BOOKS. Illustrations and their corresponding parts lists shall be arranged as to minimize the amount of cross-searching necessary to locate a part in the parts list from its drawing reference, or to locate the part on an illustration from its entry in the parts list. The parts list shall include the following data:

1) Drawing reference (locator)
2) Manufacturer's part number
3) OEM's part number (from the supplied manufacturer)
4) Part description, including type, and size or value or reference to another drawing where such reference contains a more useful description of the part)
5) Quantity used in the currently illustrated system or subsystem

Illustrated parts manuals shall be arranged so that part numbers can be readily found and identified in the illustration for each system, subsystem, assembly, subassembly, or component part from an orderly breakdown of the complete coach. The manual shall contain a ready-reference alphanumeric part number index listing the Contractor's part number against the page in the illustrated manual where it appears. The parts lists shall identify the equivalent generic part, which is physically identified by the Contractor and shall be listed under Part Description field in the manual. In no case may any replaceable part remain unidentified.
Isometric exploded views or two-dimensional drawings that are detailed enough to show the relative location of each part shall be used to identify all vehicle systems and subsystems. The technique to be used in the rendering of these two-dimensional drawings shall be approved by SFMTA before the draft manuals are created. All parts manuals shall be accompanied by a separate price list showing the Contractor's part number against the current net price (including freight) to SFMTA of all non-generic parts used in the vehicle at the time of delivery of the manuals. Refer also to Section 10.3.3, Database Information.

9.2.4 Parts Tables in Electronic Format

In conjunction with the IPM, there shall be provided hierarchal tables in electronic format (such as Microsoft Excel) that identify all systems and their subsystems, all sub systems and their assemblies, all assemblies and their sub-assemblies and all sub-assemblies and their components, down to unique chips and transistors that may be assembled on Printed Circuit Boards. The purpose of these tables shall be to provide system and component parts data that is readily suitable for loading into the SFMTA SHOPS (or equivalent) data processing system. The tables should include all information that is presented in the IPC. Additionally, the tables should provide tracking information such as serial numbers and locations of all serialized components found in this fleet. At the highest level, the tables should make it possible to identify, by their serial numbers all of the major assemblies installed on each individual coach and thereafter all major sub-assemblies that are installed in each major assembly down to the lowest serialized sub assembly.

9.2.5 Operator's Manuals

The operator's manual shall completely, clearly and concisely illustrate the recommended procedures for the safe and efficient operation of the vehicle, including but not limited to pre- and in-service check-outs, response to safety alarm systems, control of lighting and auxiliary vehicle systems, coach mechanical operation, maintenance checks, turning characteristics of the coach, and emergency actions. The operator's manual shall also document any vehicle-related operator and passenger health and safety concerns, including but not limited to recommended practices for the avoidance of operator on-the-job injuries such as Repetitive Strain.

9.2.6 Electronic Systems Documentation

Where an electronic system is an intrinsic part of the vehicle, and where the contract for a vehicle specifies that an electronic system is field- or shop-repairable, the Contractor shall at a minimum provide circuit descriptions, schematic diagrams, voltage, waveform and/or data diagrams, troubleshooting trees and parts lists for the system as part of the maintenance/overhaul manuals in keeping with the requirements of Section 9.2.1, Maintenance Manuals. Where an electronic system is not an intrinsic part of the vehicle, and the electronic system is field- or shop-repairable, the Contractor may provide a separate documentation package for that equipment, subject to the same general standards as outlined in Section 9.2.1, Maintenance Manual. All documentation shall be submitted to SFMTA for approval. If the electronic equipment in question is not to be delivered with the vehicle, then delivery of release documentation for that equipment shall be made at least sixty (60) days before delivery of the equipment itself.

9.2.7 Surveillance Camera System Manuals

The Contractor shall provide 20 manuals, which include wiring diagrams clearly showing the interfacing vehicle wiring for the system as well as 20 sets of individual maintenance manuals for each piece of supplied equipment. These manuals shall include schematic diagrams, parts lists and maintenance procedures including but not limited to operation, preventive maintenance, troubleshooting and repair to the defective component(s) on printed circuit boards.

In addition to paper copies of this documentation, all technical graphics must be provided in electronic formats per requirement in Section 9.2 PUBLICATIONS: MAINTENANCE MANUALS, ILLUSTRATED PARTS MANUALS, OPERATOR'S MANUALS, & VEHICLE RECORD BOOKS.

9.2.8 Vehicle Records

The Contractor shall provide a vehicle record book to be included in each coach upon its arrival at the transit property. Vehicle record books are to include as a minimum the following:

1) Sub-component serial numbers
2) Test records
3) Inspection records
4) Shipping and acceptance dates.

Each book shall be indelibly marked with the serial number of the vehicle it accompanies. Vehicle record books shall be approved by SFMTA or the designated SFMTA Resident Inspector before shipment. This information will also be provided electronically as defined in Section 10.3.3, Database Information.

9.2.9 Computerized Maintenance, Preventive Maintenance, and Illustrated Parts Manual System

Maintenance, Preventive Maintenance work functions and Illustrated Parts shall include two and three dimensional and exploded view graphics. In addition to providing hard copies and CDs of these manuals as specified in Section 9.2, PUBLICATIONS: MAINTENANCE MANUALS, ILLUSTRATED PARTS MANUALS, OPERATOR'S MANUALS, & VEHICLE RECORD BOOKS. Contractor shall provide required technical services to integrate these items into the latest SPEAR Technologies maintenance and materials management system. SPEAR Technologies software includes the following applications to support this integration:

1) Image Manager – Used for providing Illustrated Parts Catalog on-line. Displays images and parts lists, automatically cross-references manufacturer part numbers to SFMTA part numbers and allows users to fill a "shopping cart" with parts requests to perform maintenance activities. Includes Parts Catalog Manager, an easy to use development tool to import and manage graphic and parts list files. Image Manager can also be used for any other graphical documentation, such as wiring schematics, technical illustrations, etc.
2) Document Manager – Used to link records in SPEAR Technologies software (such as Equipment Asset records, Preventive Maintenance Work Order Templates, Equipment Configurations) to electronic files. System opens the referenced file in its native application using the Windows Registry information for the file extension. Common applications of this module are linking complete technical manuals to coach records, associating digital photos or videos with equipment, and linking troubleshooting guides to template work orders.
3) Interface Manager – Used to import data into SPEAR Technologies software (such as Equipment Asset records, Warranty Conditions, etc.) Interface Manager uses a standard format for data imports.

Summary of project milestones and deliverables, all subject to review and approval by SFMTA, shall consist of the following:

1) Detailed design document, to be developed and completed 3 months prior to delivery of the first production coach. Agreement on Prototype module
2) Prototype module delivery (test, review, and feedback of first module)
3) Pre-production module delivery (test, review, and feedback of all modules)
4) Delivery of final software for Maintenance and Preventive Maintenance work functions and Illustrated Parts.

9.3 VEHICLE SUB-SYSTEMS INTEGRATION AND DIAGNOSTIC TESTING REQUIREMENTS

Contractor shall integrate all electronic systems on the vehicle that can communicate using the latest data link protocol as well as the coach multiplex system. The integration shall include software and hardware that collects and stores all available data in a logical manner. The software shall automatically generate an event log of all data and shall incorporate data from, but not limited to, the engine, energy storage unit, traction motor, traction generator, ABS brakes, multiplexing, video surveillance system, destination sign, vehicle speed, farebox, automatic passenger counter, fire detection/suppression system, etc. The integration shall provide for a minimum storage time of two (2) weeks. Contractor shall provide system

integration details at design review. Function and suitability of design shall be approved by SFMTA.

The Contractor shall provide Self-Diagnostic Testing Software (SDTS) that analyzes the stored data for irregularities or failures to the maximum extent possible. At a minimum, the SDTS shall provide:

1) A visual status indicator that all systems are functioning properly
2) Trouble-shooting capability to locate trouble areas down to the circuit level (for example, a PCB or module in the ABS System) for each component or sub-component on the coach.
3) Flexibility to allow SFMTA to select or de-select the data to be stored

The software shall be user friendly, simple to operate and able to function simultaneously and/or without affecting the integrity of the data from each of the other systems. The Contractor shall provide sufficient training and manuals for SFMTA personnel to operate the diagnostic testing software. All software shall be compatible with any PC laptop or desktop computer and shall be approved by SFMTA.

The integration shall also include the ability to retrieve this data through rugged, environmentally protected ports located strategically in the coach. One data port shall be installed in the engine compartment and one in an easily accessible location at the front of the coach. SFMTA will work with the Contractor to determine the optimum locations for the data ports. The Contractor shall provide details of all required equipment to retrieve diagnostic data and/or event log from these ports during the design review and the data ports shall have the capability to access and download all information as specified in this section.

10 WARRANTY AND SPARE PARTS

10.1 BASIC PROVISIONS

10.1.1 Warranty Requirements

Warranties in this document are in addition to any statutory remedies or warranties imposed on the Contractor. Consistent with this requirement, the Contractor shall warrant and guarantee to SFMTA each complete coach and specific subsystems and components according to the following provisions:

The Contractor shall ensure in its procurement arrangements that the warranty requirements of this Contract are enforceable through and against the Contractor's suppliers, vendors, and subcontractors. Any inconsistency or difference between the warranties extended to SFMTA by the Contractor and those extended to the Contractor by its suppliers, vendors, and subcontractors, shall be at the risk and expense of the Contractor. Such inconsistency or difference will not excuse the Contractor's full compliance with its obligations under the Contract Documents.

Upon request of SFMTA, the Contractor promptly shall provide to the Project Manager complete copies of written warranties or guarantees and of documentation of any other arrangement relating to such warranties or guarantees extended by the Contractor's suppliers, sub suppliers, vendors, and subcontractors covering parts, components, and systems utilized in the coach. If any vendor/supplier to the Contractor offers a warranty on a component that is longer or more comprehensive than the required warranties stated in Figure 10-1, the Contractor shall inform SFMTA of this additional warranty and pass it through to SFMTA at no additional cost to SFMTA.

The Contractor shall ensure that such suppliers, sub suppliers, vendors, and subcontractors satisfactorily perform warranty-related work.

10.1.1.1 Complete Coach

The coach shall be warranted and guaranteed to be free from defects and related defects for two (2) years or 100,000 miles, whichever comes first, beginning on the date of Acceptance or Conditional Acceptance of each coach. During this warranty period, the coach shall maintain its structural and functional integrity. The warranty shall be based on regular operation of the coach under the operating conditions prevailing in SFMTA service area.

10.1.1.2 Subsystem And Components

Specific subsystems and components shall be warranted and guaranteed to be free from defects and related defects for the times or mileages given in Figure 10-1 (Hybrid Subsystem and Component Warranty), beginning on the date of Acceptance of each coach or, if the coach is Conditionally Accepted, any component, system, or piece of equipment that is accepted after Conditional Acceptance of the coach. The basic body structure is composed of all components that are welded or riveted together to form the mainframe and body construction. Suspension beams, weldments, and structural members shall be considered as parts of the basic body structure. Bolted-on components and operating hardware are considered add-ons and therefore are not a part of the basic body structure.

Primary load carrying members of the coach structure, including structural elements of the suspension, shall be warranted against corrosion failure and/or fatigue failure sufficient to cause

physical safety or Mean Distance Between Service Failure (MDBSF) for a period of 12 years or 500,000 miles, whichever comes first.

10.1.2 Voiding Of Warranty

The warranty shall not apply to any part or component of the coach that has failed as a direct result of misuse, negligence, or accident, or that has been repaired or altered in any way so as to affect adversely its performance or reliability, except insofar as such repairs were in accordance with the Contractor's maintenance manuals and the workmanship was in accordance with recognized standards of the industry.

The warranty on any part or component of the coach shall also be void if SFMTA fails to conduct normal inspections and scheduled preventive maintenance procedures on the same part or component substantially as recommended in the Contractor's maintenance manuals, and such failure by SFMTA is the sole cause of the part or component failure.

FIGURE 10-1 HYBRID SUBSYSTEM AND COMPONENT WARRANTY

Items	Description	Years*	Mileage*
1	Engine and all items supplied by its manufacturer	5	300,000
2	Traction Motor and control system	5	300,000
3	Traction Generator and control system	5	300,000
4	Energy Storage System and control system	5	300,000
5	Drive and non-Drive Axles	5	300,000
6	Suspension	5	300,000
7	Brake System (excluding friction material)	3	150,000
8	Basic Body Structure	5	300,000
9	Structural Integrity and Corrosion Protection	12	500,000
10	Cooling System including electric fans	3	150,000
11	Heating and Ventilation Units	3	150,000
12	Power Steering System	3	150,000
13	Wheelchair Ramp System	3	150,000
14	Destination Sign and Voice Annunciation System	3	150,000
15	Door System	3	150,000
16	Air System, not limited to Compressor, Dryer, Tanks, Valves	3	150,000
17	Engine Starting System	3	150,000
18	Engine Power Supply (alternator)	3	150,000

*Whichever Occurs First

10.1.3 Exceptions To Warranty

The warranty shall not apply to scheduled maintenance items and items furnished by SFMTA, except insofar as such equipment may be damaged by the failure of a part or component for which the Contractor is responsible.

10.1.4 Detection Of Defects

If SFMTA detects a defect within the warranty periods defined in Section 10.1.1, it shall notify the Contractor's representative within a reasonable time after discovery of the defect. Within one (1) working day after receipt of notification, the Contractor's representative shall either agree that the defect is in fact covered by warranty, or reserve judgment until the subsystem or component is inspected by the Contractor's representative or is removed and examined at SFMTA property or at the Contractor's plant. At that time the status of warranty coverage on the subsystem or component shall be mutually resolved between SFMTA and the Contractor. Work

necessary to commence the inspection or repairs, under the provisions of Section 10.2, REPAIR PROCEDURES, shall commence within two (2) working days after receipt of notification by the Contractor, unless such time is extended by SFMTA, and shall be conducted in accordance with Section 10.2.1, Repairs by Contractor. Specific detail about a manufacturer repair shall be reported to the SFMTA within 24 hours of said repair.

If SFMTA and Contractor are unable to agree whether a defect is covered by the warranty provisions, SFMTA may direct the Contractor to commence repairs in accordance with Section 10.2.1, Repairs by Contractor, pending agreement by SFMTA and Contractor whether the repairs are covered by the warranty provisions. The Contractor shall promptly comply with such a request by SFMTA.

10.1.5 Fleet Defects

A fleet defect is defined as cumulative failures of any kind in the same components in the same or similar application where such items are covered by the warranty and such failures occur within the warranty period in at least twenty (20) percent of the vehicles delivered under this contract, once half of those vehicles delivered have been accepted and placed in revenue service. SFMTA shall have final approval of corrections or changes under these conditions.

10.1.5.1 Correction of Fleet Defects

The Contractor shall correct a fleet defect under the procedures specified in Section 10.2, REPAIR PROCEDURES. Within ten (10) days of receipt of notification of a fleet defect, unless SFMTA grants an extension, the Contractor shall provide SFMTA with a plan, acceptable to SFMTA, specifying how and when all coaches with defects shall be corrected. Said plan is subject to approval by SFMTA. In addition, after correcting such defects, the Contractor shall promptly undertake and complete a work program, acceptable to SFMTA, reasonably designed to prevent the occurrence of the same defect in all other coaches and spare parts purchased under this contract. Any proposed changes to a fleet defect work plan or program must be submitted to SFMTA for its approval. If (a) Contractor does not provide a plan for correction within the time specified above (or as extended by SFMTA); or (b) a specific declared fleet defect is not fully corrected within the time specified in the plan; or (c) the remainder of the coaches are not corrected in accordance with the Contractor's work program; SFMTA will assess liquidated damages in accordance with Section 19, Part V, Agreement, Volume 1.

The warranty on parts, components or sub-systems replaced as a result of a fleet defect shall be assigned a new warranty period equal to the original manufacturers or contract part warranty, whichever is longer, effective the replacement date. Any extended warranties shall commence at the conclusion of the new warranty period.

10.1.5.2 Voiding Of Warranty Provisions

The fleet defect provisions shall not apply to coach defects solely caused by noncompliance with the Contractor's recommended normal maintenance practices and procedures or caused solely by abuse of the equipment.

10.1.5.3 Exceptions To Warranty Provisions

Fleet defect warranty provisions shall not apply to damage that is a result of normal wear and tear in service. The provisions shall not apply to SFMTA-supplied items.

10.1.6 Contractor's Representative

The Contractor shall, at its own expense, provide qualified factory authorized service personnel at the SFMTA facilities from the time the first coach is delivered until 60 days after the last coach is accepted. The contractor's service personnel shall be available on request to assist SFMTA in the solution of engineering or design problems that are within the scope of the Technical Specifications and that may arise during the warranty period. Maintenance or repair instructions or suggestions from these representatives affecting warranty shall be in writing and directed to the SFMTA Project Manager. The Contractor's service personnel shall have authority to accept and approve warranty claims and make timely decisions affecting the repair of defects.

The Contractor shall be responsible for having a suitable service center for its representatives, located within San Francisco. The facility should have office space with functional communication equipment (telephone, fax and computer capabilities), a parts storage area, and working space for a minimum of two coaches. The service center should be secured in a manner to protect SFMTA property from theft, vandalism and natural disaster, to the extent possible.

On a daily basis, Contractor shall supply a record of Contractor's personnel working within SFMTA property to the SFMTA supervisor or superintendent on site. The record shall contain the following information: Date, Name, and SFMTA Vehicle ID number. Contractor shall inform SFMTA in advance of any modifications proposed on the vehicle during the warranty period.

SFMTA will work with the Contractor's representatives as much as possible to minimize the costs and time involved in conducting warranty repairs; however, due to space constraints and labor agreements, SFMTA cannot guarantee that any Contractor work will be performed on SFMTA property.

10.2 REPAIR PROCEDURES

The Contractor shall be responsible for all warranty-covered repair work. The Contractor or its designated representative shall secure parts and perform all affected warranty repair work. At its discretion, SFMTA may perform such work if it determines it needs to do so based on transit service or other requirements. The Contractor shall be responsible, and shall reimburse SFMTA, for all costs for warranty work performed by SFMTA personnel or by any contractor(s) hired by SFMTA to perform warranty work, as described in Section 10.2.2, Repairs by SFMTA.

10.2.1 Repairs By Contractor

When SFMTA requires the Contractor to perform warranty-covered repairs, the Contractor's representative must begin work necessary to effect repairs in a proper and timely manner, within two (2) working days after receiving notification of a defect from SFMTA. Whenever the Contractor makes warranty repairs, new parts, subcomponents and subsystems shall be used, unless the repair of original parts is authorized in writing by SFMTA. SFMTA shall make the coach available to complete repairs timely with the Contractor's repair schedule.

The Contractor shall provide, at its own expense, all spare parts, labor, tools and space required to complete repairs. The Contractor shall reimburse SFMTA for all expenses incurred, including labor for driving coaches, or towing charges for coaches transported, between SFMTA's facilities and Contractor's service center or the facilities of its subcontractors or suppliers. At SFMTA's option, the Contractor shall repair coaches at an offsite location, and not on SFMTA's property. If the coach is removed from SFMTA's property, the Contractor's representative shall

diligently pursue the acquisition of parts and repair procedures. The schedule and scope of the repairs shall be approved by SFMTA, and performed within ten (10) working days unless otherwise approved in writing by SFMTA

10.2.2 Repairs By SFMTA

If SFMTA elects to perform or procure a contractor to perform, the warranty-covered repairs, the following shall apply.

10.2.2.1 Parts Used

SFMTA shall use new parts, subcomponents and subsystems that Contractor shall provide specifically for this repair. Contractor shall stock the majority of parts, including those of its sub-suppliers. All parts shall be stamped or permanently marked with the OEM part number, and serial number if applicable. Warranties on parts used shall begin once the vehicle has been repaired. The OEM warranty will apply to the newly installed part with the manufacturer acknowledging the passed-through warranty.

SFMTA shall use parts or components available from its own stock only on an emergency basis. Monthly reports, or reports at intervals mutually agreed upon, of all repairs covered by warranty will be submitted by SFMTA to the Contractor for reimbursement or replacement of parts or components. The Contractor shall provide forms for these reports.

10.2.2.2 Contractor-Supplied Parts

The Contractor shall warehouse, at the Contractor's service center in San Francisco, all necessary parts to support its warranty obligations. The Contractor shall furnish parts for all warranty work, whether the warranty labor is performed by the Contractor or by SFMTA. Contractor shall deliver, prepaid, warranty parts for repairs within forty eight (48) hours of notification from SFMTA. Parts shall be delivered to SFMTA within a maximum seventy two (72) hour period after notification.

10.2.2.3 Defective Parts Return

The Contractor may request that defective parts or components covered by warranty be returned to the manufacturing plant. The Contractor shall pay the total cost for this action. Materials will be returned in accordance with the Contractor's instructions. Contractor shall provide such instructions to the SFMTA Project Manager at the beginning of the project.

The Contractor's representative shall meet with a SFMTA representative on a biweekly basis to determine which parts need to be returned to the manufacturer for evaluation, or which parts may be discarded.

10.2.2.4 Reimbursement For Labor

Contractor shall reimburse SFMTA for all warranty labor incurred by SFMTA. The amount shall be determined by multiplying the number of man-hours required to correct the defect by the current top mechanic's hourly overtime wage rate, which includes fringe benefits. Additionally, Contractor will be responsible for the cost of towing the coach if such action was necessary and if the coach was in the normal service area.

The wage rate, and therefore, the warranty labor rate, is subject to adjustment each year. The warranty labor rate shall be based on current SFMTA’s 4M mechanic, 7381, Automotive Mechanic, hourly rate plus fringe benefits and overhead.

In the event SFMTA deems it necessary to contract out for warranty repairs, the Contractor shall reimburse SFMTA for the actual cost of the repair, including charges for any warrantable parts, consequential parts or damages, labor, and towing or transportation. A 15% handling fee will be included on all outside invoices for warranty related services submitted to the Contractor.

Contractor shall reimburse SFMTA for warranty claims within thirty (30) days after each warranty claim has been submitted by SFMTA. If SFMTA does not receive payment within thirty (30) days, SFMTA may deduct the amount of the claim from the progress payments due to Contractor.

10.2.2.5 Reimbursement For Parts; Towing

In the event SFMTA uses its own parts for warranty repairs, the Contractor shall reimburse SFMTA for those parts, including all defective parts, components, and consequential parts supporting the warranty repair. The reimbursement shall be at the invoice cost of the parts or components at the time of repair and shall include applicable taxes plus a 15% handling fee.

The warranty will include the cost of towing the coach or a coach change if either was necessary because of the failure of a warranted part. Towing costs consist of SFMTA's established contracted tow truck charge including applicable taxes, any parts utilized in the transfer of the coach, any SFMTA labor expended, plus a 15% handling fee. The cost of a coach change will consist of the actual time spent at the established warranty labor rate.

Contractor shall reimburse SFMTA for warranty claims within thirty (30) days after each warranty claim has been submitted by SFMTA. If SFMTA does not receive payment thirty (30) days, SFMTA may deduct the amount of the claim from the progress payments due to Contractor.

10.2.3 Warranty After Replacement Or Repairs

The warranty on parts, components or sub-systems replaced as a result of a standard warranty repair shall be assigned a new warranty period equal to the original manufacturers or contract part warranty, whichever is longer, effective the replacement date. Any extended warranties shall commence at the conclusion of the new warranty period.

10.2.4 Failure Analysis

At SFMTA's request, the Contractor, at its cost, shall conduct a failure analysis of a failed part involved in a fleet defect or that is safety-related or a major component that could affect fleet operation that has been removed from coaches under the terms of the warranty. The analysis shall be documented and compiled into a report. The Failure Analysis Reports shall be delivered to SFMTA Project Manager within sixty (60) days of the receipt of failed parts.

10.3 DATA PROCESSING

10.3.1 Warranty And Computer Program

SFMTA's preference is to use the latest SPEAR Technologies Warranty Conditions, Claims and Payments modules for all tracking and submission of Warranty repairs and/or claims. Contractor shall accept the latest SPEAR Technologies generated Warranty Claim forms. All systems modifications, parts retrofits, and factory recalls must be documented for integration into warranty software. If an alternative Warranty technology is proposed, it shall be made available to the appropriate SFMTA staff without any restrictions.

10.3.2 Warranty Data

The warranty data shall be provided in Microsoft Excel format with the following data elements for Contractor's warranty and manufacturer warranties on all individual components and part(s). SFMTA will provide Vendor IDs to be used for this data. At the start of the project Contractor shall provide a complete list of all manufacturers and/or vendors that Contractor will use in building the vehicles. And SFMTA will provide Vendor IDs for use in the following warranty data.

10.3.2.1 Main header information

Warranty name, Vendor ID and name that is contracted to the warranty, and a vendor contract number if there is one.

10.3.2.2 Details of the warranty conditions

If the warranty is a Vehicle Class warranty, give the term value, unit of measure and reimbursement type.

If the warranty is system-related, give the term value, unit of measure, reimbursement type, whether the condition is prorated, and whether the warranty term value flows down to underlying attached components of the system.

If the warranty is a component-type of warranty, give the term value, unit of measure, reimbursement type, whether the condition is prorated, and whether the warranty term value flows down to underlying attached components.

If the warranty condition is an item warranty from Contractor or a subcontractor that manufactures parts for Contractor, then please provide the following information: Main header information as described above, Manufacturer part number, Part description, term value, unit of measure, term type, reimbursement type, and whether the condition is prorated.

Data and data processing procedures shall be approved by SFMTA to ensure compliance with these specifications and compatibility with SFMTA's data processing methods.

10.3.3 Database Information

Contractor shall supply data on the fleet to SFMTA in an electronic format in order to facilitate its loading into the SPEAR Technologies software system. This section provides layouts and data requirements for the required data elements. Contractor may supply this information in its choice of:

1) Microsoft Excel
2) Microsoft Access
3) Oracle tables

SFMTA has no preference among the above, but all provided database files must be in the same format. Files will be provided on CD-ROM or latest technology electronic data storage media using the Contractor's choice of format from the above options. At SFMTA's discretion, Contractor may transmit these files electronically directly to SFMTA.

10.3.3.1 Coach Master File

The Contractor shall provide a record for each coach at the time of delivery. This record shall be intended for import into SFMTA's own database system, shall have no access restrictions, and shall not be indexed. Contractor may supply a single file, which contains records for multiple coaches.

At a minimum, the following vehicle components shall be serialized and included in the record for the coach:

Engine	Steering gear box
Exhaust after-treatment device	Brake booster
Traction Motor	Front axle
Traction Generator	Rear axle
Differential	Hydraulic pump
Alternator	Transmission (as applicable)
Energy Storage System (ESS)	Wheelchair ramp
ECU (Electronic Control Unit or similar)	Any auxiliary modules such as a radio or GPS system, which is installed by the vendor
Destination sign(s)	Air compressor

The coach master file shall include at least the following data for all coach and all systems/components listed above:

SFMTA Equip Code	Description	Mfgr name	Mfgr part #	Model #	Serial #	Location on Coach or other Equip	UOM	Next Higher Assembly Equip Code
CHAR(35) *	CHAR(60)	CHAR (10)**	CHAR (30)	CHAR (25)	CHAR (30)	CHAR(5) ***	CHAR(2) *	CHAR(35) (if applicable)

* SFMTA will provide a coding structure for Contractor to use when creating this equipment master file
** SFMTA will provide a code and description list of Manufacturer values; Contractor will use the appropriate code from the list in this column
*** SFMTA will provide a code and description list of Location values; Contractor will use the appropriate code from the list in this column

Serialized tire "brands" table records will also be provided in the same format as above, but will be provided in a separate file. The Locations for tires on each coach are as follows (see ** note on above data table):

- Left front
- Right front
- Inner left rear
- Outer left rear
- Inner right rear
- Outer right rear

10.3.3.2 Illustrated Parts Catalog Master File

The Contractor shall provide SFMTA with the following database information on MPC-compliant latest technology electronic media for the Illustrated Parts Manual: The parts catalog data must be provided in Microsoft Excel rows and columns. Columns with data will consist of the following: Section, Graphic Title, Figure #, Item # (item 1, 2, 3 etc. on the graphic), Manufacturer Part Number, Part Description, QTY, Unit of Measure. For example see below.

Section	Fig #	Item #	Mfgr	Mfg Part #	Description	Qty	UOM	GRAPHIC_TITLE
(14)	(14)	(14)	CHAR (5)*	CHAR (30)	CHAR (60)	#(14,4)	CHAR (3)**	Coach-1-1-curb side locations

* SFMTA will provide a code and description list of Manufacturer values, Contractor will use the appropriate code from the list in this column

** SFMTA will provide a code and description list of UOM values, vendor will use the appropriate code from the list in this column

Example:

Section	Fig #	Item #	Mfgr	PN	Description	Qty	UOM	GRAPHIC_TITLE
2	1	1	Am Seat	500895	INSTALLATION DRIVER S BARRIER	1	EA	coach-1-1-curb side locations

Images – Parts catalog images must be provided in TIF format and they must comply with the CCITT3 compression level. Image naming will match Graphic Title contained in the record defined above.

The parts catalog data must be provided in Microsoft Excel rows and columns. Columns with data will consist of the following: Section, Graphic Title, Figure #, Item # (item 1, 2, 3 etc. on the graphic), Manufacturer Part Number, Part Description, QTY, Unit of Measure. For example see below.

Section #	Fig #	Item #	Mfgr	Mfg Part #	Description	Qty	UOM	GRAPHIC_TITLE
(14)	(14)	(14)	CHAR(5)*	CHAR(30)	CHAR(60)	#(14,4)	CHAR(3)**	coach-1-1-curb side locations

* SFMTA will provide a code and description list of Manufacturer values; Contractor will use the appropriate code from the list in this column

** SFMTA will provide a code and description list of UOM values; vendor will use the appropriate code from the list in this column

Example:

Section	Fig	Item	Mfgr	PN	Description	Qty	UOM	GRAPHIC_TITLE
2	1	1	Am Seat	500895	INSTALLATION DRIVER S BARRIER	1	EA	coach-1-1-curb side locations

Images – Parts catalog images must be provided in TIF format and they must comply with the CCITT3 compression level. Image naming will match Graphic Title contained in the record defined above.

- The Contractor shall provide SFMTA with the following database information on MPC-compliant latest technology electronic data storage media for all parts used on the coach:

Mfgr name	Mfgr part #	Description	Net price w/freight	UOM	Next Higher Assembly Part #
CHAR(5)	CHAR(30)	CHAR(60)	NUMBER(14,2)	CHAR(2)*	CHAR(30) (if applicable)

* SFMTA will provide a code and description list of Manufacturer values; Contractor will use the appropriate code from the list in this column.
** SFMTA will provide a code and description list of UOM values, vendor will use the appropriate code from the list in this column

All warranty repairs done by the coachbuilder at their shop must include a copy of the work performed to document work history by SFMTA into SPEAR Technologies software.

10.3.3.3 Publications Software

The Contractor shall provide the following on CD-ROM or latest technology electronic data storage media AutoCAD Drawings (only for the drawings contained in the Manuals), including all pertinent software and licenses.

1) Maintenance Manuals
2) Parts Manuals
3) Training Manuals
4) Wiring and Air Diagrams

10.4 SPARE PARTS

The Contractor shall furnish the spare parts and equipment required in the Price Proposal. The parts and equipment shall be identical to and totally interchangeable with like items supplied with the coaches. Delivery of these parts and equipment shall be completed prior to delivery of the first production coach. Spare parts shall be bar-coded with one of the five internationally recognized bar-coding standards. SFMTA shall review and approve Contractor bar code plan prior to bar coding spare parts.

Each coach shall be delivered with a preventative maintenance filter kit, specific to the coach.

Parts manuals (both paper (2 copies) and electronic Excel format) shall be completed prior to the delivery of the first production coach. Production of the remaining coaches shall not commence until SFMTA has reviewed and accepted the parts manuals.

The Contractor shall update the parts books (both paper and electronic Excel format) within thirty (30) days of any changes made for the 12 years after the initial production of the SFMTA coaches described in this request. The parts books shall have the following indexes sorted in the following order:

1) By part manufacturer's description
2) By coach manufacturer's description
3) By part manufacturer's part number
4) By coach manufacturer's part number
5) By IPC number

The price of all parts shall be included in each index by coach manufacturer's part number. The Contractor shall provide consistent pricing for six-month intervals and shall provide a corrected price sheet every six months. The detail of the parts books shall be to the level of providing bolt size, lengths and metal grades in addition to cross reference to the part manufacturer or component manufacturer's part number.
In the event there are updates which affect the durability, reliability or safety of spare parts and components supplied as part of this contract, or if there is a running change made during production, the Contractor shall exchange on a one-for-one basis the originally purchased parts with the new superseded parts within sixty (60) days of their release.

10.4.1 Recommended Spare Parts from Build Sheet

The Contractor shall submit a recommended spare parts list for SFMTA's use when planning and ordering spare parts and to support SFMTA's initial start-up for revenue operation. The quantities shall be based on the quantity of coaches on order at the time the parts list is generated, and shall be sufficient to cover SFMTA's reasonable needs for five (5) years.

Spare parts shall be interchangeable with their corresponding part. All spare parts shall be reconfigured to the latest revision during the warranty period. The recommended spare parts list shall take into consideration the potential for certain unused parts and assemblies to "age" and otherwise experience degradation in performance or reliability when installed. All such parts and assemblies should be clearly marked with date of manufacture, ideal storage conditions information, and shelf life date. This information tag should be clearly visible when the part, container, or assembly is stored.

10.4.1.1 Contractor's Recommendations/Prices

The Contractor's recommended spare parts list shall include the following:

I. Grouping by system, and special tool for stocking identification.
II. Generic name, trade name, description, rating, accuracy, Contractor's part number, original equipment manufacture's (OEM's) name, OEM's part number, drawing references, and correlation with the maintenance manuals.
III. Correlation for the recommended quantities with reliability requirements and lead time on the basis of the following classifications:

    A. Consumable – Parts with an expected life of less than five years.
    B. Wear – Parts that may be expected to require regular replacement under normal maintenance schedules, such as mechanical parts subject to continuous operation.
    C. One Shot – Parts that normally require replacement after performing their function one time, such as fuses.
    D. Long Lead (Three months or greater) – Parts that are not readily available from distributors or manufacturer, such as specially made.
    E. Exchange Assemblies – Assemblies that will be exchanges with failed units (or units that are not responding as specified) on the supplied equipment and that must be inventoried as complete assemblies.

IV. A cross-reference and indexing system for replacement components common to more than one subsystem (whether vehicle, test equipment, or special tool). Such components shall have only one part number.
V. Alternate sources of supply for all commercially available replacement parts.
VI. Current prices for all replacement parts.

10.4.2 Availability

The Contractor shall guarantee the availability of replacement parts for the coaches for at least a 15-year period after the date of acceptance of the last coach. Spare parts shall be interchangeable with the original equipment and shall be manufactured in accordance with the Quality Assurance Provisions in these Technical Specifications. Contractor shall guarantee availability of fourteen (14) day delivery or less from receipt of normal purchase order. Contractor shall not make exclusive agreements with sub-suppliers that would preclude SFMTA from purchasing components directly from sub-suppliers. Contractor shall be able to expedite delivery (e.g. overnight delivery) of emergency shipments for 85% of the coach parts.

Spare parts must be available to repair all electronic assemblies, subassemblies, and sub-subassemblies. Special provisions shall be made to supply those components that are not readily available on the commercial market (custom parts, for example). Any custom-made transformers, inductors, programmable components, or other devices containing proprietary firmware, shall be made available to SFMTA as spare parts. When the original manufacturer is no longer able to supply the spare IC's, the associated proprietary firmware, transformer design specifications, and other relevant detail must be provided to SFMTA at that time.

SFMTA will work with the contractor's representative as much as possible to minimize the costs and time involved with conducting warranty repairs, however due to space constraints and labor agreements; SFMTA cannot guarantee that any contractor work will be performed on SFMTA property.

11 RELIABILITY, MAINTAINABILITY, SAFETY

The Contractor shall establish and maintain an efficient reliability program to maintain the Mean Distances Between Failures (MDBF) as specified in Section 11.2, VEHICLE RELIABILITY REQUIREMENTS. The reliability engineering tasks shall focus on the prevention, detection and correction of reliability design deficiencies, weak parts and overall work quality defects. Reliability engineering shall be an integral part of the vehicle design process, including design changes. The reliability program shall monitor and control sub-suppliers' design and manufacture of parts to ensure compliance with the reliability sections and the contract terms.

11.1 SERVICE LIFE

The coach, including all subsystems, shall be designed to operate in transit service for at least 12 years or 500,000 miles. It shall be capable of operating at least 40,000 miles per year, up to and including its 12th year. Components and structural members shall be designed to withstand the loads and motor torque reactions expected in revenue service on any route in San Francisco.

11.2 VEHICLE RELIABILITY REQUIREMENTS

The vehicles shall be designed to meet the service goal for a Mean Distance Between Failures (MDBF) of 8,000 miles. The Contractor shall demonstrate compliance with these reliability requirements in both analysis and in revenue service of the first 10 (ten) accepted production coaches delivered during the first year or the first 40,000 miles.

11.3 FAILURES

Failure definitions are for the purpose of reliability demonstration testing, specification compliance and warranty administration.

11.3.1 Accountable Failures

Failures that are determined by the Failure Review Board to have been caused by a design flaw or defect in the vehicle subsystems or components shall be tallied against the applicable warranty and fleet defect provision in this contract. Failures that are tallied for calculating the achieved reliability are those that meet the following criteria:

- They are detected on the equipment during any period the test is in process and test time is being accumulated and recorded - all safety-critical failures are accountable;
- They are verified by subsequent re-testing or investigation; and

They are independent (primary) failures. In addition, an item failure will be accountable and included in the MDBF calculations when one or more of the following conditions exists:

i. Inability of the equipment to attain or sustain minimum specified output requirements;
ii. Item failure symptoms which are detected under operations in test and recur in subsequent re-testing, but diagnosis and determination of the basic cause cannot be accomplished, or
iii. Multiple independent (primary) item failures detected on the equipment during measurement test time will be individually accountable.

11.3.2 Non-Accountable Failures

Item failures will be excluded from the MDBSF computations when one of the following conditions exist:

- The item failure cannot be duplicated during subsequent re-test, and the cause cannot be determined by investigation and analysis. SFMTA will judge the adequacy of the Contractor's analysis for this determination;
- The item failure is a dependent (secondary) failure resulting from an independent (primary) failure;
- The item failure is caused by mishandling, abuse, improper storage or accidental damage;
- The item failure is the direct result of improper test procedure or improper test equipment;
- The failure is a recurrence of one thought to have been corrected by adjustment or repair, and occurs within 20 test hours of the original failure; or,
- The item failure occurred in a unit that had been subjected to verified operational or environmental stresses beyond design requirements.

11.4 FAILURE REVIEW BOARD

A failure review board with members from SFMTA and the Contractor shall be convened to periodically review and determine the relevance of each failure and to recommend appropriate corrective action, both for vehicles undergoing reliability demonstration testing and for those under warranty. The failure review board shall be in effect during the complete coach period of the warranty, and as necessary to resolve fleet defects.

11.5 RELIABILITY PROGRAM PLAN

The Contractor shall submit a formal Reliability Program Plan to the SFMTA Project Manager/Representative for review and approval (Reference Section 13.1, PREFERRED DELIVERY SCHEDULE). The Reliability Program Plan shall identify the Contractor's methodology for attaining and demonstrating compliance with the reliability requirements of this section. The Reliability Program Plan shall address the following specific topics as a minimum:

A. Contractor's organization responsible for managing the reliability program;
B. Reliability program objectives;
C. Reliability design techniques
D. Reliability analysis techniques;
E. Reliability demonstration test (burn-in) plan;
F. Reliability controls for Contractor, subcontractors and vendors;
G. Fault reporting system for collecting and analyzing equipment failure data;
H. Reliability status reporting.

11.6 MAINTAINABILITY

The Contractor shall establish and maintain an efficient maintainability program to support the maintainability requirements as specified in Section 11.6.4, Maintenance And Inspection of the contract. Maintainability engineering shall be an integral part of the vehicle design process, including design changes. Methods shall be taken to assure the sub-suppliers efforts are consistent with the overall system requirements.

All systems or components serviced as part of periodic maintenance or whose failure may cause a physical safety hazard or road call shall be readily accessible for service and inspection. To the extent practicable, removal or physical movement of components unrelated to the specific maintenance or repair tasks involved shall be unnecessary. Relative accessibility of components, measured in time required to gain access, shall be inversely proportional to frequency of maintenance and repair of the components. Accessibility to components needing frequent maintenance shall be considered during the design reviews. The body and structure of all coaches shall be designed for ease of maintenance and repair. Ease of repair shall correspond to the vulnerability of the item to damage in service.

All maintenance manuals shall be provided to SFMTA (Reference Section 9.2, PUBLICATIONS: MAINTENANCE MANUALS, ILLUSTRATED PARTS MANUALS, OPERATOR'S MANUALS, & VEHICLE RECORD BOOKS).

11.6.1 Tools

Each coach shall be designed for disassembly, re-assembly, servicing, and maintenance by use of tools and items, which are normally available as commercial standard items. Electronics assemblies and subassemblies shall also be maintainable by the use of standard, commercially available test equipment and maintenance tools. The Contractor must provide any special tools or special information that is needed to repair and reassemble electronic assemblies. Special tools not listed in ATTACHMENT 13: Special Tools List shall be recommended to SFMTA by Contractor for consideration. Special tools shall be subject to approval by SFMTA and the Contractor shall supply jacks or dollies in accordance with ATTACHMENT 13: Special Tools List. All grease fittings shall be capable of being serviced from a pitted area. Jacks or dollies shall be supplied to remove the engine, energy storage system, traction motor, traction generator, ramp and other equipment boxes.

11.6.2 Electrical

Electrical subsystems shall consist of replaceable units so that each major component, apparatus panel, or wiring harness is easily separable with standard hand tools or by means of connectors. Each unit, except the main body wiring harness, shall be removable and replaceable in less than 30 minutes by a 4M mechanic.

11.6.3 Tire

A 4M mechanic shall complete jacking and changing any one tire in less than 30 minutes from the time the coach is approached.

11.6.4 Maintenance And Inspection

Scheduled maintenance or inspection tasks as specified by the Contractor shall be within the prevailing industry practices and subject to SFMTA approval. Scheduled maintenance tasks shall be related and shall be grouped in maximum mileage intervals. Routine scheduled maintenance actions shall not be required at intervals of less than 6,000 miles, except for routine daily service performed during fueling operations. Higher levels scheduled maintenance tasks shall occur at even multiples of 6,000 miles. It shall be possible for 4M mechanic to accomplish the scheduled maintenance or inspection tasks as specified by the Contractor. Scheduled maintenance tasks shall be related and shall be grouped in maximum mileage intervals. Higher levels of scheduled maintenance tasks shall occur at even multiples of mileage for lower-level tasks.

11.6.5 Hazards Definitions
A hazard is defined as any real or potential condition that can cause injury or death, or damage to or loss of equipment or property.

11.6.6 System Safety Program Objectives
The contractor shall have the responsibility of developing a System Safety program that shall as a minimum have as its objective minimizing hazards as defined in Section 11.6.5, Hazards Definitions. The System Safety program shall also be consistent with FTA guidelines, which certify the vehicle acceptable for revenue service and maintenance. System safety engineer/personnel shall be identified and shall be involved throughout the entire program. System safety engineer/personnel shall be responsible for problem identification, resolution reporting and submitting design changes affecting safety to the SFMTA Project Manager / Representative for approval.

11.6.7 System Safety Criteria
Criteria for system design and subsequent operation procedures shall assure that system safety objectives for vehicles are implemented throughout design development, testing, delivery, operations and maintenance. Safety of passengers, mechanics and operator shall be taken into full consideration.

Potential or actual hazards that have been identified through analysis shall be limited in accordance with the following order of precedence:
- Design for minimum hazard
- Use of safety devices
- Use of warning devices
- Use of special procedures.

11.6.8 System Safety Data
Contractor shall provide appropriate system safety information and procedures for inclusion in training instructions, lesson plans and other publications.

12 QUALITY ASSURANCE

12.1 CONTRACTORS IN-PLANT QUALITY ASSURANCE REQUIREMENTS

12.1.1 Quality Assurance Organization

The Contractor shall establish and maintain an effective in-plant quality assurance organization. It shall be a specifically defined organization directly responsible to the Contractor's top management.

12.1.1.1 Control

The quality assurance organization shall exercise quality control over all phases of production from initiation of design through manufacture to preparation for delivery. The organization shall also control the quality of supplied articles.

12.1.1.2 Authority and Responsibility

The quality assurance organization shall have the authority and responsibility for quality control, personnel inspection planning, establishment of the quality control system, and acceptance or rejection of materials and manufactured articles in the production of the coaches. These responsibilities include assuring that all components meet the engineering requirements for reliability, safety, and maintainability.

12.1.2 Quality Assurance Organization Functions

The functions of the quality assurance organization shall include, but not be limited to, the following:

12.1.2.1 Work Instructions

The quality assurance organization shall verify inspection operation instructions to ascertain that the manufactured product meets all prescribed requirements.

12.1.2.2 Records Maintenance

The quality assurance organization shall maintain and use records and data essential to the effective operation of its program. These records and data shall be available for review by the Resident Inspector(s). Inspection and test records for this procurement shall be available for a minimum of 2 years after inspections and tests are completed.

12.1.2.3 Corrective Actions

The quality assurance organization shall detect and promptly assure correction of any conditions that may result in the production of defective coaches. These conditions may occur in designs, purchases, manufacture, tests, or operations that culminate in defective supplies, services, facilities, technical data, or standards.

12.1.3 Standards and Facilities

The following standards and facilities shall be basic in the quality assurance process.

12.1.3.1 Configuration Control

The Contractor shall maintain drawings, assembly procedures, and other documentation that completely describe a qualified coach that meets all of the specification requirement options and special requirements of this procurement. The quality assurance organization shall verify that each coach is manufactured in accordance with these controlled drawings, procedures and, documentation.

12.1.3.2 Measuring And Testing Facility
The Contractor shall provide and maintain the necessary gauges and other measuring and testing devices for use by the quality assurance organization to verify that the coaches conform to all specification requirements. These devices shall be calibrated at established periods against certified measurement standards that have known valid relationships to national standards.

12.1.3.3 Production Tooling As Media Of Inspection
When production jigs, fixtures, tooling masters, templates, patterns, and other devices are used as media of inspection, they shall be proved accurate at formally established intervals and adjusted, replaced, or repaired as required to maintain quality.

12.1.3.4 Equipment Use By Resident Inspector(s)
The Contractor's gauges and other measuring and testing devices shall be made available for use by the Resident Inspector(s) to verify that the coaches conform to all specification requirements. If requested, the Contractor's personnel shall be made available to operate the devices and to verify their condition and accuracy.

12.1.4 Control of Purchases
The Contractor shall maintain quality control of purchases.

12.1.4.1 Supplier Control
The Contractor shall require that each supplier maintain a quality control program for the services and supplies that it provides. The Contractor's quality assurance organization shall inspect and test materials provided by suppliers for conformance to specification requirements. Materials that have been inspected, tested, and approved shall be identified as acceptable to the point of use in the manufacturing or assembly processes. Controls shall be established to prevent inadvertent use of nonconforming materials.

12.1.4.2 Purchasing Data
The Contractor shall verify that all applicable specification requirements are properly included or referenced in purchase orders of articles to be used on SFMTA coaches.

12.1.5 Manufacturing Control
The Contractor shall ensure that all basic production operations, as well as all other processing and fabricating, are performed under controlled conditions. Establishment of these controlled conditions shall be based on the documented work instructions, adequate production equipment, and special working environments as necessary.

12.1.5.1 Completed Items
A system for final inspection and test of complete vehicles and the spare parts package shall be provided by the quality assurance organization. It shall measure the overall quality of each complete item.

12.1.5.2 Nonconforming Materials
The quality assurance organization shall monitor the Contractor's system for controlling nonconforming materials. The system shall include procedures for identification, segregation, and disposition.

12.1.5.3 Statistical Techniques
Statistical analysis, tests, and other quality control procedures may be used when appropriate in the quality assurance processes.

12.1.5.4 Inspection Status
A system shall be maintained by the quality assurance organization for identifying the inspection status of components and complete SFMTA coaches. Identification may include cards, tags, or other normal quality control devices.

12.1.6 Inspection System
The quality assurance organization shall establish, maintain, and periodically audit a fully documented inspection system. The system shall prescribe inspection and test of materials, work in progress, and completed articles. At a minimum, it shall include the following controls.

12.1.6.1 Inspection Stations
Inspection stations shall be at the best locations to provide for the work content and characteristics to be inspected. Stations shall provide the facilities and equipment to inspect structural, electrical, hydraulic, and other components and assemblies for compliance with the design requirements.

Stations shall also be at the best locations to inspect or test characteristics before they are concealed by subsequent fabrication or assembly operations. These locations shall minimally include, underbody structure completion, body framing completion, body prior to paint preparation, water test before interior trim and insulation installation, traction motor installation completion, subsystem components, underbody dress-up and completion, coach prior to final paint touch-up, coach prior to road test, and coach after final road test.

12.1.6.2 Inspection Personnel
Sufficient trained inspectors shall be employed to ensure that all materials, components, and assemblies are inspected for conformance with the coach design and specifications.

12.1.6.3 Inspection Records
Acceptance, rework, or rejection identification shall be attached to inspected articles. Articles that have been accepted as a result of approved materials review actions shall be identified. Articles that have been reworked to specified drawing configurations shall not require special identification. Articles rejected as unsuitable or scrap shall be plainly marked and controlled to prevent installation on the coach. Articles that become obsolete as a result of engineering changes or other actions shall be controlled to prevent unauthorized assembly or installation. Unusable articles shall be isolated and then scrapped.

Discrepancies noted by the Contractor or Resident Inspector(s) during assembly shall be entered by the inspection personnel on a record that accompanies the major component, subassembly, assembly, or coach from start of assembly through final inspection. Actions shall be taken to correct discrepancies or deficiencies in the manufacturing processes, procedures, or other conditions that cause articles to be in non-conformance with the requirements of the contract specifications. The inspection personnel shall verify the corrective actions and mark the discrepancy record. If discrepancies cannot be corrected by replacing the nonconforming materials, the Resident Inspector(s) shall approve the modification, repair, or method of correction.

12.1.6.4 Quality Assurance Audits

The contractor's quality assurance organization shall establish and maintain a quality control audit program. The contractor shall submit a Quality Assurance Plan for SFMTA review and approval prior to the commencement of building the first coach of this contract. Records of this program shall be subject to review by SFMTA representatives during the manufacture of coaches for this contract.

12.1.6.5 First Article Inspection

The first article coach shall undergo a detailed inspection by SFMTA personnel or representatives. The purpose of this inspection will be to ensure that the coach has been built to approved engineering and that all agreed changes have been incorporated. The configuration established at this inspection shall become a benchmark for all future production coaches.

Dependent on circumstances, this first built coach may have to participate in the Federal Coach Testing Program "Altoona Test" to qualify this procurement for federal funding. The contractor shall inform SFMTA of the status of the proposed equipment in regards to the required testing prior to its manufacture.

SFMTA may require this coach be kept at the manufacturing plant to insure its availability as a "template" in the event there is a question concerning the production coaches are conforming to this pattern.

Coach inspection snag list will be transmitted to SFMTA and the assembly line for immediate production corrections, so as not to have repeated delivery of coaches with repeat snags. Corrections shall be made at the manufacturing facility prior to delivery and contractor shall provide a corrective action report to SFMTA explaining what was done to prevent these from occurring on the production buses.

12.1.7 Resident Inspector

Resident Inspector (s) shall represent SFMTA at the Contractor's plant. They shall monitor, in the Contractor's plant, the manufacture of transit coaches built under the procurement. The Resident Inspector(s) will be authorized to approve the pre-delivery acceptance tests, and to release the coaches for delivery. Upon request to the quality assurance manager/supervisor, the Resident Inspector(s) shall have access to the Contractor's quality assurance files related to this procurement. These files shall include drawings, material standards, parts lists, inspection processing and reports, and records of defects.

No less than 30 calendar days prior to the beginning of coach manufacture, the Resident Inspector(s) will meet with the Contractor's quality assurance manager/supervisor. They will review the inspection procedures and checklists. The Resident Inspector(s) may begin monitoring coach construction activities 2 weeks prior to the start of SFMTA coach fabrication.

The Contractor shall provide office space for the Resident Inspector(s) in proximity to the final assembly area. This office shall be equipped with desks, two (2) telephones, file cabinets, chairs, and clothing lockers sufficient to accommodate the Resident Inspector staff. Office accommodations shall be at least equivalent to those utilized by the Contractor's staff.

The presence of the Resident Inspector(s) in the plant shall not relieve the Contractor of its responsibility to meet all of the requirements of this procurement.

12.1.8 Compliance Demonstration

Upon written request of the SFMTA Project Manager/Representative the Contractor shall demonstrate compliance with any requirement of these specifications. Requests shall normally be made such that the demonstration can be scheduled in advance of the delivery of the prototype and production coaches. Other demonstrations shall be requested after delivery should the SFMTA Project Manager/Representative suspect that the prototype or production coaches are not in conformance to these specifications. The demonstrations shall consist of formal tests conducted on the prototype and/or representative production coaches and witnessed by the SFMTA Project Manager/Representative. In lieu of conducting tests of a destructive nature, the demonstration requirement may be satisfied by a comprehensive analysis of sufficient scope and quality to show specification compliance. The burden of demonstrating compliance rests on the Contractor but is subject to approval by the SFMTA Project Manager/Representative or Project manager. Contractor shall be responsible for associated costs to demonstrate compliance and any work required to correct any non-compliance conditions.

12.2 TEST REQUIREMENTS

12.2.1 General

This section defines and establishes the requirements for comprehensive testing of the coaches to be developed and managed by the Contractor. SFMTA or its authorized representatives will have the option of overseeing all testing. The tests shall ensure proof-of-design and shall determine the compliance with the following requirements:

- Duty Cycle
- Performance
- Dimensional
- Accessibility (ADA)
- Noise Control (Audible and Electronic)
- Contract Compliance
- Reliability and Maintainability

The tests shall also ensure that the production vehicles, including all components and subsystems, will function as required in the SFMTA environment. Modifications to the initial hybrid system integration design, system programming, and specification of related subsystems (including rear axle ratio), shall be made as needed in order to best meet these requirements. Reliability will be emphasized. Design qualification, production conformance, and acceptance testing on all vehicle components and subsystems are required and subject to review and approval by SFMTA. Criteria for evaluating coaches in the pre-delivery and post-delivery tests will be uniform.

12.2.1.1 Submittals

The following items shall be submitted for SFMTA approval:

- Test Program
- Test Procedures
- Test Reports, Training manuals, O&M manuals

12.2.1.2 Test Program

The test program shall include all tests required to verify compliance with these specifications. In general, all specified requirements shall be subject to verification by test. Tests, by definition,

include visual observation, non-destructive examination, equipment operation under extreme environmental conditions, accelerated-life operation, normal performance, abnormal performance, observation of normal operation and maintenance, and results of induced failures/faults.

The Test Program shall identify all tests by reference to the appropriate specification section. The test program shall cover all Contractor's and their sub-supplier's tests and location of tests to be completed prior to coach delivery, and identify all testing to be conducted by the Contractor on SFMTA's property prior to acceptance. SFMTA is requiring brake and noise test programs be completed in the SFMTA's San Francisco service area. As part of this contract, for tests which the contractor proposes will be performed outside of the SFMTA's San Francisco service area, the contractor shall provide travel and expenses for two SFMTA representative witnesses. Rates and duration shall be based on accepted FTA guidelines for the area being traveled to. The Contractor shall manage the testing and reporting process. The Test Program shall provide, for each major subsystem, a detailed explanation of how the requirements of this section will be met. Cases where the Contractor intends to meet the requirements of this section through some means other than testing shall be identified in the Test Program.

12.2.1.2.1 Test Facilities

The Contractor shall provide competent personnel in appropriate technical disciplines to ensure an uninterrupted test program. Where appropriate, tests shall be conducted under simulated operating conditions. Special tools, test equipment, instrumentation, data processing, and spare parts required during testing shall be furnished by the Contractor.

12.2.1.2.2 Test Procedures

Contractor shall submit an overall test procedure for each design qualification and conformance tests and each acceptance test for approval 30 days prior to the scheduled date of the test. The Contractor shall provide all equipment and instrumentation required to conduct tests. Training, to observe or participate in the test, if required by SFMTA, shall be provided by the Contractor. The test procedures shall contain at least the following:

- Test objective
- Success/failure criteria and justification for criteria in quantitative terms
- Sequence of testing
- Equipment and instrumentation required
- Test setup, description, and diagrams
- Test methodology
- Data evaluation procedure
- Type of report or data to be submitted to SFMTA.

With prior approval, the Contractor may submit proven existing procedures that differ from this format. At least 30 days prior to each test, the Contractor shall notify the SFMTA Project Manager/Representative in writing of the date, time, and location the test will be performed. SFMTA or its authorized representative will have the right to witness any and all tests. The tests specified herein are specific tests requested by SFMTA. The Contractor with SFMTA direction and approval is required to develop a complete list of design and component qualification test and pre and post delivery tests. The Contractor and its subcontractors may perform additional testing, as they deem necessary.

12.2.1.2.3 Test Reports

Within 30 days after successful completion of each test, a report shall be provided that summarizes results, analyses, and corrective actions. Reports shall include photographs, charts, and additional data to support the test results. Reports must include a statement that certifies conformance to specified requirements. Should submitted data not be acceptable to SFMTA, the Contractor shall complete the tests as specified with no increase in contract cost or extension of the delivery schedule. The reports of each test shall be included in the appropriate Coach History Book.

12.2.1.3 Design And Component Qualification And Conformance Testing

The Contractor shall demonstrate that each component supplied meets the requirements of these specifications. In cases where testing costs would be excessive, or where test results might be inconclusive, design integrity may be demonstrated through analyses In cases where the component or subsystem in question is substantially similar in design and application to equipment previously used in transit service, the design may be qualified through submission of revenue service data.

In all other cases, the Contractor shall conduct a proof-of-design test that demonstrates that the requirements of these specifications are met. These tests need not be repeated if they are successfully completed and witnessed. If a test is failed, the Contractor shall make any necessary modifications to the equipment and rerun the test until it is successfully completed.

12.2.1.3.1 Design And Component Qualification Through Analysis

If tests to demonstrate compliance with certain requirements are shown to be excessively expensive or potentially inconclusive, approval may be given to waive the requirements for certain design qualification and conformance tests. The process for qualification through analysis is as follows:

a. Submit a waiver request that details cost excessiveness, the specific design attributes that will be qualified in through design analysis
b. Submit design qualification analysis report with sufficient documentation (i.e. designs, calculations, standards references, etc.)
c. Obtain approval during the design review process.

12.2.1.3.2 Waiver For Proven Equipment

If the component or subsystem in question is substantially identical in design to equipment previously deployed in other transit applications, it may not be necessary to conduct design qualifications tests on that equipment. To obtain a waiver for proven equipment, the Contractor must submit:

(a) A list of the quantities and locations of current equipment installations
(b) A description of all relevant differences in the equipment and the equipment's application vis-à-vis the requirements of these specifications and other installations
(c) Results of any relevant design qualification tests that have previously been conducted on the equipment
(d) Cost reduction analysis

Based on the data submitted, SFMTA will determine whether to waive the requirements for design qualification testing. Specific requirements for each set of equipment shall be

considered individually, and it will be possible for certain tests to be waived while others may still be required.

12.2.1.3.3 Design And Component Qualification Testing

These tests shall be run on production equipment that has passed production acceptance testing. These tests shall stress the equipment under environmental conditions at least as severe as those described in Section 1, OVERALL REQUIREMENT. While stressed in this way, it shall be demonstrated that the equipment performs its intended functions without failure.

12.2.1.3.4 Subsystem Qualification Testing

Major subsystems shall be assembled separate from the vehicle and shall be tested to verify compliance with these specifications. Related subsystems may be integrated and tested together to verify compliance of the individual subsystems and to verify the design of the interface between them.

The interfaces between equipment and between subsystems are viewed as crucial aspects of the system design. To verify these interfaces, it is preferred that subsystem tests be designed to include as many system interfaces as possible. Any equipment attributes that can be tested during subsystem testing need not be tested again at the component level.

12.2.1.4 Acceptance Testing

Fully documented acceptance tests shall be performed on all assemblies and the completed vehicle. Acceptance test procedures shall be updated based on experience gained from previous qualification testing or vehicle operation. Test procedures shall be expanded to focus on areas that prove to be, or have historically been defective, deficient, or unreliable.

Tests shall be conducted at the point of manufacture. The tests shall ensure that each unit is produced to at least the same quality level as the unit presented for the first article inspection.

12.2.2 Prototype Tests

The prototype test program shall consist of all tests outlined in Section 12.2.3, Pre-Delivery Tests, through Section 12.2.4, Post-Delivery Tests. The prototypes shall be accepted by SFMTA as a production coach only if it is identical to the accepted production coaches. The prototypes shall have adjustable mounts for the interior and exterior mirrors, fareboxes and other components as requested by SFMTA to determine their optimum location for operators. The hybrid system and related subsystems shall be adjustable or modifiable to the extent that vehicle reliability and performance can be optimized during testing while simulating in-service conditions. Final location of these components will be determined prior to assembly of production coaches.

12.2.2.1 Prototype Pre-Delivery Tests

Factory tests shall include those tests specified in Section 12.2.3, Pre-Delivery Tests. In addition, the prototypes shall be instrumented during road tests.

12.2.2.2 Prototype Post-Delivery Tests

Post-delivery tests shall include the following two phases. During Phase I, the prototype shall be instrumented to record time, speed, acceleration, distance, APU sub-system coolant temperatures, and brake pressure, and loaded with weights to simulate passenger load. While instrumented and loaded, the coach shall be tested on the routes specified in Section 1.4, DUTY CYCLE, to verify that the performance requirements in these specifications are being achieved.

All records of test results shall be readable on a standardized PC labeling/language throughout. Computer, stored on a CD-ROM, and shall be presentable on 8-1/2 by 11 paper.

In Phase II, the prototype shall be placed into simulated revenue service or actual revenue service on routes, determined by SFMTA for up to 9,000 miles or 3 months. This purpose of this test is to determine any changes or adjustments needed to achieve optimum vehicle performance, meet the desired MDBF and determine the final configuration of the production coaches, including the prototype coach.

12.2.3 Pre-Delivery Tests

The Contractor shall conduct acceptance tests at its plant on each coach following: 1) completion of manufacture and 2) before delivery to the SFMTA. These pre-delivery tests shall include visual and measured inspections, as well as testing of the total coach operation and water tightness. The tests shall be conducted and documented in accordance with written test procedures to ensure that the completed coaches have attained the desired quality and have met the requirements of these Technical Specifications.

The pre-delivery tests shall be scheduled and conducted with sufficient notice so that they may be witnessed by the Resident Inspector(s), who may accept or reject the results of the tests. The results of pre-delivery tests, and any other tests, shall be filed with the assembly inspection records for each coach. The under floor equipment shall be made available for inspection by the Resident Inspector(s), using a pit or coach hoist provided by the Contractor. A hoist, scaffold, or elevated platform shall be provided by the Contractor to easily and safely inspect coach roofs. Delivery of each coach shall require written authorization of the Resident Inspector. Release of each coach for delivery shall require written authorization of the Contractor. An executed copy of the authorizations shall accompany the delivery of each coach. SFMTA will not furnish an operator for these pre-delivery tests.

12.2.3.1 Visual And Measured Inspection

Visual and measured inspections shall be conducted with the coach in a static condition. The purpose of the inspection is to verify overall dimensional and weight requirements, to verify that required components are included and are ready for operation, and to verify the function of components and subsystems that are designed to operate with the coach in a static condition.

12.2.3.2 Water tightness

Each coach shall be tested as per Section 2.1.7, Exclusion of Water.

12.2.4 Post-Delivery Tests

The SFMTA Project Manager/Representative may conduct post-delivery tests on each delivered coach. The post-delivery tests will include visual inspection and coach operation.

Coaches that fail to pass the post-delivery tests are subject to non-acceptance. The SFMTA Project Manager/Representative will record details of all defects on the appropriate test forms and will notify the Contractor of non-acceptance. The defects detected during these tests shall be repaired according to procedures set forth in Section 67 of the Sample Agreement, Part V, of Volume 1.

12.2.4.1 Visual Inspection

The post-delivery visual inspection is similar to the inspection at the Contractor's plant and will be conducted with the coach in a static condition. Any deficiencies, defects or visible delivery damage will be identified and recorded during the visual inspection of each coach.

12.2.4.2 Post-Delivery Acceptance Test

Prior to acceptance, each vehicle shall have a minimum of 500 driven miles. This mileage can be accumulated during the drive away trip.

During the drive away trip, the speed and operation en route shall be controlled to conform to the recommendations of the system suppliers and tire supplier so as to prevent damage to any part of the coach. At the time of delivery, a written report shall be submitted to SFMTA by the Contractor listing all incidents and unusual coach performance as well as the quantity of fuel, oil, coolant and other fluids added to the coach during the trip. In the event the drive away trip of any coach is interrupted, for any reason, the Contractor shall include in the report a description of the nature of the service or repair, and the cause and restoration, if any, required to continue the trip. Failure to submit this written report will result in SFMTA not accepting delivery of the coach.

12.3 PROJECT PLANNING, SCHEDULING AND CONTROL

12.3.1 Introduction

This section specifies the requirements for project planning, scheduling and progress reporting to be performed by the Contractor in conjunction with the Contract work. Critical Path Method scheduling (CPM) shall be employed by the Contractor for planning, scheduling and reporting all work required by the Contract Documents.

12.3.2 Definition And Clarifications

Baseline Schedule: The detailed CPM schedule, prepared by the Contractor, indicating the Contractor's plan for executing the Contract work. This schedule shall include the Contractor's logic network drawings, all schedule network reports and all schedule resource reports. The Baseline Schedule shall conform to all requirements of the Contract Documents.

The Baseline Schedule shall be revised as necessary to incorporate approved Contract modifications. The Contractor's performance or other avoidable delays shall not be considered justification for Baseline Schedule revision.

Current Schedule: The updated logic network and supporting reports indicating actual progress to date and forecasted logic and progress for the remaining work. The update will be, at a minimum, to the same level of detail as the Baseline Schedule. Monthly updates of the current schedule shall be a contract requirement. The City may withhold payment if this schedule update is delinquent.

Supplemental Schedule(s): Detailed schedules prepared by the Contractor, at the request of the SFMTA Project Manager / Representative, to substantiate proposed Contractor changes that may have a schedule impact.

Summary Level Bar Chart: A summary level bar chart schedule encompassing the entire Contract and indicating all Contract required milestones or Contractor identified milestone events.

Monthly Plan: A detailed plan of the work, in bar-chart format, to be accomplished in the coming weeks. Relationships between the Monthly Plan and Current Schedule activities shall be identified.

As-Built Schedule: The resulting schedule incorporating all actual activity durations, milestone completions and Contract extensions as accomplished or incurred during the Contract duration. The Contractor shall submit this As-Built Schedule to the City at the completion of the Contract work.

Work Day: Any day except Saturdays, Sundays, US legal holidays. If multiple shifts per day or extended hours (more than eight hours per shift) are scheduled, this is to be noted with the particular scheduled activities to which this applies.

Use of Float: Float identified in the baseline, or Current Schedule is jointly owned by the City and the Contractor. Its use must be approved in the scheduling update process.

12.3.3 Description Of Submittals

A Baseline Schedule and Management Plan shall be submitted to SFMTA for review and approval (Reference Section 13.1, PREFERRED DELIVERY SCHEDULE).

12.3.3.1 Baseline Schedule

A Baseline Schedule shall be submitted by the Contractor and shall include the following aspects:

- The program logic to be initially reviewed and approved by SFMTA prior to Initial Design Review.
- The costs and resources, as required, attributable to each activity of the accepted Baseline Schedule. Costs shall be allocated by bid item and shall match bid amounts.
- All activities related to major subsystems for the Prototype and Production coaches.

The schedule documents, reports, lists, computer software with documentation and electronic files are required with each submittal. The Baseline Schedule shall be developed using Microsoft Project Software or approved equal.

12.3.3.2 Management Work Plan

The Management Work Plan shall include protocols, procedures, and assignments of responsibility for key personnel and correspondence forms for all phases of the contract and all project activities for the duration of the contract. Once the Management Work Plan is approved, key personnel shall not be substituted without approval from SFMTA. If the Contractor plans to substitute key personnel, a 30-day advance notice, and qualification of new personnel shall be required. At the request of SFMTA, or when approved changes are made, the Contractors Management Work Plan shall be updated to include the latest revision to the project scope or other changes in project circumstances.

12.3.4 Early Completion Schedule

The Contractor may submit a schedule, which contains completion dates in advance of the dates specified in this Contract. The City may reject the schedule and require the Contractor to furnish a schedule indicating completion by the end of the originally scheduled Contract period. The City shall not be liable for damages, loss of profit or any additional compensation as a result of such rejection.

12.3.5 Progress Review Meetings

On the date mutually agreed upon by the City and the Contractor, Schedule and a Progress Review meeting will be held, at which time the CPM schedule will be reviewed. The City, the Contractor and if necessary the appropriate subcontractors shall attend the meeting.

Schedule Monitoring and Progress Reporting: At monthly intervals, and at other times at the request of the City, the Contractor shall update the prior month's Current Schedule indicating progress during the reporting period, the latest schedule status, any approved Contract modifications and any proposed logic changes. The schedule update shall be prepared concurrently with, and be an integral part of, progress evaluation and reporting.

During the Schedule and Progressed Review meeting, the Contractor's schedule submission will be discuss and revised by the Contractor as necessary. The City may require the Contractor to modify any portions of the schedule because of "behind schedule" activities. The marked up schedule documents from this meeting will serve as the Current Schedule until the Contractor incorporates the change in the computer program and produces the updated Current Schedule. City participation in the schedule review process shall not relieve the Contractor from the Contract required milestone completion dates of the Baseline Schedule in effect.

12.3.6 Modifications To The Schedule

When requested by the SFMTA Project Manager/Representative, the Contractor shall submit supplemental schedule(s) to substantiate proposed Contract changes that may have an impact on the schedule within three (3) working days to the SFMTA's Project Manager/Representative for review and approval; otherwise, any proposed Contract change will not be considered by the City.

Modifications: Upon approval of a Contract modification by the City, the approved change will be incorporated in the Baseline Schedule during the monthly update process.

12.3.7 Scheduling Of Work

The program shall at minimum be divided into the following:

- Design Development Periods
- SFMTA Review Periods
- Prototype(s) Manufacturing and Testing
- Production Manufacturing and Testing for each coach
- Warranty Program
- Contract Deliverables (training manuals, interactive training)

The work shall be scheduled to:

- Be completed within the Contract time allowances.
- Comply with requirements of the Contract Documents.

13 DELIVERY SCHEDULE

13.1 PREFERRED DELIVERY SCHEDULE

The City's preferred delivery schedule is indicated below. Completion of items as indicated below shall occur before the time periods listed have elapsed.

Item	**Calendar Days after Notice-to-Proceed**
1) Submittal of Baseline Schedule and Management Work Plan	--30--
2) Submittal of vehicle drawings, control, Reliability Program Plan and test plans	--60--
3) Submittal of training program (including lesson plans)	90
4) Delivery of prototype coach[1]	--105--
5) Submittal of draft operations, maintenance, parts manuals, recommended spare parts	--180--
6) Approval of Prototype Coach (estimated)	--195--

Item	**Calendar Days after Approval of Prototype**
7a) Production starts	--45--
7b) Beginning of coach delivery[2]	--75--
7c) Coach delivery per month 1 month of 6 & 5 months of 10	--NA--
8) Delivery of first half of spare parts (Lot 1)	--60--
9) Delivery of second half of spare parts (Lot 2)	--120--
10) Completion of training program	600
11) Submittal of final operations, maintenance, and parts manual	--90--
12) Delivery of special tools	--60--
13) Completion of coach delivery	175

[1] Approval to deliver prototype will not be granted until after receipt and approval of all vehicle drawings, controls and test plans.

[2] Approval to deliver production vehicles will not be granted until after submittal of a satisfactory training plan; draft operations, maintenance, and parts manuals; all computer software, manuals, current FSRP's, document and demonstrate their operation and after successful completion of all appropriate tests as described in Section 12.2, TEST REQUIREMENTS of the Technical Specification.

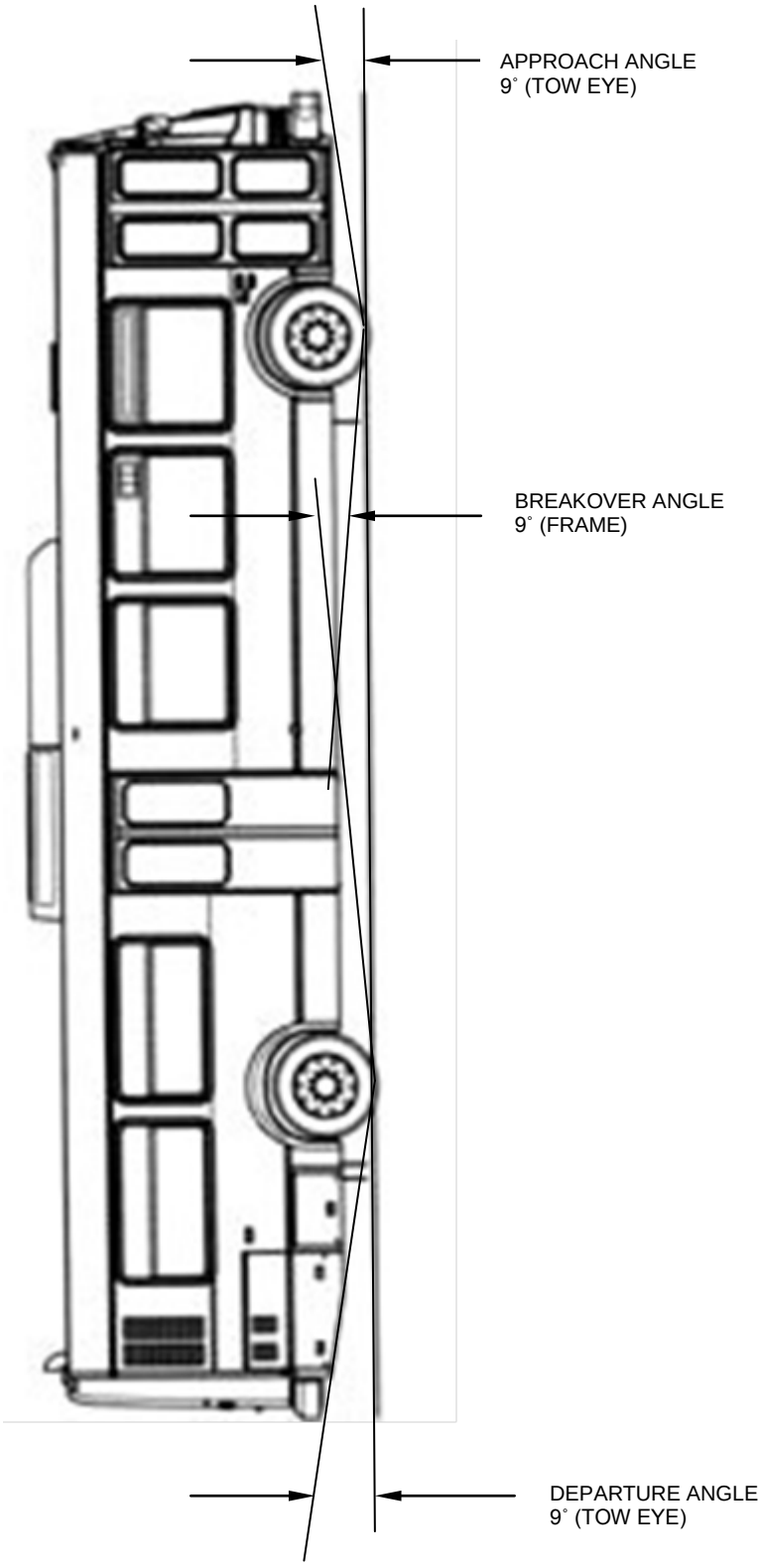
13.2 PROPOSED DELIVERY SCHEDULE

Delivery schedules proposed (See Delivery Schedule Worksheets in Volume 1, Appendix B,1C, 2C and 3C) will be compared with the City's preferred delivery schedules and the proposed delivery schedules will be rated accordingly.

13.3 COACH DELIVERY

Coaches shall be delivered at a rate not to exceed three (3) coaches for every 2 weeks.

ATTACHMENT 1: CLEARANCE



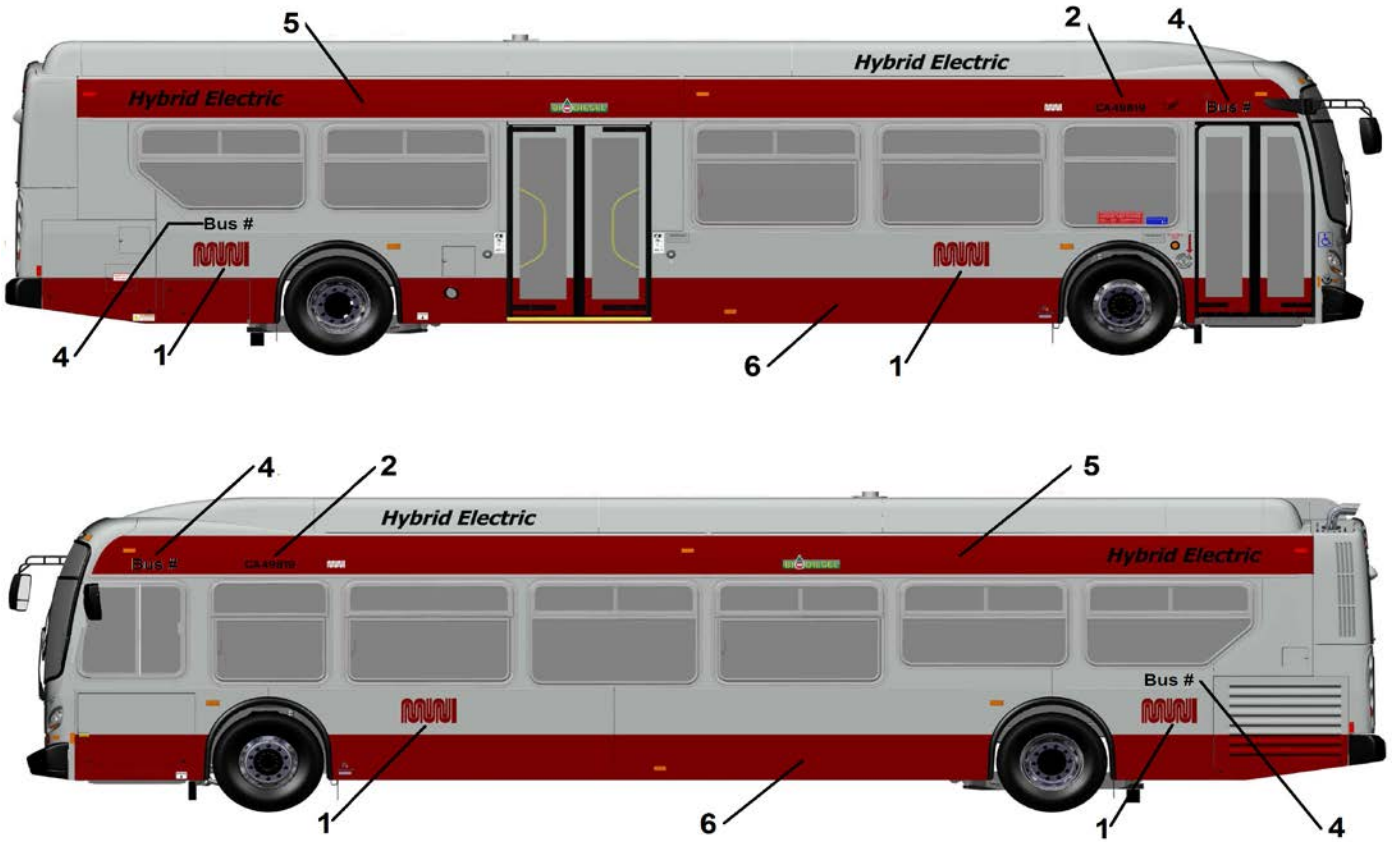
ATTACHMENT 2: DECAL LISTING

Item No.	*Description*	*Type*	*Qty*	*Color*	*Location*	*Size*
I-01	Any number of signal, service or guided dogs	Decal	1	Black/White	Above operator window	10 x 5 ¼
I-02	Caution: Door Open Inward…	Decal	2	Red/White	On each half of Exit door	13 x 5
I-03	Coach I.D No. Braille Sign - (riveted)	Decal	1	White on bk	Back of operator barrier	2 ¼ x 4
1-04	Destination route sign	Decal	1	Red on white	On front destination sign door – above operator	
i-05	Warning – Your Picture and Voice	Decal	2	White/Clear	Front Panel – Rear of Operator Barrier Panel	
I-06	Important Muni Phone Number	Decal	1	Red/Silver	Above Operator Window	
I-07	Thank You for Riding MUNI	Decal	1	Black	Front Designation Sign door Curbside	
I-08	Information Gladly Given but Safety Requires Avolding..	Decal	1	Bk/White	Back of Operator Barrier	
I-09	SFMTA Accessible Service for Information call ….	Decal	2	Bk/Blue/Wh	Near disable area	5 ¼ x 2
I-10	No Smoking, Food Radios	Decal	2	Blue/red/Wh	Front, rear above seats	12 ½ x4 ½
I-11	Please HOLD On Sudden Stops	Decal	10	Red black	On all side window sliders (forward slider)	
I-12	Please Move to the Rear (Curb-side)	Decal	4	Red/White	On all window Sliders (Aft Sliders)	
I-13	Please Move to the Rear (Street-side)	Decal	5	Red/White	On all window Sliders (Aft Sliders)	
I-14	Safety Rules – “Require Passengers to Stand ….	Decal	1	Red/White/Bk	Front of Destination Sign Access Panel	
I-15	Take One	Decal	5	White/Red	On all “Take One” boxes	
I-16	These seats must be vacated (persons in wheelchair)	Decal	2	White/Blue	Window over wheelchair accommodation area	
I-17	These seats must be vacated for (person with cane)	Decal	2	White/Blue	First passenger window over the long seats	
I-18	Vehicle No. 4”	Decal	2	White	Front and Rear on Bulkhead	
I-19	Wait for Light	Decal	1	Black/White	Above Exit Door on Header Box	
I-20	Warning, It is unlawful … (No Graffiti)	Decal	2	Red/white/bk	Rear of Coach/Front Destination Sign Door	
I-21	Watch your Step	Decal	2	Red/White/Bk		
I-22	Assault Driver	Decal	1	Red/Black	Rear Panel	
I-23	Electronic Device Prohibitive Use Warning	Decal	1	Yellow/Black	Operator Compartment Area	
I-24	Stand Behind “Yellow Line”	Decal	1	Red/Yellow	Above Rear Door	
I-25	Coach I.D Number “Plate”	Decal	1	White/Black	Behind Driver – On Barrier Panel	
I-26	Rear Door “Touch Tape”	Decal	1	Black/Yellow	Vertical Panel next to door sensor # 3 and # 4 door	1 ¾” x 39 1/8”

ATTACHMENT 2: DECAL LISTING

Item No.	Description	Type	Qty	Color	Location	Size
E-01	Arrow (Kneeling direction, black/Red	Decal	1	Red/Black	Curbside, near entry door, light indicator	9 ½ x 1
E-02	CPUC - I.D. No. CA 49819	Decal	2	Black	Both sides of coach& near the front of roof line	18 ¾ x 3 ¾
E-03	Disabled Logo	Decal	1	Blue on white	Front, curbside near headlite	6 x 6
E-04	Kneeling Bus	Decal	1	Red on White	On side of entrance door below light indicator	5 ¾ x 2 5/8
E-05	SMTA Logo (Worm) Red	Decal	4	Red	Both side of bus-above rear wheelwell, curbside front mid panel	23 ½ x 11 1/2
E-06	Please Board with Exact Fare	Decal	1	Red on Silver	On left side of entrance door below window	16 ½ x 5 1/8
E-07	Customer Using Lift	Decal	1	Blue on White	Curbside front of vehicle	3 x 7 ½
E-08	Vehicle Number 4" Series	Decal	6`	Black	C/S frt above door, front panel S/S above operator door, Rear Panel upper panel	
E-09	SFMTA Logo (Worm) 3" White	Decal	2	White on clear	Curbside and Street Center Roof Line	
E-10	Reflective Red Ruby Tape – 3M	Decal	100ft 100 ft	Red	Curbside/Street Lower Panel – Roof Line Panel – Curbside/Streetside roof line	TBD
E-11	Hybrid Electric	Decal	4	Black	C/S, S/S Rear Roof Line	
E-12	Black Reflective Tape – Rear Engine Door	Decal	1	Black	Bottom of Engine Door	
E-13	Thanks for Riding	Decal	1	Black	On Side of Entrance Door	7" circle
E-14	Warning – Your Picture and Voice	Decal	2	Black	Near Entrance/Exit Door	
E-15	WWW. SFMTA.com	Decal	2	Black	On Engine Door	
E-16	----------					
E-17	Vehicle Number- Roof – 32"	Decal	4	Black	On Roof of Vehicle	
E18	Tole	Decal	1	Red	Curbside, Front Panel	
E-19	Your Dollars at Work	Decal	1	Black	Near Entrance Door	
E-20	Bio Diesel	Decal	3	Green	Curbside roof line above exit door – Street side roof line	
E-21	SMTA Logo (Worm) Red	Decal	1	Red	Front Panel - Middle	20 x 10
E-22	SMTA Logo (Worm) Red	Decal	1	Red	Front Panel , Driver side lower corner	10 ½ x 5
E-23	All Door Boarding	Decal	2	White/Red/bk	Adjacent to All Rear Doors	4 x 8 ¼

ATTACHMENT 3: DECAL (EXTERIOR NUMBERING)



Two side views of Muni Hybrid Electric bus:

1. MUNI – 10 inch Cardinal Red Reflective
2. ICC#2 in Helvetic CA 49810
3. Bus Number 4” White
4. Bus Number 4” Black
5. Paint Strip in Cardinal Red
6. Decal, Skirt Panel in Cardinal Red

ATTACHMENT 4: SFMTA EXTERIOR COLOR SCHEME

Front View and Rear view of Muni Hybrid Electric:

1. Body Paint Color – Silver #9161 SP
2. Trim Paint Color – Cardnial Red # 916 SP
3. Skirt Decal – Cardinal Red # 916 SP

ATTACHMENT 5: MATERIALS, COLORS AND FINISHES

NOTE: 1) All brand name call-outs are understood to include the phrase, 'or approved equal';
2) Where stainless steel, aluminum or fiberglass is called for, natural finish/color is acceptable.

BUMPERS	Romeo Rim High Energy Level Polymer (HELP)
Front and Rear Bumpers	
Color:	Black (colored throughout)
Reference:	Section 2.2.11 (Bumper System)

FINISH	DuPont Imron 6000, 3.5 VOC base coat/ clear cost system PPG Delta DBHS 3.5VOC or approved equal
Coach Exterior Color	Silver # 9161 sp
Reference:	Section 2.2.6 (Finish and Color)
Coach Interior Color	Black N3472 (with flattener) For Operator area in front of Standee Line
Reference:	Section 2.3.4 (Front End)

FLOOR COVERING	Altro Transflor
Aisle floor*	Altro Transflor
Color:	D25-421 Midnight
Reference:	Section 2.4.3 (Floor Covering)

- For Arctic, front section shall be as specified, trailer shall be ribbed flooring thoughout rear area

Floor under seats	Altro Transflor
Color:	D25-421 Midnight
Reference:	Section 2.4.3 (Floor Covering)
Operator's Platform	Altro Transflor
Color:	D25-421 Midnight
Reference:	Section 4.13 (OPERATOR'S PLATFORM)
Standee line	Altro Transflor Two (2) inches wide
Color:	Yellow (colored throughout)
Reference:	Section 2.4.3 (Floor Covering)
Step Nosing	Altro Transflor Two (2) inches wide
Color:	Yellow (colored throughout)
Reference:	Section 2.5.1.1 (Step Treads)
Step Tread	Altro Transflor
Color:	D25-421 Midnight
Reference:	Section 2.5.1.1 (Step Treads)

ATTACHMENT 6: MATERIALS, COLORS AND FINISHES

Glazing	
Passenger Windows	55 percent luminous transmittance.
Reference:	Section 3.1.3.2 (Materials)
Operator's Side –Window	76 percent luminous transmittance
Reference:	Section 4.4.2 (Side Window)
Door Glass	55 percent luminous transmittance
Reference:	Section 3.2.3 (Door Glazing)
Windshield	single-density tint
Reference:	Section 4.4.1 (Windshield)

INTERIOR TRIM	Textured stainless steel or anodized aluminum
Trim moldings	
Reference:	Section 2.3 (INTERIOR TRIM, PANELING AND ACCESS)

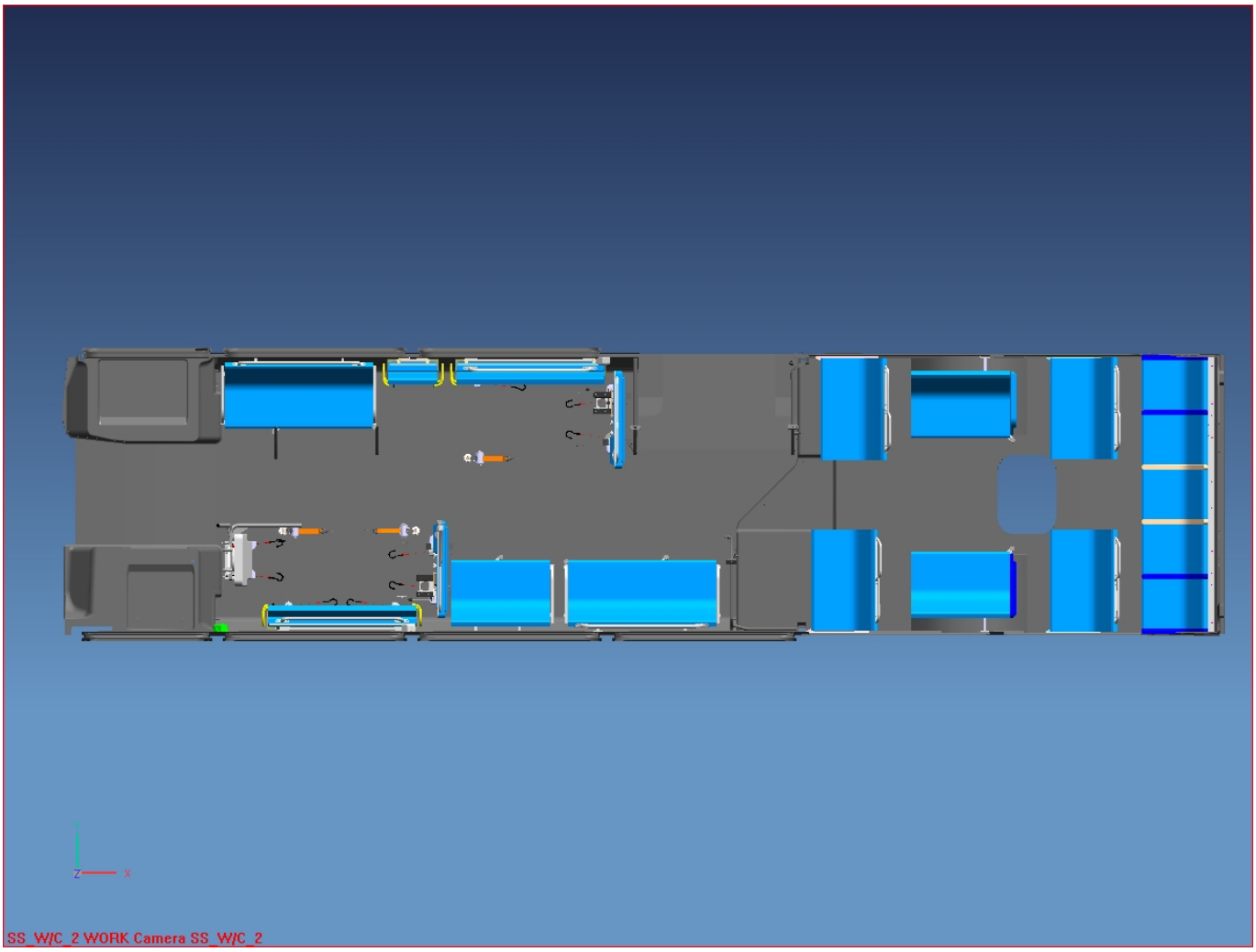
PANELING	Non-absorbing graffiti resisistant material (final colors TBD with prototype)
Divider panels	1/4 inch thick
Color:	Grey
Reference:	Section 2.3.1 (Modesty and Side Trim Panel)
Headlining	1/16 inch smooth and matte
Color:	Grey
Reference:	Section 2.3.3 (Headlining)
Operator barrier	1/10 inch thick
Color:	Grey
Reference:	Section 4.8 (OPERATOR BARRIER)
Rear Bulkhead	1/16 inch thick
Color:	Grey below the window / white above the window
Reference:	Section 2.3.2 (Rear Bulkhead)
Side Wall	1/10 inch thick
Color:	Grey
Reference:	Section 2.3.1 (Modesty and Side Trim Panel)

Passenger Seats	Fiberglass
Color:	Shell: Grey, American Seating # 980 Back and Inserts: Red, American Seating # 1781 / Blue, American Seating # 989
Reference:	Section 3.7.4 (Construction and Materials)
Seat Shell Backs	Stainless Steel (diamond pattern)
Reference:	Section 3.7.4 (Construction and Materials)
Seat Handhold	Stainless Steel
Reference:	Section 3.7.2.1 (Transverse Seat)
Stanchions/Handholds	Stainless Steel with Yellow Powder Coated
Reference:	Section 3.9 (PASSENGER ASSISTS)

Steering Wheel	Vehicle Improvement – Part # BKBL2024D4V
Horn Button	Vehicle Improvement – Part # HB9T
Color:	black
Reference:	Section 4.1.5 (Steering Wheel and Horn Button)
Wheel Housings	12-gauge or heavier stainless steel or equivalent fiberglass
Reference:	Section 2.6 (WHEEL HOUSING)
Wheels	Aluminum (Alcoa Dura-Brite)
Reference:	Section 5.9.1 (Wheels)

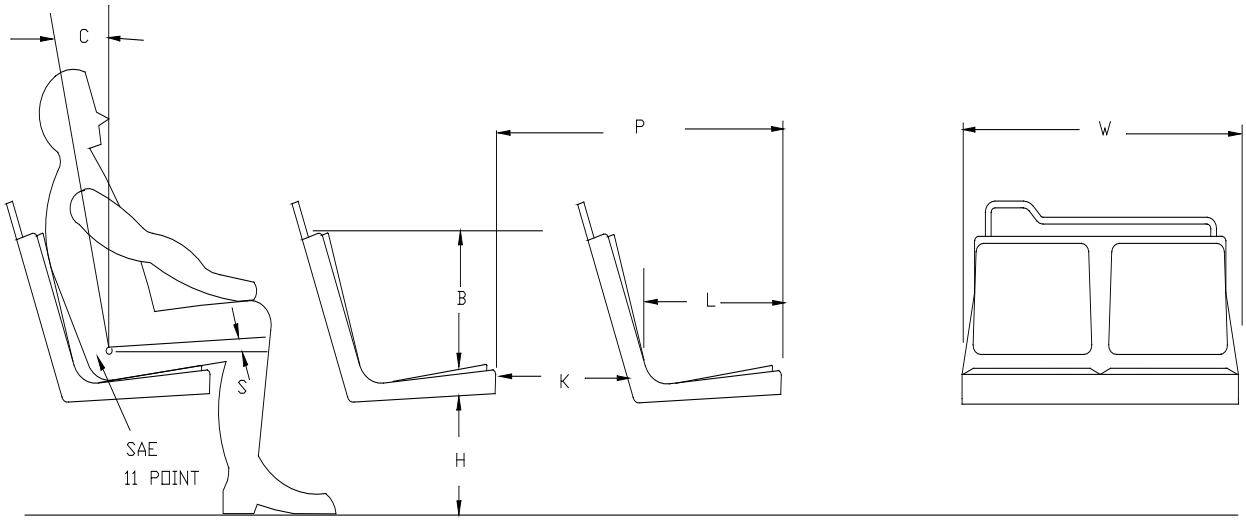
Window Sash	Clear anodized aluminum
Reference:	Section 3.1.3.2 (Materials)

ATTACHMENT 7: SFMTA TYPICAL SEATING LAYOUT



This is a picture of the typical seating layout inside the bus shown for reference only

ATTACHMENT 8: SEATING DIMENSIONS AND STANDARD CONFIGURATION



W	WIDTH	DOUBLE SEATS 35 INCHES MINIMUM SINGLE SEATS 18 INCHES MINIMUM
L	LENGTH	17 + 1 INCHES
B	BACK HEIGHT	15 INCHES MINIMUM
H	SEAT HEIGHT	TRANSVERSE SEATS 17 + 1 INCHES LONGITUDINAL SEATS 18 + 2 INCHES
S	SEAT CUSHION SLOPE	5° TO 11°
C	SEAT BACK SLOPE	8° TO 17°
K	HIP-TO-KNEE ROOM	29 INCHES MINIMUM
P	PITCH	REFERENCE ONLY

* Reference SAE Standard J826

ATTACHMENT 9: AMERICAN CONFERENCE OF GOVERNMENTAL INDUSTRIAL HYGIENIST (ACGIH)

The ACGIH is an organization devoted to the administrative and technical aspects of occupational and environmental health. The guidelines and recommendations developed by the ACGIH are intended only for use in industrial hygiene by trained professionals. The threshold value limits (TVLs) for electric and magnetic fields present either time weighted average (TWAs) or ceiling values which most workers can be repeatedly exposed without adverse health effects.

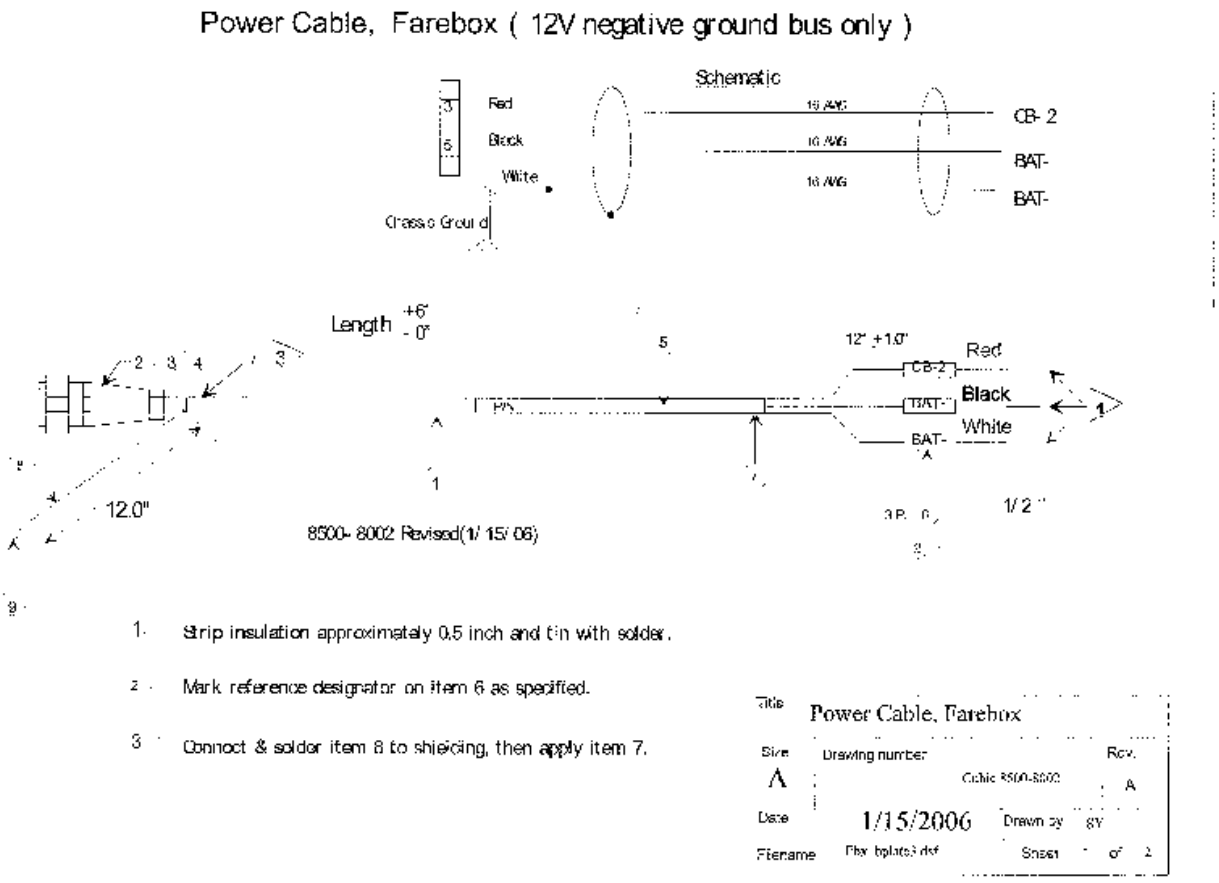
The basis for the TVLs are specific to the field type and frequency range. No specific target organs have been identified for deleterious effects due to static magnetic fields. The ceiling value has been set a level below which no deleterious effects have been demonstrated in humans or animals. The whole body TWA has been set at the level used by Lawrence Livermore National Laboratory to limit the potential in the large aorta of an adult human to 1 mV. The ceiling for pacemaker wearers is based on the observation that the reed-relay switch in pacemaker can be closed by flux densities as low as 17,000 mG, placing the pacemaker in a synchronous pacing mode. Certain implanted medical devices such as aneurysm clips may experience significant magnetic forces and torques in strong flux densities if they contain ferromagnetic materials. No basis has been given for extremity limits.

The limits for magnetic fields in the 1 Hz to 30 Hz (sub-RF) range have been set to limit the maximum induced current density within the human body to 10 mA/m^2 (rms). Other than the currently unresolved issue of risk of power frequency fields, there is no evidence of harmful effects from sub-RF magnetic fields that induce current densities in the body below 10 mA/m^2. The limits for pacemaker wearers are designed to avoid electromagnetic interference (EMI) that has been demonstrated to cause certain models to revert to an asynchronous mode or exhibit abnormal pacing characteristics at 60 Hz flux densities as low as 1,000 mG. At very low frequencies approaching DC there is concern that pacemaker reed switches may be closed by the field.

The basis for the electric field limits below 30 kHz are identical to the case of magnetic fields: maintaining induced current densities within the body below 10 mA/m^2. The limits for electromagnetic fields between 30 kHz and 3 MHz have been set to protect against shock and burn hazards. For the entire frequency range from 30 kHz to 300 GHz, the threshold limit values are intended to limit the average whole body specific absorption rate (SAR) to 0.4 W/kg. The primary concern is thermal damage.

ATTACHMENT 10: POWER CABLE, FAREBOX

The following is a blueprint showing a schematic of the farebox power cable connections.

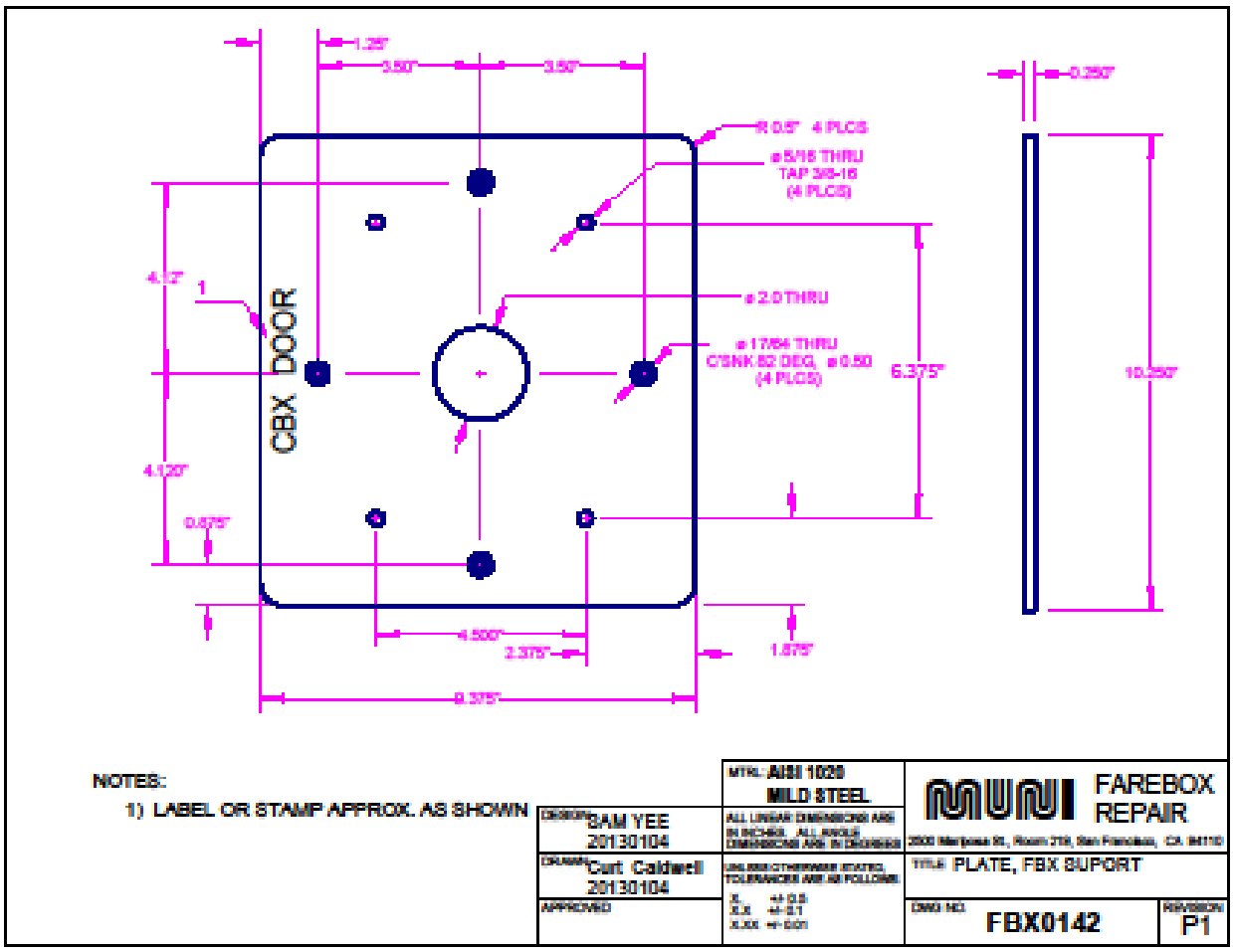


Item #	Part Number	Description	Vendor	Qty
1	8500-8033	Power Cable, Farebox	TBD	1
2	206708	Plug assembly	AMP	1
3	206966	Cable Clamp Kit	AMP	1
4	66360-3	Socket Contact	AMP	2
5	C2692	3cond 14 AWG, shielded	Carol	AR
6	FIT-221-1/2	Heat Shrink Tubing, Black	Alpha	AR
7	Sat-33-292	Marker, Cable	Brady	EA
8	C7514	Wire, 14 AWG, White	Alpha	in
9	327732	PIDG – Ring Tongue	Amp	1

ATTACHMENT 11: FAREBOX MOUNTING SUPPORT PLATE

The following is a drawing of the farebox mounting support plate indicating plate dimensions, hole locations and sizes.

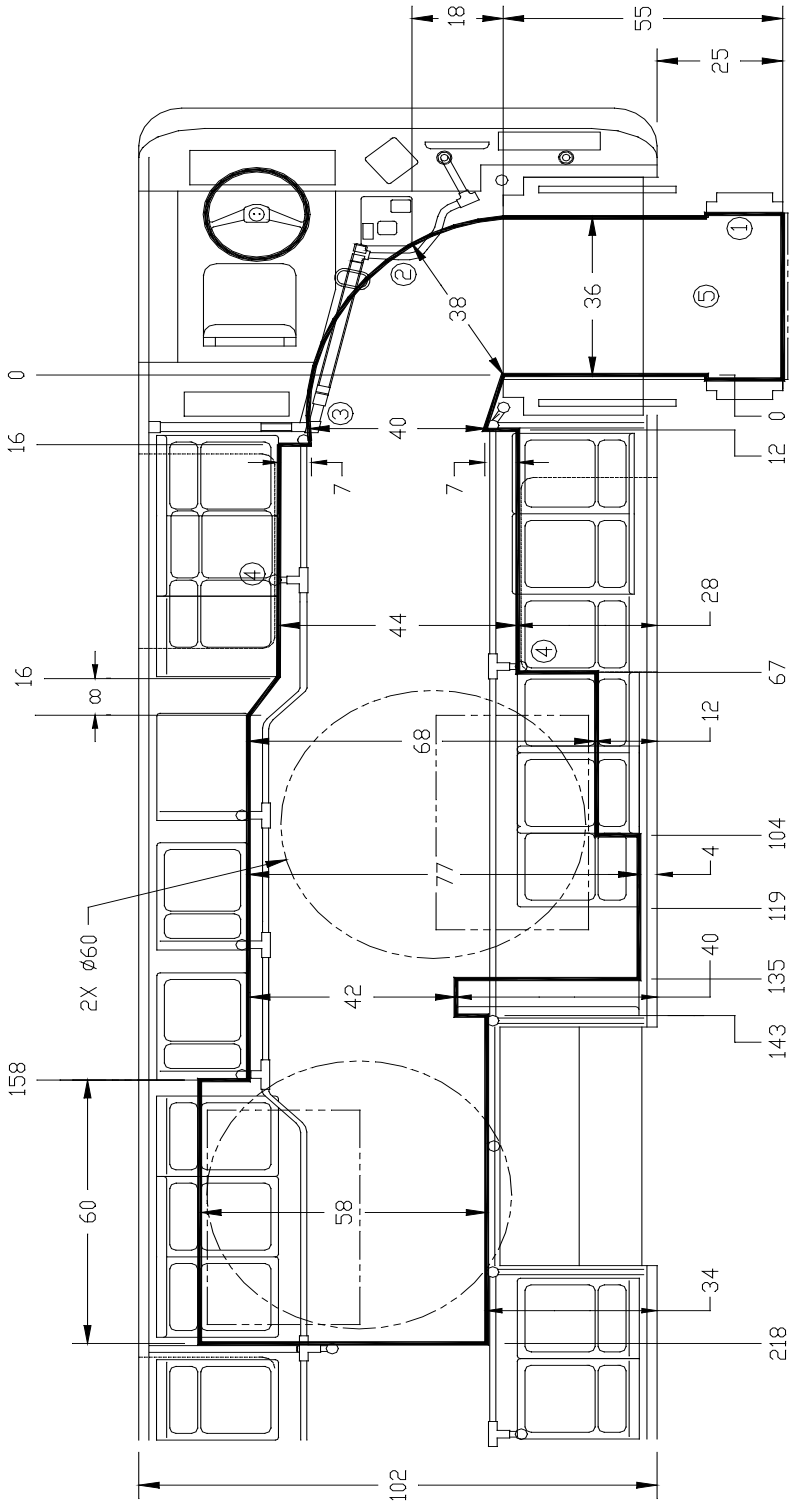
Note: The orientation of farebox equipment shall be subject to SFMTA approval



ATTACHMENT 12: WHEEL CHAIR MANEUVERING ROOM

The following is a drawing of the required wheelchair maneuvering room at the entrance of the bus and the wheelchair securement area.

For Reference Only



NOTES:

1. PLATFORM WIDTH INCREASED BY 1″.
2. HAND RAIL CLEARANCE REDUCED BY 3″ AT 35″ ABOVE THE FLOOR.
3. DRIVER'S BARRIER BAR CLEARANCE REDUCED BY 4″ AT 35″ ABOVE THE FLOOR.
4. PASSENGER VERTICAL HAND RAIL CLEARANCE REDUCED BY 1″.
5. FULLY DEPLOYED LIFT WITH 13″ BARRIER EXTENDS 25″ FROM SIDE OF BUS.
6. ALL DIMENSIONS ARE IN INCHES.

ATTACHMENT 13: SPECIAL TOOLS LIST

Special Tools List	
1	Field Tester, Electrical Assemblies (Section 1.16.2)
2	Shop Tester, Electrical Assemblies (Section 1.16.2)
3	Towing Adapter (Section 2.1.5)
4	Hoisting Adapter (Section 2.1.6)
5	Wheelchair Ramp Maintenance Controller (Section3.6.2)
6	Destination Signs - Programming package (Section 3.10)
7	Voice Annunciator - Programming Workstation, Recording Station, and Data Collection Tool Package (Section 3.11)
8	Surveillance Camera System – Viewing stations (Section 3.13.8)
9	Surveillance Camera System - Special Tools (Section 3.13)
10	Engine Diagnostic Reader and Rebuild Special Tools (Section 6.4 and Section 9.3)
11	ABS Brakes- Diagnostic Software (Section 5.3.7)
12	Fire Suppression System - Testing Kit (Section 5.11)
13	PLC System - Laptop Programmer and Maintenance Reader (Section 7.9)
14	Powerplant Dolly (Section 11.6.1)
15	Automatic Passenger Counter diagnostic tools and software required for service (Section 3.18)
16	Wireless on-board diagnostic communication sending unit, to be used for real time, off-site engineering support.
17	ToughBook computers equipped to communicate with vehicle using wireless and/or plug-in diagnostic communication links.
18	Latest Data Link Handheld diagnostic devices capable of reading propulsion system and chassis maintenance data.
19	Axle Tool Kit (Section 5.1.1)
20	Bus-mounted data recorder test, troubleshoot and repair equipment (Section 5.10)
21	Propulsion System Diagnostic and Specialty Tool Kit (Section 6.2)
22	Disc Brake Lathe and Attachment Fixture For SFMTA to service the rotors on the vehicle (Section 5.3.1)
23	Propulsion System – Generator Dolly
24	Propulsion System – Motor Dolly

ATTACHMENT 14: SFMTA PROPOSED TRAINING SCHEDULE

No.	Training Curriculum	No. of Sessions	No. of Students per Session	Total Students to be Trained	Hours per Session	Available Training Hours	Operators	Op Trainers	Street Sup	Serv/Clean	Maint Trainers	Mechanics	Foreman	Managers
1	Operator Training	8	2	16	8	128	x	x	x					
2	Daily Service Training	6	3	18	8	144				x	x		x	x
3	Propulsion System Includes	32	10	320	8	2560					x	x	x	x
	Operation													
	Diagnostic													
	Energy Maintenance and Service													
	Energy Storage Maintenance													
	Component R & R													
4	Towing	1	4	4	8	32					x	x	x	x
5a	Bus Electrical & Controls	13	10	128	8	1040					x	x	x	x
5b	IT Electrical	13	10	128	8	1040					x	x	x	x
6	Disc Brakes & Air System	20	10	192	8	1600								
7	Door System Includes	8	8	64	8	512								
	Maintenance													
	Control													
8	Wheelchair Ramp	5	8	40	8	320					x	x	x	x
9	Basic Bus Maint. & Repair	20	10	200	8	1600					x	x	x	x
	Axle and suspension													
	Steering													
	Heating and Ventilation													
	Preventive Maintenance													
10	Body Component Repair	5	10	48	8	400					x	x	x	x
Estimated Total Number of Training Hours Available						10,000								

The number of training hours shown in this table is SFMTA estimate and may vary according to the bus manufacturer.